RPS

Dunkellin River and Aggard Stream Flood Relief Scheme

Environmental Impact Statement (EIS)

Volume II Main Report

October 2014

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Dunkellin River and Aggard Stream Flood Relief Scheme

Environmental Impact Statement

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1 INTRODUCTION

RPS was commissioned by Galway County Council to prepare an Environmental Impact Statement (EIS) for the Dunkellin River and Aggard Stream Flood Relief Scheme in south County Galway (hereafter "the scheme"). The Dunkellin River and the Aggard Stream form part of the Dunkellin Drainage District which was constructed in or around 1857 and Galway County Council has a statutory maintenance responsibility for this district.

In 2010 a study on flooding on the Dunkellin River and the Aggard Stream (from Craughwell Village to Kilcolgan) was commissioned as a result of flooding that occurred in the area in November 2009. Galway County Council is now progressing the flood relief scheme to design stage and propose to submit the scheme for planning approval to An Bord Pleanála (ABP) in line with Section 175 of the Planning and Development Act 2000, as amended.

The scheme includes for flood relief works to be completed along the main channel of the Dunkellin River from Craughwell to Kilcolgan (over 11 km) and along the Aggard Stream which runs from the townland of Cregaclare (near Ardrahan) to its outfall at the confluence of the Dunkellin and Craughwell Rivers (over 7.5 km).

A combination of river widening, deepening, culvert upgrade and replacement, bridge improvement and replacement and general channel maintenance make up the proposed measures for this scheme.

The intention of the scheme is to provide optimum flood relief with minimal environmental impact whilst also controlling the overall capital investment required.

Further details on the proposed scheme are set out in **Chapter 6.**

The required environmental outputs associated with the scheme are set out in three distinct stages as follows:

Stage 1

- Environmental Constraints Study,
- Public Consultation.

Stage 2

- Environmental Assessment of Viable Options,
- Screening for Appropriate Assessment.

Stage 3

- **Environmental Impact Statement (EIS),**
- Appropriate Assessment,
- Public Consultation.

This report fulfils one required element of Stage 3 – to complete an Environmental Impact Statement for the flood relief scheme.

The Planning and Development Regulations 2001, as amended, Schedule 5 Part II, Section 10 (f) (ii) states that an EIS is required to be completed for the following:

"Canalisation and flood relief works, where the immediate contributing sub-catchment of the proposed works (i.e. the difference between the contributing catchments at the upper and lower extent of the works) would exceed 100 hectares or where more than 2 hectares of wetland would be affected or where the length of river channel on which works are proposed would be greater than 2 km".

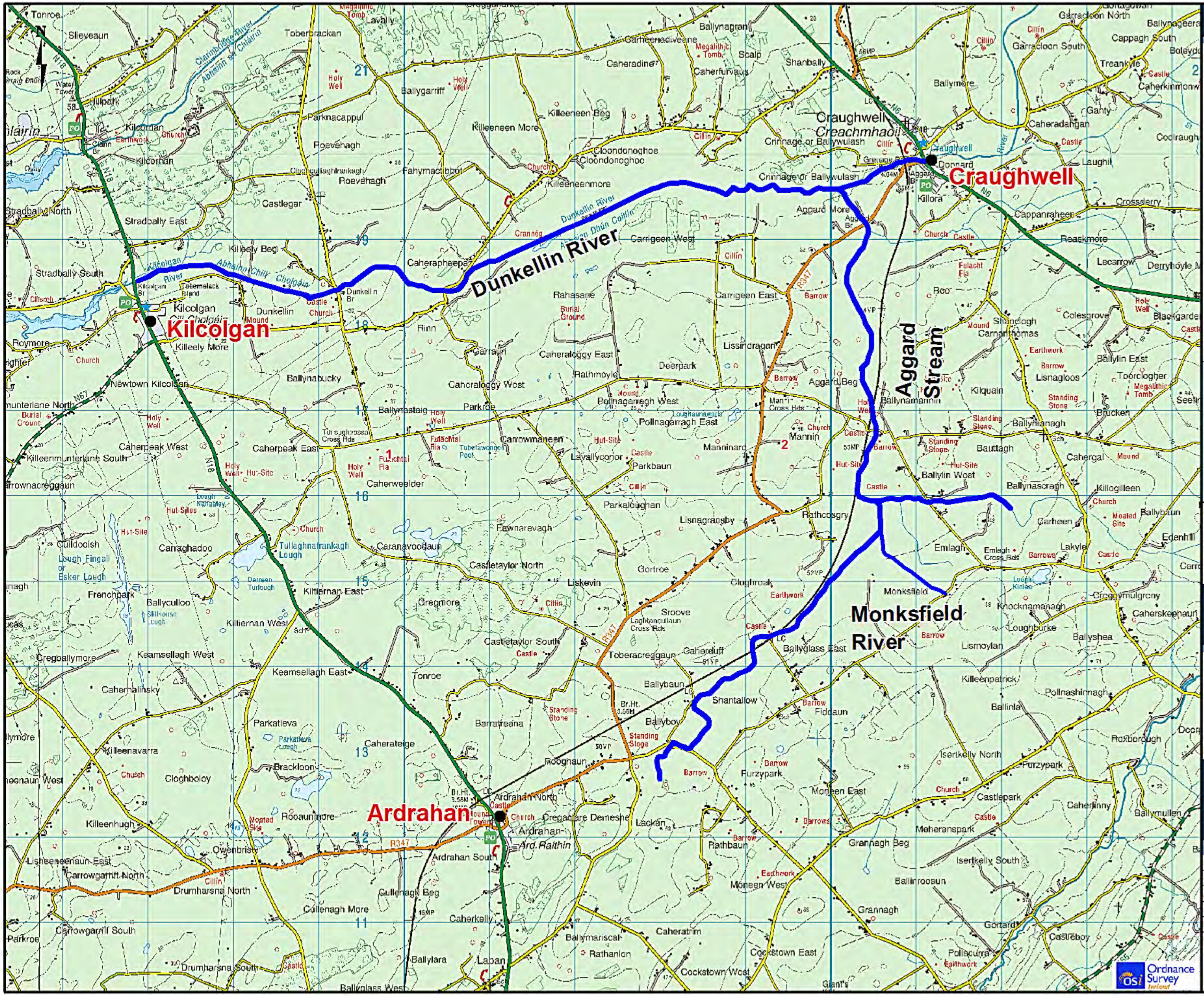
An EIS is required for the Dunkellin River and Aggard Stream Flood Relief Scheme as the length of river channel proposed for flood relief works exceeds 2 km and the immediate contributing sub-catchment exceeds 100 hectares.

Figure 1.1 shows the extent of the area proposed for the flood relief scheme.

It should be noted that in addition to the completion of an EIA an Appropriate Assessment is also being completed for this project in order to fulfil the requirements of the Habitats Directive (92/43/EEC). The Appropriate Assessment forms a separate part of this application.

It should be noted that **Appendix A** contains the scheme detail and relevant scheme drawings as generated by the scheme design consultants, Tobin Consulting Engineers in a report entitled "*Dunkellin River and Aggard Stream Flood Relief Scheme – Description of the Proposed Works*", (Tobin Consulting Engineers, September 2014). This report has been used and referenced throughout the EIS, particularly within the following chapters of this EIS:

- Section 5 – Study Area,
- Section 6 – Scheme Description,
- Section 7 – Need for the Proposed Scheme and Alternatives Considered, and
- Section 8 – Hydrology and Drainage.



Legend

Dunkellin River, Aggard Stream & Monksfield River Study Section

Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Extent of the Study Area

Figure 1.1

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Notes

1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. All levels are referred to Ordnance Datum, Malin Head.
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2 ENVIRONMENTAL IMPACT ASSESSMENT

2.1 LEGISLATIVE CONTEXT

Environmental Impact Assessment (EIA) can be described as "*the process for anticipating the effects on the environment caused by a development*". *An Environmental Impact Statement (EIS) is the document produced as a result of that process" (*EPA, 2002)[1].

The purpose of producing an EIS for the Dunkellin River and Aggard Stream Flood Relief Scheme is to identify the potential environmental impacts of the proposed flood alleviation measures and examine how these impacts can be avoided or reduced during the implementation and operation of the scheme measures.

This EIS is prepared having regard to all relevant EU Directives and national legislation including:

- The Council Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment;
- The EU Directive implemented in Ireland through S.I. No. 349 of 1989 entitled European Communities (Environmental Impact Assessment) Regulations, 1989 as amended;
- The Planning and Development Regulations, 2001, as amended;
- The Planning and Development Act 2000, as amended; and
- S.I. No. 470/2012 - European Union (Environmental Impact Assessment) (Flood Risk) Regulations 2012.

This EIS has been completed in accordance with the requirements of Article 94 of the Planning and Development Regulations 2001, as amended.

The following guidance documents were also consulted in the preparation of this EIS:

- '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, 2002.

2.2 ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

The main purpose of the EIA process is to identify the likely significant impacts on the human environment, the natural environment and on cultural heritage associated with the scheme and to determine how to eliminate or minimise such impacts. The EIS summarises the environmental information collected during the impact assessment.

Several interacting steps typify the early stages of the EIA process and include:

- Screening;
- Scoping and Consultation;
- Assessing Alternatives; and
- Assessing and Evaluating.

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[1] *Guidelines on the Information to be Contained in Environmental Impact Statements, EPA, 2002*

Screening: This stage establishes if an EIS is required. It has already been established in accordance with the Planning and Development Regulations 2001, as amended, Schedule 5 Part II, Section 10 (f) (ii) that an EIS is required to be completed.

Scoping and Consultation: This stage identifies the issues likely to be important and the likely significant impacts of the scheme through consulting with various parties. Details of the various methods of scoping and consultation completed as part of the EIA process are further set out in **Chapter 4**.

Assessing Alternatives: This stage outlines the possible alternative approaches to the project including do nothing and alternative methods of alleviating future flooding (non-structural, retention etc.). This stage of the EIA process is set out in **Chapter 7**.

Assessing and Evaluating: The central steps of the EIA process include baseline assessment (desk study and field surveys) to determine the status of the existing environment, impact prediction and evaluation, and determining appropriate mitigation measures where necessary. This stage of the EIS is presented in **Chapter 8** to **Chapter 17**.

2.3 STRUCTURE OF THIS EIS

This EIS has been prepared in the following format:

Non-Technical Summary: This document provides a summary description of the existing environment, the application process, and describes the main potential impacts associated with the scheme using non-technical terminology.

Background and Scope: This section addresses the legislative, planning and policy context of flood alleviation. Alternatives to the proposed measures are considered and the scoping and consultation process which has been undertaken is described. Finally, any technical difficulties encountered during the assessment process are detailed.

Study Area Description and Proposed Flood Relief Scheme: This section describes the study area in the context of its setting and surrounding land use. It also provides a description of the scheme detailing the individual flood alleviation measures proposed.

Environmental Impact Assessment: This section examines the individual environmental aspects of the study area as required under Article 94 of the Planning and Development Regulations 2001-2013. Each of the environmental aspects as listed below are examined in terms of the existing or baseline environment, identification of potential impacts during the implementation and operation of the scheme and where necessary mitigatory measures are identified. The interaction of the environmental aspects with each other is also examined in this section as is the cumulative impact of the scheme with surrounding land uses.

Environmental aspects considered include:

- Hydrology and drainage;
- Soils, geology and hydrogeology;
- Terrestrial ecology;
- Aquatic ecology and water quality;
- Air quality and climate;
- Noise and vibration;
- Archaeology, architectural and cultural heritage;
- Landscape and visuals;
- Human beings and material assets;

- Traffic; and
- Interaction of the foregoing.

The assessment follows the "*Grouped Format Structure"* as set out in '*Guidelines on the Information to be contained in Environmental Impact Statements',* EPA, 2002*.* This method of assessment examines each environmental topic as a separate section making reference in each section to the existing environment, the potential impacts of the scheme and proposed mitigation measures. As a result each environmental topic is presented in the following format:

- Introduction;
- Methodology;
- Existing Environment;
- Potential Impacts;
- Proposed Mitigation Measures;
- Residual Impacts; and
- Conclusions.

Summary & Conclusions: This section summarises the findings of the assessments and includes conclusions on the impacts of the scheme on the existing environment.

2.4 EIS STUDY TEAM

This EIS has been prepared by RPS on behalf of Galway County Council. Input was obtained from specialists who contributed to the EIS and are outlined in **Table 2.1.**

Table 2.1 EIS Study Team

Chapter	Topic	Specialists
	Non-Technical Summary	RPS
1	Introduction	RPS
2	Environmental Impact Assessment	RPS
3	Policy, Planning and Legislation	RPS
4	Consultation	RPS
5	Alternatives	RPS
6	Site Description	RPS/Tobin
7	Project Description	RPS/Tobin
8	Terrestrial Ecology	RPS
10	Aquatic Ecology and Water Quality	Aquatic Services Unit (ASU)
11	Hydrology and Drainage	RPS/Tobin
12	Soils, Geology and Hydrogeology	RPS
13	Air Quality And Climate	RPS
14	Noise and Vibration	RPS
15	Archaeology, Architectural and Cultural Heritage	Irish Archaeological Consultancy Services Ltd.
16	Landscape and Visuals	RPS
17	Human Beings and Material Assets	RPS
18	Traffic	RPS
19	Spoil Management	RPS
20	Indirect, Cumulative and Impact Interactions	RPS
21	Summary of Impacts and Mitigation Measures	RPS

2.5 TECHNICAL DIFFICULTIES

There were no technical difficulties encountered during the preparation of this EIS.

3 POLICY PLANNING AND LEGISLATION

This chapter of the EIS sets out current EU, national, regional and where relevant local policy and legislation relating to flood management and its place within the planning and development system and considers the scheme in the context of this policy and legislation.

3.1 EU POLICY AND LEGISLATION

In 2002 the European Commission (EC) recognised that flood events have the potential to undermine the EU's drive towards sustainable development and that the risk of flooding was on the increase. In response to severe flooding experienced along the Danube and Elbe Rivers in 2002, the Commission took the initiative to launch concerted action at Community level to help reduce the severity of flood events and the damage caused by these floods. A European Flood Action Programme resulted and in 2007 the EU Commission implemented **Directive 2007/60/EC of the European Parliament and of the Council of 23rd October 2007 on the Assessment and Management of Flood Risks or [EU Flood Directive (2007/60/EC)]**.

The overall aim of the Directive is to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. It also has the purpose of establishing a framework for the assessment and management of flood risks. The Directive has specific requirements which each Member State must implement. These include the following:

- a *Preliminary Flood Risk Assessment* (PFRA), which was to be completed by the end of 2011, that shall identify areas of potentially significant flood risk based on available or readily-derivable information;
- the production of flood hazard and risk maps for the areas identified under the PFRA, to be completed by 2013; and
- the preparation of *Flood Risk Management Plans* (FRMPs) at a catchment or river basin scale, setting out measures aimed at achieving objectives for the management of flood risks within the areas identified under the PFRA, to be completed by 2015.

The Directive requires that the above is undertaken in a coordinated manner with the implementation of **the Water Framework Directive (2000/60/EC)** to promote integrated river basin management. The Directive further requires that the active involvement of the public and stakeholders be encouraged, and that the above requirements are made readily available to the public.

3.2 NATIONAL POLICY AND LEGISLATION

In September 2004, the Irish Government approved the **Flood Policy Review- Final Report** which was published by the **Flood Policy Review Group**. It sets out the national policy on flooding as follows:

'to minimise the national level of flood risk to people, businesses, infrastructure and the environment, through the identification and management of existing, and particularly potential future, flood risks in an integrated, proactive and catchment-based manner'.

This report also presents the possible causes, extents and impacts of flooding, responsible bodies, future policy proposals and resource requirements for same. Among other things the report sets out the determining factors when considering the implementation of a flood relief scheme as follows:

"(a) the scheme must be technically feasible;

(b) the scheme must generally be cost beneficial (a cost benefit analysis is undertaken to determine the economic merits of the project); and

(c) the scheme must also be environmentally compatible (an Environmental Impact Study is normally undertaken for each scheme and the scheme must satisfy the requirements of the EIS)."

The National Development Plan (NDP) 2007-2013 further set out structural measures to be implemented in order to provide relief from flooding where such occurs, prevent the creation of new problem areas and to maintain existing defences. The plan stated that this will be achieved through structural works involving the construction of flood relief schemes which will be implemented in an environmentally friendly fashion as far as possible, taking account of the principles of the Government's **National Biodiversity Plan**.

In November 2009 the OPW in association with the Department of the Environment Heritage and Local Government (DoEHLG) published **Planning System and Flood Risk Management – Guidelines for Local Authorities**. The core objectives of these guidelines are to:

- Avoid inappropriate development in areas at risk of flooding;
- Avoid new developments increasing flood risk elsewhere, including that which may arise from surface water run-off;
- Ensure effective management of residual risks for development permitted in floodplains;
- Avoid unnecessary restriction of national, regional or local economic and social growth;
- Improve the understanding of flood risk among relevant stakeholders;
- Ensure that the requirements of EU and national law in relation to the natural environment and nature conservation are complied with at all stages of flood risk management.

The EU Flood Directive (2007/60/EC) was transposed into Irish law through the **European Communities (Assessment and Management of Flood Risks) Regulations 2010 (S.I. No. 122 of 2010).** The regulations appoint the Commissioners of Public Works in Ireland as the Competent Authority under the Directive, reinforcing the Lead Agency role the OPW was given in 2004 under the **National Flood Policy**. The regulations also identify roles for other organisations, such as the Local Authorities, Waterways Ireland and ESB, to undertake certain duties with respect to flood risk within their existing areas of responsibility.

The OPW has developed a ***Catchment Flood Risk Assessment and Management*** **(CFRAM) Programme**. This programme lies at the core of the assessment of flood risk and the long-term planning of the flood risk management measures throughout the country, including capital structural and non-structural measures. The programme delivers on core components of the National Flood Policy, adopted in 2004, and on the requirements of the EU Floods Directive.

The CFRAM Programme is being delivered through the CFRAM Studies. The CFRAM Studies are comprehensive catchment-based studies focused on *Areas of Potentially Significant Risk* (APSRs), for which detailed flood maps are produced and flood risk management measures are assessed and taken to outline design. These measures will be prioritised and set out in a *Flood Risk Management Plan* (FRMP).

The procurement process for the national programme of CFRAM Studies, has been initiated and the OPW has set out the following:

The CFRAM Programme comprises three phases:

- *The Preliminary Flood Risk Assessment (PFRA): 2011;*
- *The CFRAM Studies and parallel activities: 2011-2015; and*
- *Implementation and Review: 2016 onwards.*

The Programme provides for three main consultative stages:

- *2011 Preliminary Flood Risk Assessments;*
- *2013 Flood Hazard Mapping; and*
- *2015 Flood Risk Management Plans.*

(Source: http://www.cfram.ie/)

3.3 REGIONAL POLICY

The **Regional Planning Guidelines for the West 2012-2022** have the following policies and objectives relative to flood management works:

Policy SPP11: Development of catchment management strategies and design of flood management works will be informed by the Habitats Directive Assessment process and/or other relevant environmental assessment.

Objective SPO31: To ensure that where flood alleviation works take place the natural heritage and landscape character of rivers, streams and watercourses are protected and enhanced to the greatest extent possible, and that there are no negative impacts on the Conservation Objectives of Natura 2000 sites through Habitats Directive Assessment.

Further to this, the **Draft Regional Flood Risk Appraisal** was published in January 2010 forming part of the Draft Regional Planning Guidelines for the West Region 2010-2022. It sets out policies, objectives and monitoring for Flood Risk Management in the Western Region.

The Galway County Development Plan 2009-2015 also sets out the circumstance where development of flood relief schemes will be further considered under **Objective HL40** ....*Development proposals which include proposals for mitigation and management of flood risk will only be considered where avoidance is not possible and where development can be clearly justified with the Guidelines Justification Test".*

The draft Galway County Development Plan 2015-2021 sets out policies and objectives of the management of flooding and **Policy FL 1 – Flood Risk Management Guidelines** states that: "*It is the policy of Galway County Council to support, in co-operation with the OPW, the implementation of the EU Flood Risk Directive (2007/60/EC), the Flood Risk Regulations (SI No. 122 of 2010) and the DEHLG/OPW publication The Planning System and Flood Risk Management Guidelines (2009)".*

Table 3.1 summarises the policy and legislation presented in this section and relates it directly to the Dunkellin River and Aggard Stream Flood Relief Scheme.

Table 3.1 Policy and Legislation Relative to the Dunkellin River and Aggard Stream Flood Relief Scheme

Policy/Legislation	Requirements/Objectives	Proposed Flood Relief Scheme (the scheme)
	EU POLICY	
Directive 2007/60/EC on the Assessment and Management of Flood Risks.	• Aim is to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. • Establish a framework for the assessment and management of flood risks.	The scheme is compatible with the requirements of the Directive and with Ireland's requirement to comply with the Directive.
	NATIONAL POLICY	
Flood Policy Review Group in 2004 - Flood Policy Review-Final Report.	National Policy on flooding: 'to minimise the national level of flood risk to people, businesses, infrastructure and the environment, through the identification and management of existing, and particularly potential future, flood risks in an integrated, proactive and catchment-based manner'. In determining if a flood relief scheme is to be implemented the regard must be had to the following broad criteria: (a) the scheme must be technically feasible; (b) the scheme must generally be cost beneficial (a cost benefit analysis is undertaken to determine the economic merits of the project); and (c) the scheme must also be environmentally compatible (an Environmental Impact Study is normally undertaken for each scheme and the scheme must satisfy the requirements of the EIS).	The scheme is compatible with the requirements of the National Policy.
The National Development Plan (NDP) 2007-2013.	Structural Measures to be implemented in order to: (a) Provide relieve from flooding where such occurs; (b) Prevent the creation of new problem areas; and (c) Maintain existing defences. This will be achieved through structural works involving the construction of Flood Relief Schemes. All these schemes will be implemented in an environmentally friendly fashion as far as possible, taking account of the principles of the Government's National Biodiversity Plan.	The scheme is compatible with the requirement of the Strategy.

Policy/Legislation	Requirements/Objectives	Proposed Flood Relief Scheme (the scheme)
Planning System and Flood Risk Management – Guidelines for Local Authorities, 2009.	The core objectives of the Guidelines are to: • Avoid inappropriate development in areas at risk of flooding; • Avoid new developments increasing flood risk elsewhere, including that which may arise from surface water run-off; • Ensure effective management of residual risks for development permitted in floodplains; • Avoid unnecessary restriction of national, regional or local economic and social growth; • Improve the understanding of flood risk among relevant stakeholders; • Ensure that the requirements of EU and national law in relation to the natural environment and nature conservation are complied with at all stages of flood risk management.	The scheme will take full consideration of these Guidelines through proper design, layout and environmental assessment.
European Communities (Assessment and Management of Flood Risks) Regulations 2010 (S.I. No. 122 of 2010).	Integrates and enforces the (EU Flood Directive) (2007/60/EC) into Irish legislation.	The scheme is compatible with the requirements of the Regulations.
Catchment Flood Risk Assessment and Management (CFRAM) Programme.	The Programme delivers on core components of the National Flood Policy, adopted in 2004, and on the requirements of the EU Floods Directive.	The scheme will take the CFRAM Programme into consideration in its implementation.
	REGIONAL POLICY	
Regional Planning Guidelines for the West 2012-2022.	**Policy SPP11:** Development of catchment management strategies and design of flood management works will be informed by the Habitats Directive Assessment process and/or other relevant environmental assessment. **Objective SPO31:** To ensure that where flood alleviation works take place the natural heritage and landscape character of rivers, streams and watercourses are protected and enhanced to the greatest extent possible, and that there are no negative impacts on the Conservation Objectives of Natura 2000 sites through Habitats Directive Assessment.	The scheme is compatible with the requirement of these Guidelines.

Policy/Legislation	Requirements/Objectives	Proposed Flood Relief Scheme (the scheme)
Draft Regional Flood Risk Appraisal.	Sets out policies, objectives and monitoring for Flood Risk Management in the Western Region.	The scheme is compatible with the requirement of the Appraisal.
The Galway County Development Plan 2009-2015.	**Objective HL40:** ....Development proposals which include proposals for mitigation and management of flood risk will only be considered where avoidance is not possible and where development can be clearly justified with the Guidelines Justification Test".	The scheme is compatible with the Policies and Objectives of the plan.
The Draft Galway County Development Plan 2015-2021.	**Policy FL 1 – Flood Risk Management Guidelines**.... "It is the policy of Galway County Council to support, in co-operation with the OPW, the implementation of the EU Flood Risk Directive (2007/60/EC), the Flood Risk Regulations (SI No. 122 of 2010) and the DEHLG/OPW publication The Planning System and Flood Risk Management Guidelines (2009)".	The scheme is compatible with the Policies and Objectives of the plan.

4 SCOPING AND CONSULTATION

This Section describes the consultation carried out in relation to the Environmental Impact Statement (EIS) and the Dunkellin River and Aggard Stream Flood Relief Scheme and outlines the key issues raised by stakeholders, both statutory and non statutory (including the general public). Consultation forms an essential part of the EIA process. In this case, the early involvement of stakeholders has helped to ensure that the views of various groups or individuals were taken into consideration from the constraints stage through selecting a preferred viable flood relief scheme and to the preparation of this EIS.

Consultation was carried out through written communication, holding public information events and meeting with statutory authorities and interested parties throughout the course of the EIS process. These are further outlined in the following sections.

4.1 WRITTEN CONSULTATION

In March 2011, when the environmental assessment work was being commenced, a letter was issued to twenty-nine statutory and non-statutory stakeholders informing them of the commencement of the environmental assessment of the proposed flood relief scheme. The letter set out a brief background to the scheme and the environmental steps that would be completed during the planning process. The correspondence further invited stakeholders for comment on what should be included in the scope of this environmental work. **Figure 4.1** shows an example scoping letter issued and **Table 4.1** sets out the stakeholders that were consulted and the responses received.

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4th May 2011

Our Ref: MGE0260LT0034
File Ref: MGE0260 - 360

Re: Scoping of Environmental Assessment for the proposed Dunkellin River and Aggard Stream Flood Relief Scheme, Co. Galway.

Dear Sir/Madam,

I am writing to you to inform you that RPS has been appointed by Galway County Council in conjunction with the Office of Public Works (OPW) to provide the environmental consultancy services associated the above mentioned scheme.

The extent of the Dunkellin River catchment is shown in **Figure 1**. The Craughwell River and Dunkellin River, together with the Aggard Stream to the south of Craughwell, form part of the Dunkellin Drainage District, where the length of the main channel within this district from its source to its estuary, is approximately 45km, encompassing a total catchment area of approximately 373km^2.

The extent of the flood relief scheme and the resulting study area within this catchment is highlighted in bold in **Figure 1** and is divided into two distinct channels as follows:

- the **Dunkellin/Craughwell River** from approximately 200m upstream of Craughwell Village, through the Rahasane Turlough cSAC, to the sea at Kilcolgan, and
- the **Aggard Stream and Monksfield River** from the townland of Cregaclare (near Ardrahan) to its outfall at the confluence of the Dunkellin and Craughwell Rivers.

Figure 1 Dunkellin River and Aggard Stream Catchment

RPS

The subject area is within a catchment containing several environmental designations (Natura 2000 Sites) and as a result an Appropriate Assessment may be required to be completed in order to comply with the Habitats Directives (92/43/EEC). A summary detail of these sites is attached to this correspondence.

Historically flooding has been a feature of the study area and in more recent time the most notable flood events to occur were in January of 2005 and November of 2009.

As a result of these events, Galway County Council in conjunction with the OPW commissioned a Study to identify practical measures to address flooding on the Dunkellin River including the Aggard Stream. This report was published in June 2010 and is available to view at: http://www.opw.ie/en/FloodRiskManagement/Publications/#d.en.13741.

The study recommends that 11 no. possible flood alleviation measures that should be considered. The project is now being progressed to the preferred options, design and planning stages. The following environmental stages form an integral part of this process:

Stage 1

- Environmental Constraints Report
- Screening for Appropriate Assessment

Stage 2

- Environmental Assessment of Viable Options
- Appropriate Assessment (if deemed necessary as a result of the Appropriate Assessment Screening).

Stage 3

- Environmental Impact Assessment (EIA)

RPS has commenced Stage 1 of this process – Environmental Constraints Report and Screening for Appropriate Assessment.

If you would like to make a comment regarding Stage 1 of the scheme, please forward your correspondence to the undersigned at your earliest convenience. It is our intention to consult with you again as the project progresses.

Please contact the undersigned directly if you have any queries in relation to the proposed scheme.

I trust this is satisfactory and I look forward to hearing from you.

Yours faithfully,

Maeve Walsh

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Senior Scientist,
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Galway.
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Figure 4.1 Example Scoping Letter Issued to Stakeholders

Table 4.1 Key Issues Raised by Stakeholders on the Dunkellin River and Aggard Stream Flood Relief Scheme

Body Issued Notice by RPS (by letter on 29.03.11)	Date and nature of Response	Comments
Teagasc	E-mail on 04.04.11	Confirmed will not be making a submission.
Department of Agriculture, Fisheries and Food	E-mail on 06.04.11	No comment to make at this stage of the process.
Geological Survey of Ireland	E-mail on 08.04.11	Acknowledgement of letter.
Development Applications Unit	E-Mail in 11.04.11	Acknowledgement of letter – Issued to relevant divisional ecologist of NPWS.
Clarinbridge Oyster Co-Op Society Ltd	Letter on the 18.04.11	• Proposed flood relief scheme has the potential to wipe out the oyster and shellfish industry in Dunbuleaun Bay considering past events in 1990s when drainage of Rahasane Turlough killed most of the native oysters. • Flooding measures proposed may not remedy the existing flooding - possible that at high tide flooding will still occur and will be more detrimental once widening and deepening of the river has taken place. • Landowners from the upper Dunkellin catchment believe that a combination of lack of regular maintenance of existing drainage channels and landowners practices of erecting fences in dry river bed and leaving dams in streams over winter was exacerbating the flooding issue.
Inland Fisheries Ireland	Letter on 19.04.11	• Use of Environmental River Enhancement Programme methods – riparian and instream environment to be protected and where possible enhanced. • Angling amenity of the Dunkellin from Kilcolgan Bridge to Kileely Bridge to be enhanced (645 yards of the north bank at Stradbally East). • Replace existing culvert at Croomacrin/ Knocknaboley, New Inn with box culvert. • Normal constraints should apply regarding timing of works. • Minimise sediment transport which could affect oyster fisheries downstream.

Body Issued Notice by RPS (by letter on 29.03.11)	Date and nature of Response	Comments
National Roads Authority	Letter on 20.05.11	• Any proposed works to bridge structures requires consultation with NRA Structures Unit and LA.Prior to preparation of EIS consultation should be had with relevant Council in conjunction with the NRA. • Consult with Tony Collins Galway County Council NRDO regarding the proposed N18/N17 Scheme traversing study area. • Assess visual impacts from existing national roads. • Have regard for ABP conditions on road schemes in area, i.e. cumulative impacts. • Have regard for Manual of Contract Documents for Road Works. • Have regard for construction guidelines including Air Quality, Noise Regulations, etc. • A traffic and transport assessment should be carried out. • Designers are asked to consult with NRA regarding road safety audit. • Proposals for crossing national roads/motorways must be identified to allow the NRA to review and comment etc.
Bord Iascaigh Mhara (BIM)	Letter on 28.04.11	• South east Galway Bay is an important area for shellfish aquaculture, providing employment and revenue for the region. • Alteration of the drainage pattern within the lower catchment of the river system in question may have adverse effect on shellfish in the are due to lowering of salinity levels and increase in suspended solids.
An Taisce	No Response to Date	
Birdwatch Ireland		
Bat Conservation Ireland		
Fáilte Ireland - West		

Body Issued Notice by RPS (by letter on 29.03.11)	Date and nature of Response	Comments
Western River Basin District Project Office	No Response to Date	
Heritage Officer, Galway Co Co		
Environment Department, Galway Co Co		
Water Services Unit, Galway Co Co		
Planning Department, Galway Co Co		
Galway County Development Board		
Roads & Transportation Unit, Galway Co Co		
EPA Headquarters		
Irish Farmers Association (Galway Branch)		
The Marine Institute		
IFA Aquaculture		
Irish Shellfish Association		
Galway Rural Development Company Ltd		
Western Development Commission		
Galway Archaeological and Historical Society		
Irish Rail		
National Roads Authority		

4.2 PUBLIC/STAKEHOLDER CONSULTATION

Two public information evenings were held during the course of preparing the environmental reports for the scheme. The purpose of these events was to inform stakeholders and the general public of the progress and details of the scheme and to provide an opportunity to offer their views. Details on each of these information evenings are set out below.

4.2.1 Public Information Evening No. 1

A public information evening was arranged on the 17th May 2011 from 4pm to 7pm at St. Michael's Community Centre in Craughwell, Co. Galway.

The event was advertised in the Connacht Tribune Newspaper (13th May) and the Galway Advertiser Newspapers (12th May). Copies of the public notice are shown in **Figure 4.2** and **Figure 4.3**. In addition the notice was announced on Galway Bay FM Radio from the 10th May 2011 to the 17th May 2011 inclusive several times throughout each day.

The format of the event was centred on the presentation of two separate information boards, one detailing the design and engineering aspects of the scheme and the other detailing the environmental constraints associated with the scheme. (Refer to **Image 4.1** and **Image 4. 2**).

Attendees were requested to fill out an attendance log and were invited to fill out a comments sheet setting out their views and concerns regarding the scheme. Representatives from RPS and the project design consultants were present for the duration of the event to explain and discuss the environmental and engineering elements of the scheme respectively. Representatives from Galway County Council and the OPW also attended the event.

GALWAY COUNTY COUNCIL
Public Information Notice

Environmental Constraints and Assessment of the Dunkellin River and Aggard Stream Flood Relief Scheme

PUBLIC INFORMATION EVENING

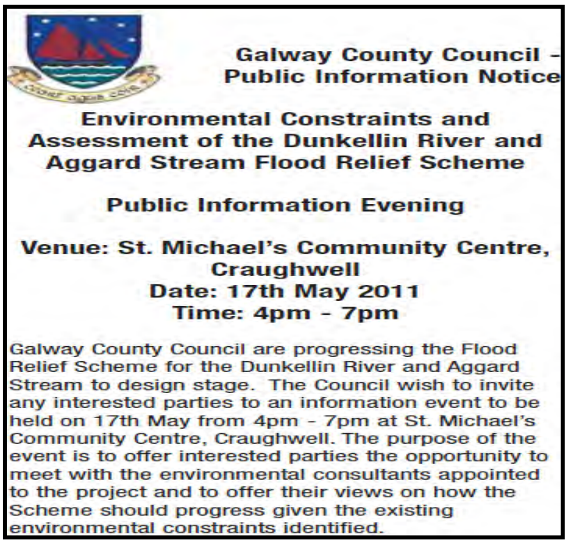
VENUE: St. Michael's Community Centre, Craughwell
DATE: 17th May 2011
TIME: 4pm - 7pm

Galway County Council are progressing the Flood Relief Scheme for the Dunkellin River and Aggard Stream to design stage. The Council wish to invite any interested parties to an information event to be held on 17th May from 4pm - 7pm at St. Michael's Community Centre, Craughwell.

The purpose of the event is to offer interested parties the opportunity to meet with the environmental consultants appointed to the project and to offer their views on how the Scheme should progress given the existing environmental constraints identified.

Figure 4.3 Public Information Notice Galway Advertiser 12th May 2011

Figure 4.2 Public Information Notice Connacht Tribune 13th May 2011



Galway County Council – Public Information Notice

Environmental Constraints and Assessment of the Dunkellin River and Aggard Stream Flood Relief Scheme

Public Information Evening

Venue: St. Michael's Community Centre, Craughwell
Date: 17th May 2011
Time: 4pm - 7pm

Galway County Council are progressing the Flood Relief Scheme for the Dunkellin River and Aggard Stream to design stage. The Council wish to invite any interested parties to an information event to be held on 17th May from 4pm - 7pm at St. Michael's Community Centre, Craughwell. The purpose of the event is to offer interested parties the opportunity to meet with the environmental consultants appointed to the project and to offer their views on how the Scheme should progress given the existing environmental constraints identified.

Image 4.1 Public Consultation Evening No. 1 – Craughwell Community Centre

Image 4.2 Public Consultation Evening No. 1 - 17th May 2011

A total of 37 people signed the attendance log. However it was noted that not every attendee signed in and it is estimated that a total of 45 to 50 people attended the information evening. Eleven comment sheets were filled out and returned on the evening. Some attendees took comment sheets away to return to RPS at a later date. RPS did not receive any further comment sheets from attendees.

The feedback that resulted from the event was obtained through a combination of noted discussions and analysis of written comments received on the evening.

The following are a summary of the issues raised regarding the scheme:

- Concern that if the proposed measures are implemented, the biological communities (including oyster and mussel production areas) in the receiving bay will be threatened;
- Salinity will be reduced in the bay in the event of extreme rainfall as a result of freshwater being discharged at a faster rate. This has the potential to harm the shellfish in the bay and to cause losses in oyster and mussel production areas, particularly of juveniles;
- The improved channel will increase the risk of microbiological contamination as a result of faster flow from Craughwell wastewater treatement plant (WWTP) and Loughrea WWTP;
- A cost benefit analysis should be carried out regarding the impact on shellfish waters, both at a local level and with regard to this areas overall drainage plans;
- Measures should be put in place to retain the water upstream and to control the water downstream;

- The measures should be considered in association with other drainage works (either new or maintenance) in this area, especially where these may affect other inputs into this designated shellfish water;
- The assessment should include consideration of future changes such as worst case climate change predictions and other development plans in the area;
- The overall Environmental Impact Assessment and Planning Application process for the project should not be rushed;
- If measures are implemented there is the possibility that once the increased flows reach Rahasane in times of flood it could spread to Kileenea and Carrigan before it ever reaches Rinn. This could impact on geese and ducks nesting in these areas;
- Widening the river channel may allow the influence of tidal waters to occur further upstream in times of high tide with potential impacts on the wildlife of Rahasane Turlough;
- The process of completing the Environmental Impact Assessment and obtaining planning permission through An Bord Pleanála is much too lengthy and needs to be fast tracked to ensure works are carried out as soon as possible;
- Immediate cleaning and maintenance works, e.g. channel cleaning, would alleviate a certain amount of flooding while the more long term measures are being approved;
- The Dunkellin River should be regularly cleaned upstream of Craughwell if the works are not proposed upstream of Craughwell (Rathgorgan, Athenry);
- Since the construction of the M6, flooding at Kiltulla, Athenry has been more frequent. If the river was cleaned this would help the situation;
- The water in the channel at Rahasane Turlough needs to be able to get away at a faster rate than it currently does to prevent flooding in this area; and
- The proposed works from Rahasane Turlough to Kilcologan should be carried out simultaneously with the proposed works on the Aggard Stream and at Craughwell to ensure flooding does not occur in new areas.

It should be noted that the majority of the concerns raised at the Public Information Evening No. 1 related to design issues associated with the scheme. These issues were brought to the attention of the project design consultants for their consideration.

4.2.2 Public Information Evening No. 2

A second public information evening was arranged on the 15th July 2014 from 4pm to 7pm at St. Michael's Community Centre in Craughwell, Co. Galway.

The event was advertised in the Connacht Tribune Newspaper (11th July) and the Galway Advertiser Newspapers (10th July). Copies of the public notice are shown in **Figure 4.4** and **Figure 4.5**. In addition the notice was announced on Galway Bay FM Radio from the 10th July 2011 to the 14th July 2014.

The purpose of this event was to display the final proposed flood relief measures, the findings of the environmental assessments and to inform people of the planning process through An Bord Pleanála including time lines opportunity to make submissions etc.

Attendees were requested to fill out an attendance log and were invited to fill out a comments sheet setting out their views and concerns regarding the Scheme. Representatives from RPS, the project design consultants, the OPW and Galway County Council were present for the duration of the event to explain and discuss the environmental and engineering elements of the Scheme respectively.

Figure 4.5 Public Information Notice Galway Advertiser 10th July 2014

Figure 4.4 Public Information Notice Connacht Tribune 11th July 2014

A total of 46 people signed the attendance log. However it was noted that not every attendee signed in and it is estimated that a total of 55 to 60 people attended the information evening. Seven comment sheets were filled out and returned on the evening.

The feedback that resulted from the event was obtained through a combination of noted discussions and analysis of written comments received on the evening.

The following are a summary of the issues raised regarding the scheme:

- Concern that if the proposed measures are implemented, the biological communities (including oyster and mussel production areas) in the receiving bay will be threatened;
- Salinity will be reduced in the bay in the event of extreme rainfall as a result of freshwater being discharged at a fast rate. This has the potential to harm the shellfish in the bay and to cause losses in oyster and mussel production areas, particularly of juveniles;
- Measures including cleaning of swallow holes, removal of instream boulders and sheet rock etc. should be completed in the Cregaclare/Aggard area over and above the proposed measures of the scheme;
- Maintenance measures should be considered for smaller schemes of three to four households which are currently not considered under the proposed scheme, e.g. Ballynaharna.

- Deepening of the Cregaclare Stream should be carried out in order to alleviate flooding at Ballyboy Ardrahan area;

- Request that a derogation from European law should be given which currently seems to be impeding any work on the turlough. Maintenance of the main channel in a reasonable condition to take normal flow of water should be allowed;

- Access to house insurance for individual residents currently being affected by flooding in the area should be given consideration under an appropriate arm of the State; and

- Concern about the amount of material that will be coming off-site from the scheme, where the material will be used and if material will be taken from both sides of the river. Will the long term loss of farming on the northern bank be compensated for?

It should be noted that the majority of concerns raised at the information evening related to smaller schemes in the region not benefiting from the scheme and in some cases that additional flooding of the attendee's lands and properties could result from the proposed scheme measures.

4.3 OTHER CONSULTATIONS

A number of meetings took place with Galway County Council, the OPW, the design engineers, the environmental consultants and various statutory bodies and interested parties. Details of these meetings are set out below.

4.3.1 Meeting with National Parks and Wildlife Service (NPWS)

A meeting took place in Galway County Buildings on the 16th September 2011 with the National Parks and Wildlife (NPWS). The following people were in attendance:

- OPW – Richard Dooley, Paul Costello;

- Galway County Council – Frank Gilmore, Liam Gavin and Sean Langan;

- NPWS – Julie Fossit and Enda Mooney; and

- RPS – Paula Kearney, PJ Griffin, Willie Madden and Dr. Bernadette Ni Chatháin.

The purpose of the meeting was to discuss the scheme, the proposed scope of environmental and more specifically ecological work associated with it, and timescales for completion. It was agreed at this meeting that a proposed scope of the Natura Impact Statement (NIS) and required surveys for inclusion in the EIS would be issued by RPS to the NPWS for their consideration. This scope was subsequently issued to the NPWS on the 26th September 2011.

4.3.2 Meeting with Bord Iascaigh Mhara (BIM) and the Clarinbridge Oyster Co-Operative

A meeting took place in Galway County Buildings on the 6th March 2012 with Bord Iascaigh Mhara (BIM) and the Clarinbridge Oyster Co-Operative. The following people were in attendance:

- Galway County Council - Frank Gilmore, Liam Gavin and Sean Langan;

- BIM - Peter Donlon;

- Clarinbridge Oyster Co-Operative - Mary Mullins, Michael Egan and Noel Bannon;

- RPS - Willie Madden and James Massey; and

- Tobin - Michael McDonnell.

The purpose of the meeting was to present and discuss the scheme, the hydraulic modelling of the river channel and freshwater discharge in a flood event similar to 2009 with predicted changes, hydraulic modelling of the inner bay with regard to salinity levels, independent expert opinion from NUI, Galway and the overall benefits of the proposed scheme.

4.3.3 Second Meeting with National Parks and Wildlife Service (NPWS)

A second meeting took place with the National Parks and Wildlife (NPWS) in Galway County Buildings on the 17th October 2012. The following people were in attendance:

- OPW - Richard Dooley and Shane O'Flaherty;
- Galway County Council - Frank Gilmore and Liam Gavin;
- NPWS - Julie Fossit and Jim Ryan;
- Consultant Ecologist - Roger Goodwillie;
- RPS - Paula Kearney, Willie Madden and Maeve Walsh;
- Tobin - Michael McDonnell.

The purpose of this meeting was to set out the objectives of the scheme, discuss the potential impacts on Rahasane Turlough and to agree on the information that should be issued to the NPWS relating to the scheme.

Further to this meeting the NPWS stated that they would further consult on the project when asked to do so by An Bord Pleanála during the statutory consent process.

4.4 ONGOING/STATUTORY CONSULTATION

The proposed Flood Relief Scheme has been submitted by Galway County Council to An Bord Pleanála for planning permission under the Planning and Development Act 2001, as amended.

This EIS accompanies the application to the Board in accordance with Section 175 of the Planning and Development Act 2000, as amended. (*Environmental impact assessment of certain development carried out by or on behalf of local authorities*). Section 175 of the Act sets out specific requirements in terms of public consultation and Galway County Council has completed the following in order to fulfil the requirements of the legislation:

- Published a notice in a newspaper circulating in the region of the proposed Flood Relief Scheme (i.e. Galway) that it intends to apply to the Board for permission to develop the Scheme and that the application is accompanied by an EIS;
- Made the application and EIS available for a period of six weeks at the offices of Galway County Council and the public are invited to make submissions to the Board in relation to the EIS; and
- Forwarded a copy of the application and EIS to the prescribed bodies (i.e. as set out in Articles 121 of the Planning and Development Regulations 2001-2013 as amended by Article 29 of the Planning and Development Regulations 2006).

Table 4.2 summarises the various type of consultation that were undertaken throughout the course of completing the EIS for the Dunkellin River and Aggard Stream Flood Relief Scheme.

Table 4.2 Summary of Consultation Associated with the EIS for the Dunkellin River and Aggard Stream Flood Relief Scheme.

Consultation Method	Details	Comments/Findings
Written Consultation	EIS Scoping letter issued to 29 stakeholders, 29th March 2011.	Response received from eight Stakeholders.
Public Consultation	Public Information Evening in Craughwell, 17th May 2011. Public Information Evening in Craughwell, 15th July 2014.	45 to 50 people attended. 55 to 60 people attended.
Other Consultation	• Meeting with NPWS, 16th September. • Meeting with BIM and Clarinbridge Oyster C-Operative, 6th March 2012. • Meeting with NPWS, 17th October 2012.	• Agreed scope of surveys required for a Natura Impact Statement (NIS). • Set out the details of the scheme, outcome of salinity levels and external expert opinion. • Agree on the information that should be issued to the NPWS relating to the scheme. Note: Further to this meeting the NPWS stated that they would further consult on the project when asked to do so by An Bord Pleanála during the statutory consent process.
Statutory Consultation	Comply with the requirements of Section 175 of the Planning and Development Act 2000, as amended.	Galway County Council have: • Published a public notice. • Made the EIS planning and application available for public viewing. • Forwarded copies of the EIS and the application to the prescribed bodies.

5 STUDY AREA

The Dunkellin River has a total catchment area of 373 km^2 with a high density of tributary streams in the east, forming a main channel east of Craughwell Village. It flows west for approximately 11 km from Craughwell and discharges to Dunbulcaun Bay at Roevehagh just north of Kilcolgan Village. The Aggard Stream and the Monksfield River flow from the south for approximately 7 km where they join the Dunkellin River 1 km west of Craughwell Village. **Figure 5.1** shows the extent of the entire catchment.

Whilst the Dunkellin River drains a significant area of land to the east, northeast and south of Craughwell village (>200 km^2), the particular reaches of river considered in this project are:

- Approximately 11 km of the Dunkellin River which runs in a westerly direction from 200 m upstream of Craughwell Village to the sea at Kilcolgan.

- Approximately 7.5 km of the Aggard Stream which runs from the townland of Cregaclare (near Ardrahan) to its outfall at the confluence of the Dunkellin and Craughwell Rivers, approximately 1 km south of Craughwell Village.

5.1 LAND USE IN THE STUDY AREA

The study area encompasses lands surrounding the course of the Aggard Stream from its source to its confluence with the Dunkellin River from just upstream of Craughwell Village to its discharge to Galway Bay just west of Killcolgan. The two main settlements within this region are the villages of Craughwell and Kilcolgan. Beyond these urban settlements the main land use of the study area is agricultural. The lands are low lying and are composed of good arable land with cattle rearing and milk production as well as some tillage. Mineral extraction is present in the study area. There are three extractive industry related activities in the wider region – Goode Concrete in Adrahan, Canon Concrete in Oranmore and Tonroe Quarry.

Given the region's location relative to Galway City another major land use within the study area is residential, with a population density ranging from 90 to 175 people per hectare in and close to the urban centres of Craughwell and Kilcolgan with approximately 60 people per hectare in the southern rural part of the study area. Residential settlement is for the most part in ribbon development following the local road network. **Image 5.1** shows typical farm land and dwelling locations in the study area.

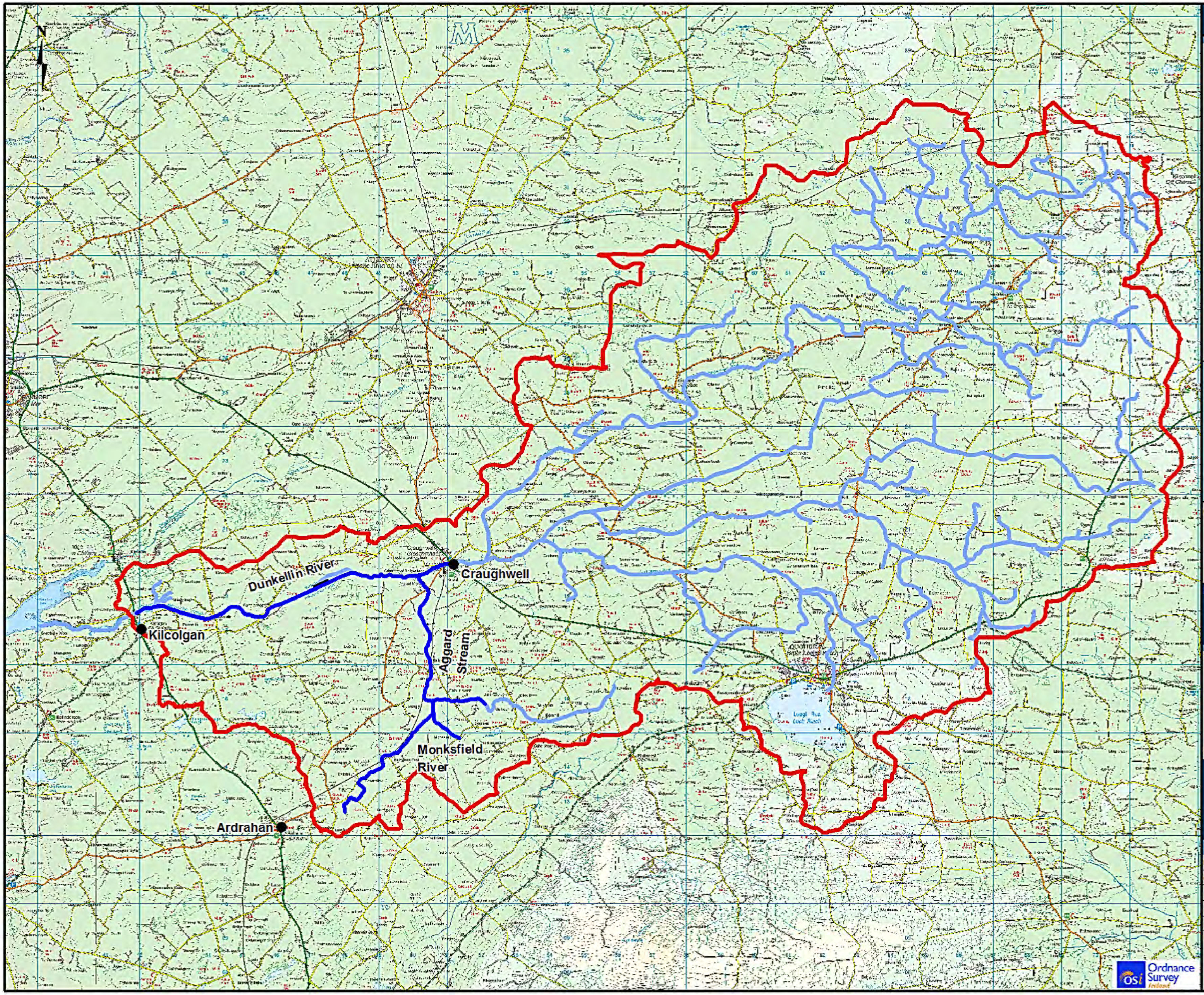
Image 5.1 Typical Land Use in the Study Area

Dunkellin River in mid-ground of Image

Source: Dr. Martin O'Grady, Inland Fisheries Ireland (I.F.I), October 2010

The study area is further divided into the Dunkellin River and the Aggard Stream.

Details of the Dunkellin River are further set out in **Appendix A, Part 1**. The Dunkellin River can be further divided into three general zones along its length for the purposes of the scheme:



Legend

- Dunkellin River Catchment
- Dunkellin River, Aggard Stream & Monksfield River Study Section
- Dunkellin River Tributaries

Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Extent of the Dunkellin River Catchment Map

Figure 5.1

RPS

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Issue Details

Drawn by: MCS	Project No. MGE0260		
Checked by: MW	File Ref. MGE0260MI0002		
Approved by: WM			
Scale: 1:150,000@A4	Drawing No.	Rev.	
Date: October 2014	MI0002	F01	

Notes

1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. All levels are referred to Ordnance Datum, Malin Head.
3. Ordnance Survey Ireland Licence EN 0005014

- **Zone 1** – 250m Upstream of Craughwell Village to Rahasane Turlough (refer to **Appendix A, Section 1.1)**
- **Zone 2** – Rahasane and Rinn Turlough Complex (refer to **Appendix A, Section 1.2)**
- **Zone 3** – Rinn Townland to the N18 at Kilcolgan **(**refer to **Appendix A, Section 1.3).**

Details of the Aggard Stream are further set out in **Appendix A, Section 1.4.**

6 PROJECT DESCRIPTION

This chapter of the EIS sets out the flood relief scheme proposed for the Dunkellin River and Aggard Stream. In completing this chapter Schedule 6(2) (a) of the Planning and Development Regulations 2001-2013 (setting out the elements to be included when describing the proposed development) has been considered. The scheme is considered in terms of design rationale, detailed measures, construction stage activities, spoil management, and operational or maintenance requirements.

Appendix A contains the scheme detail and relevant scheme drawings as generated by the scheme design consultants, Tobin Consulting Engineers in a report entitled "*Dunkellin River and Aggard Stream Flood Relief Scheme – Description of the Proposed Works*", (Tobin Consulting Engineers, September 2014). Specific sections of this report are referenced below.

The scheme includes for flood relief works to be completed along the main channel of the Dunkellin River from Craughwell to Kilcolgan (over 11 km) and along the Aggard Stream which runs from the townland of Cregaclare (near Ardrahan) to its outfall at the confluence of the Dunkellin and Craughwell Rivers (over 7.5 km).

A combination of river widening, deepening, culvert upgrade and replacement, bridge improvement and replacement, and general channel maintenance make up the proposed measures for this scheme.

The intention of the scheme is to provide optimum flood relief with minimal environmental impact whilst also controlling the overall capital investment required.

It should be noted in order to facilitate the detailed design of the proposed scheme a series of site investigations will take place in the study area to determine the ground conditions along the route of the proposed channel works (bank works downstream of the Rahasane Turlough and in channel works Upstream of the Turlough at Craughwell Village) and in the vicinity of the proposed bridge underpinning and replacement works. These investigation works do not form part of this scheme and so are not considered in the scope of this EIS. The site investigation works are subject to the appropriate assessment process in line with the Habitats Directive.

It should also be noted that it is a legal requirement that Galway County Council carry out general maintenance works on the upper Aggard Stream. This work is separate to the works proposed as part of the scheme which is the subject of this EIS. This work was also subject to the Appropriate Assessment process in line with the Habitats Directive.

This section is further divided into the following:

- Scheme Design Rationale;
- Proposed Flood Alleviation Measures;
- River Enhancement Programme;
- Salinity Modelling;
- Construction Stage and Programme;
- Excavation and Spoil Management;
- Ancillary Works and Emergency Plan;
- Operational/Maintenance Stage Requirements; and
- Other Projects.

6.1 SCHEME DESIGN RATIONALE

Appendix A, Section 2 sets out the approaches taken in designing a suitable scheme.

6.2 PROPOSED FLOOD ALLEVIATION MEASURE

The hydraulic models of the Strategic Schemes, combined with early public consultation, consultation with Galway County Council and the OPW, indicated that the particular selection of flood alleviation measures, as detailed here, would produce the overall preferred scheme which would provide optimum flood relief with minimal environmental impact whilst also controlling the overall capital investment required.

The proposed measures strike a delicate balance at Rahasane Turlough SAC and SPA. Extreme floods would be passed through the turlough where possible, by limited excavations downstream of the turlough and adaptations at Rinn Bridge, which would deliberately minimise the predicted changes in water levels within the turlough so to maintain the ecologically critical water level range.

6.2.1 Dunkellin River

As set out in **Section 5.1**, the Dunkellin River study area was further divided into three zones. Measures proposed are set out in **Table 6.1**. Details, including diagrams and figures, of the scheme at each of these locations are set out in **Appendix A, Section 3.2**, **Section 3.3** and **Section 3.4** and associated drawings **(6408-2202 to 6408-2211)**.

Table 6.1 Summary of the Proposed Flood Alleviation Measures Proposed for the Dunkellin River and Aggard Stream Flood Relief Scheme.

Zone	Works Item No.	Description of Location	Proposed Scheme
1	1	Main Channel (Craughwell Village).	The main channel will be depended from 17.85 mOD (35m u/s of the road bridge in Craughwell) to 14.66 mOD (610 m d/s of the railway bridge).
	2	R446 Bridge.	The channel will be deepened by approximately 0.6m at the R446 Road Bridge (underpinning of the bridge will be required).
	3	Masonry Arch Pedestrian Bridge.	The channel will be deepened by approximately 0.6m at each arch (underpinning of the arches will be required).
	4	Bypass Channel (Craughwell Village).	The channel will be graded from an u/s level of 18.5 mOD to a d/s level of 18 mOD. (The bypass bridge will require underpinning to match proposed bed levels).
	5	Railway Bridge.	The channel will be deepened by up to 0.75 m (underpinning/scour protection of the railway bridge will be required).
2	6	Works at Rahasane Turlough.	It is not proposed to complete any works within or adjacent to the main body of the Rahasane Turlough cSAC.
3	7	Channel Works at Rinn.	A two stage channel typically 20 m wide will be constructed from approximately 50 m upstream

Zone	Works Item No.	Description of Location	Proposed Scheme
			of Rinn Bridge to approximately 50 m downstream of the bridge. Strictly out of channel maintenance works aimed at removal of encroachment of terrestrial vegetation, removel of fallen/instream trees, with no dredging and no channelization/arterial drainage works. Terrestrial vegetation along the river banks would be managed (i.e. trimming back of brambles and scrub) rather than being removed.
	8	Works at Rinn Bridge.	Three flood eyes will be provided each measuring 3.1m wide x 2.1m deep.
	9	Channel Works beginning upstream of Dunkellin Bridge.	Mainenance works aimed at the removal of encroachment of terrestrial vegetation, removal of fallen/instream trees. Vegetation along the river bans would be managed (i.e. trimming back to 1.0 m to 1.5 m above high flood levels or top of bank) rather than being removed. Flood relief works will commence approximately 175 m upstream of the Dunkellin Bridge and consist of the constrcution of a two stage channel typically 20 m wide.
	10	Works at Dunkellin Bridge.	In conjunction with localised channel widening to facilitate the proposed bridge works (30m), the existing flood eyes shall be replaced with two new box culverts each measuring 13 m wide x 2.3 m deep.
	11	Channel Works from Dunkellin Bridge to Kileely Beg Bridge.	Two stage channel works will continue from Dunkellin Bridge to Kileely Beg Bridge with a typical channel width of up to 20m.
	12	Works at Kileely Beg Bridge.	In conjunction with localised channel widening to facilitate the proposed bridge works (14m), a new bridge will be provided with an 18m span and a soffit level of 7.8mOD.
	13	Salmon Counter.	The salmon counter will be relocated to a position upstream of Kileely Beg Bridge as part of the river enhancement works.
	14	Channel Works from Kileely Beg Bridge to the N18 Bridge.	Two stage channel works will continue from Kileely Beg to the N18 Bridge with a typical channel width of up to 20m. From a distance of 400m upstream of the N18 Bridge the two stage channel will be tapered back to match existing channel widths.
	15	Works at Kilcolgan and N18 Bridges.	No works proposed.

6.2.2 The Aggard Stream

The proposed works along the Aggard Stream will consist of minor culvert replacement works whereby existing blocked and undersized (600 mm) piped crossings will be replaced with larger (1,500 mm) diameter precast concrete open jointed pipes. The proposed works will involve minor localised excavations within the existing stream. **Figure 6.1** shows the location of these culverts.

The works proposed for the Aggard Stream are minor in nature and consist of maintenance works aimed at the removal of encroachment of vegetation, removal of fallen trees and other obstacles (i.e. gates, minor obstructions, fences in the river, poor culvert conveyance, etc.), excessive silt deposits and that excavations not include for significant dredging and no channelization/ arterial drainage works. Vegetation along the river banks would be managed (i.e. trimming back) rather than being removed, where at all possible.

Where required, silt removal will take place along the stream length. It is proposed to use the right hand bank where possible to deposit any material removed in this process up to a maximum of 30 m from the stream.

Details of this proposed works, locations of culvert replacement etc are further detailed in **Appendix A, Section 3.5** and associated drawings **(6408 - 2220, 6408 - 2221** and **6408 – 2222).**

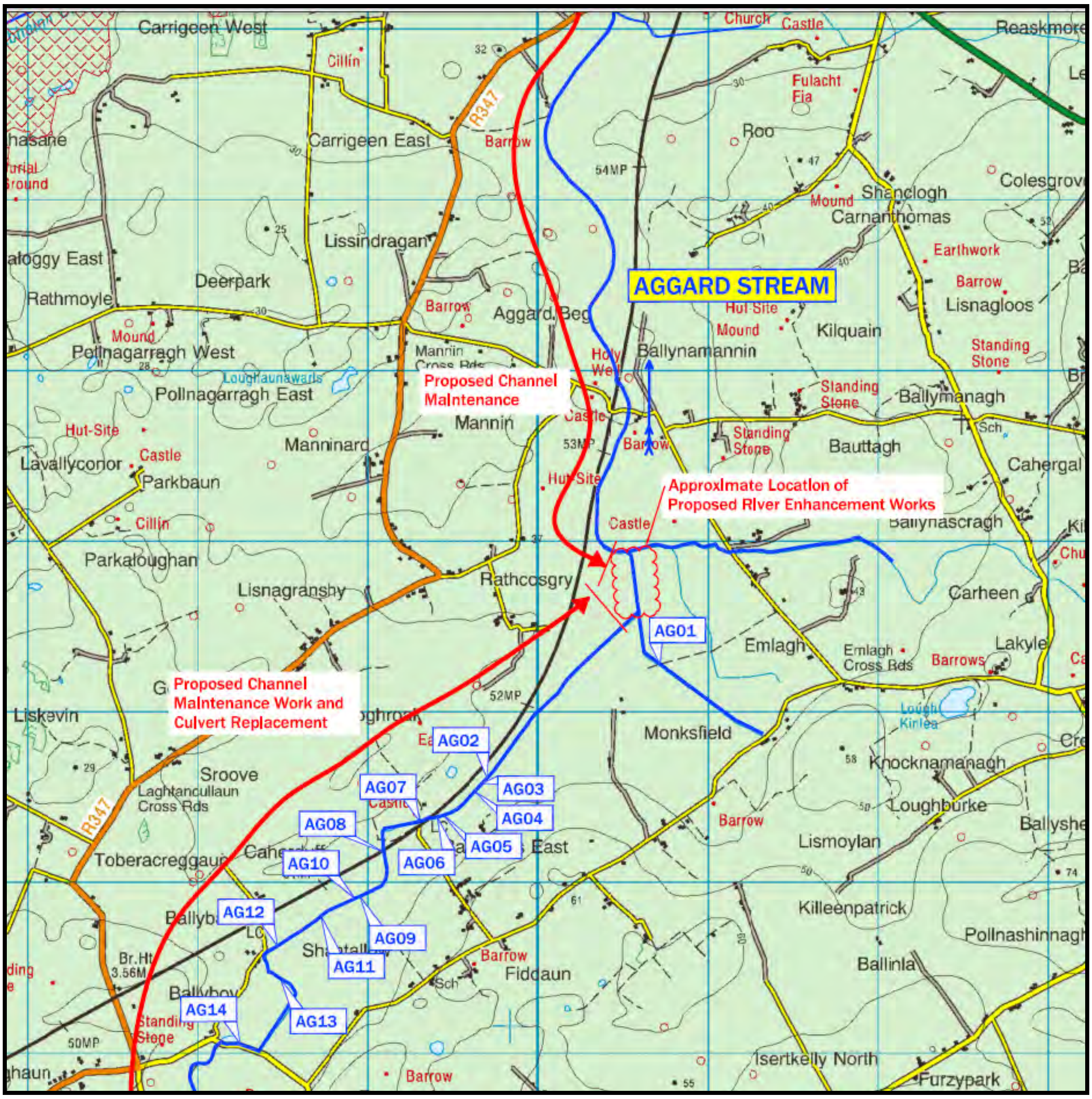


Figure 6.1 **Location of 14 No. Culverts Proposed to be Replaced along the Aggard Stream (Source: Tobin 2014).**

6.3 ENVIRONMENTAL RIVER ENHANCEMENT PROGRAMME

An initial river enhancement programme was proposed by Inland Fisheries Ireland (IFI). This programme was based on general good practice recommendations having knowledge of the study area concerned and was subject to a detailed design stage. This programme is set out under within **Appendix No. 3 (first section)** to the report included in **Appendix A** to this report

Further to this a detailed river enhancement programme was proposed by IFI which took into consideration the detailed design measures being proposed as part of the scheme. Details on these enhancement measures and how they are to be incorporated into the scheme are set out within **Appendix No. 3 (second section)** to the report included in **Appendix A** to this report.

6.4 SALINITY MODELLING

A comparative study was carried out to examine the impact if any of the scheme on shellfish in the receiving marine waters. The objective of completing this modelling was to conclude if the scheme could cause decreases in salinity in the receiving shellfish waters that would prove detrimental to the shellfish population in times of flood such as the 2009 event.

The modelling demonstrated that, for this event, the salinity levels at the shellfish beds would experience minimal effects due to the scheme. Refer to **Appendix E** in this report for further details and a copy of the full report in this regard.

6.5 CONSTRUCTION STAGE AND PROGRAMME

A combination of channel deepening, underpinning of bridge structures, channel widening and culvert replacement are proposed as measures for the Flood Relief Scheme. The proposed construction methods at specific locations has been have been set out in **Appendix A, Section 3.2**, **Section 3.3** and **Section 3.4.**

A construction works programme has been devised for the scheme and this is presented in **Figure 6.2**. The programme clearly respects the environmental sensitivities of the receiving environment and the recommendations of consultees. It should be noted that this is an outline programme of works only and may be subject to alterations subject to the timing of planning approvals, the final detailed design stage programme and following the appointment of a works contractor. Further details are set out in **Appendix A, Section 5**.

RPS

	No. of Employees	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16
Advanced Works																						
Vegetation Clearance		Vegetation Clearance			No Vegetation Clearance Permitted March to Sept						Vegetation Clearance Permitted Sept to February					No Vegetation Clearance Permitted March to Sept						
Out Of River Works downstream of the Rahasane Turlough																						
River Works Crew No. 1 – Out of River Works or Channel Widening of the Dunkellin River from Kilcolgan Bridge to Killeely Beg Bridge.	6																					
Channel Widening of the Dunkellin River from Killeely Beg Bridge to Dunkellin Bridge.	6																					
River Works Crew No. 1 – Out of River Works or Channel Widening of the Dunkellin River from Dunkellin Bridge to Rinn Bridge.	6																					
River Works Crew No.2 - Out of River Works or Channel Widening of the Dunkellin River from Rinn	6																					
Bridge Works Crew A – Bridge Works at Killeely Beg Bridge.	8																					
Bridge Works Crew B – Out of River Bridge (Left Bank Works) /Culvert Works at Dunkellin Bridge.	8																					
Bridge Works Crew C – Out of River Bridge (Left Bank Works) /Culvert Works at Rinn Bridge.	8																					
In River Works upstream of the Rahasane Turlough																						
Bridge Works Crew D– In River Works or Channel Deepening downstream of the Railway Bridge (Rock Removal).	4																					
Bridge Works Crew E– In River Works or Channel Deepening in Craughwell.	4																					
Bridge Works Crew F – In River Works or Underpinning at the Railway Bridge in Craughwell.	4																					
Out Of River Works on the Bypass Channel followed by works on main R446 bridge & Multi-Arched Bridge																						
Works Crew No. 1 – Out of River Works or Channel deepening and underpinning along the bypass channel and retaining walls	4																					
Works Crew No. 2 – Out of River Works or Underpinning of the Old Stone Multi-arched bridge (Extended Programme to cater for variability in river flows)	4											Restrictions Apply to Works within this Time Period										
Works Crew No. 3 – Out of River Works or Underpinning of the main R446 bridge in Craughwell (Extended Programme to cater for variability in river flows).	4																					
Landscaping																						
Completion/Snagging and Handover																						

Estimated Max Number of Employees on Site	44

Figure 6.2 **Outline Construction Programme (Source Tobin 2014).**

6.6 EXCAVATION AND SPOIL MANAGEMENT

It is anticipated that approximately 70,000 m³ of overburden, rock and riverbed will be removed from the river and its surroundings as a result of channel deepening and widening as part of the scheme. It is envisaged that different techniques will be adopted with regard to the reuse or disposal of excavated material. However, the overall intention will be to reuse the excavated material as side slope protection, creation of flood embankments, creation of bankside spoil embankments and the creation of extended spoil heaps where initial treatment will require removal of topsoil, spreading of excavated material and reinstatement of the topsoil, undertaken with a view to minimising the transport of material off-site.

Further details on how the volume of the material was calculated is detailed in **Appendix A, Table 6-1, p.63.**

6.7 ANCILLARY WORKS AND EMERGENCY PLAN

Details on ancillary works including the number and location of site compounds as well as the provision of emergency plans and health and safety during construction are set out in **Appendix A, Section 7** and **Section 8**.

6.8 OPERATIONAL/MAINTENANCE STAGE REQUIREMENT

When fully implemented, the scheme will provide a defence against the 1 in 100 year flood event with allowance also made for future drainage works upstream of Craughwell and climate change.

However, the Dunkellin River channel and Aggard Stream will require regular maintenance to prevent vegetation becoming overgrown thus increasing the risk of future flooding.

Galway County Council proposes to undertake maintenance over a five year maintenance programme with activities being carried out as follows:

- Light trimming of vegetation; and

- Non invasive cleaning of the river to remove excess silt or debris which may have gathered in the river.

6.9 OTHER PROJECTS

Work on the construction of new motorway between Gort and Tuam in County Galway is expected to begin in late 2014/ early 2015. The new 57 km motorway will consist of a four lane carriageway from Gort in the south of the county to Tuam in the north. With regard to the proposed Dunkellin and Aggard Flood Relief Scheme, the proposed motorway will cross the Dunkellin River at a point approximately 600 m upstream of the Dunkellin Bridge and 400 m upstream of where the scheme will commence.

The environmental specialists who have completed assessments as part of this EIS have had regard for the potential in combination effects of this project.

7 NEED FOR THE PROPOSED SCHEME AND ALTERNATIVES CONSIDERED

It should be noted that **Appendix A** contains the scheme detail and relevant scheme drawings as generated by the scheme design consultants, Tobin Consulting Engineers in a report entitled "*Dunkellin River and Aggard Stream Flood Relief Scheme – Description of the Proposed Works*", (Tobin Consulting Engineers, September 2014).

7.1 NEED FOR THE PROPOSED SCHEME

The Dunkellin River and the Aggard Stream form part of the Dunkellin Drainage District, which was constructed in or around 1857, for which Galway County Council have a statutory maintenance responsibility. Following on from Arterial Drainage Works completed along the Dunkellin River in the mid 1850s and later in the early 1920s, the Office of Public Works prepared an Arterial Drainage Design for the Dunkellin/Lavally Catchments in the mid 1900s (circa 1950). This Arterial Drainage Scheme, as detailed on the original design drawings, included for alterations to the channel widths, channel regrading (bed level) and deepening of a number of the bridges/structures.

During this time there have been a number of flood events on this system and historically a number of studies have taken place detailing the response of Rahasane Turlough to high rainfall events. Most recently the flood events of January 2005 and November 2009 caused widespread flooding of this system and the surrounding lands. The resulting impacts of this flooding prompted the need to develop a flood relief scheme for the Dunkellin River and Aggard Stream system.

Further details on these recent flood events including photographic evidence are set out in **Appendix A, Section 2.1**.

It is proposed that if the flooding of lands and property which occurred in the January 2005 and November 2009 events is to be avoided in the future, there is a need to implement a flood relief scheme for this water system. Those hydraulic restrictions set out in **Appendix A** should form the basis of these measures.

7.2 ALTERNATIVES CONSIDERED AND JUSTIFICATION FOR THE SCHEME

Alternatives must be considered as part of the EIA process in accordance with the Planning and Development Regulations 2001 (SI 600), Schedule 6 (1) (d) which states that the following needs to be considered: "*An outline of the main alternatives studied by the developer and indication of the main reasons for his or her choice, taking into account the effects on the environment".*

Furthermore the EPA Publication "*Advice Notes on Current Practice (in the preparation of Environmental Impact Statements)*" suggests that when assessing alternatives they should be described where relevant in three main ways: alternative locations, designs and processes.

The scheme must obviously take place within the confines of the Dunkellin River and Aggard Stream and so alternative locations are not considered further. The issue of alternative design and processes are dealt with through review of alternative flood alleviation approaches and further refined to look at alternative scheme options and specific measures within the chosen approach. Furthermore a "do nothing" scenario is also considered in this section.

Figure 7.1 at the end of this section summarises the process through which alternatives were considered and how the ultimate preferred scheme was derived.

It should be noted that in the course of arriving at the final preferred scheme there were eleven variations to the scheme made. The final preferred scheme emerged suitable, taking into consideration the environmental and engineering constraints of the system.

7.2.1 Do Nothing Scenario

If no flood alleviation measures are implemented along the Dunkellin River or Aggard Stream, the possibility of future flood events, similar to those that occurred in January 2005 and November 2009, will continue to persist and possibly increase with climate change predictions. This will result in continued economic and social implications for businesses, residents and transport links which are located in the regions affected by previous floods.

7.2.2 Alternative Flood Alleviation Approaches

A range of flood alleviation approaches were considered in arriving at a preferred scheme and associated set of alleviation measures. These include the following:

Non-Structural Measures: Risk assessment, research programme, forecasting and flood warning systems.

Removal and Relocation: Relocate affected flooded properties away from flood risk areas.

Flow Diversion and/or Reduction: Diverting flood water through alternative channels, retaining water upstream etc.

Flow Retention: Provide lands upstream (e.g. wetlands) for the retention of flood waters.

Flood Defences: Introducing structural elements to the river system to lessen the impact of flood water.

Structural Measures: Alter/remove instream structures, widen and deepen water channel for increased conveyance.

In assessing the suitability of these range of flood relief approaches, structural measures were considered the most appropriate given the extent and frequency of the flooding, the number of properties affected, costs, land availability, river morphology, hydrology and output of modelling.

7.2.3 Alternative Scheme Options and Measures

A series of alternative flood relief measures were considered throughout the study area. These alternatives considered included the following;

- **At Craughwell Village**

  a. Pumping of the excess flood river flows was considered at the early stages of the study. Whilst this proved to be an effective technical option the pumps were of a size that did not merit consideration. In addition, the pipework required was also significant in size and the flow velocities had the potential to create a risk of significant ground disturbance at their point of discharge.

  b. Whilst demolition of the existing multi-arched stone pedestrian bridge was considered in the initial study, early consultation with statutory bodies indicated that even though the structure was not protected, the bridge was considered to be of archaeological significance and may also be used as a bat roost and as such demolition was not considered to be a viable option.

  c. Channel widening of the existing river, within the village of Craughwell, was also considered at an early stage of the study. However, the main hydraulic restriction along this channel reach was the railway bridge. Channel widening would require the construction of a large flood culvert under the railway line. This alternative was not considered to be viable as installation of a large structure would require, for safety and health reasons, closure of the railway line for a significant period of time, a restriction not considered to be possible.

d. The provision of bypass culverts were also considered on each side of the R446 road bridges. However, due to localised access and land acquisition restrictions, the presence of existing utilities such as water mains, gas mains, broadband (fibre optic) facilities, underground power cables and telephone cabling and the need for road closures on the R446 this option was not considered to be a viable solution.

- **At Rahasane Turlough**

Channel widening of the existing channel between the mouth of Rahasane Turlough to Rinn Bridge was also considered. **Figure 7.2** shows the affect this widening has compared to the preferred scheme, most notably at levels over 15.7 m. This alternative scheme is not considered to be viable as it has the potential to reduce the water profile in the Rahasane Turlough cSAC, to levels which would significantly impact on the normal flood regime and therefore impact on the local flora and fauna. As a result this was not considered to be a viable option.

- **Downstream of Rahasane Turlough to the N18 at Kilcolgan Bridge**

a. Channel deepening of the existing river, downstream of Rahasane Turlough cSAC, was also considered at an early stage of the study. However, the main hydraulic restriction along this channel reach was the water level in the turlough. Channel deepening would require significant reductions in bed levels throughout this reach of the river. This alternative was not considered to be viable as it has the potential to reduce the water profile in Rahasane Turlough cSAC, to levels which would significantly impact on the normal flood regime and therefore impact on the local flora and fauna. This was not considered to be viable as the turlough is a protected habitat and heritage site.

Following the exclusion of these possible flood alleviation measures, three broad modelling or Strategic Schemes have been examined in the development of the preferred flood relief scheme.

Strategic Scheme No. 1

This first scheme examines a package of coherent, effective works, concentrating on channel improvements and reconstruction of those structures whose removal would be essential in an effective scheme of works. It examined the impact of works associated with:

- deepening particular lengths of the channel between bridge structures;
- the use of flood eyes or bypass/over culverts at the Dunkellin Bridge and Rinn Bridge;
- removal of the old multi-arched stone bridge crossing (pedestrian bridge) in Craughwell; and
- deepening of the bed level at the Railway Crossing and R446 (formerly N6) bridge in Craughwell Village.

Strategic Scheme No. 2

This second scheme examined the incremental benefit of more extensive bridge replacement, including:

- the impact of channel widening in lieu of deepening as examined under Strategic Scheme No.1;
- the complete replacement of the Killeely Beg and Dunkellin Bridges;
- the use of bypass culverts at the Railway Bridge in Craughwell;
- removal of the old multi-arched stone bridge crossing (pedestrian bridge) in Craughwell; and
- the complete replacement of the bridges on the R446 in Craughwell with larger span structures.

Strategic Scheme No. 3

This third scheme or the "Proposed Preferred Scheme" examined the benefit of more extensive main channel deepening (Dunkellin River) in Craughwell and the deepening of the bypass channel in Craughwell, including :

- the impact of channel widening in the lower reaches of the Dunkellin River at Kilcolgan;
- the complete replacement of the Killeely Beg Bridge;
- the provision of two large box culverts in place of existing flood eyes at the Dunkellin Bridge;
- the addition of three new flood eyes at Rinn Bridge downstream of the Rahasane Turlough cSAC;
- the deepening of the main channel in Craughwell including underpinning of the railway bridge in Craughwell;
- the deepening of the main channel in Craughwell to facilitate retention, by underpinning, of the old multi-arched stone bridge crossing (pedestrian bridge) in Craughwell; and
- the deepening of the main channel in Craughwell to facilitate retention, by underpinning, of the bridge crossings on the R446 in Craughwell.

The hydraulic models of the Strategic Schemes, combined with early consultation with Galway County Council and the OPW, indicated that the particular selection of flood alleviation measures, included in "Proposed Preferred Scheme" would produce the overall preferred scheme which would provide optimum flood relief with minimal environmental impact whilst also controlling the overall capital investment required.

The proposed works strike a delicate balance at Rahasane Turlough cSAC. Extreme floods would be safely and effectively passed through the Turlough, by adaptations at Rinn Bridge, which would deliberately not change the flow control at the ecologically critical normal water level range in average years.

Figure 7.1 overleaf summarizes the approach taken when dealing with alternatives for the scheme in terms of location, design and process.

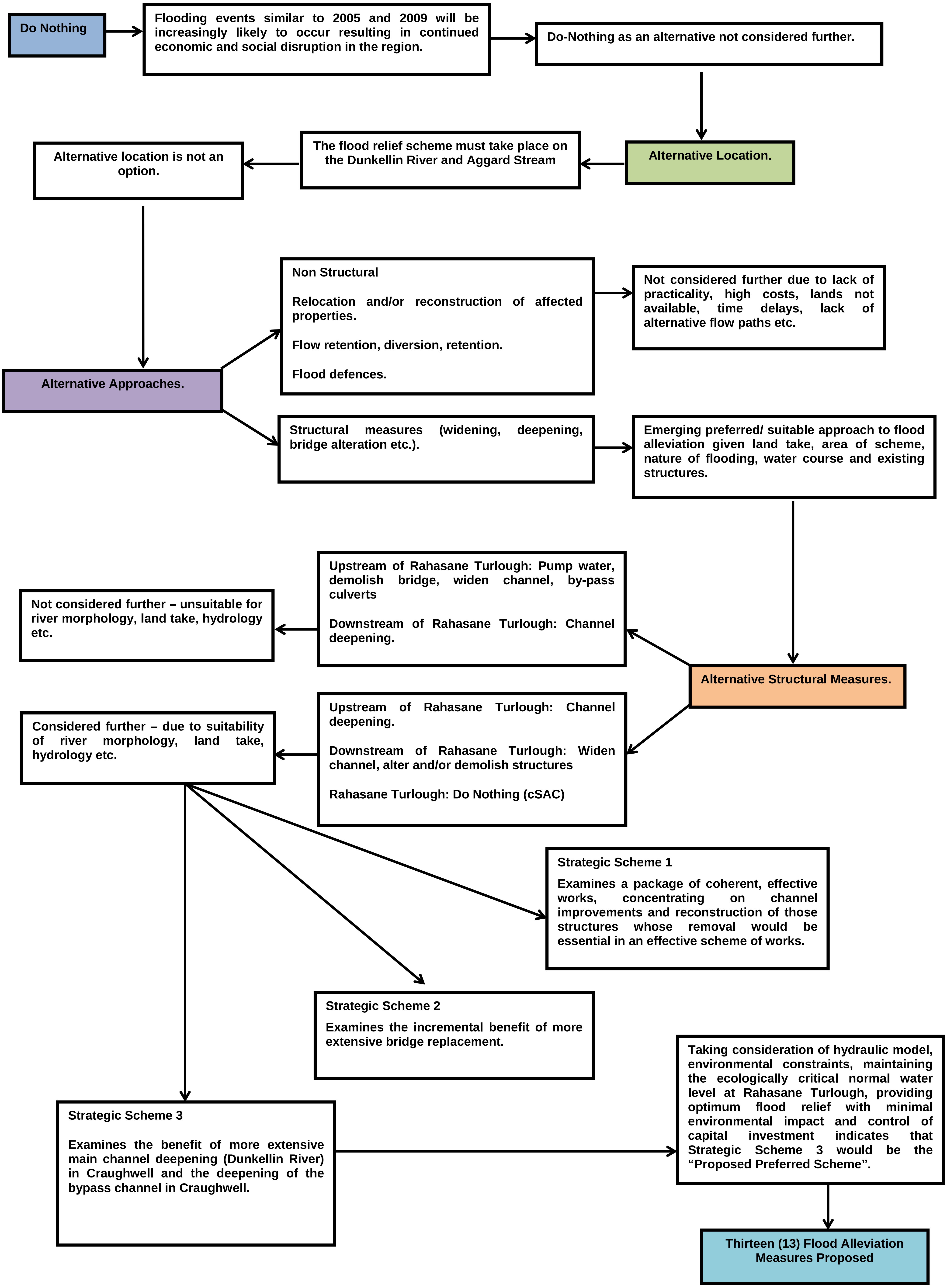


Figure 7.1 Approach to Alternatives Considered for the Dunkellin River and Aggard Stream Flood Relief Scheme

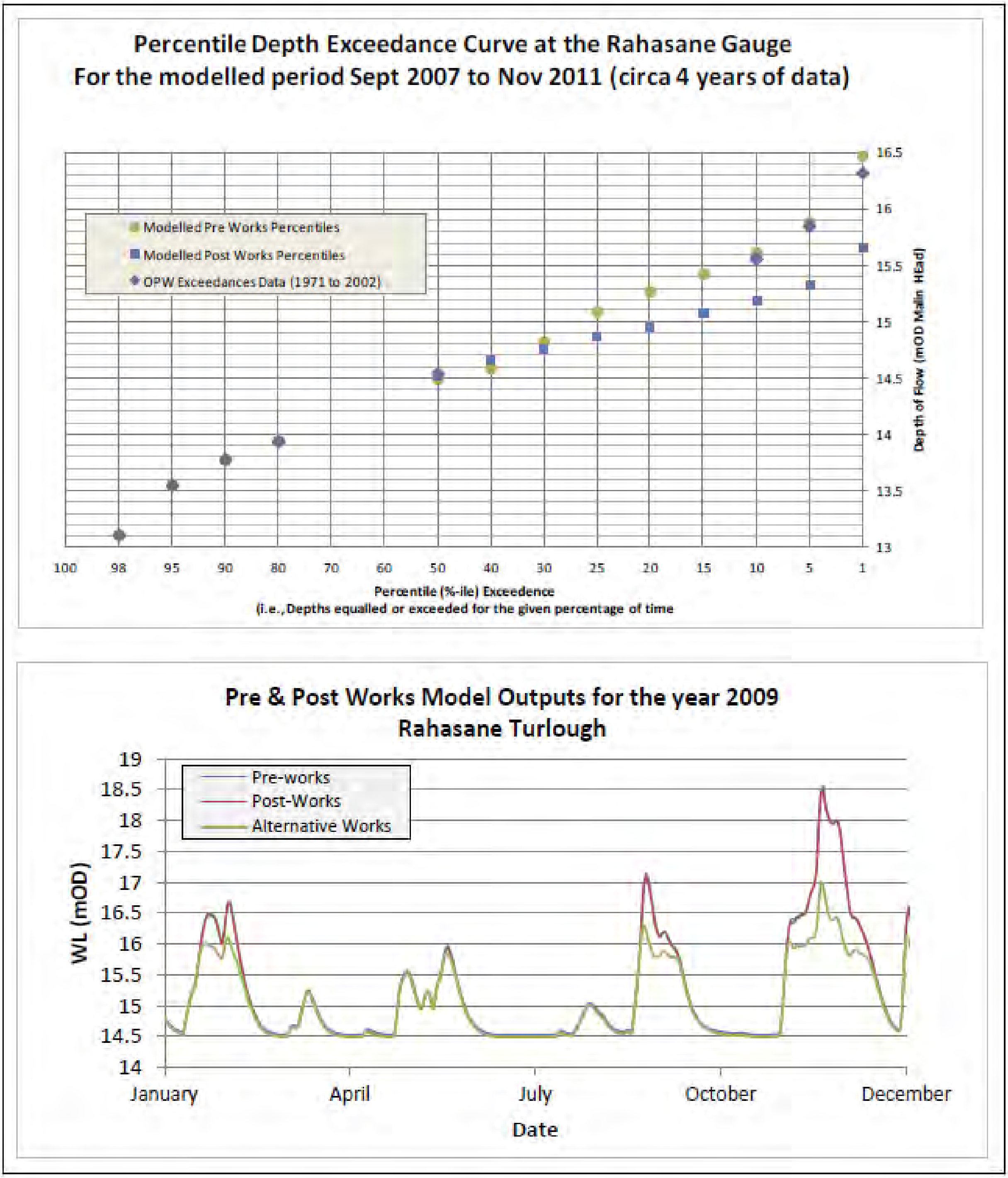


Figure 7.2 **Impact of Alternative Works on the Depth Ranges within Rahasane Turlough (Source: Tobin, 2014)**

8 HYDROLOGY AND DRAINAGE

8.1 INTRODUCTION

This chapter of the EIS examines the existing baseline environment in terms of hydrology and sets out the flood modelling methods used for the scheme and assesses the potential impact of the scheme on the existing hydrological environment of the Dunkellin River and Aggard Stream. Mitigation measures are recommended to minimise any adverse impacts where appropriate.

It should be noted that **Appendix A** contains the scheme detail and relevant scheme drawings as generated by the scheme design consultants, Tobin Consulting Engineers in a report entitled "*Dunkellin River and Aggard Stream Flood Relief Scheme – Description of the Proposed Works*", (Tobin Consulting Engineers, July 2014).

8.2 METHODOLOGY

The hydrology of the study area was reviewed through a combination of site walkovers and a review of hydrologically related records and data. This information was further used in the development of a flood relief design standard for input to the flood model for the scheme.

The hydrological modelling, identification and assessment of potential impacts has been assessed by the scheme design consultants. For further detail and background to the hydrological model, methodology and approach to this assessment reference should be made to **Appendix A**.

8.3 EXISTING ENVIRONMENT

The hydrological environment of the study area is divided into the Dunkellin River and the Aggard Stream.

Details of the Dunkellin River are further set out in **Appendix A, Part 1**. The Dunkellin River can be further divided into three general zones along its length for the purposes of the scheme:

- **Zone 1** – 250m Upstream of Craughwell Village to Rahasane Turlough (refer to **Appendix A, Section 1.1**);
- **Zone 2** – Rahasane and Rinn Turlough Complex (refer to **Appendix A, Section 1.2**); and
- **Zone 3** – Rinn Townland to the N18 at Kilcolgan (refer to **Appendix A, Section 1.3**).

Details of the Aggard Stream are further set out in **Appendix A, Part 1.4**.

8.4 POTENTIAL IMPACTS

Following the development of the Preferred Scheme (or Viable Scheme), as outlined in **Table 6.1** an examination of the capacity of the proposed channel was undertaken to establish its performance to accommodate a range of flows.

To this end the potential impacts on a range of hydrological features and functions was assessed by the scheme design consultants and are detailed in **Appendix A, Section 4.** The potential impacts can be further divided and are detailed in **Table 8.1**.

Table 8.1 Hydrological Features and Functions Assessed

Hdrological Feature or Function	Further Described in these Sections of the *Decription of the Proposed Works* report contained in Appendix A to this report.
Effect of the Proposed Two Stage Channel Works (Channel Widening) on water levels in the channel downstream of the Rahasane Turlough cSAC.	Section 4.1
Changes to Surface Water Profile within the Rahasane Turlough cSAC for a Defined Range of Flows.	Section 4.2
Impact on Flow Velocities.	Section 4.3
Impact on Flow Volumes.	Section 4.4

8.5 MITIGATION MEASURES

The proposed flood alleviation measures as set out in **Table 6.1** have been proposed to ensure that future flood events will be reduced through confining the flood waters to the existing river channel. Therefore no further mitigation measures are required in the context of predicted changes to the river's flow regime.

A number of mitigation measures will be implemented in order to protect and enhance the existing water quality and function of the Dunkellin River and Aggard Stream. These measures are further detailed in **Chapter 11** to this report.

8.6 RESIDUAL IMPACTS

It is not anticipated that there will be any negative residual impacts resulting on the hydrology of the Dunkellin River and Aggard Stream as a result of implementing the flood alleviation measures.

8.7 CONCLUSION

This chapter of the EIS examines the existing baseline environment in terms of hydrology and found that it can be divided into the Dunkellin River and Aggard Stream. The Dunkellin River flows through Rahasane Turlough (SAC and SPA) and flows into Galway Bay SAC.

A detailed flood model was developed for the system which has taken into consideration flood relief design standards, estimated return period for the November 2009 event, climate change and future flow scenarios and sets out the flood modelling methods used for the scheme and assesses the potential impact of the scheme on the existing hydrological environment of the Dunkellin River and Aggard Stream.

Potential for impacts on the hydrological features and function of same were further explored by the scheme design consultants in terms of potential impact on the surface water profile, changes to flow velocities and volumes as a result of the proposed works. Details of this assessment are presented in **Appendix A** of this document. The following conclusions have been made:

- the post-works water surface profile associated with mean annual flow is in most cases contained within the main channel downstream of Rinn Bridge;

- there are no changes expected in the water surface profile through Rahasane Turlough for any magnitude of flood;

- Examination of the channel velocities in the mathematical model (HEC-RAS) for the existing channel and the scheme scenario shows that expected changes in flow velocities is minimal; and

- It is expected that implementation of the scheme will result in a marginal increase (less than 1%) in the rate at which water is discharged to Galway Bay during a similar November 2009 flood event and on balance the volume of flood water passing Killeely Beg Bridge will not change significantly.

Mitigation measures have been recommended to minimise any impacts where necessary.

9 SOILS, GEOLOGY AND HYDROGEOLOGY

9.1 INTRODUCTION

This section of the EIS examines the baseline environment in terms of soils, geology and hydrogeology and assesses the potential impact of the proposed works associated with the flood relief works on the Dunkellin River and Aggard Stream on these on these environmental attributes. Mitigation measures are recommended to minimise any adverse impacts.

This section should be read in conjunction with the hydrological assessment, site layout plans, drawings and project description provided.

9.2 METHODOLOGY

The soils, geology and hydrogeology of the site were assessed by means of a desk study of literature pertinent to the site and the surrounding area. A site walkover was carried out on the 14th July 2011.

The following sources of information were used in conjunction with the walkover in order to complete the assessment:

- Geological Survey of Ireland (GSI) 1:100,000 Geology of Galway Bay (Sheet 14),
- GSI Well Record Database,
- GSI National Vulnerability Map,
- Teagasc Subsoils Map,
- Aerial Photographs,
- Clarinbridge Groundwater Body Description (GSI),
- Water Framework Directive (WFD) Water Body Reports http://watermaps.wfdireland.ie,
- Ordnance Survey of Ireland (O.S.I.) 1:50,000 Map Discovery Series and Historical Mapping
- Guidelines on the Information to be contained in Environmental Impact Statements, EPA 1995 and 2002,
- Geology and the EIS process, IGI, 2002
- Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Scheme; *NRA (National Roads Authority), 2009.*
- Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements; IGI (Institute of Geologists of Ireland), 2013.

The methodology for impact assessment is defined by the EPA Guidelines to be contained in Environmental Impact Statements (1995 & 2005). An application of these guidelines to Soils, Geology and Hydrogeology is outlined in the NRA document *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes* (2009).

In this methodology the significance of an impact is defined by considering the importance of the attribute impacted and the magnitude of the impact. The importance of geological and hydrogeological attributes (rating criteria) is defined in accordance with the NRA Guidelines which are presented in **Table 9.1**.

Table 9.1 Rating Criteria for the Hydrological Attributes

Importance	Criteria	Typical Examples	
		Geology	Hydrogeology
Extremely high	Attribute has a high quality or value on an international scale.	-	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation, e.g. SAC or SPA status.
Very high	Attribute has a high quality or value on a regional scale.	Geological feature rare on a regional or national scale (NHA).	Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status.
High	Attribute has a high quality or value on a local scale.	Geological feature of high value on a local scale (County Geological Site).	Groundwater provides largeproportion of baseflow to local rivers. Locally important potable water source supplying > 1000 homes.
Medium	Attribute has a medium quality or value on a local scale.	Small existing quarry or pit Sub-economic extractable mineral resource.	Locally Important Aquifer. Potable water source supplying > 50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale.	Poorly drained and/or low fertility soils.	Poor Bedrock Aquifer. Potable water source supplying <50 homes.

The magnitudes of the impacts on the existing environment of the attributes were defined in accordance with the criteria provided in the EPA publication - *Guideline on the Information to be Contained in Environmental Impact Statements* (2002). These are presented in **Table 9.2.**

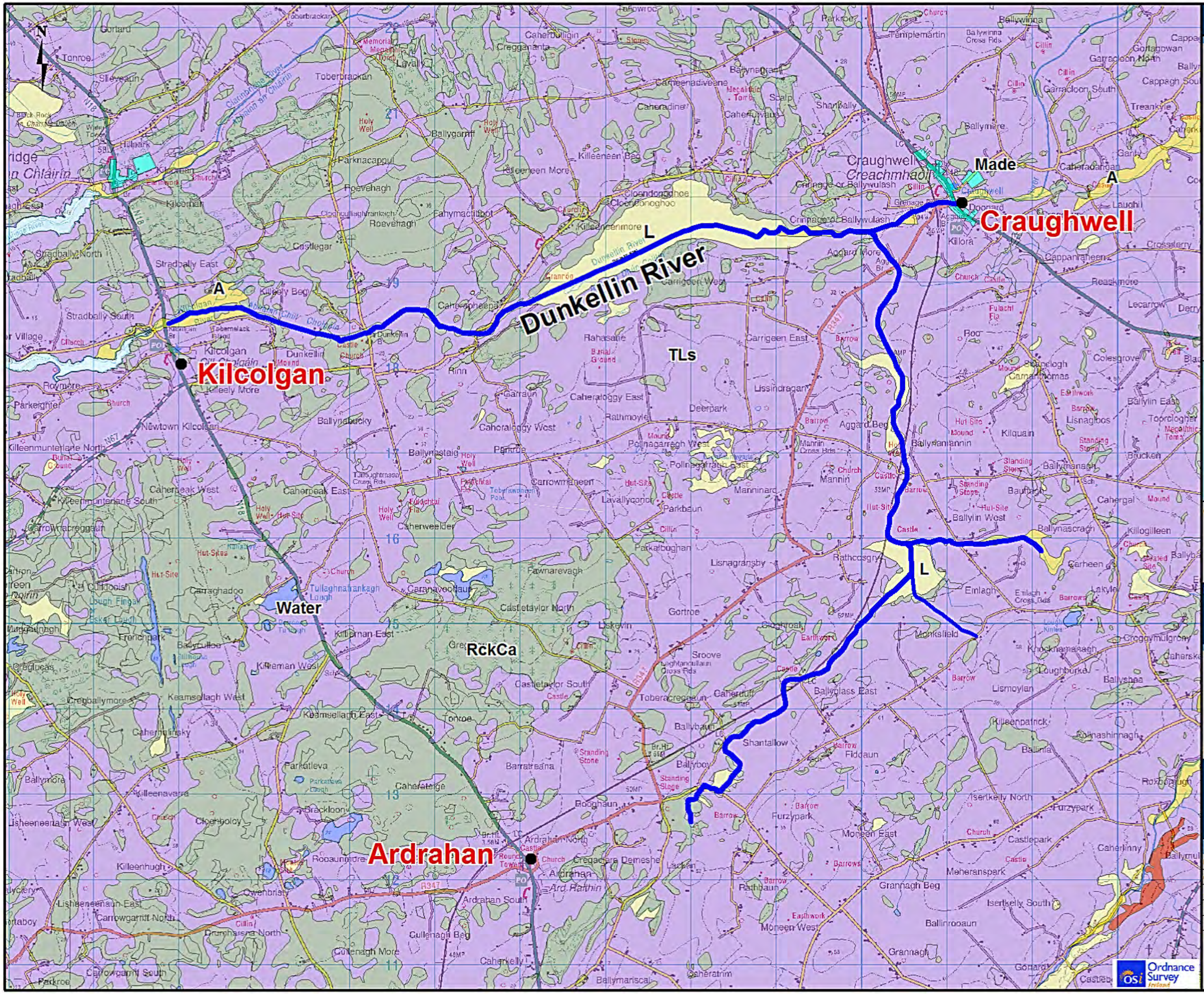
Table 9.2 Impact Assessment Criteria

Significance of Impact	Description
Imperceptible	An impact capable of measurement but without noticeable consequences.
Slight	An impact that alters the character of the environment without affecting its sensitivities.
Moderate	An impact that alters the character of the environment in a manner that is consistent with existing or emerging trends.
Significant	An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
Profound	An impact which obliterates all previous sensitive characteristics.

9.3 EXISTING ENVIRONMENT

9.3.1 Soils & Subsoils

The main subsoils type within the study area is limestone till. Subsoil thickness ranges from 0 to 20 m in the region. There is an area of made ground in the village of Craughwell and areas of alluvium at Craughwell village, Rahasane Turlough and Kilcolgan village. The area around Rahasane Turlough is comprised chiefly of lake sediments. Along the Aggard Stream section of the study area there are deposits of lake sediments and alluvium. Outcrops of karst rock are scattered throughout the study area. Subsoils in the study area are shown on **Figure 9.1.**



Legend

Dunkellin River, Aggard Stream & Monksfield River Study Section

Soils:
- Till derived chiefly from Limestone (TLs)
- Karst Rock (RckCa)
- Lake Sediments (L)
- Made Ground
- Alluvium (A)
- Cutover Peat (Cut)
- Water

Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Soils Map

Figure 9.1

RPS
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Issue Details

Drawn by: MCS		Project No. MGE0260	
Checked by: MW		File Ref. MGE0260MI0006	
Approved by: WM			
Scale: 1:60,000@A4		Drawing No. MI0006	Rev. F01
Date: October 2014			

Notes
1. This drawing is the property of RPS Group Ltd. It is a confidential document and must not be copied, used, or its contents divulged without prior written consent.
2. All levels are referred to Ordnance Datum, Malin Head.
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9.3.2 Bedrock Geology

The bedrock geology of the area is predominately limestone. Undifferentiated Visean Limestone is the main type of limestone underlying the Dunkellin River in the study area. The Visean limestone is a pure bedded limestone which means it has a high calcium carbonate content. The bedrock geology of the area to the south of the Dunkellin River is comprised of the Castlequarter Member of the Tubber Formation, the Burren Formation and the Lucan Formation. The Castlequarter Member of the Tubber Formation consists of monotonous light to medium grey shelf limestone topped by a dolomite bed. The Burren Formation consists mainly of pale grey clean skeletal limestone and the Lucan Formation consists of dark limestone and shale. Details on bedrock geology are shown on **Figure 9.2.**

The location of mineral sites and quarries in the area are shown in **Figure 9.2** and detailed in **Table 9.3.**

Table 9.3 Mineral and Quarry Sites Located in the Study Area

Location No.	Mineral	Townland	Notes
2167	Sand & Gravel	Ballyboy	Sand & Gravel Pit
5211	Lead	Parkatleva	Exploration Site
1746	Calcite	Killely More	Exploration Site
5232	Calcite	Killely More	Exploration Site
2288	Dimension Stone	Tonroe	Active Limestone Quarry – Goode Concrete Ltd
5256	Flourspar	Tonroe	Exploration Site
5212	Lead	Mugaunagh	Exploration Site

9.3.3 Hydrogeology

The rock underlying the majority of the study area is classified by the Geological Survey of Ireland (GSI) as **Rkc** which is Regionally Important Karstified Aquifer with a conduit karst flow system. A segment of rock underlying the Aggard Stream is classified as **Ll** which is a Locally Important Aquifer which is moderately productive in local zones. The aquifer classification in the study area is shown on **Figure 9.3.**

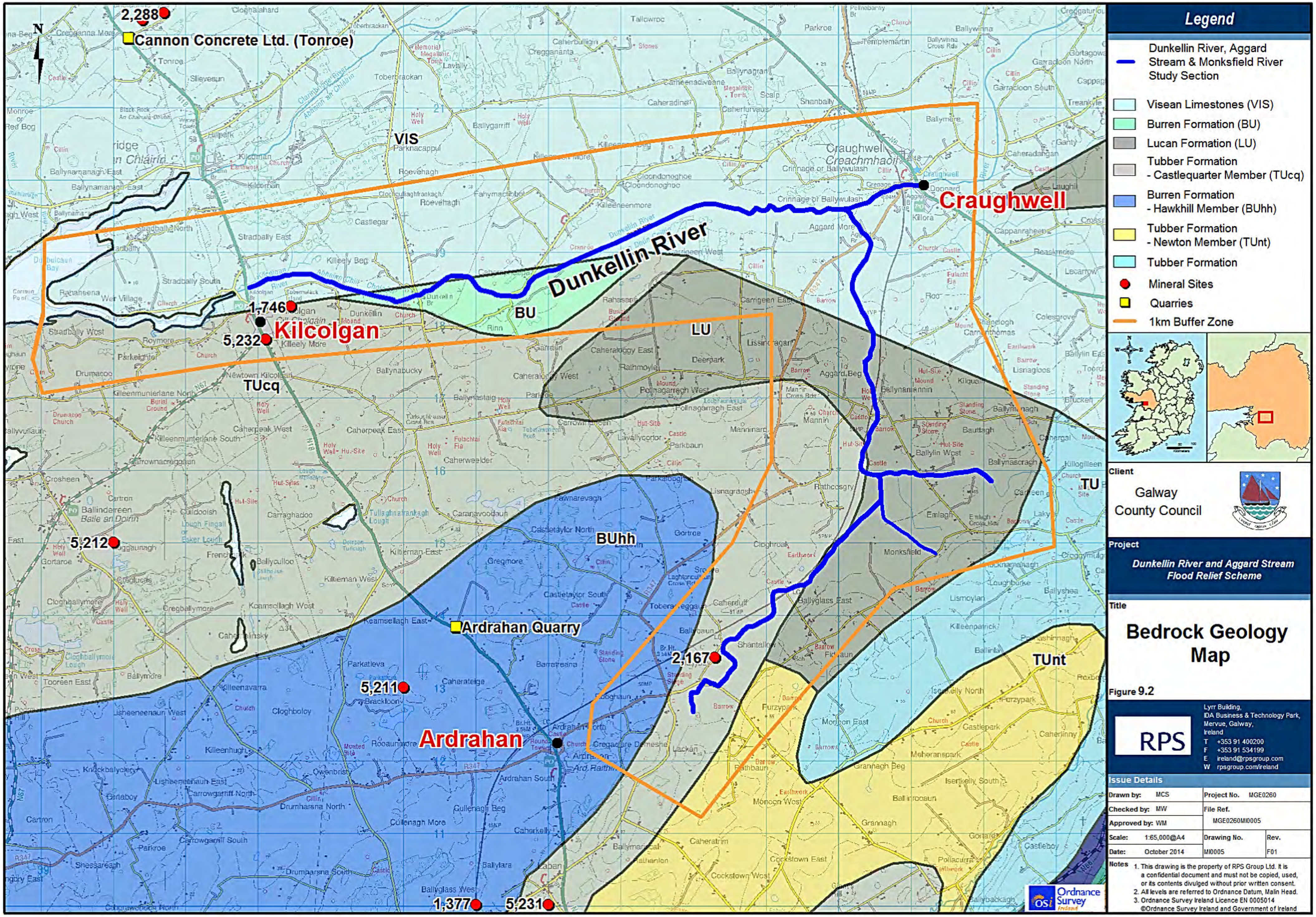
The GSI records show that there are a number of Group Water Supplies (GWS) located in the region which are shown in **Figure 9.3** and listed in **Table 9.4.** There are also a number of individual household groundwater supplies throughout the area, however a full register of such supplies is not available. The GSI records include the large spring abstraction for the Clarinbridge-Kilcolgan Regional Water Supply. This is no longer used as a source of public water supply (EPA 2011); however there remains a significant spring overflow which is a major groundwater discharge point from the aquifer.

Table 9.4 Group Water Supplies in the Region

Water Supply Name	Type	Abstraction (m^3/d)
Rinn GWS	Borehole	218*
Castletaylor - Adrahan GWS	Borehole	136
Caherdine/Caherdevan GWS	Borehole	70
Roevehagh GWS	Spring	102
Ganty - Craughwell GWS	Borehole	31
Carrigeen GWS	Borehole	34
Lisnagransby GWS	Borehole	58
Ballyglass/Fiddane GWS	Borehole	8
Kiltiernan/Kilcolgan GWS	Borehole	147*

**This represents borehole yield as opposed to actual abstraction*

The vulnerability of the aquifer underlying the Dunkellin River is classified by the GSI as Extreme. A significant proportion of this is described as rock near the surface or karst. The majority of the aquifer surrounding the Aggard Stream is classified by the GSI as “High Vulnerability” with small intermittent


Legend
Dunkellin River, Aggard Stream & Monksfield River Study Section
Visean Limestones (VIS)
Burren Formation (BU)
Lucan Formation (LU)
Tubber Formation - Castlequarter Member (TUcq)
Burren Formation - Hawkhill Member (BUhh)
Tubber Formation - Newton Member (TUnt)
Tubber Formation
Mineral Sites
Quarries
1km Buffer Zone
Client
Galway County Council
Project
Dunkellin River and Aggard Stream Flood Relief Scheme
Title
Bedrock Geology Map
Figure 9.2
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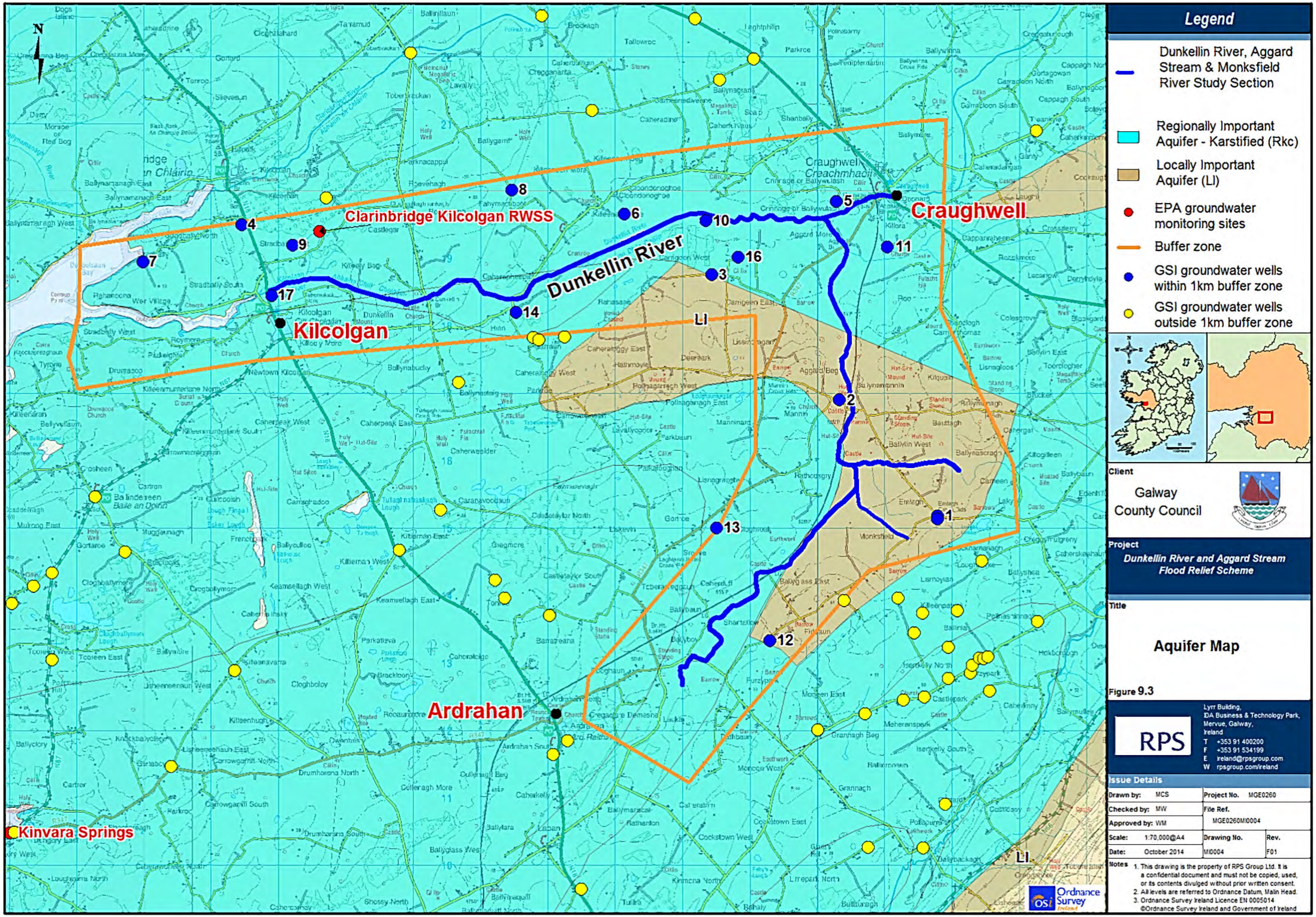
Cannon Concrete Ltd. (Tonroe)
Ardrahan Quarry
Dunkellin River
Kilcolgan
Craughwell
Ardrahan
VIS
BU
LU
TUcq
BUhh
TUnt
TU
2,288
1,746
5,232
5,212
5,211
2,167
1,377
5,231
Ordnance Survey Ireland


N
Dunkellin River
Kilcolgan
Craughwell
Ardrahan
Kinvara Springs
Clarinbridge Kilcolgan RWSS
LI
1
2
3
4
5
6
7
8
9
10
11
12
13
14
16
17
Legend
Dunkellin River, Aggard Stream & Monksfield River Study Section
Regionally Important Aquifer - Karstified (Rkc)
Locally Important Aquifer (LI)
EPA groundwater monitoring sites
Buffer zone
GSI groundwater wells within 1km buffer zone
GSI groundwater wells outside 1km buffer zone
Client
Galway County Council
Project
Dunkellin River and Aggard Stream Flood Relief Scheme
Title
Aquifer Map
Figure 9.3
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areas of “Extreme Vulnerability” and “Extreme (rock near the surface or karst)”. The groundwater vulnerability for the study area is shown in **Figure 9.4.**

There are numerous karst features within the study area as shown in **Figure 9.5**. There are 21 no. karst features located within a 1 km buffer zone shown in **Figure 9.5** and detailed in **Table 9.5**. Two other significant karst features have been identified outside the study are to the north-west at Clarinbridge-Lavally Estate Spa and Clarinbridge Spring.

Table 9.5 Karst Features Within 1km Buffer Zone

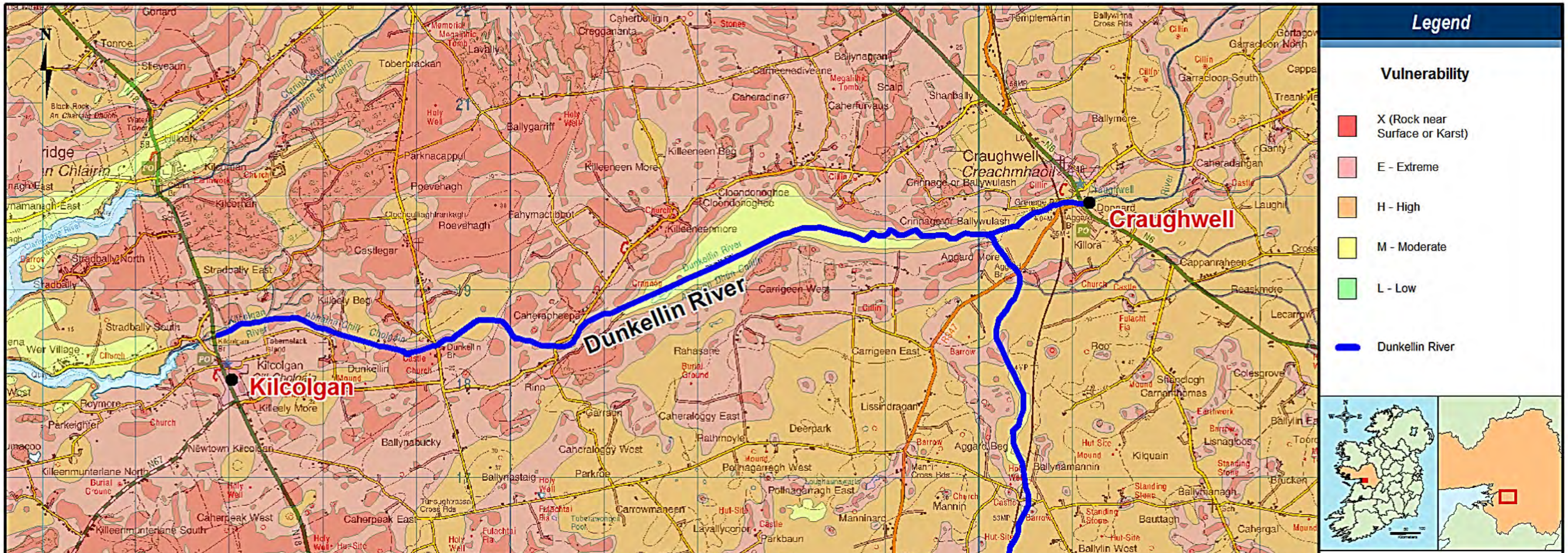
Map No	Type	Name	Townland
1	Cave	N/A	Ballymannagh
2	Cave	N/A	Killora
3	Turlough	Killora Turlough	Killora
4	Cave	N/A	Roo
5	Turlough	Aggard	Aggard Beg
6	Turlough	N/A	Killeeneen More
7	Cave	N/A	Stradbally South
8	Turlough	N/A	Kilcornan
9	Turlough	N/A	Castlegar
10	Turlough	Dunkellin	Roevehagh
11	Turlough	Rahasane	Rahasane/ Carrieen West
12	Swallow Hole	Cregaclare	Lackan
13	Spring	N/A	Lackan
14	Spring	Kilcolgan East	Kilcornan
15	Spring	Kilcolgan West	Stradbally
16	Swallow Hole	N/A	Crinnagh
17	Spring	Killeely Beg Spring	Killeely Beg
18	Spring	Tobernalack	Killeely More
19	Turlough	N/A	Lackan
20	Turlough	N/A	Lackan
21	Spring	Rahasane House	Rahasane

Tracer tests carried out by the GSI show that a number of karst features in the area are interconnected (**Figure 9.5**). Of particular interest to this study, the tests show definite interconnection of karst features to the south and east of the river channels with those in the north west of the study area. Karst features 2 (Cave), 3 (Turlough), 6 (Turlough) and 11 (Turlough-Rahasane) as well as other karst features several kilometres to the south of the study area all show connectivity to Karst features north west of the Dunkellin River channel – namely: Lavally Estate Spa, Clarinbridge Spring, 7 (Cave) 8 (Turlough),14 (Spring),15 (Spring),17 (Spring) and18 (Spring).

Groundwater investigations undertaken by Drew (1986) note “*permanent or semi-permanent springs in the Dunkellin catchment are those which provide much of the baseflow discharge for the Aggard River (Manning Springs and Aggard Springs) both with a relatively constant discharge. There are also a series of springs close to Dunkellin-Raford channel that become operative only during high water conditions. These include the major spring near Rahasane House which contributes a flow of c.0.5 cumecs to the turlough, a series of medium springs on the north side of the Dunkellin Turlough and, much the largest, the springs upstream of Rahasane Turlough*.”

The recent assessment of the turlough hydrology by Tobin Consulting Engineers (2012) estimate the average input of the Rahasane House Spring to the turlough water balance is $0.24 m^3/s$, which is of the same order to that estimated above.

Groundwater velocities in the catchment are in the order of 12 to 210 m/hr depending on location and groundwater levels. Groundwater velocities are in the order of 12 to 90 m/hr to Clarinbridge springs and 4 to 210 m/hr to Dunkellin springs. Groundwater velocities increase by 1.5 m/hr in high water conditions. The data suggest a zone of higher transmissivity stretching inland from the main discharge points at the



Legend

Vulnerability

- X (Rock near Surface or Karst)
- E - Extreme
- H - High
- M - Moderate
- L - Low
- Dunkellin River

Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Groundwater Vulnerability

Figure 9.4

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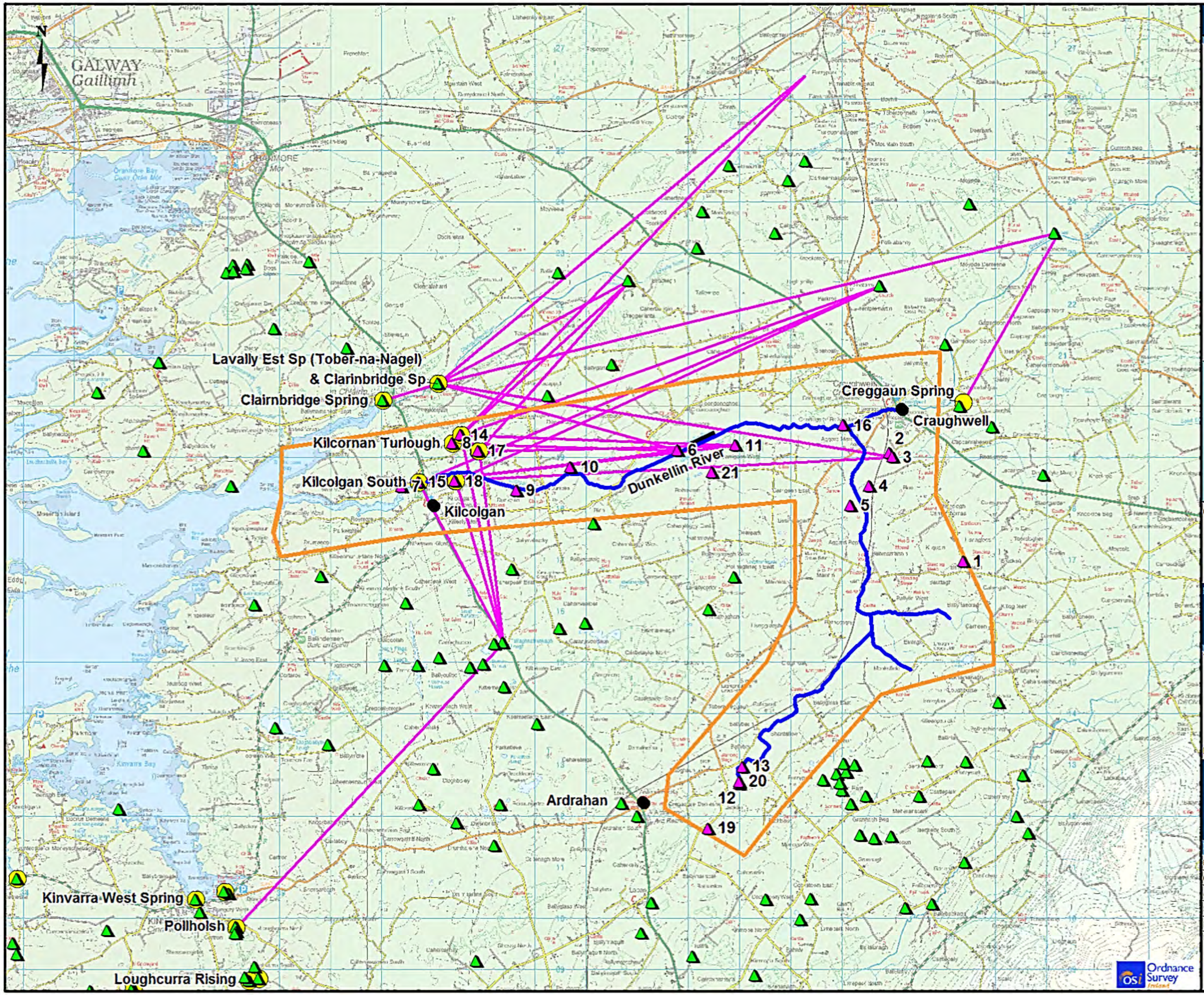

Legend

- Dunkellin River, Aggard Stream & Monksfield River Study Section
- Karst Features
- 1km Buffer Zone
- Karst Features Outside 1km Buffer Zone
- Tracer Lines
- Tracer Output Sites

Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Karst Features & Tracer Lines

Figure 9.5

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head of the estuaries. Overall, flow directions are to the west, with groundwater discharging to littoral and intertidal springs at the head of the main estuaries.

9.3.4 Groundwater Dependant Terrestrial Ecosystems (GWDTE)

Groundwater dependent terrestrial ecosystems (GWDTE) are wetlands which critically depend on groundwater flows and/or chemistries and are included in the register of protected areas established under Regulation 8 of the European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003).

Rahasane Turlough is the most important turlough for birdlife in the country. In a relatively recent national survey, it was also rated very highly for its vegetation and supports two rare species listed in the Irish Red Data Book. Turloughs are a rare habitat type and are given priority status under Annex I of the European Habitats Directive. Drainage is a major threat to turloughs.

Rahasane was formerly the natural sink of the Dunkellin River, but now an artificial channel takes some of the water further downstream. The turlough consists of two basins which are connected at times of flood but separated as the waters decline. Water escapes the artificial channel to sweep around the northern basin, and again in the west, where it flows into an active swallow-hole system. The main swallow holes here are constantly changing and reach up to 5 m in diameter and 2 to 3 m deep. Some minor collapses are found elsewhere in the turlough, as well as a small number of more permanent pools.

There is surface flow monitoring directly up and down stream of the turlough at the gauges No. 29010, 29007, 29002. An analysis of the hydrographs from these gauges shows this section of the river which flows though the turlough fluctuates between a losing and gaining stream (with respect to groundwater) throughout the year. There are groundwater monitoring wells present in the area which were installed during a previous flood alleviation study. There has been no ongoing monitoring of groundwater or surface water levels on a regular basis within the turlough.

The other turloughs within the study area are all considered GWDTEs including Dunkellin Turlough, Castlegar Turlough, Killora Turlough, Aggard Turlough, Killeeneen Turlough, Kilcornan Turlough and the turloughs at Lackan. The available information on the hydrogeology of these features is not as good as that available for Rahasane Turlough. Information on the hydrogeological connections with other karst features is provided by the GSI.

9.3.5 Geological Heritage

The Geological Survey of Ireland (GSI) and the Irish Geological Heritage programme (IGH) works in partnership with the National Parks and Wildlife Service (NPWS) of the Department of Environment, Community and Local Government to identify and select important geological and geomorphological sites throughout the country for designation as NHAs (Natural Heritage Areas).

Rahasane Turlough is designated as an NHA under the IGH 1 Karst Theme with the following synopsis: "*Rahasane Turlough functions as an enormous estavelle (ground orifice which, depending on weather conditions and season, can serve either as a sink or as a source of freshwater), there being a very large number of estavelles of widely differing capacities particularly on the northern side of the feature. Under low water conditions, the turlough is the terminal sink for the Dunkellin River but under wetter conditions some flow continues along the artificial channel to the estuary*". The site already lies within Rahasane Turlough NHA and SAC and the GSI also note that a main threat to the turlough is drainage.

9.4 POTENTIAL IMPACTS

The full scopes of works are described in **Chapter 6**. The proposed engineering measures will be completed at the following reaches of rivers as follows:

- Approximately 11 km of the Dunkellin River which runs in a westerly direction from Craughwell Village to the sea at Kilcolgan; and

- Approximately 7.5 km of the Aggard Stream which runs in a southerly direction from Craughwell to Ardrahan.

The main engineering works proposed along the Dunkellin River are outlined in **Table 9.6** below. The works include channel widening, channel regrading, alterations to bridge designs and relocation of a salmon counter. In addition to the engineering measures detailed in **Table 9.6**, additional works will be undertaken within the river channel to aid the passage of fish up the river.

It is not proposed to undertake any significant arterial drainage works along the Aggard Stream. The proposed works associated with the Aggard Stream will be limited to culvert replacement and the replacement of field wall crossings together with maintenance works including the non-invasive trimming of bank-side vegetation and the removal of areas of silt build up along the full length of the channel.

9.4.1 Construction Stage

The potential impact of the individual engineering items are summarised on **Table 9.6**. The potential impacts as they relate to proposed activities are outlined below.

9.4.1.1 Accidental Spillages and Leaks

There is a potential for accidental soil and groundwater contamination due to spills and leaks of oils and other contaminants during the construction stage of the proposed works. The potential for these impacts to occur is minimised by adhering to the relevant construction guidelines (CIRIA C532 and C648).

9.4.1.2 Channel Widening and Spoil Spreading

The proposed works include the excavation of soil materials along the banks of the river. An assessment of the expected volume of excavated material has been completed and is included in **Table 6.1**, **p.63**, of the report included in **Appendix A** to this report. The total estimated volume of material to be excavated is 69,790m³.

The excavated material will be reused for side-slope protection, creation of bankside spoil embankments and the creation of extended spoil heaps. It is expected that where this material is spread on adjacent lands the material will be between 0 and 0.5 m thick. Initial treatment will require removal and storage of topsoil, spreading of excavated material and reinstatement of the topsoil. This will minimise the transport of material offsite and aim to return the soils to the pre-works quality.

The nature of the excavated material will be a mixture of topsoil, subsoil, weathered rock and solid bedrock. Teagasc subsoil mapping indicates the soil type along the river where the excavation is to occur is Grey Brown Podzolics. The depth of the topsoil can potentially be very thin and there is a risk that the reinstated ground may not be of a comparable quality.

Where soil cannot be returned to a similar quality this would constitute a permanent negative impact on the soils and geology of the area. The attribute importance of the soils is considered to be medium as they are considered in general moderately drained with moderate fertility. A permanent impact on a significant proportion of the soil in the area would constitute a moderate impact on the soils and geology.

Material deposited in the vicinity of existing karst features could lead to subsidence and a disturbance of the hydrogeological system. The area exposed by the excavation will be more susceptible to karstification due to the removal of the soil and subsoil. This may lead to local alterations of the shallow karst (epikarst). However as the excavated material is being deposited in the adjacent lands this will lead to additional buffering and reduced karstification in these areas. As a result the net impact on the local and regional karst fissure systems is expected to be imperceptible.

The proposed deposition areas are shown in the scheme drawings attached to the report in **Appendix A**. These areas have been assessed using information currently available from GSI databases, detailed historical and current OSI maps, aerial photography and site visits. The proposed spread areas downstream of Killeely Beg Bridge will include the upwelling and channel of the Tobernalac springs.

9.4.1.3 In-channel Works

In-channel works are proposed at a number of stages throughout the scheme including:

- Relocation of the Salmon Counter (Item 3); and
- Channel Regrading (Items 10 - 14).

It is proposed to complete in-channel works using cofferdam type construction whereby flow can be restricted allowing the civil engineering works to be undertaken in the dry conditions. It is proposed to use surface dewatering pumps to dewater the section of the channel under construction. It is possible that during such works significant groundwater inflows from the channel bed could occur where fractured limestone is exposed. Inflows can be expected laterally though the weathered bedrock (epikarst) and also vertically where discrete fissures are intercepted in the riverbed.

Where groundwater inflows are significant water management controls will be required. This may involve aquifer dewatering to lower the water table below the base of the channel in the vicinity of the works. Dewatering would constitute a temporary, slight negative impact on the groundwater flow regime and potentially affect adjacent groundwater supplies if present.

In-channel regrading works can lead to river sediment disturbance with subsequent siltation and deposition downstream of the location which is considered a slight impact on soils and geology.

9.4.1.4 Channel Maintenance

Channel maintenance, which includes non-invasive trimming of bank-side vegetation and the removal of areas of silt build up along the full length of the channel, is expected to have a temporary imperceptible impact on the soils, geology and hydrogeology.

9.4.2 Operational Stage

The potential impact of the individual engineering items is summarised in **Table 9.6**. The potential impacts as they relate to proposed activities are outlined below.

9.4.2.1 Channel Widening Works

The proposed design for channel widening works (items 7, 9, 11 and 14) ensures that it will not involve excavation within the existing channel (in river works) and it is not proposed to alter the existing bed levels. This method of construction means that average annual flow can be contained within the existing channel and excavation can be undertaken along the bank with minimal interference to the water quality.

Based on this design it is expected that baseflow (groundwater contribution) to the river will only be altered during higher flows when the main channel floods. Groundwater contribution during lower flows will continue in a similar pattern as there will be minimal influence at these times. Improved drainage during storm events will reduce the potential for groundwater flooding along the floodplain and is considered a slight neutral impact.

9.4.2.2 Channel Regrading

Channel regrading is proposed at the following locations:

- Work Item No. 1: The main channel shall be deepened by 1.0m to 1.5m over an approximate length of 950m;

- Work Items 2, 3, 4: Reduction in bed level in the range of 0.5m to 0.6m over an approximate length of 850m; and

- Work Item 5: Reduction in bed level of 0.75m at the railway bridge.

The deepening of these channels will alter the baseflow in the river channel during lower flows. The water-table in the vicinity will be lowered as a result of the deeper channel. This will typically result in increased groundwater flow into the river channel and improved drainage of adjacent lands. There may also be a slight impact on local groundwater users where the abstraction is from a shallow well or spring. There are no shallow wells currently documented within the vicinity of the works. Improved drainage during storm events will reduce the potential for groundwater flooding along the floodplain. This is considered a slight neutral impact.

9.4.2.3 Rahasane Turlough

Channel deepening of the existing river, downstream of Rahasane Turlough cSAC, was considered at an early stage of the study. However, the main hydraulic restriction along this channel reach was the water level in the turlough. Channel deepening would require significant reductions in bed levels throughout this reach of the river. This alternative was not considered to be viable as it has the potential to reduce the water profile in Rahasane Turlough cSAC to levels that would significantly impact on the normal flood regime and therefore impact on the local flora and fauna. This was not considered to be viable as the turlough is a protected habitat and heritage site.

The impact of the proposed works on the turlough was examined across a range of flows. The range of flows examined included the average flow, the 10th percentile, the 5th percentile and November 2009 flood. The reduction in the water levels and flooded extent was examined as part of this work.

Appendix A, Figure 4.4 and **Figure 4.5** shows the predicted surface water profile along the length of Rahasane Turlough for the November 2009 and two year return flood event respectively are applied to the scheme. There is no perceptible change in the modelled flood levels following the proposed works.

Appendix A, Figure 4.6 shows the predicted surface water profile at a cross sectional location within Rahasane Turlough cSAC when the November 2009 Flood event, the 5th percentile flow, the 10th percentile flow and average flow area are applied to the model. There is an imperceptible change in the water levels in the turlough for these events.

Appendix A, Figure 4.7 shows the estimated flood extent for the November 2009 flood before and after flood alleviation works are implemented. There is no perceptible change in the flooded extent of the turlough over these modelled flood events

The modelling results were also used to develop a Depth Duration/Percentile Exceedance Curve for Rahasane Gauging station. The results show no perceptible impact on the flooding frequency or the persistence of the flood levels. This data has also been presented as a water level hydrograph for the turlough for the four years from 2008 to 2011. A comparison of the hydrograph before and after the proposed works shows no perceptible change in the water level fluctuations.

In summary, the output of the modelling has shown there will be no perceptible change to the flooding extent, flood levels or flood frequency at Rahasane Turlough as a result of the scheme. The potential impact on the hydrogeology of the turlough is therefore considered to be an imperceptible neutral impact.

9.4.2.4 Dunkellin Turlough

During high flows, the Dunkellin River also overtops its banks approximately 750 m downstream of Rinn Bridge and flood waters enter Dunkellin Turlough. The surface drainage from the turlough is restricted by flow through Dunkellin Bridge immediately downstream of the turlough. The flood eyes at the bridge are currently restricted by a number of blockages and are insufficiently sized to cater for predicted flood events. The proposed works at the bridge and immediately upstream (Work Items 9 and 10) include:

- Two stage channel with an additional width of up to 20 m from approximately 175 m upstream of the Dunkellin Bridge;

- The existing flood eyes shall be replaced with two new box culverts each measuring 13 m wide x 2.3 m deep; and

- Localised channel widening (to 30 m) to facilitate the proposed bridge works.

The predicted reduction in the November 2009 peak flood level will be from 10.44 mOD to 9.68 mOD at the bridge. The removal of obstructions from the bridge and installation of the new flood eyes will reduce the incidence of surface flood waters backing up and entering the turlough. This will return the turlough to a more natural flood cycle where the flood water composition, flooding levels and flood frequency/duration are more dependent on the groundwater levels and more characteristic of baseline conditions before the construction of the bridge and the later blockage of the flood eyes. Therefore proposed works are considered to have a slight positive impact on the hydrogeology of the turlough during operation.

9.4.2.5 Other Karst Features

There are a large number of karst features located within the study area as outlined in **Section 9.3.3.** There is considered to be no potential for impact at the features where the character is defined by the geomorphology such as caves and enclosed depressions. Hydrogeological impacts have been considered for features such as springs, swallow holes and turloughs.

There is an unnamed turlough directly upstream of Killeely Bridge at Castlegar. The area on both banks of the river is liable to flooding in this location. The historical 6 inch maps show a single turlough which was subsequently dissected by the arterial drainage works. The proposed works will encroach on the boundary of the turlough adjacent to the river as a result of the embankment land take and there will be some spoil spreading in the area. These changes are not considered to have a significant effect on the hydrogeology of the feature. It is expected that groundwater flooding will continue to occur in the area. The new embankment may prevent surface runoff of flood waters into the river, which may extend the duration of flooding at this location.

There are a number of proven connections between karst features in the area by successful dye tracing experiments. These connections are typically via underground karst conduits which act like pipes connecting the different features. Therefore a turlough at one location can be draining underground to a spring or another turlough downstream. For instance there are a number of proven connections from Rahasane Turlough to the springs at Kilcolgan, Killeely Beg Spring, Kilcornan Turlough, Clarinbridge Spring and Lavally Estate Spring.

There is not considered to be any perceptible impact on these downstream features as predicted impact on Rahasane Turlough is considered to be imperceptible.

Table 9.6 Summary of Engineering Works and Potential Geological and Hydrogeological Impacts

Works Item	Description of Location	Proposed Works	Construction / Operational	Quality	Duration	Significance
1	Main Channel (Craughwell Village).	The main channel shall be deepened from 17.85 mOD (35 m u/s of the road bridge in Craughwell) to 14.66 mOD (610 m d/s of the railway bridge).	Construction	Negative	Temporary	Slight impact on hydrogeology
			Operation	Positive	Permanent	Slight impact on soils
2	R446 Bridge.	The channel shall be deepened by approximately 0.6 m at the R446 Road Bridge (underpinning of the bridge will be required).	Construction	Negative	Temporary	Slight impact on hydrogeology
			Operation	Positive	Permanent	Slight impact on soils
3	Masonry Arch Pedestrian Bridge.	The channel shall be deepened by approximately 0.6 m at each arch (underpinning of all arches will be required).	Construction	Negative	Temporary	Slight impact on hydrogeology
			Operation	Positive	Permanent	Slight impact on soils
4	Bypass Channel.	The channel shall be graded from an u/s level of 18.5 to a d/s level of 18.0 mOD. (The bypass bridge will require underpinning to match proposed bed levels).	Construction	Negative	Temporary	Slight impact on hydrogeology
			Operation	Positive	Permanent	Slight impact on soils
5	Railway Bridge in Craughwell	The channel shall be deepened by up to 0.75 m. (underpinning/scour protection of the railway bridge will be required)	Construction	Negative	Temporary	Slight impact on hydrogeology
			Operation	Neutral	Permanent	Slight impact on hydrogeology
Channel Maintenance works along the Aggard Stream.		Culvert replacement works.	Construction	Negative	Temporary	Imperceptible Impact on geology
			Operation	No impact predicted		
6	*Works at Rahasane Turlough.*	*It is not Proposed to Complete any Works within the Rahasane Turlough cSAC.*	Construction	No Predicted Impacts		
			Operation	Neutral	Permanent	Imperceptible
7	Channel Works at Rinn.	A two stage channel typically 20 m wide will be constructed from approximately 50m upstream of Rinn Bridge to approximately 50 m downstream of the bridge.	Construction	Negative	Permanent	Imperceptible
			Operation	Neutral	Permanent	Slight impact on hydrogeology

Works Item	Description of Location	Proposed Works	Construction / Operational	Quality	Duration	Significance
8	Works at Rinn Bridge	Provide three flood eyes measuring 3.9 m wide x 2.1 m deep.	Construction	Negative	Temporary	Imperceptible
			Operation	No Predicted Impacts		
9	Channel Works beginning upstream of Dunkellin bridge	Works will commence approximately 175m upstream of the Dunkellin bridge and consist of the construction of a two stage channel with an additional width of up to 20 m.	Construction	Negative	Permanent	Imperceptible
			Operation	Neutral	Permanent	Slight impact on hydrogeology
10	Works at Dunkellin Bridge	In conjunction with localised channel widening to facilitate the proposed bridge works (30m), the existing flood eyes shall be replaced with two new box culverts each measuring 13 m wide x 2.3 m deep.	Construction	Negative	Temporary	Imperceptible
			Operation	Positive	Permanent	Slight impact on hydrogeology
11	Channel Works from Killeely Beg Bridge to Dunkellin Bridge	Two stage channel works continue from Dunkellin Bridge to Killeely Beg Bridge with a typical channel width of up to 20 m.	Construction	Negative	Permanent	Imperceptible
			Operation	Neutral	Permanent	Slight impact on hydrogeology
12	Works at Killeely Beg Bridge	In conjunction with localised channel widening to facilitate the proposed bridge works (14m), a new bridge shall be provided with an 18 m span and a soffit level of 7.80 mOD.	Construction	Negative	Temporary	Imperceptible
			Operation	No Predicted Impacts		
13	Salmon Counter	The salmon counter will be relocated to a position upstream of Kileely Beg bridge as part of the river enhancement works.	Construction	Negative	Temporary	Slight impact on soils and geology
			Operation	No Predicted Impacts		
14	Channel Works from the N18 Bridge to Killeely Beg Bridge	Two stage channel works will continue from Killeely Beg to the N18 Bridge with a typical channel width of up to 20m. From a distance of 400m upstream of the N18 Bridge the two stage channel will be tapered back to match existing channel widths.	Construction	Negative	Permanent	Imperceptible
			Operation	Neutral	Permanent	Slight impact on hydrogeology

Works Item	Description of Location	Proposed Works	Construction / Operational	Quality	Duration	Significance
15	Works at Kilcolgan & N18 Bridges	No Works Proposed.	Construction	No Predicted Impacts		
			Operation	No Predicted Impacts		

9.5 MITIGATION MEASURES

9.5.1 Construction Stage

The potential impacts on geology and hydrogeology at construction stage are considered to be slight to imperceptible. The existing design contains a number of mitigating measure to minimise any impacts on the geology and hydrogeology including soil and water management.

All construction works should be completed in accordance with the following best practice guidelines to ensure the potential for accidental soil and groundwater contamination is minimised:

- CIRIA (Construction Industry Research and Information Association) guidance on '*Control of Water Pollution from Construction Sites' (CIRIA Report No C532, 2001); and*

- CIRIA (Construction Industry Research and Information Association) guidance on '*Control of Water Pollution from Linear Construction Projects*' (CIRIA Report No. C648, 2006).

Where dewatering of the aquifer is required to produce a dry working environment for in-channel works a local water feature survey, including private and public wells, should be completed in conjunction with a hydrogeological risk assessment to determine the potential impact on local groundwater users.

Spreading of excavated materials should not be undertaken in the immediate vicinity of karst features. A large number of karst features have been documented in the region, however, the GSI karst database is incomplete and many field scale karst features are not included. Material deposition should be excluded from within 5 m of any karst feature including springs, enclosed depressions (dolines), swallow holes, turloughs and caves.

The final design of new river embankments should be approved by a geotechnical engineer. In particular the design and construction should ensure that the toes of the embankments are not susceptible to scouring during flood events as this could lead to slope failure.

The construction of the bankside spoil embankments should be complete to ensure slope stability based on mixture rock and soil type used in the construction. The final design of these features should be approved by a geotechnical engineer to ensure slope failure will not occur.

9.5.2 Operational Stage

There has been limited monitoring of the groundwater levels and turlough levels at Rahasane Turlough. As such, the hydrogeological conditions controlling the water level fluctuations are poorly understood. It is recommended that groundwater level monitoring and turlough stage monitoring are undertaken as part of the scheme. The monitoring should be coordinated with the Environmental Protection Agency (EPA) who is required to monitor the hydrogeology of the turlough under the Water Framework Directive (WFD) as it constitutes a groundwater dependant ecosystem.

The monitoring data should be reviewed following a period of 12 months of monitoring. This will allow the modelled fluctuations and response of the turlough to be compared to observed levels. Where discrepancies are evident between the observed and modelled levels a review of the model calibration and potential impacts on the turlough should be reconsidered.

9.6 RESIDUAL IMPACTS

There are no significant residual negative impacts expected to the soils, geology and hydrogeology. Slight temporary negative impacts are expected on the soils due to the deposition of silts on downstream river beds as a result of in channel works. Slight permanent impacts are expected on geology due to the excavation of river channel bedrock during channel regarding works. A slight positive impact is expected on the hydrogeology of Dunkellin Turlough.

9.7 CONCLUSION

The proposed flood alleviation works on the Dunkellin River and Aggard Stream will be completed in karstified limestone bedrock environment which constitutes a regionally important aquifer. In addition, the works will be conducted directly up and down stream of Rahasane Turlough which is the largest turlough in the country and has been defined as a Special Area of Conservation (SAC).

The flood alleviation measures have been designed to minimize the impacts on the geology and hydrogeology of the area.

Outputs from the flood modelling have shown there will be no perceptible change in the overall flooding regime in Rahasane Turlough. Other aspects of the proposed work including channel widening, channel regrading, spoil deposition and channel maintenance have been assessed to determine their potential impact on the soils, geology and hydrogeology.

There are slight to imperceptible impacts expected on the soils, geology and hydrogeology as a result of the proposed works.

There will be a reduction in the ingress of surface water flood waters into Dunkellin Turlough and the turlough at Castlegar/Killeely Beg as a result of the proposed development. This is not considered to impact the hydrogeology of the features, i.e. the groundwater flow into and out of the turloughs. There are no other impacts expected at any groundwater dependant ecosystems in the study area.

Mitigation measures have been recommended in relation to aquifer dewatering for in-channel works, exclusion zones for spoil deposition surrounding karst features and groundwater and surface water monitoring in Rahasane Turlough.

Monitoring of the turlough levels and surrounding groundwater levels in the area is recommended.

9.8 REFERENCES

EPA (2011) Water Framework Directive - Groundwater Monitoring Programme Site Information: Clarinbridge Kilcolgan RWSS. Environmental Protection Agency.

10 TERRESTRIAL ECOLOGY

10.1 INTRODUCTION

This section of the EIS assesses the ecological value of the study area, assesses the potential impacts on the terrestrial ecology of the surrounding area and recommends mitigation measures in order to alleviate these impacts. This assessment has been carried out in accordance with the EPA document *Guidelines on Information to be contained in Environmental Impact Statements* (EPA, 2002).

This chapter of the EIS examines the terrestrial environment of the proposed Dunkellin River and Aggard Stream Flood Relief Scheme (the scheme). The principal objectives of this study are to:

- Complete a desk study and to obtain relevant terrestrial and aquatic ecological data for the zone of influence (ZOI) of the proposed works;
- Identify and describe sites of known or potential ecological interest; and
- Assess the significance of the likely significant impacts of the scheme on each of these environmental aspects.

Please see **Chapter 6** of this EIS which outlines the Project Description. It should also be noted that **Chapter 11** contains details on the assessment and potential impacts relating to aquatic ecology including fisheries.

10.2 STUDY AREA AND ZONE OF INFLUENCE

The study area encompasses the course of the Aggard Stream from its source to its confluence with the Dunkellin River and the floodplain and surrounding lands of the Dunkellin River from just upstream of Craughwell Village to its discharge to Galway Bay just west of Kilcolgan.

The Zone of Influence (ZOI) extends beyond the study area to include those Environmental Resources and Receptors outside the study area that is likely to be affected by the biophysical changes caused by the project. As part of the assessment, the ecological areas and features (i.e. the ecological receptors) likely to be affected by the biophysical changes caused by the project, however remote from the proposed Flood Relief Scheme (FRS) are assessed.

10.3 METHODOLOGY

10.3.1 General

This assessment has been prepared in accordance with the following guidelines;

- *Guidelines on the information to be contained in Environmental Impact Statements* (EPA 2002);
- *Advice Notes on current practice in the preparation of Environmental Impact Statements* (EPA, 2003);
- European Communities (Environmental Impact Assessment) Regulations, 1989 to 2006;
- Planning and Development Act, 2000 (as amended);

- Institute of Ecology and Environmental Management *Draft Guidelines for Ecological Impact Assessment* (IEEM[2] 2006);
- *Appropriate Assessment of Plans and Projects in Ireland Guidance for Planning Authorities* (DoEHLG, 2009);
- Managing Natura 2000 Sites: the provisions of Article 6 of the 'Habitats' Directive 92/43/EEC, Office for Official Publications of the European Communities, Luxembourg (EC, 2000);
- *Assessment of Plans and Projects Significantly Affecting Natura 2000 Sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC*, Office for Official Publications of the European Communities, Luxembourg (EC, 2002);
- *Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC – Clarification of the concepts of: alternative solutions, imperative reasons of overriding public interest, compensatory measures, overall coherence, opinion of the commission* (EC, 2007);
- *Interpretation Manual of European Union Habitats*. Version EUR 27. European Commission 2007;
- *The Status of EU Protected Habitats and Species in Ireland*. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland NPWS (2008);
- *Guidelines for the Assessment of Ecological Impacts of National Road Schemes Rev. 2. National Roads Authority NRA* (2009);
- *NRA Guidelines on Ecological Surveying Techniques for Protected Flora and Fauna on National Road Schemes*. National Roads Authority (NRA, 2008); and
- Council Directive 92/43/EEC of 21st May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive) and Directive 2009/147/EC (codified version of Directive 79/409/EEC as amended) (Birds Directive) – transposed into Irish law as European Communities (Birds and Natural Habitats) Regulations 2011.

The methodology comprises the following elements: Desk Study, Consultation and Field Assessments. These elements are used to identify, describe and map areas of known or potential ecological value.

A review of Ordnance Survey maps and high resolution aerial photographs of the study area was carried out prior to field visits. This exercise aimed to identify areas of low ecological value, such as; urban areas, areas under arable cultivation or under intensive pasture. Conversely, the review of aerial photographs was also used to identify areas of potentially high ecological value such as woodlands and wetlands, so that field survey work was targeted to focus upon these. Multidisciplinary site surveys were carried for terrestrial and aquatic flora and fauna, during the optimum seasons for the habitats and species. Specific surveys for targeted plant community groups, birds and mammals were conducted during the optimum seasons.

10.3.2 Desk Study

The sources of published material that were consulted as part of the desk study for the purposes of the EIS are as follows;

[2] Now known as the Chartered Institute of Ecology and Environmental Management (CIEEM)

- A review of the National Parks & Wildlife Service (NPWS) natural heritage database for designated areas of ecological interest and sites of nature conservation importance within and adjacent to the study area. Designated sites within 15km of the study area are shown on **Figure 10.1**;

- The New Atlas of British and Irish Flora (Preston *et al*., 2002) and the various British Trust for Ornithology (BTO) Bird Atlases;

- NPWS Rare and Protected Species Database;

- Literature review to identify and collate relevant published information on both ecological aspects of the study area and relevant ecological studies conducted in other areas; and

- Review of Ordnance Survey maps and of aerial images where available.

The NPWS Site Synopses for sites of nature conservation contain a description of the scientific interest and conservation importance of each designated site. The Natura 2000 Data Form contains relevant background information on each of the designated sites, while the Conservation Objectives summarises the aims and objectives of the designation awarded to a particular site. Where available, Conservation Objectives supporting documents were also reviewed, such as the Turloughs supporting document for Galway Bay Complex SAC (NPWS, 2013c). All of these documents were referenced for each of the designated conservation areas.

A full desktop review was conducted of the higher plant species recorded within the Ordinance Survey (OS) National Grid Squares (10 km x 10km) within which the proposed flood relief works are located. The principal source of information regarding the distribution of flora in Ireland is the *New Atlas of the British & Irish Flora* (Preston *et al.*, 2002). The data included in this Atlas is from the 1987-1999 Atlas survey. The Atlas shows data for vascular plants in individual 10 km Grid Squares or 'hectads'. The records for the relevant Grid Squares (M41, M42, M51 and M52; **Figure 10.2**) were consulted and a search was carried out to investigate if any rare or protected plant species had been recorded in the squares, during the 1987-1999 atlas survey (and previous surveys) carried out by the Botanical Society of the British Isles (BSBI). The NPWS were consulted for records of rare and protected species within the study area. The NPWS Maps and Data Database and the NPWS Rare Plants Database for all rare and protected species for the relevant Grid Squares was consulted in order to identify any legally protected or rare plant species known to be present within the study area. The desktop review also included the identification of vascular plants that are listed in Annex II of the EU Habitats Directive, Flora Protection Order (FPO) of 1999, the Wildlife Act 1976, the Irish Red Data Book (IRDB) and the NPWS Site Synopsis for designated conservation areas.

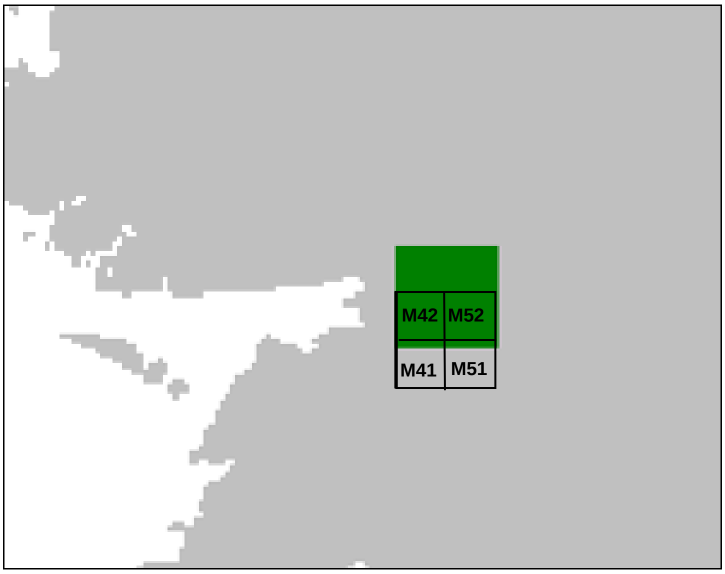
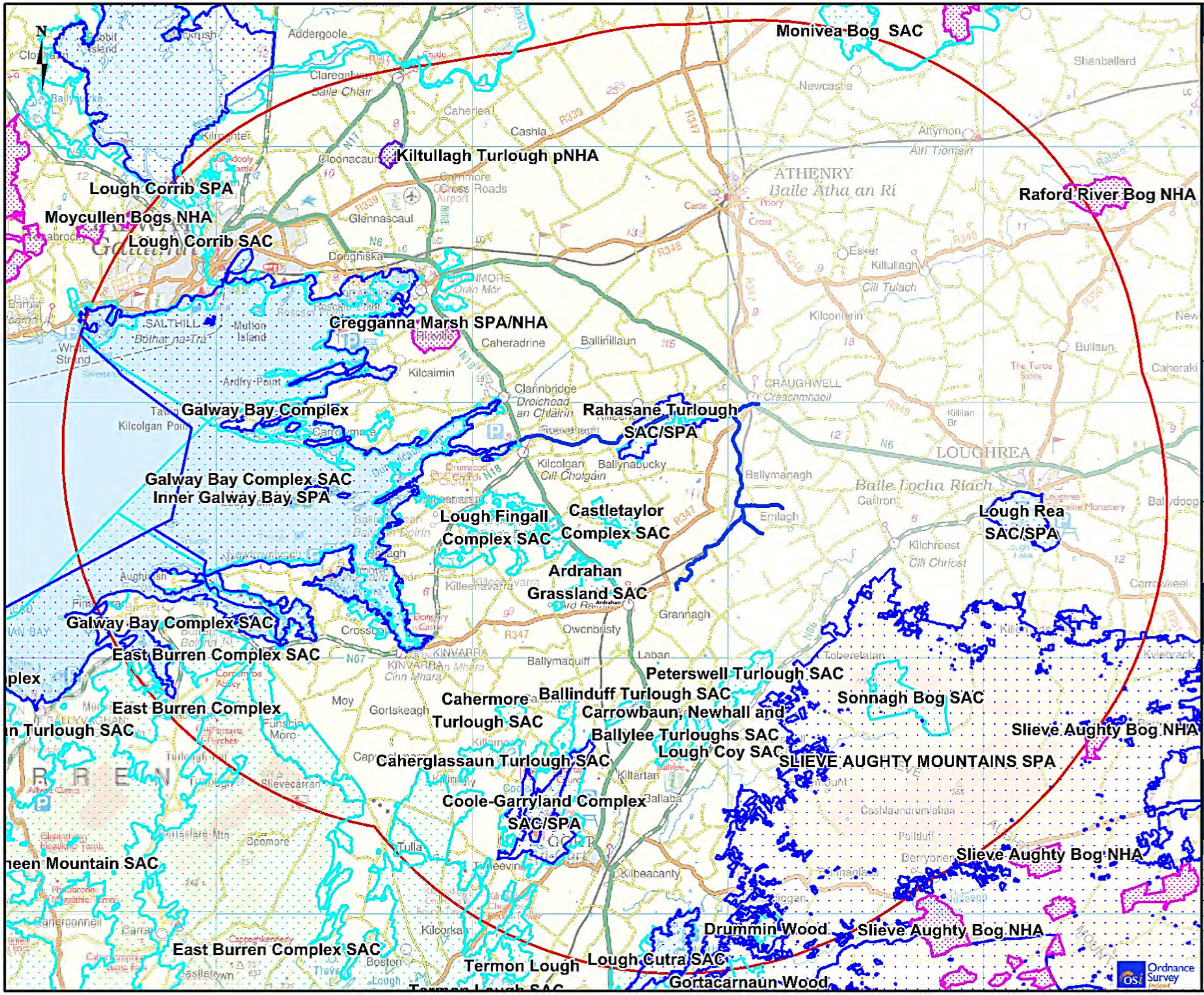


Figure 10.2 10km Squares M41, M42, M51 and M52



Legend

- Dunkellin River, Aggard Stream & Monksfield River
- Special Area of Conservation (SAC)
- Special Protection Area (SPA)
- Natural Heritage Area (NHA)
- Proposed Natural Heritage Area (pNHA)
- 15km radius

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Dunkellin River and Aggard Stream Flood Relief Scheme

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Designated Sites within a 15km Radius of the Study Area

Figure 10.1

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A full desktop review of bird and mammal species and populations of conservation concern within the relevant Grid Squares which are traversed or are adjacent to the scheme was undertaken.

'The Bird Atlas 2007-2011: *The Breeding and Wintering Birds of Britain and Ireland: 2007-2011*' (Balmer *et al*., 2013) was consulted for information regarding the population trends and distribution of birds recorded in the relevant Grid Squares. The birds listed under Annex I which are offered special protection by the EU Birds Directive and on the Birds of Conservation Concern in Ireland (BoCCI) (Colhoun and Cummins, 2013) red list were also identified.

Those listed on the BoCCI red list meet one or more of the following criteria:

- Their breeding population or range has declined by more than 50% in the last 25 years;
- Their breeding population has undergone significant decline since 1900; or
- They are of global conservation concern.

The Butterfly Ireland website (www.butterflyireland.com) and Irish Butterflies website (www.irishbutterflies.com) were consulted to identify the presence of any rare species within the study including: Marsh Fritillary, Small Blue, Green Hairstreak, Purple Hairstreak, Dingy Skipper, Large Heath and Brimstone.

10.3.3 Walkover Surveys and Site Visits

Following a full desktop study of available biological information pertaining to the study area, RPS ecologists carried out ecological assessments from the 6th to the 10th of June, 11th and 12th of July and the 8th of November in 2011 with vegetation surveys completed within the footprint of Rahasane Turlough on the 5th, 6th, 11th and 12th of June 2014.

These studies included;

- Habitat surveys and mapping;
- Surveys of turlough vegetation communities as described and mapped by Goodwillie (1992);
- Mammal surveys;
- Aquatic surveys (these were conducted by Aquatic Services Unit and are the subject of **Chapter 11**).

The data collected during these surveys provided detailed information on the existing environment. The habitat mapping information is used for assessing the impacts of the proposed works on the terrestrial and aquatic environments.

10.3.4 Habitat Mapping

The field survey comprised of an assessment of the range of habitats within the study area based on desktop and vegetation surveys. The habitats on site were classified in accordance with The Heritage Councils '*A Guide to Habitats in Ireland'* (Fossitt, 2000) and mapped in accordance with '*Best Practice Guidance for Habitat Survey and Mapping*' (Smith *et al*., 2011).

The Fossitt (2000) classification is a standard scheme for identifying, describing and classifying wildlife habitats in Ireland. The classification is hierarchical and operates at three levels, outlining the correlation between its habitat categories and the phytosociological units (plant communities) of botanical classifications. Links with Priority and Non-Priority Annex I habitats of the Habitats Directive (92/43/EEC) are also described as per the *Interpretation Manual of European Union Habitats - EUR27*. The Interpretation Manual is a scientific reference document published by the European Commission for the interpretation of Priority and Non-Priority Annex I habitat types of the Council Directive

92/43/EEC. This manual incorporates descriptive sheets for Priority and Non-Priority Habitats, which establishes clear, operational scientific definitions of habitats, using pragmatic descriptive elements (e.g. characteristic plants) and taking into consideration regional variations. The *Status of EU Protected Habitats and Species in Ireland* (NPWS, 2013a) was also consulted which provides details on the status of listed habitats and species and also provides lists of typical species for these habitats in Irish context.The ecological interest of the site is assessed based on whether it is of *international, national or local importance* as this has a direct bearing on the potential magnitude and the significance of impacts. Seasonal factors that affect distribution patterns and habitats or species were taken into account when conducting the surveys and the potential of the site to support certain populations.

The habitats within the study area were surveyed in 2011 and 2014. The habitats identified from the upper extent of the works as far as the N18 Kilcolgan Bridge are shown in **Figure 10.3**. They are based on detailed walkover surveys and an interpretation of the aerial photography. The habitats within the turloughs were also classified in accordance with the *Turloughs over 10 ha: Vegetation Survey and Evaluation*, internal report to the National Parks and Wildlife Service by Roger Goodwillie in 1992, referred to in the rest of this document as Goodwillie (1992). In Goodwillie (1992), thirty-two turlough vegetation communities were recorded within turloughs, seventeen of these were recorded within Rahasane Turlough. Vegetation community surveys were completed for this project in 2011 and 2014.

The distribution of these habitats within the study area is illustrated in **Figure 10.3 Habitat Map**.

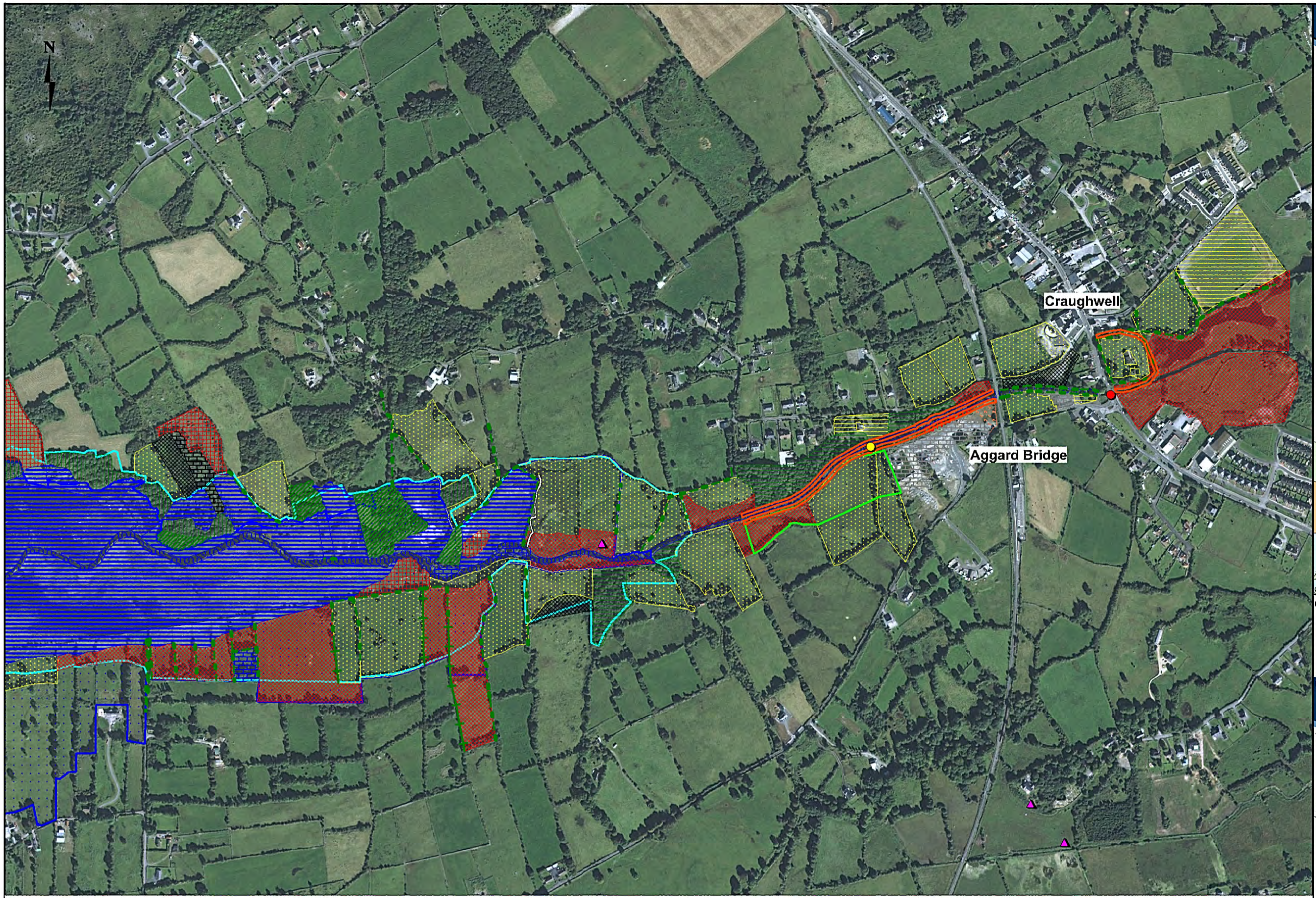
10.3.5 Botanical Surveys

Common, dominant and noteworthy plant species were recorded as part of the habitat and vegetation community surveys completed in June 2011 and within Rahasane Turlough in June 2014. The impact of the scheme on flora species of conservation value was also assessed.

10.3.6 Vegetation Community Surveys

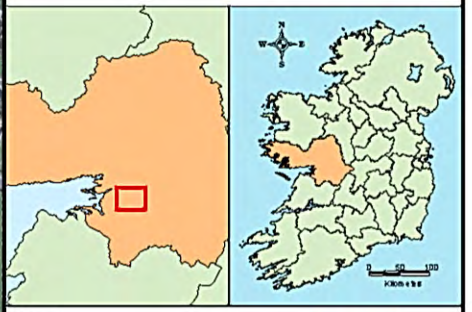
In June 2014, a vegetation community survey was completed within Rahasane Turlough (**Figure 10.4**). This survey sought to verify those vegetation communities mapped and described by Goodwillie (1992). To this end, a series of relevés were taken along nine longitudinal transects. These transects correspond to topographical lidar information and run perpendicular to the Dunkellin River; i.e. running in a general north to south plane across the turlough basin. The location for each relevé was dictated by discrete changes in the turlough basin’s topography, sourced from baseline topographical lidar surveys of the turlough (See **Figure 10.4**). Where a number of relevés were located within close proximity to one another and there was no discernible change in the vegetation community or plant species composition, representative relevés were taken. Additional relevés were also taken along transects where a notable or discernible change of plant species composition occurred within a vegetation community or indeed a change of vegetation community. In some cases, relevés could not be taken due to water depths and unsafe ground conditions, especially nearer the Dunkellin River and the large channel located within the turloughs northern basin. In this case, notes were taken on the relevant cover and abundance of plant species within these areas in addition to features such as water depth, vegetation height and substrate composition.

2 m x 2 m relevé samples were taken from each relevé point. A ten figure grid reference was obtained for each relevé point and was used to relocate the relevé (on average captured to 1 metre accuracy with a handheld GPS unit) during the field walkover surveys. Cover in vertical projection for all species was recorded on the Domin scale (Kent and Coker 1992), as were other general environmental parameters; i.e. water height, vegetation height, % forb, % grass, % bare ground and poaching. A digital photograph was also captured for each relevé taken in addition to a general note detailing environmental variables, conditions and threats of the relevé area and its immediate surrounds.



BL1 Stone Walls and Other Stonework
BL3 Buildings and Artificial Surfaces
ED3 Recolonising Bare Ground
ER2 Exposed Calcareous Rock
FL6 Turloughs
FS1 Reed and Large Sedge Swamps
FW1 Eroding Upland Rivers
FW2 Depositing Lowland River
FW3 Canals
FW4 Drainage Ditches
GA1 Improved Agricultural Grassland
GA2 Amenity Grassland
GM1 Marsh
GS1 Dry Calcareous and Neutral Grassland
GS2 Dry Meadows and Grassy Verges
GS4 Wet Grassland
HD1 Dense Bracken
WD1 Mixed Broadleaved Woodland
WN2 Oak-Ash-Hazel Woodland
WN4 Wet Pedunculate Oak Ash Woodland
WS1 Scrub
WS5 Recently-felled Woodland
WL1 Hedgerows
WL2 Treelines
Kingfisher Suitable Banks
Otter Activity
Proposed Channel Works
Proposed Spoil
Proposed Landspreading Areas
Karst Features
SAC

Legend



Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Habitat Map

Figure **10.3 (1 of 4)**

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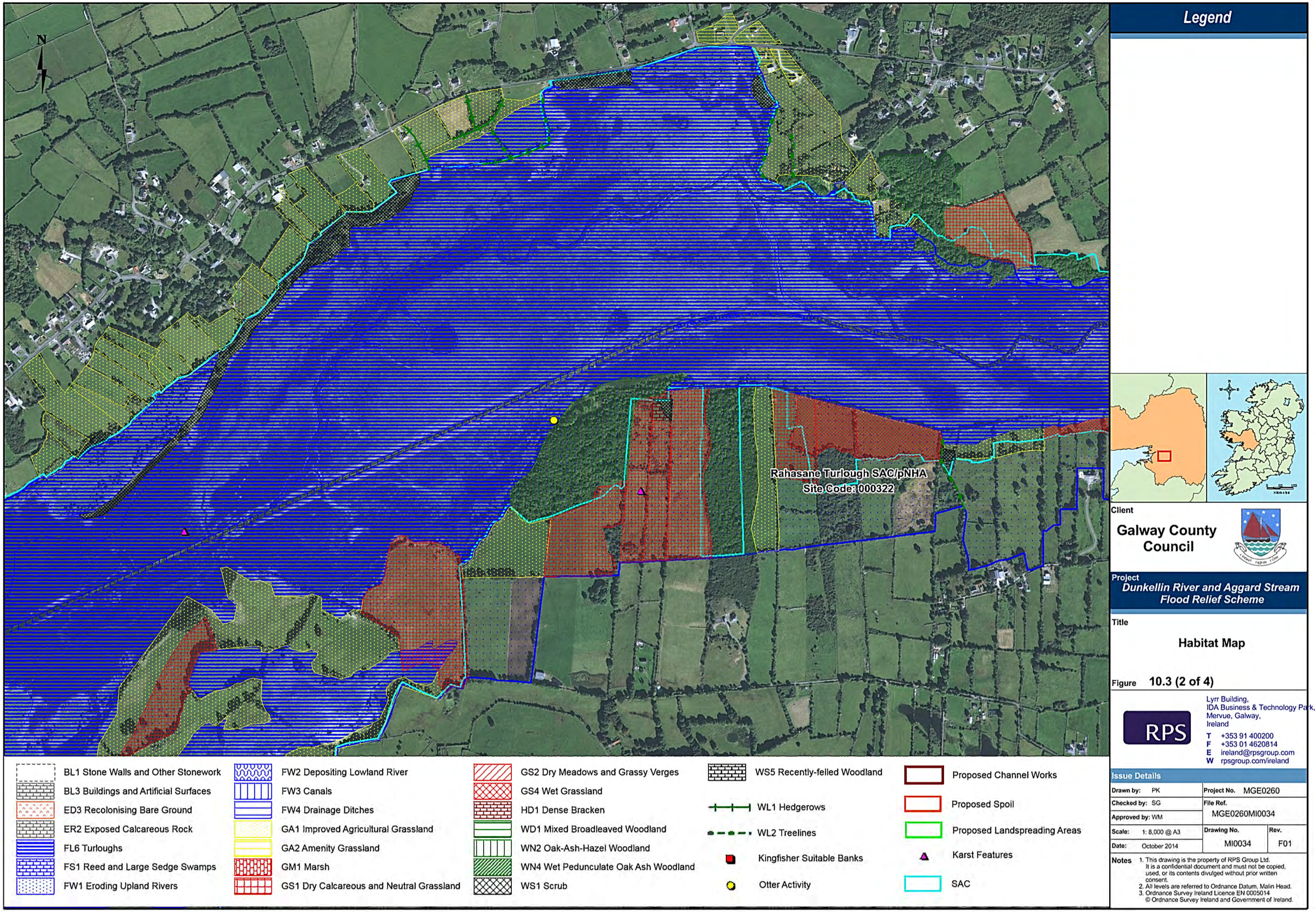
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Rahasane Turlough SAC/pNHA
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Proposed Landspreading Areas
Karst Features
SAC
Client
Galway County Council
Project
Dunkellin River and Aggard Stream Flood Relief Scheme
Title
Habitat Map
Figure 10.3 (2 of 4)
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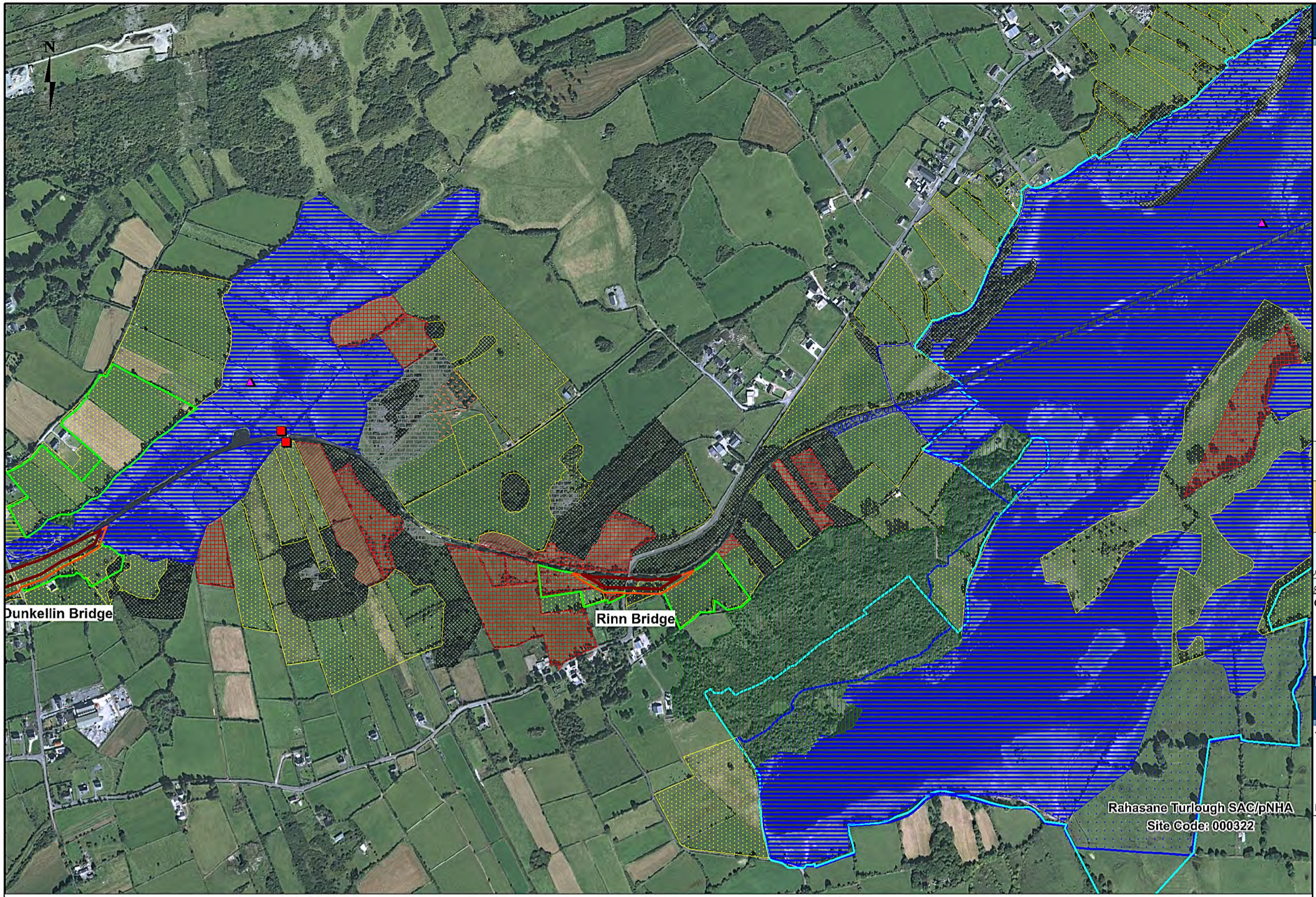

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Otter Activity
Proposed Channel Works
Proposed Spoil
Proposed Landspreading Areas
Karst Features
SAC

Legend

Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Habitat Map

Figure **10.3 (3 of 4)**

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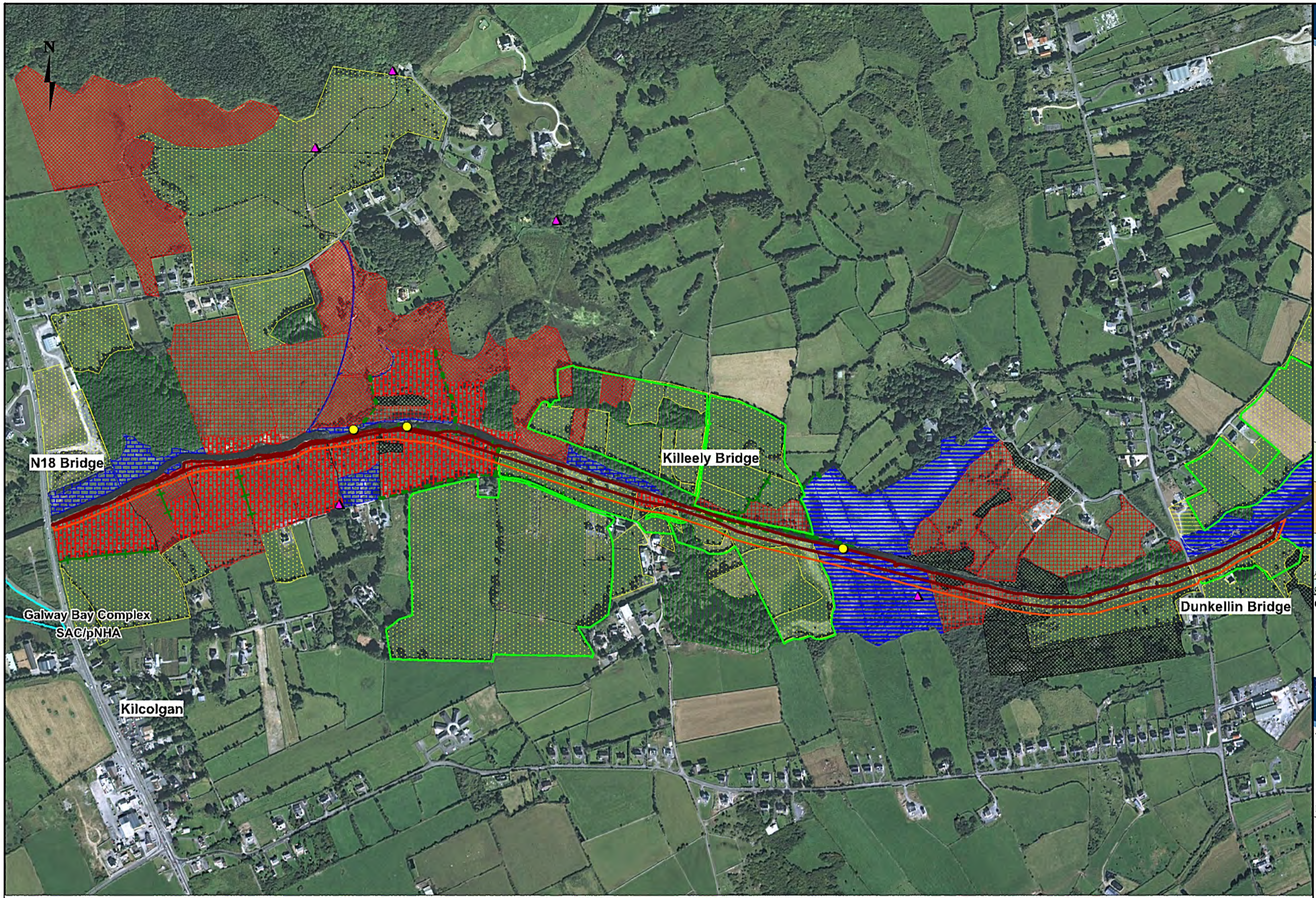

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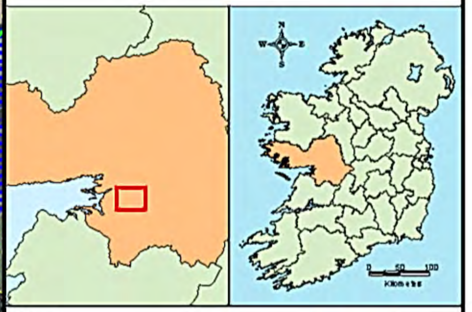
Legend



Client

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Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Habitat Map

Figure **10.3 (4 of 4)**

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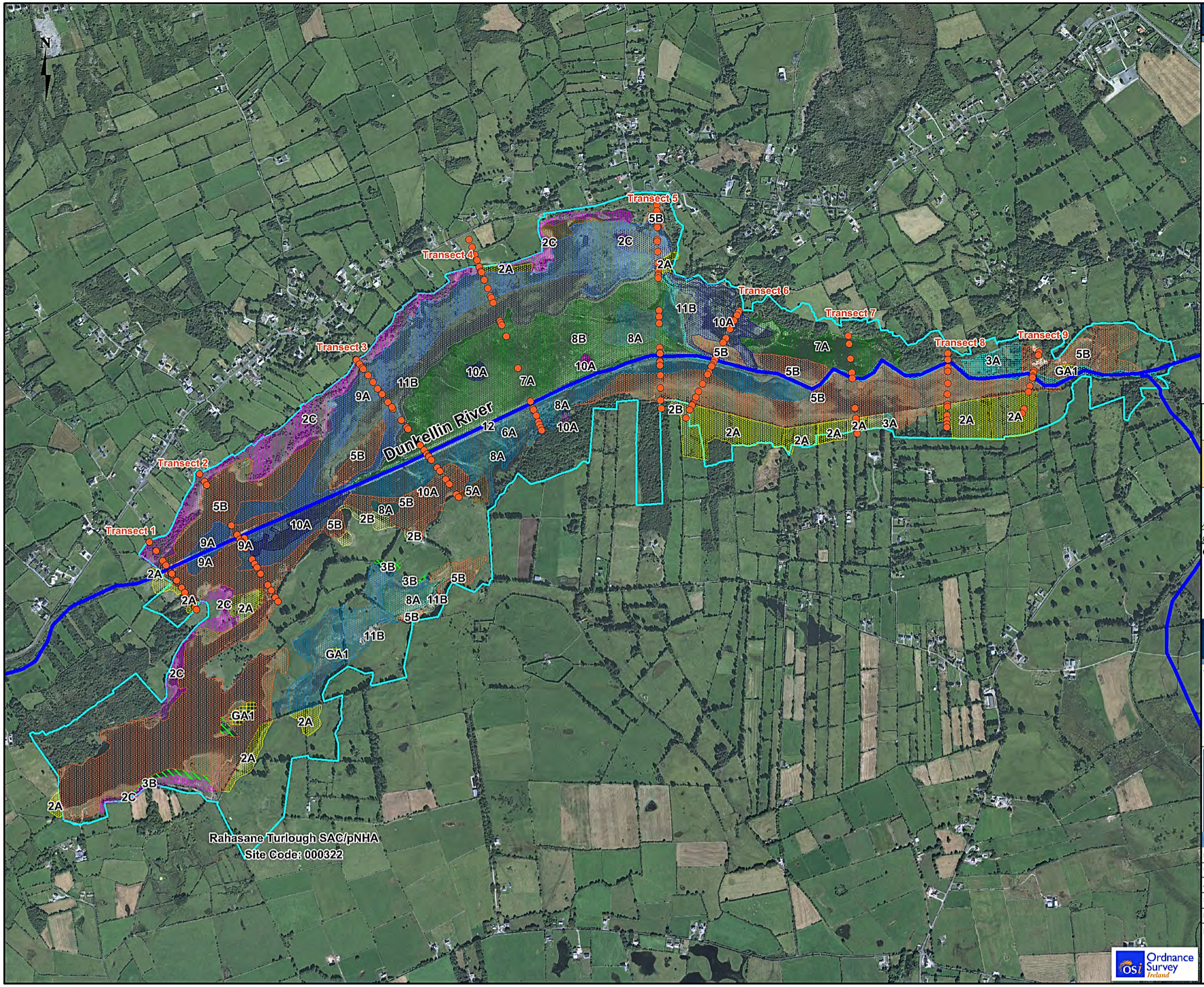
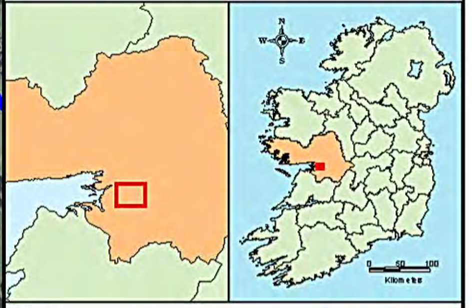


Legend

Rahasane Vegetation Communities

- 2A Lolium grassland
- 2B Poor grassland
- 2C Limestone grassland
- 3A Tall herb
- 3B Sedge heath
- 5A Dry weed
- 5B Potentilla reptans (species poor)
- 6A Dry Carex nigra
- 7A Polygonum amphibium (grassy)
- 8A Polygonum amphibium
- 8B Wet annuals
- 9A Temporary Pond
- 10A Oenanthe aquatica
- 11B Peaty Pond
- Releve Locations
- SAC Boundary



Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Vegetation Communities within Rahasane Turlough

Figure **10.4**

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Notes

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10.3.7 Birds and Mammals

During the course of the Phase 1 Habitat Survey, the birds and mammals encountered were recorded, and any bird or mammal species of conservation concern which were found was investigated and noted. Mammal signs were actively searched for in habitats of potential importance to protected mammal species such as watercourses and their banks (otter) and woodlands (badgers, bats, red squirrel and others), etc. Any buildings or other structures that have potential to hold roosting bats, and that may have to be removed for the construction of any of the route options, were noted and mapped. A Kingfisher habitat suitability survey was carried out between the 14th and 16th November, 2011.

Furthermore, Rahasane Turlough is recognised as the most important turlough site in the country for over-wintering wildfowl (NPWS, 2004). As a result, the turlough and its seasonally resident birds have been routinely surveyed under the Irish Wetland Bird Survey (IWeBS). This represents a back catalogue of more than 20 years data on over-wintering avifauna utilising Rahasane Turlough and its environs. The findings of these ongoing and historic IWeBS surveys and those individuals involved in undertaking these surveys were consulted during this assessment process.

10.3.8 Bats

A bat suitability survey was completed for bridge structures and treeline habitats within the study area, which could potentially be used by roosting or foraging bats (**See Appendix B.2)**.The findings of desktop analysis is provided in greater detail in Section **10.3.9.4**.

10.3.9 Aquatic Ecology

The aquatic ecology assessment is contained within **Chapter 11** of this EIS.

10.3.10 Amphibians and Reptiles

During the course of Phase 1 Habitat Survey the presence of common frog (*Rana temporaria*), smooth newt (*Lissotriton vulgaris*) and common lizard (*Lacerta* v*ivipara*) was investigated and noted within the study area.

10.3.11 Terrestrial Invertebrates

The surveys for terrestrial invertebrates were undertaken as part of the multi-disciplinary site surveys and potential habitats to support Marsh Fritillary were also surveyed for the species. The aquatic macroinvertebrate communities were assessed during the Aquatic Surveys details of which are provided in **Chapter 11**.

10.3.12 Limitations in Methodology

Some limitations were encountered during the surveys due to poor or unsafe access at some locations; e.g. the margins of the Dunkellin River and channel located within the turlough's northern basin.

10.3.13 Impact Assessment Criteria

All ecological sites were assessed according to the criteria for site evaluation outlined in the NRA '*Guidelines for Ecological Impact Assessment of National Road Schemes*' (NRA, 2009). The geographic frame of reference which is used to determine value is provided in **Table 10.1**.

Table 10.1 Ecological Site Assessment Scheme

Ratings for Ecological Sites
International Importance: 'European Site' including Special Area of Conservation (SAC), Site of Community Importance (SCI), Special Protection Area (SPA) or proposed Special Area of Conservation. Proposed Special Protection Area (pSPA). Site that fulfils the criteria for designation as a 'European Site' (see Annex III of the Habitats Directive, as amended). Features essential to maintaining the coherence of the Natura 2000 Network. Site containing 'best examples' of the habitat types listed in Annex I of the Habitats Directive. Resident or regularly occurring populations (assessed to be important at the national level) of the following: Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; and/or Species of animal and plants listed in Annex II and/or IV of the Habitats Directive. Ramsar Site (Convention on Wetlands of International Importance Especially Waterfowl Habitat 1971). World Heritage Site (Convention for the Protection of World Cultural & Natural Heritage, 1972). Biosphere Reserve (UNESCO Man & the Biosphere Programme). Site hosting significant species populations under the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals, 1979). Site hosting significant populations under the Berne Convention (Convention on the Conservation of European Wildlife and Natural Habitats, 1979). Biogenetic Reserve under the Council of Europe. European Diploma Site under the Council of Europe. Salmonid water designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988, (S.I. No. 293 of 1988).
National Importance: Site designated or proposed as a Natural Heritage Area (NHA). Statutory Nature Reserve. Refuge for Fauna and Flora protected under the Wildlife Acts. National Park. Undesignated site fulfilling the criteria for designation as a Natural Heritage Area (NHA); Statutory Nature Reserve; Refuge for Fauna and Flora protected under the Wildlife Act; and/or a National Park. Resident or regularly occurring populations (assessed to be important at the national level) of the following: Species protected under the Wildlife Acts; and/or Species listed on the relevant Red Data list. Site containing 'viable areas' of the habitat types listed in Annex I of the Habitats Directive.
County Importance: Area of Special Amenity. Area subject to a Tree Preservation Order. Area of High Amenity, or equivalent, designated under the County Development Plan. Resident or regularly occurring populations (assessed to be important at the County level) of the following: Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; Species of animal and plants listed in Annex II and/or IV of the Habitats Directive; Species protected under the Wildlife Acts; and/or Species listed on the relevant Red Data list. Site containing area or areas of the habitat types listed in Annex I of the Habitats Directive that do not fulfil the criteria for valuation as of International or National importance. County important populations of species or viable areas of semi-natural habitats or natural heritage features identified in the National or Local BAP, if this has been prepared. Sites containing semi-natural habitat types with high biodiversity in a county context and a high degree of naturalness, or populations of species that are uncommon within the county. Sites containing habitats and species that are rare or are undergoing a decline in quality or extent at a national level.

Ratings for Ecological Sites
Local Importance (higher value): Locally important populations of Priority species or habitats or natural heritage features identified in the Local BAP, if this has been prepared; Resident or regularly occurring populations (assessed to be important at the Local level) of the following: Species of bird, listed in Annex I and/or referred to in Article 4(2) of the Birds Directive; Species of animal and plants listed in Annex II and/or IV of the Habitats Directive; Species protected under the Wildlife Acts; and/or Species listed on the relevant Red Data list. Sites containing semi-natural habitat types with high biodiversity in a local context and a high degree of naturalness, or populations of species that are uncommon in the locality; Sites or features containing common or lower value habitats, including naturalised species that are nevertheless essential in maintaining links and ecological corridors between features of higher ecological value.
Local Importance (lower value): Sites containing small areas of semi-natural habitat that are of some local importance for wildlife; Sites or features containing non-native species that are of some importance in maintaining habitat links.

10.3.14 Characterising Impacts

The methodology for the assessment of impacts is derived from *the Guidelines for Ecological Impact Assessment* (IEEM, 2006). When describing changes/activities and impacts on ecosystem structure and function, reference should be made to the parameters, which are discussed below.

Positive or negative: Is the impact likely to be positive or negative? Positive impacts merit just as much consideration as negative ones, as international, national and local policies increasingly press for projects to deliver positive biodiversity outcomes.

Magnitude: 'Magnitude' should be predicted in a quantified manner wherever possible and relates to the quantum of an impact, for example the number of individuals affected by an activity.

Extent: 'Extent' should also be predicted in a quantified manner and relates to the area over which the impact occurs. Where the receptor is in an area of a particular plant community for example, Extent=Magnitude.

Duration: 'Duration' is intended to refer to the time during which the impact is predicted to continue, until recovery or re-instatement (which may be longer than the impact-causing activity). This should be quantified wherever possible, and interpreted in relation to the ecological processes involved rather than on a human timescale.

Reversibility: 'Reversibility' should be addressed by identifying whether an impact is ecologically reversible (either spontaneously or through specific action) and whether such an outcome is likely.

Timing and frequency: The timing of impacts in relation to important seasonal and/or life-cycle constraints should be evaluated. Similarly, the frequency with which activities (and concomitant impacts) would take place can be an important determinant of the impact on receptors and should also be assessed and described.

10.3.15 Integration of Impact Characteristics

An informed integration, for each potentially significant impact, of each of these impact characteristics is necessary in order to underpin the determination of impact significance set out below. In each case, it is important to assess the likelihood that the change will occur as anticipated and that the impact on ecological structure and function will manifest as predicted. The following scale should be applied (adapted from IEEM 2006):

- Near-certain: >95% chance of occurring as predicted,
- Probable: 50-95% chance of occurring as predicted,
- Unlikely: 5-50% chance of occurring as predicted, or
- Extremely unlikely: <5% chance of occurring as predicted.

10.4 EXISTING ENVIRONMENT

10.4.1 Designated Areas

The site synopses produced by the NPWS contain a description of the scientific interest and conservation importance of each designated site. Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) are designated under the EU Habitats Directive (92/43/EEC) and the EU Birds Directive (79/409/EEC), respectively, and as such form part of the Natura 2000 network of sites. In total 28 Natura 2000 Sites, candidate Special Areas of Conservation (SAC's) and Special Protection Areas (SPA's) lie within a 15km radius of the proposed works (ref. **Figure 10.1**). These are listed below:

1. Cregganna Marsh **SPA** (Site Code: 004142)
2. Monivea Bog **cSAC**/pNHA (Site Code: 002352),
3. Lough Corrib **cSAC**/pNHA (Site Code: 000297),
4. Slieve Aughty Mountains **SPA** (Site Code: 004168),
5. Sonnagh Bog **cSAC**/pNHA (Site Code: 001913),
6. Peterswell Turlough **cSAC**/pNHA (Site Code: 000318),
7. Lough Coy **cSAC** (Site Code: 002117),
8. Cahermore Turlough **cSAC** (Site Code: 002294),
9. Ballinduff Turlough **cSAC** (Site Code: 002295),
10. Coole Garryland Turlough **cSAC** (Site Code:002294)
11. Coole Garryland Turlough **SPA (Site Code 002294)**
12. Kiltartan Cave **cSAC** (Site Code: 000286),
13. East Burren Complex **cSAC** (Site Code: 001926),
14. Lough Cutra c**SAC** (Site Code: 000299)
15. Lough Cutra **SPA** (Site Code: 004056)
16. Caherglassaun Turlough **cSAC/** pNHA (Site Code: 000238)
17. Drummin Wood **cSAC** (Site Code: 002181)
18. Carrowbaun, Newhall and Ballylee Turloughs **cSAC** (Site Code: 002293)
19. Lough Fingall Complex **cSAC**/pNHA (Site Code: 000606),
20. Kiltiernan Turlough **cSAC**/pNHA(Site Code: 001285),
21. Castletaylor Complex **cSAC**/pNHA(Site Code: 000242),
22. Lough Rea **cSAC** (Site Code: 000304),
23. Lough Rea **SPA** (Site Code: 004134)
24. Ardrahan Grassland **cSAC** (Site Code: 002244),
25. Rahasane Turlough **cSAC** Site Code: 000322)
26. Rahasane Turlough **SPA** (Site Code 004089)
27. Galway Bay Complex **cSAC**/pNHA (Site Code: 000268), and
28. Inner Galway Bay **SPA** (Site Code: 004031).

Given that the Natura 2000 sites 1 to 18 above do not lie within either the Dunkellin River surface water catchment or the Clarinbridge groundwater catchment, a reasonable assumption may be made that the proposed works will not have any direct or indirect impacts on these sites.

Lough Rea cSAC/SPA (Site Code: 000304/004134) lies approximately 13 km upstream of the proposed works, and so it is also assumed that this site will not be affected. Castletaylor Complex cSAC (Site Code: 000242), is approximately 2.2 km from the proposed works, and Lough Fingall Complex cSAC (Site Code: 000606) and Kiltiernan Turlough cSAC are approximately 2.4 km and 3.7km respectively from the proposed works but neither are directly hydrologically linked with the Dunkellin River so it is also assumed that the proposed works will not impact on these designated sites. Similarly, Ardrahan Grassland cSAC is located 2.2 km to the west at its nearest point and again it is considered that the proposed works will not impact this Natura 2000 site due to the lack of hydrological connectivity.

In addition to those sites listed above there are two Natural Heritage Areas and one proposed Natural Heritage Areas (NHA) within 15 km of the study area, which include the Raford River Bog NHA located 14.6 km north-east, Slieve Aughty Bog located 14.6 km south-east and Kiltullagh Turlough pNHA located 11.8 km to the north. NHAs are legally protected from damage from the date they are formally proposed for designation. Proposed Natural Heritage Areas have not been statutorily proposed or designated, but do have some protection under the Rural Environmental Protection Scheme (REPS), Agri-Environmental Options Scheme (AEOS), Planning and Licensing Authorities in addition to Forest Service requirement for NPWS approval before they will pay afforestation grants on pNHA lands.

Sections of the Dunkellin River are designated under the Rahasane Turlough (**cSAC**/pNHA Site Code: 000322)/ **SPA** (Site Code: 004089) at the eastern extent of the study area, and under Galway Bay Complex **cSAC**/pNHA (Site Code: 000268) at the western extent of the study area.

A brief description of Rahasane Turlough **cSAC**/pNHA, Galway Bay Complex **cSAC**/pNHA, Inner Galway Bay **SPA** (Site Code: 004031) and their qualifying features is given in the following section. The full site synopses for Rahasane Turlough **cSAC**/pNHA, Rahasane Turlough **SPA**, Galway Bay Complex **cSAC**/pNHA and Inner Galway Bay **SPA** are included as **Appendix B.1** to this report.

10.4.1.1 Rahasane Turlough cSAC (Site Code: 000322)

Rahasane Turlough is of major ecological significance as one of only two large turloughs which still function naturally. It is the most important turlough for birdlife in the country (NPWS, 2004). It consists of two basins which are connected at times of flood but separated as the waters decline. The larger of these, the northern basin, takes the Dunkellin River westwards. Rahasane was formerly the natural sink of the Dunkellin River, but now an artificial channel takes some of the water further downstream.

The qualifying habitats found within Rahasane Turlough SAC are provided in **Table 10.2.**

Table 10.2 Rahasane Turlough cSAC Annex I Habitats

Habitat code	Habitat name (cSAC Qualifying Feature)	% Cover (approx.)	Representivity
3180	**Turloughs***	93	A

***Priority Annex I habitat under Annex I of the EU Habitats Directive**

10.4.1.2 Rahasane Turlough SPA (Site Code: 004089)

Rahasane Turlough SPA is of high ornithological importance and supports seven species of national importance. The Wigeon and Golden Plover populations are of particular note as they each represent approximately 4% of the national totals of these species. The occurrence of Greenland White-fronted Goose, Whooper Swan and Golden Plover is of importance as these species are listed on Annex I of the E.U. Birds Directive.

The qualifying Annex I bird species found within Rahasane Turlough SPA are provided in **Table 10.3** and **Table 10.4**.

Table 10.3 Rahasane Turlough SPA Annex I Bird Species

Species code	Species name	Population significance
A038	Whooper Swan *(Cygnus Cygnus)*	C
A395	Greenland White-fronted Goose*(Anser albifrons flavirostris)*	C
A140	Golden Plover *(Pluvialis apricaria)*	B

Table 10.4 Rahasane Turlough SPA Regularly Occurring Migratory Birds Not Listed on Annex I

Species code	Species name	Population significance
A050	Wigeon (*Anas penelope*)	B
A052	Teal (*Anas crecca*)	C
A053	Mallard (*Anas platyrhynchos*)	C
A054	Northern Pintail (*Anas acuta*)	C
A056	Northern Shoveller (*Anas clypeata*)	C
A061	Tufted Duck (*Aythya fuligula*)	C
A142	Lapwing (*Vanellus vanellus*)	C
A149	Dunlin (*Calidris alpina*)	C
A156	Black-tailed Godwit (*Limosa limosa*)	B
A160	Curlew (*Numenius arquata)*	C
A162	Redshank (*Tringa tetanus*)	C
A179	Black-headed gull (*Chroicocephalus ridibundus*)	C

10.4.1.3 Galway Bay Complex cSAC (Site Code: 000268)

This large coastal site is of immense conservation importance, with many habitats listed on Annex I of the EU Habitats Directive, four of which have priority status (lagoon, *Cladium* fen, turlough and orchid-rich calcareous grassland). The examples of shallow bays, reefs, lagoons and salt marshes are amongst the best in the country. The site supports an important Common Seal colony and a breeding Otter population, both species that are listed on Annex II of the EU Habitats Directive, and six regular Annex I EU Birds Directive species.

The qualifying habitats found within the Galway Bay Complex SAC are provided in **Table 10.5.**

Table 10.5 Galway Bay Complex SAC Annex I Habitats

Habitat code	Habitat name (cSAC Qualifying Feature)	% Cover (approx.)	Representivity
1160	Large Shallow Inlets and Bays	81	A
1140	Mudflats and sandflats not covered by seawater at low tide	7	A
1170	Reefs	2	A
5130	*Juniperus communis* formations on heaths or calcareous grasslands	1	B
7230	Alkaline fens	1	B
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites)*	1	B
3180	Turloughs*	1	B
7210	Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae**	1	B
1310	*Salicornia* and other annuals colonizing mud and sand	1	C
1410	Mediterranean salt meadows (*Juncetalia maritimi*)	1	A
1330	Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	1	A
1220	Perennial vegetation of stony banks	1	B
1150	Coastal lagoons*	1	A

The qualifying species found within the Galway Bay Complex SAC are provided in **Table 10.6**.

Table 10.6 Galway Bay Complex SAC Annex II Species

Species code	Species name	Population significance
1365	Common Seal *(Phoca vitulina)*	B
1355	Otter (*Lutra lutra*)	C

10.4.1.4 Inner Galway Bay SPA (Site Code: 004031)

Galway Bay SPA is a very large, marine-dominated, site situated on the west coast of Ireland. This large coastal site is of immense ornithological importance, with two wintering species having populations of international importance and a further sixteen species having populations of national importance. The breeding colonies of Sandwich Tern, Common Tern and Cormorant are also of national importance. Also of note is that seven of the regularly occurring species are listed on Annex I of the E.U. Birds Directive, i.e. Red-throated Diver, Black-throated Diver, Great Northern Diver, Golden Plover, Bar-tailed Godwit, Sandwich Tern and Common Tern.

The qualifying Annex I bird species found within Inner Galway Bay SPA are provided in **Table 10.7.**

Table 10.7 Inner Galway Bay SPA Annex I Bird Species

Species code	Species name	Population significance
A001	Red-throated Diver *(Gavia stellata)*	C
A002	Black-throated Diver *(Gavia arctica)*	A
A003	Great Northern Diver *(Gavia immer)*	B
A140	Golden Plover *(Pluvialis apricaria)*	C
A157	Bar-tailed Godwit *(Limosa lapponica)*	B
A191	Sandwich Tern *(Sterna sandvicensis)*	B
A193	Common Tern*(Sterna hirundo)*	B
A182	Common Gull *(Larus canus)*	C
A179	Black Headed Gull *(Chroicocephalus ridibundus)*	C
A169	Turnstone *(Arenaria interpres)*	C
A162	Red Shank *(Tringa totanus)*	C
A160	Curlew *(Numenius arquata)*	C
A149	Dunlin *(Calidris alpina)*	C
A142	Lapwing *(Vanellus vanellus)*	B
A137	Ringed Plover *(Charadrius hiaticula)*	B
A069	Red Breasted Merganser *(Mergus serrator)*	B
A056	Northern Shoveler *(Anas clypeata)*	B
A052	Teal *(Anas crecca)*	C
A050	Eurasian Wigeon *(Anas Penelope)*	C
A048	Shelduck *(Tadorna tadorna)*	C

Potential impacts on Natura 2000 sites associated with the scheme are discussed in greater detail as part of the accompanying Natura Impact Statement (NIS).

10.4.2 NPWS Rare and Protected Species Records

The NPWS Rare and Protected Species database was consulted for records on species of conservation importance in the area. The site for the proposed scheme lies within the 10 km Grid squares (hectads) M41, M42, M51 and M52. According to this database, there are records for seventeen rare and protected species within the four grid squares. However, the NPWS dataset is known to be incomplete, particularly for fish, bats and birds, and so the absence of records for a species does not necessarily mean that the species does not occur in the area.

The relevant hectads are displayed in **Figure 10.2** while the NPWS rare and protected species recorded within these squares are shown in **Table 10.8.**

Table 10.8 NPWS Rare and Protected Species Records

Common Name	Scientific Name	Grid Square(s)	Sample Locations
Barn Owl	*Tyto alba*	M51	Lakyle Castle
Red Deer	*Cerbus elahpus*	M41	N/A
Hedgehog	*Erinaceus europaeus*	M42, M51, M52	Athenry, Loughrea, Kiltullagh
Irish Hare	*Lepus timidus* subsp. *hibernicus*	M41, M42, M51, M52	Kinvara, Clarinbridge, Castledaly, Craughwell
Otter	*Lutra lutra*	M41, M42, M52	Dunkellin River (near Rinn), Clarinbridge at N18, Streams near Rockmore, stream south of Coldwood
Pine Marten	*Martes martes*	M52	N/A
Badger	*Meles meles*	M41, M42, M51, M52	Kilcolgan, Clarinbridge, Castledaly,
Rough Poppy	*Papaver hybridum*	M41	Castle Taylor
Small-White Orchid	*Pseudorchis albida*	M42, M51	Castle Lambert, St. Clerans
Common Frog	*Rana temporaria*	M42, M51, M52	Frenchfort, Moneen East, Clonoo East, Athenry, Carnaun N.S., Craughwell, Kingsland, Esker.
Red Squirrel	*Sciurus vulgaris*	M52	Confirmed within woodland and scrub habitats at Carrigeen West
Wood Bitter-vetch	*Vicia orobus*	M41, M42,	Toberroe State Forest, Castle Lambert, Frenchfort.

10.4.3 Terrestrial Invertebrate Data

10.4.3.1 Lepidoptera

Records on the Butterfly Ireland website http://www.butterflyireland.com/ support one record for Marsh Fritillary from M51. In addition, the National Biodiversity Data Centre online database supports one record from M51 (20 individuals recorded) in early September 2012. The Marsh Fritillary is protected under Annex II of the EU Habitats Directive. This species, whose larval food plant is Devil's Bit Scabious (*Succisa pratensis*), has become endangered due to the ongoing habitat loss of its peatland and heathland habitats. Marsh Fritillary was not identified during the many site walkover surveys completed for this project. In addition, the extent of the proposed relief scheme does not support suitable habitat or indeed suitable abundances Devil's bit scabious (*Succisa pratensis*) to support this butterfly species.

10.4.4 Bird Atlas Data

The Bird Atlas 2007-2011: The Breeding and Wintering Birds of Britain and Ireland (Balmer *et al*., 2013) was consulted for information on breeding and wintering birds recorded within 10 km grid squares M41, M42, M51 and M52 within which the study area is located. The following sources of information were consulted in order to determine the conservation status of bird species:

- Annex I of the EU 'Birds Directive'; and

- The 'Red List' of Birds of Conservation Concern in Ireland (BoCCI) (Cummins and Colhoun, 2013).

Table 10.9 Breeding and Wintering Records for Birds of High Conservation Concern Recorded by Balmer *et al*., 2013 from 10 km National Grid Squares M41, M42, M51 and M52.

Species	Qualification for 'High Conservation Concern' status	Status in OS 10km square M41	Status in OS 10km square M42	Status in OS 10km square M51	Status in OS 10km square M52
Shoveler (*Anas clypeata*)	BoCCI, Red List	Wintering – Confirmed	Wintering - Not Recorded	Wintering - Not Recorded	Wintering - Not Recorded
		Breeding – Possible	Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded
Wigeon (*Anas penelope*)	BoCCI, Red List	Wintering - Confirmed	Wintering - Confirmed	Wintering - Confirmed	Wintering - Confirmed
		Breeding – Confirmed (Non-breeding)	Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded
Pintail (*Anas acuta*)	BoCCI, Red List	Wintering - Confirmed	Wintering - Not Recorded	Wintering - Not Recorded	Wintering - Not Recorded
		Breeding – Confirmed (Non breeding)	Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded
Pochard (*Aythya ferina*)	BoCCI, Red List	Wintering - Confirmed	Wintering – Not Recorded	Wintering – Not Recorded	Wintering – Not Recorded
		Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded
Dunlin (*Calidris alpina*)	EU Birds Directive Annex I; BoCCI, Red List	Wintering - Confirmed	Wintering – Not Recorded	Wintering - Confirmed	Wintering – Not Recorded
		Breeding- Probable	Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded
Tufted Duck (*Aythya fuligula*)	BoCCI, Red List	Wintering - Confirmed	Wintering - Not Recorded	Wintering - Confirmed	Wintering - Not Recorded
		Breeding Probable	Breeding – Not Recorded	Breeding - Not Recorded	Breeding – Not Recorded
Lapwing (*Vanellus vanellus*)	BoCCI, Red List	Wintering - Confirmed	Wintering - Confirmed	Wintering - Confirmed	Wintering - Confirmed
		Breeding - Confirmed	Breeding - Not Recorded	Breeding – Probable	Breeding – Not Recorded
Golden Plover (*Pluvialis apricaria*)	EU Birds Directive Annex I; BoCCI, Red List	Wintering - Confirmed	Wintering - Confirmed	Wintering - Confirmed	Wintering - Confirmed
		Breeding – Confirmed (Non Breeding)	Breeding - Not Recorded	Breeding - Not Recorded	Breeding - Not Recorded

Species	Qualification for 'High Conservation Concern' status	Status in OS 10km square M41	Status in OS 10km square M42	Status in OS 10km square M51	Status in OS 10km square M52
Common Redshank (*Tringa tetanus*)	BoCCI, Red List	Wintering - Confirmed	Wintering - Confirmed	Wintering – Not Recorded	Wintering – Not Recorded
		Breeding – Probable	Breeding – Not Recorded	Breeding - Not Recorded	Breeding – Not Recorded
Barn Owl (*Tyto alba*)	BoCCI, Red List	Wintering – Not Recorded	Wintering – Not Recorded	Wintering - Confirmed	Wintering – Not Recorded
		Breeding - Confirmed	Breeding - Non-breeding	Breeding - Confirmed	Breeding - Possible
Meadow Pipit (*Anthus pratensis*)	BoCCI, Red List	Wintering - Confirmed	Wintering - Confirmed	Wintering - Confirmed	Wintering - Confirmed
		Breeding - Confirmed	Breeding - Confirmed	Breeding - Confirmed -	Breeding - Confirmed
Grey Wagtail (*Motacilla cinerea*)	BoCCI, Red List	Wintering - Confirmed	Wintering - Confirmed	Wintering – Not Recorded	Wintering - Confirmed
		Breeding - Possible	Breeding - Confirmed	Breeding - Possible	Breeding - Confirmed
Yellowhammer (*Emberiza citrinella*)	BoCCI, Red List	Wintering - Confirmed	Wintering - Confirmed	Wintering – Not Recorded	Wintering – Not Recorded
		Breeding - Probable	Breeding - Possible -	Breeding - Not Recorded	Breeding - Not recorded
Herring Gull (*Larus argentatus*)	BoCCI, Red List	Wintering – Confirmed	Wintering – Not Recorded	Wintering – Not Recorded	Wintering – Not Recorded
		Breeding – Confirmed (Non-Breeding)	Breeding - Confirmed (Non-Breeding)	Breeding – Not Recorded	Breeding – Not Recorded
Red Grouse (*Lagopus lagopus*)	BoCCI, Red List	Wintering – Not Recorded	Wintering - Not Recorded	Wintering - Confirmed	Wintering – Not Recorded
		Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded
Black-headed Gull (*Chroicocephalus ridibundus*)	BoCCI, Red List	Wintering - Confirmed	Wintering - Confirmed	Wintering - Confirmed	Wintering – Confirmed
		Breeding – Confirmed (Non-breeding)	Breeding – Confirmed (Non-breeding)	Breeding - Confirmed (Non breeding)	Breeding – Not Recorded

Species	Qualification for 'High Conservation Concern' status	Status in OS 10km square M41	Status in OS 10km square M42	Status in OS 10km square M51	Status in OS 10km square M52
Woodcock (*Scolopax rusticola*)	BoCCI, Red List	Wintering - Confirmed	Wintering – Not Recorded	Wintering – Not Recorded	Wintering – Not Recorded
		Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded
Ruff (*Asio flammeus*)	EU Birds Directive Annex I; BoCCI, Amber List	Confirmed - Wintering	Wintering – Not Recorded	Wintering – Not Recorded	Wintering – Not Recorded
		Breeding - Not Recorded	Breeding - Not Recorded	Breeding - Not Recorded	Breeding - Not Recorded
Short-eared Owl (*Asio flammeus*)	EU Birds Directive Annex I; BoCCI, Amber List	Wintering - Confirmed	Wintering – Not Recorded	Wintering – Not Recorded	Wintering – Not Recorded
		Breeding - Not Recorded	Breeding - Not Recorded	Breeding - Not Recorded	Breeding - Not Recorded
Peregrine (*Falco peregrinus*)	EU Birds Directive Annex I; BOCCI Green List	Breeding – Possible	Breeding – Not Confirmed	Breeding - Probable	Breeding – Not Confirmed
		Wintering - Confirmed	Wintering - Confirmed	Wintering - Confirmed	Wintering – Not Confirmed
Kingfisher (*Alcedo atthis*)	EU Bird's Directive Annex I; BoCCI, Amber List	Wintering – Not Recorded	Wintering – Not Recorded	Wintering – Not Recorded	Wintering – Not Recorded
		Breeding – Not Recorded	Breeding – Not Recorded	Breeding - Confirmed	Breeding - Possible
Whooper Swan (*Cygnus cugnus*)	EU Bird's Directive Annex I; BoCCI, Amber List	Wintering - Confirmed	Wintering – Not Recorded	Wintering - Confirmed	Wintering - Confirmed
		Breeding – Confirmed (Non-breeding)	Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded

Species	Qualification for 'High Conservation Concern' status	Status in OS 10km square M41	Status in OS 10km square M42	Status in OS 10km square M51	Status in OS 10km square M52
Greenland White-fronted Goose (*Anser albifrons*)	EU Bird's Directive Annex I; BoCCI, Amber List	Wintering - Confirmed	Wintering – Not Recorded	Wintering – Not Recorded	Wintering – Not Recorded
		Breeding – Confirmed (Non-breeding)	Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded
Hen Harrier (*Circus cyaneus*)	EU Bird's Directive Annex I; BoCCI, Amber List	Wintering - Confirmed	Wintering – Not Recorded	Wintering - Confirmed	Wintering - Confirmed
		Breeding – Not Confirmed	Breeding – Not Confirmed	Breeding - Confirmed	Breeding – Not Confirmed
Little Egret (*Egretta garzetta*)	EU Bird's Directive Annex I; BoCCI, Green List	Wintering - Confirmed	Wintering - Confirmed	Wintering - Confirmed	Wintering - Confirmed
		Breeding – Confirmed (Non-breeding)	Breeding – Confirmed (Non-breeding	Breeding – Confirmed (Non-breeding)	Breeding – Not Recorded
Merlin (*Falco columbarius*)	EU Bird's Directive Annex I; BoCCI, Amber List	Wintering - Confirmed	Wintering – Confirmed	Wintering – Confirmed	Wintering - Confirmed
		Breeding – Not Recorded	Breeding – Not Recorded	Breeding - Confirmed	Breeding – Not Recorded
Great Northern Diver (*Gavia immer*)	EU Bird's Directive Annex I; BoCCI, Amber List	Wintering - Confirmed	Wintering – Not Recorded	Wintering – Not Recorded	Wintering – Not Recorded
		Breeding – Confirmed (Non-Breeding)	Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded
Mediterranean Gull (*Larus melanocephalus*)	EU Bird's Directive Annex I; BoCCI, Amber List	Wintering – Not Recorded	Wintering – Not Recorded	Wintering – Not Recorded	Wintering – Not Recorded
		Breeding – Confirmed (Non-Breeding)	Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded
Bar-tailed Godwit (*Limosa lapponica*)	EU Bird's Directive Annex I; BoCCI, Amber List	Wintering - Confirmed	Wintering – Not Recorded	Wintering – Not Recorded	Wintering – Not Recorded
		Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded	Breeding – Not Recorded

Twenty-nine bird species are recorded as either breeding (or if not breeding, present during the breeding season) or wintering within Grid Squares M41, M42, M51 and M52, fourteen of which are protected under Annex I of the EU Birds Directive. The habitat preferences of these species are discussed below[3].

- **Whooper Swan** - Winter migrant on associated bays, lakes, estuaries and adjacent fields. Ireland's winteering population breeds in Iceland.
- **Greenland White-Fronted Goose** - Winter migrant associated with wet grassland, salt marshes, peat bogs and improved grassland fields. Migrates north to breed on tundra, often by lakes and rivers.
- **Peregrine Falcon** - Winter in open country and breeds on coastal and inland cliffs and are commonly associated with quarry sites.
- **Golden Plover** - Winter on arable pastures. Breed in heather moors, blanket bogs & acidic grasslands. Distribution limited to the uplands of northwest counties in Ireland.
- **Dunlin** - Wintering population common on coastal areas, particularly on tidal mudflats and estuaries. Few inland wintering populations. Breeds and nests on the ground in sparse, low vegetation favouring machair habitats.
- **Kingfisher** - Resident species on watercourses and rarely moves from their territories. Kingfishers breed in tunnels dug in vertical banks along streams and rivers.
- **Hen Harrier** - Widespread in the winter, found in open country and on the coast. Breeding birds are confined to moorland and young forestry plantations, where they nest on the ground
- **Little Egret** - Little Egrets use a variety of wetland habitats, including shallow lakes, riverbanks, lagoons, coastal estuaries and rocky shorelines. Breeds in lakes, marshes, flooded fields & estuaries.
- **Merlin** - Much more widely distributed in the winter than in the breeding season. Merlins move away from high ground at this time of the year and can often be seen on the coast, where concentrations of other birds are attractive as prey species. Nests on the ground on moorland, mountain and blanket bog. Also nests in woodland and has taken to nesting in forestry plantations adjacent to moorland.
- **Great Northern Diver** - Great Northern Divers occur along the Irish coastline between September and April and are usually observed as single birds or small groups. Winter migrant, no breeding birds in Ireland.
- **Mediterranean Gull** - Present in Ireland as a wintering species in increasing numbers. The Mediterranean Gull is a recent colonist having arrived in Ireland in 1995 and first bred in the Republic in 1996 in Co. Wexford. Prefers low lying islands near the coast on which to breed.
- **Bar-tailed Godwit** - Wintering distribution entirely coastal confined to estuaries, with largest numbers recorded on sandy estuaries. Small numbers recorded use non-estuarine coastline. Bar-tailed Godwits breed in northern Norway, Finland and further to the north and east.
- **Ruff** - Small numbers winter on estuaries along the southern coast of Ireland. Ruff do not breed in Ireland though passage birds are seen in Ireland before moving to breed in meadows and bogs in Scandinavia and Russia.
- **Short-eared Owl -** Widespread winter visitor to coastal lowlands (dunes, scrubby fields, machair). Rare and sporadic breeding species in uplands throughout Ireland. The majority of the European population breeds in Scandinavia and Russia.

[3] Habitat description preferences have been gleaned from the Birdwatch Ireland Website http://www.birdwatchireland.ie/IrelandsBirds/tabid/541/Default.aspx

10.4.5 I-WeBS Data

The Irish Wetland Bird Survey (I-WeBS) was consulted for information on wintering waterbirds at Rahasane Turlough. **Table 10.10** presents annual peak counts compared to 1% of the national and international totals for qualifying Annex I bird species found within Rahasane Turlough SPA.

Table 10.10 Annual peak counts (I-Webs data) for Birds Listed as Special Conservation Interests of Rahasane Turlough 2005/6 to 2012/13

Species	Annual Peak Counts								1% National	1% Inter-national
	05/06	06/07	07/08	08/09	09/10	10/11*	11/12	12/13		
Whooper Swan (*Cygnus cygnus*)	75	105	128	183	94	251	68	94	130	270
Greenland White-fronted Goose (*Anser albifrons flavirostris*)	100	61	98	65	70	63	57	55	110	240
Golden Plover (*Pluvialis apricaria*)	5000	3500	6500	7000	1500	7000	6000	300	1700	9,300
Wigeon (*Anas penelope*)	3000	3000	5000	4000	4000	3500	2500	3500	820	15,000
Teal (*Anas crecca*)	109	420	1000	2000	1000	300	550	320	450	5,000
Mallard (*Anas platyrhynchos*)	110	60	260	150	220	600	380	344	380	20,000
Northern Pintail (*Anas acuta*)	50	39	52	208	124	54	102	5	20	600
Northern Shoveller (*Anas clypeata*)	94	10	56	260	216	66	200	190	25	400
Tufted Duck (*Aythya fuligula*)	54	12	2	57	62	45	82	75	370	12,000
Lapwing (*Vanellus vanellus*)	3500	2700	4000	3000	300	2000	3500	330	2100	20,000
Dunlin (*Calidris alpina*)	100	250	200	200	300	350	45	10	880	13,300
Black-tailed Godwit (*Limosa limosa*)	100	1200	1000	350	500	750	700	600	140	610
Curlew (*Numenius arquata*)	175	359	94	120	180	86	110	115	550	8400
Redshank (*Tringa tetanus*)	19	76	72	74	120	41	23	20	310	3900
Black-headed gull (*Chroicocephalus ridibundus*)	71	347	293	250	150	150	200	65	N/A	20,000

***Data from Birdwatch Ireland – Galway Branch website**

10.4.6 Flora Atlas

The principal source of information regarding the distribution of flora in Ireland is the *New Atlas of the British & Irish Flora* (Preston *et al*., 2002). The data included in this atlas is from the 1987-1999 atlas survey. This atlas shows data for vascular plants in individual hectads (10 km by 10 km squares). The scheme falls within hectads M41, M42, M51 and M52 **(Figure 10.2)**. The records for these hectads were consulted and a search was carried out to investigate if any rare or protected plant species had been recorded in the square during the 1987-1999 atlas survey (and previous surveys) carried out by the Botanical Society of the British Isles (BSBI). The search included the vascular plants that are listed in Annex II of the EU Habitats Directive, Flora Protection Order (FPO) of 1999, the Wildlife Act 1976 and as amended, the Irish Red Data Book (IRDB) and the NPWS site synopsis. The results of this investigation are displayed in **Table 10.11**.

Table 10.11 Flora Atlas Data for Grid Squares M41, M42, M51 and M52

Common Name	Scientific Name	Square M41	Square M42	Square M51	Square M52
Corn Chamomile	*Anthemis arvensis*	§	-	-	-
Bats-in-the-Belfry	*Campanula trachelium*	*	-	-	-
Musk thistle (Nodding thistle)	*Carduus nutans*	§	-	-	-
Blue Fleabane	*Erigeron acris*	§	-	-	-
Dropwort	*Filipendula vulgaris*	*	-	-	-
Alder Buckthorn	*Frangula alnus*	+	-	-	-
Sharp-leaved Fluellen	*Kickxia elatine*	§	-	-	-
Yellow Bird's-nest	*Hypopitys monotropa*	-	-	§	-
Green-winged Orchid	*Anacamptis morio*	-	-	*	§
Rough Poppy	*Papaver hybridum*	§	-	-	-
Small White Orchid	*Pseudorchis albida*	-	+	§	-
Northern Yellow Cress	*Rorippa islandica*	+	+	-	-
Shepherd’s Needle	*Scandix pecten-veneris*	-	§	-	-
Wood Bitter Vetch	*Vicia orobus*	-	+	-	-
Fen Violet	*Veronica persicifolia*	+	-	-	§

+ Record from the 1987-1999 BSBI Flora Atlas survey
** Record from the 1970-1986 BSBI Flora Atlas survey*
§ Pre-1970 Record
- Not recorded in the relevant Grid Square during any Flora Atlas Survey

10.4.6.1 Brief Species Description

Bats-in-the-Belfry was recorded in Grid Square M41 during the 1970-1986 flora atlas survey. It is a large perennial herb, found as a native on dry, base-rich, usually calcareous soils in woodland, scrubby grassland and hedge banks; in Ireland it is also reported from river banks and swamp woodland. It is also grown in gardens, and occurs as a naturalised alien on a wider range of soils and habitats. It is generally a lowland species which has declined slightly through habitat loss arising from the cessation of coppicing and the removal of hedgerows. This species is listed as Vulnerable in the Irish Red Data Book for Vascular Plants but is not afforded legal protection in Ireland.

Dropwort was recorded in Grid Square M41 during the 1970-1986 flora atlas survey. A perennial herb, mainly occurring in calcareous grassland on chalk and limestone downs, and in rough pasture; also found on coastal and inland heaths over limestone, chalk and other basic rocks, including serpentine. It has declined in its chalk habitats in S. England because of the lack of grazing or conversion of grassland to arable, but the distribution seems unchanged elsewhere. It is grown in gardens, sometimes escaping and becoming naturalised. This species is listed as Rare in the Irish Red Data Book for Vascular Plants but is not afforded legal protection in Ireland.

Alder Buckthorn was recorded in Grid Square M41 during the 1987-1999 flora atlas survey. This deciduous shrub or small tree grows on a wide range of soils, but avoids drought-prone and permanently waterlogged sites. It is found in scrub on fen peat, on the edges of raised mires, on heaths and in valley mires, in scrub, hedgerows and in woodland. It regenerates strongly after cutting, burning or grazing. It is generally a lowland species and its overall distribution is stable, however there have been some losses since the 1962 *Atlas*. This species is listed as Rare in the Irish Red Data Book for Vascular Plants but is not afforded legal protection in Ireland.

Green-winged Orchid was recorded in Grid Square M41 during the 1970-1986 flora atlas survey. This is a tuberous perennial herb of damp to dry, base-rich to mildly acidic soils. It is most frequent in hay meadows and pastures, but also grows on sand dunes, heaths and roadsides, and in quarries, gravel-pits, churchyards and lawns. The steady decline of this species due to the ploughing and improvement of grasslands has taken place throughout the 19th and 20th centuries. It is often present in only small numbers in 10 km squares where it was once more frequent. This species is listed as Vulnerable in the Irish Red Data Book for Vascular Plants but is not afforded legal protection in Ireland.

Small White Orchid was recorded in Grid Square M42 during the 1987-1999 flora atlas survey and from Grid Square M51 pre-1970. This is a tuberous perennial with small, inconspicuous greenish-white flowers and a faint scent. It is found on open, well-drained upland pastures and heaths. This species has undergone a decline in recent years which mirrors that of the Green-winged Orchid (discussed above). Agricultural improvement and increased grazing pressure on hill pastures seem likely to have led to its decline. This species is listed as Vulnerable in the Irish Red Data Book for Vascular Plants, and is afforded legal protection under the Flora Protection Order, 1999.

Northern Yellowcress is an annual or short-lived perennial cress. The species is characteristic of damp muddy sites kept open by late flooding or by cattle trampling. It is found in flower from early July until mid-September so seems to have an opportunistic phenology (Goodwillie, 1992). It is listed as Rare in under the Red Data List for Vascular plant species but is not afforded legal protection under the Flora Protection Order, 1999. This species was recorded in Grid Squares M41 and M42 in the 1987-1999 BSBI Flora Atlas Survey. It is mentioned in the site synopsis of Rahasane Turlough cSAC as occurring in semi-aquatic communities fringing the main channel of the river and in muddy pools in the basin of that turlough. At Rahasane, Goodwillie recorded it along the fringes of the Dunkellin River main channel and along the margins of isolated pond habitats surrounded by more expansive areas of wet grassland. This species was not identified during the 2011 habitat surveys (due to extensive flooding of the turlough basin. Similarly it was not identified during the targeted vegetation surveys completed in 2014.

Wood Bitter-vetch, a bushy perennial of meadows, scrub and rocks in hilly districts, is listed as Vulnerable in the Irish Red Data Book and is afforded legal protection in Ireland under the Flora Protection Order, 1999. This species was recorded in Grid Squares M42 during the 1987-1999 flora atlas survey.

Fen Violet, a perennial herb generally found on the margins of turloughs, is listed as Rare in the Irish Red Data Book but is not afforded legal protection in Ireland. It is a poor competitor, preferring areas subject to fluctuating water levels, cattle trampling or peat-digging. Seed is long-lived and its distribution in Ireland is stable. This species was recorded in Grid Squares M41 during the 1987-1999 flora atlas survey and from Grid Square M52 as a pre-1970 record. It is mentioned in the site synopsis of Rahasane Turlough cSAC as occurring in less-well drained areas of that turlough. At Rahasane, this species has been recorded (Goodwillie, 1992) from the 6A *Carex nigra* vegetation community located within the southern basin of the turlough.

There are pre-1970 records for the species **Corn Chamomile, Musk thistle (Nodding thistle), Blue Fleabane, Sharp-leaved Fluellen, Yellow Bird's-nest, Rough Poppy and Shepherd's Needle,** but none of these species have been recorded in subsequent surveys. It is therefore assumed that they have disappeared from the area.

10.4.7 Habitats in the Existing Environment

The habitats found in the study area of the scheme, with total area or length within the floodplain, and within Rahasane Turlough SAC, are provided in **Table 10.12**. The species lists for the vegetation community surveys completed within Rahasane Tulough are provided in **Appendix E** of the accompanying NIS. Summary descriptions of habitats within the footprint and the immediate environs of the scheme are provided below.

10.4.7.1 Turloughs FL6

Turloughs are Groundwater Dependent Terrestrial Ecosystems (GWDTE). GWDTE are wetlands which critically depend on groundwater flows and/or chemistries and are included in the register of protected areas established under Regulation 8 of the European Communities (Water Policy) Regulations 2003 (S.I. No. 722 of 2003).

The turloughs found within the study which are considered GWDTEs include Rahasane Turlough, Dunkellin Turlough, Castlegar Turlough, Killora Turlough, Aggard Turlough, Killeeneen Turlough, Kilcornan Turlough and the turloughs at Lackan, details of which are obtained from the GSI database of karst features in Ireland. The available information on the hydrogeology of these features is not as good as that available for Rahasane Turlough. Information on the hydrogeological connections with other karst features is provided by the GSI.

Only one of these karst features is covered by statutory designation, namely Rahasane Turlough (Site Code: SAC000322 and SPA004089), through which the Dunkellin River flows.

Table 10.12 Habitats Found within the Floodplain area and Rahasane SPA / SAC.

Habitat Type	Fossitt Code	Area (ha) within Floodplain	Area (ha) within SAC
Freshwater			
Turloughs	***FL6***	***228.21***	***203.3***
Eroding Upland Rivers	FW1	0.88	0.10
Depositing Lowland River	FW2	2.99	2.71
Canals	FW3	1.93	1.74
Drainage Ditches	FW4	0.07	0
Reed and Large Sedge Swamps	FS1	2.45	0.49
Grassland and Marsh			
Improved Agricultural Grassland	GA1	26.55	12.08
Amenity Grassland	GA2	0.19	0
Dry Calcareous & Neutral Grassland	GS1	13.37	11.30
Dry Meadows & Grassy Verges	GS2	0.34	0
Wet Grassland	GS4	15.23	10.73
Marsh	GM1	12.67	0
Woodland			
Mixed Broadleaved Woodland	WD1	0.79	1.12
Oak-Ash-Hazel Woodland	WN2	3.32	14.17

Habitat Type	Fossitt Code	Area (ha) within Floodplain	Area (ha) within SAC
Wet Pedunculate Oak Ash Woodland	WN4	1.32	2.15
Scrub	WS1	7.74	6.22
Recently-felled Woodland	WS5	0	0.14
Exposed Rock and Disturbed Ground			
Exposed Calcareous Rock	ER2	0.04	0
Cultivated and Built Land			
Recolonising Bare Ground	ED3	0.20	0
Buildings and Artificial Surfaces	BL3	0.40	0
Linear Terrestrial Habitats			
Hedgerows (in kms)	WL1	1.64	0.48
Treelines (in kms)	WL2	3.75	2.27

Karst features located within the study area are shown in **Figure 9.5** and are listed in **Table 10.13.**

Table 10.13 Karst Features within Study Area

Feature No	Type	Name	Townland
1	Cave	N/A	Ballymannagh
2	Cave	N/A	Killora
3	Turlough	Killora Turlough	Killora
4	Cave	N/A	Roo
5	Turlough	Aggard	Aggard Beg
6	Turlough	N/A	Killeeneen More
7	Cave	N/A	Stradbally South
8	Turlough	N/A	Kilcornan
9	Turlough	N/A	Castlegar
10	Turlough	Dunkellin	Roevehagh
11	Turlough	Rahasane	Rahasane/ Carrieen West
12	Swallow Hole	Cregaclare	Lackan
13	Spring	N/A	Lackan
14	Spring	Kilcolgan East	Kilcornan
15	Spring	Kilcolgan West	Stradbally
16	Swallow Hole	N/A	Crinnagh
17	Spring	Killeely Beg Spring	Killeely Beg
18	Spring	Tobernalack	Killeely More
19	Turlough	N/A	Lackan
20	Turlough	N/A	Lackan

Rahasane was formerly the natural sink of the Dunkellin River, but now an artificial channel takes some of the water further downstream. The turlough consists of two basins which are connected at times of flood but separated as the waters decline. Water escapes the artificial channel to sweep around the northern basin and again in the west where it flows into an active swallow-hole system. The main swallow holes here are constantly changing and reach up to 5 m in diameter and 2 to 3 m deep. Some minor collapses are found elsewhere in the turlough, as well as a small number of more permanent pools.

Dr. Roger Goodwillie was appointed by RPS and Galway County Council in order to assess the upper limit of turlough vegetation at Rahasane Turlough. The upper limit of turlough habitat was defined as being all areas within the normal limit of flooding as indicated by the distinctive epilithic and epiphytic moss, *Cinclidotus fontinaloides*. In addition to *C. fontinaloides* wet grassland usually dominates turloughs and can include Creeping Bent (*Agrostis stolonifera*), small sedges (*Carex nigra* and *C. panicea*), Silverweed (*Potentilla anserina*), Meadowsweet (*Filipendula ulmaria*), Creeping Buttercup (*Ranunculus repens*), Marsh Pennywort (*Hydrocotyle vulgaris*) and Amphibious Bistort (*Persicaria amphibia*).

Dr. Goodwillie identified the upper limit of turlough vegetation as being at 16.5 mOD which was then used as a guide to inform the level of flood relief works which would be acceptable without reduction of regular flooding levels to this elevation. In addition, the proposed 16.5 mOD flooding level coincides with much of the boundary wall around Rahasane Turlough and the indicator moss *C. fontinaloides*.

The upper limits of Dunkellin and Castelgar turloughs were assessed in the first instance by consulting 6 inch OSI mapping which show the extent of these turloughs as mapped between 1837 and 1842. In the second instance the upper limits of these turloughs were defined by the upper limit of *C. fontinaloides.* The upper limit of these turloughs were found to coincide with the upper boundary walls which currently exist around the edges of the turloughs and which are also shown on the 6 inch mapping.

Goodwillie (1992) identified seventeen of the thirty-two turlough vegetation communities within Rahasane Turlough. Vegetation community surveys completed for this project in 2011 and 2014 found slight variation in the vegetation communities identified in 1992 when compared to 2014. Further discussion of the past (1992) and current distribution and coverage of Turlough vegetation communities at Rahasane are discussed in **Table 10.14** and displayed in **Figure 10.4.**

Table 10.14 Turlough vegetation communities identified at Rahasane Turlough by Goodwillie (1992)

Turlough Vegetation Community Types (Goodwillie, 1992)	Vegetation Community Type General Descriptions (Goodwillie, 1992)[4]	Area within Rahasane (Ha) 1992 (Taken from Goodwillie, 1992)	Area within Rahasane (Ha) 2014 (as per RPS vegetation surveys 2014)
2A Lolium grassland	*This community is found on the more eutrophic fields around Turlough margins. Such sites may be naturally rich, especially if there is limestone near the surface, or they may be fertilized and grazed. The main species in terms of coverage are usually* Agrostis stolonifera, Scorzoneroides autumnalis *and* Plantago lanceolata *but at times* Trifolium repens, Festuca rubra, Lolium perenne *or* Calliergon cuspidatum *may be almost as common.* Poa *species are important in many places, both* P. pratensis *and* P. trivialis*, but often* Bellis perennis, Ranunculus acris *and* R. repens *are more conspicuous. Late in the season* Cynosurus *and locally* Cirsium arvense *invite attention because of their size and persistence.* Cerastium fontanum *and* Odontites verna *are practically restricted to this community.* *The community was usually recognised by the presence of* Lolium, Festuca rubra, Trifolium repens, Bellis, Cirsium arvense *and* Poa *spp. It is especially common in the drier turloughs in good land, for example Belclare and Peterswell.*	Stretches on the flooded edges of agricultural fields (5.4)	This grassland habitat is located on the northern and southern extremities of the turlough basin. Coverage has expanded since the 1992 surveys with areas of 2B and 2C now corresponding to 2A and the Fossitt 2000 category GA1 (19.05). Intersected by transects
2B Poor grassland	*This would seem to be the more natural type of fringing grassland at the higher levels of a turlough where there has been no management as pasture and the soil is naturally damp.* Trifolium repens, Potentilla anserina *and* Agrostis stolonifera *are the main species with a substantial amount of* Filipendula ulmaria, Carex hirta, Ranunculus repens *and often of* Calliergon cuspidatum, Poa trivialis *and* Schedonorus arundinaceus *also. As in the last community there is often* Lolium *in small quantity along with* Scorzoneroides autumnalis, Taraxacum officinale *and* Plantago lanceolata*.* Phleum pratense *is often noticeable in its native form (ssp.* bertolonii*) while* Elymus repens *locally forms colonies. The community was recognised by the presence of* Schedonorus arundinaceus, Carex hirta, Phleum, Filipendula *and* Potentilla anserina*. It is the most widespread of the vegetation types, occurring in more than 80% of turloughs. Since it usually forms a fringe it seldom covers a lot of ground and the larger sites have the greatest area (e.g. Ballinturly).*	Stretches on the flooded edges of agricultural fields (8.4)	Like 2C, this habitat has contracted in coverage since the 1992 surveys, Many of those fields located along the southern boundary of the Turlough basin have been improved and now resemble 2A vegetation community (1.7)
2C Limestone grassland	*A dwarf, grazed grassland is frequently found around limestone pavement or on other shallow calcareous soils. It appears very species-rich but in fact covers a more defined habitat than, for example, 2B so has a*	In places with outcropping limestone this is the	Located throughout the northern and to a lesser extent, southern

[4] Excerpts taken from Goodwillie (1992) report

Turlough Vegetation Community Types (Goodwillie, 1992)	Vegetation Community Type General Descriptions (Goodwillie, 1992)[4]	Area within Rahasane (Ha) 1992 (Taken from Goodwillie, 1992)	Area within Rahasane (Ha) 2014 (as per RPS vegetation surveys 2014)
	lower number of species altogether. Festuca rubra and Agrostis stolonifera are the most frequent grasses, often with some Lolium *and* Cynosurus cristatus. Trifolium repens, Galium verum, Potentilla anserina, Plantago lanceolata *and* Carex panicea *and/or C.* flacca *are also important species though* Bellis perennis, Achillea millefolia, Lotus cor*niculatus and* Centaurea nigra *are more noticeable. Because* of the *western location of most turloughs* Plantago maritima *is quite frequently found in this community and it may also be enriched with certain limestone specialities like* Campanula rotundifolia, Pimpinella minor, Daucus carota, Thymus polytrichus *or, in the Burren,* Filipendula vulgaris*. Its occurrence is limited to dryish, shallow soils on or close to limestone outcrops. Normally it is found as a narrow band around the margins of a turlough but in a few cases, as at Killtullagh and Rahasane, it covers extensive areas.*	predominant vegetation (22.5)	extremities of the Turlough basin. In some instances, the 2C vegetation community has been slightly improved through sustained grazing and possible fertilisation. In most instances this vegetation community is in transition towards the 2A community (18.09). Intersected by the northern reaches of Transects 1-4.
3A Tall herb	*This is a distinct habitat rather than plant community and is recorded to be able to compare habitat diversity between turloughs. It contains widely different vegetation depending on the level of rock exposure involved. On the floor of a basin it often includes* Cladium, Carex elata *and sometimes* Frangula alnus *which are clearly in contact with groundwater throughout the year. At mid-level* Rhamnus, Carex flacca, Galium boreale *and* Leontodon hispidus *are frequent, with* Rubus caesius, Schoenus nigricans *or occasionally* Thalictrum flavum*. At higher levels* Sedum acre, Lotus corniculatus *and* Plantago *spp. are characteristic, with* Calluna, Vicia cracca, Antennaria dioica *and, in the Burren,* Euphorbia exigua*.*	Along the north shore east of Shanbally Castle, narrow fields of Iris (2.0)	Dense yellow iris growth on the northernmost reaches of Transect 9. Localised pocket of reed canary grass dominated wetland near the southern boundary (2.4)
3B Sedge heath	*Sedge heath is usually short, sheep-grazed vegetation on quite level ground near the top edge of the turlough basin. The soil is peaty but dries out in the summer months except for local seepages. In some cases the community covers old cultivation ridges and it seems likely that some leaching takes place. The plant cover is made up of sedges, especially* Carex panicea *and* C. flacca, *with* Festuca rubra, Succisa, Lotus corniculatus, Scorzoneroides autumnalis *(and* L. taraxacoides*),* Potentilla erecta *and usually* Calliergon cuspidatum*.* Deschampsia cespitosa, Schedonorus arundinaceus, Danthonia decumbens, Molinia caerulea *and* Nardus stricta *are found with lower frequency while* Carex hostiana, C.nigra *and* C. pulicaris *occur in places. Sedge heath is the most species-rich community of any of those described since, in different places; it is subject to both leaching and calcareous seepage. It has elements of limestone grassland with* Plantago maritima, Prunella, Ranunculus acris, Bellis perennis *and* Potentilla reptans *as well as fen species like* Cirsium dissectum, Briza media *and* Parnassia palustris*. The community was recognised usually by the presence of* Deschampsia, Carex flacca, Danthonia, Nardus *or* Leontodon taraxacoides*.*	Along the southern edge where it grows as a fringe below the more calcicole community (1.4)	Not located within the footprint of those transects surveyed in June 2014 surveys (1.4). Small pockets of this habitat located to the south of Rahasane turlough basin proper

Turlough Vegetation Community Types (Goodwillie, 1992)	Vegetation Community Type General Descriptions (Goodwillie, 1992)[4]	Area within Rahasane (Ha) 1992 (Taken from Goodwillie, 1992)	Area within Rahasane (Ha) 2014 (as per RPS vegetation surveys 2014)
5A Dry weed	*Disturbed soil occurs in most grazed turloughs either in field entrances, on the shores at flood level or around swallow holes. It thus may include soil and rock substrates but seldom marl which occurs at lower levels. The plant community varies with the site and its history so that there is no pre-eminent species:* Potentilla anserina*,* Agrostis stolonifera, Phalaris arundinacea *and* Rumex *spp often cover the most ground but* Stellaria media, Polygonum amphibium*;* P. aviculare *and* P. persicaria *are also frequent. The* Rumex *species include* R. crispus*,* R. obtusifolius *and* R.conglomeratus *and on level sites they are often the most conspicuous plants. They are characteristic of a Dry* Carex nigra *community. (q.v.) that is being subjected to overgrazing and is breaking down.* Phalaris, Carex hirta, P. amphibium, Myosotis scorpioides, Potentilla reptans *and* Rorippa palustris *are important near swallow holes.*	On the north shore, where trampling is intense and some animals are over-wintered (1.6)	Located to the north of the Dunkellin River between Transects 4 and 5. In June 2014, this area supported 9A vegetation community. 5A community likely to colonise when water levels recede. Other isolated pockets that correspond to this habitat are dotted around the turlough basin but are not large enough to be mapped discretely (1.6)
5B *Potentilla reptans* (sp. Poor)	*This is a distinctive community covering large areas of drift filled turloughs where superficial drainage is quite good, for example in the Rahasane southern basin. It consists of* Carex nigra, Potentilla anserina, Agrostis stolonifera *with a constant presence of* P. reptans, Mentha aquatica *and* Ranunculus repens. P. reptans *itself is much outweighed by* P. anserina *but its leaves can usually be found with little searching even if it flowers rather seldom. The vegetation is usually closely grazed, frequently by sheep, and the* Phalaris *and* Carex hirta *which are often present are much reduced in height. This community often grades into Wet* Carex nigra *below and the other community (4B) above. It is the main location for* Viola persicifolia *with some V. canina while in certain turloughs it includes* Teucrium scordium *and* Taraxacum sect. palustris*. MacGowran (1985) states that the water table is 1m or less below the surface in the summer months and that the community is flooded for up to 30 weeks. In the field the community was identified by and* Carex nigra *with significant amounts of* Phalaris *and* Mentha *aquatica.*	In very large expanses at both ends of the turlough. Covers the majority of the southern basin and extends around the nearby edges of the main basin (84.5)	As in 1992, occurs in large expanses both to the north and south of the Dunkellin River. Remains one the characteristic habitats of the turlough. Traversed by transects 1, 2, 6, 7, 8 & 9 (84.5)
6A Dry *Carex nigra*	*There are extensive stands of* Carex nigra *towards the base of many turloughs where they approach the long-lasting pools or permanent ponds. In terms of cover* Potentilla anserina, Agrostis stolonifera *and* Ranunculus repens *may be the dominant plants but there is usually abundant* C.nigra *and often* C. hirta *and* Phalaris arundinacea. Mentha aquatica, Filipendula *and* Rumex crispus *are widespread along with Lotus corniculatus and* Scorpidium revolvens*. Despite its name there are places in which* C.nigra *is rare or absent, perhaps in response to nutrient enrichment or trampling by cattle. Here* P. anserina *and* A. stolonifera *may cover almost all the ground. The substrate for this community seems generally to be mineral rather than peaty and some of the purest*	In the central southern section and as well as in the southern turlough, which locally contains *V. persicifolia* (25.0)	Large continuous area located immediately south of the Dunkellin River, traversed by transects 2, 3,4, 5 and 6 (25.0)

Turlough Vegetation Community Types (Goodwillie, 1992)	**Vegetation Community Type General Descriptions (Goodwillie, 1992)[4]**	**Area within Rahasane (Ha) 1992 (Taken from Goodwillie, 1992)**	**Area within Rahasane (Ha) 2014 (as per RPS vegetation surveys 2014)**
	stands grow on marl and clay.		
6B Wet *Carex nigra*	*This community is more widespread than the last in most areas and is characteristic of a turlough that retains some dampness into the summer with the water table just below the surface. The substrate is a peaty silt or even well-humified peat. Carex nigra is frequent as in 6A and often it covers more ground than in that community. It is joined by* Potentilla anserina*,* Ranunculus repens *and* Agrostis stolonifera *but also by a suite of 'wetter' species like* Eleocharis palustris, Hydrocotyle vulgaris, Galium palustre, Caltha palustris *and* Senecio aquaticus*. In places* Glyceria fluitans*,* Phalaris arundinacea *and* Myosotis scorpioides *enter the picture with a little* Polygonum amphibium *locally. The species list is longer than in 6A: partly this is because more information was collected, partly because the community grows on a broader range of habitats, involving seepage water on the sides of turloughs as well as static groundwater at the base. This brings about stands where* Molinia, Carex disticha, Potentilla palustris *or* Veronica scutellata *occur and link the community with the next vegetation-type, Peaty* Carex nigra*. In calcareous circumstances* Carex lepidocarpa *and* Scirpus fluitans *link it with the wetter Marl pond (9A). A particular type of this community with* Lysimachia vulgaris, Sparganium emersum *etc. among rather sparse* C.nigra *is present in the lengthy flooding conditions of Glenamaddy turlough.*	(0.8)	Restricted distribution of this vegetation community within Rahasane Turlough (<1.0)
7A *Polygonum amphibium* (grassy)	*As befits its name* Polygonum amphibium *has a great range within turlough vegetation. It occurs on the fringes of some basins, around swallow holes on the mid-slopes and in permanent ponds at the bottom. It is most common in channels and long-lasting pools where moving water concentrates nutrients and allows eutrophic vegetation even in an oligotrophic basin. The present community is characteristically green and luxuriant and is made up of* P. amphibium *scattered through a dense mat of* Agrostis stolonifera, Potentilla anserina, Myosotis scorpioides *and* Ranunculus repens*. Locally* Alopecurus geniculatus *and* Carex vesicaria *are frequent while* Galium palustre, Eleocharis palustris *and* Phalaris arundinacea *are more constantly found. The other sedges are* C.nigra *and* C. hirta *in small quantity.* Fontinalis antipyretica *and* Drepanocladus *spp are found in some stands but they are apt to get swamped by the blanket of grasses. The substrate generally seems to be silty though there may be peat below the surface.*	Between the natural and artificial rivers (38.9)	Large section located between the Dunkellin River and the artificial channel. Traversed by transects 3,4, 5 and 6 (38.9)
8A *Polygonum amphibium*	*As noted above (7A)* P. amphibium *sometimes occurs in dense patches in long-lasting pools and channels associated with water movement. This community consists of the purer stands of the species which occurs with, but usually dominates,* Agrostis stolonifera, Fontinalis antipyretica *and* Eleocharis palustris*. More aquatic species are also present,* Glyceria fluitans; Apium inundatum, Rorippa amphibia *and* Calliergon giganteum *are the most frequent. The*	Between the natural and artificial rivers (7.1)	Largest section of this vegetation community traversed by Transects 5 & 7, north of the Dunkellin River (7.1)

Turlough Vegetation Community Types (Goodwillie, 1992)	Vegetation Community Type General Descriptions (Goodwillie, 1992)[4]	Area within Rahasane (Ha) 1992 (Taken from Goodwillie, 1992)	Area within Rahasane (Ha) 2014 (as per RPS vegetation surveys 2014)
	community was recognised by the abundance of the dominant species.		
8B Wet annuals	*A community based on* Polygonum *spp is characteristic of lower sites in many turloughs, growing in bare places where water lies into early summer or where the turf is broken by animal damage.* P. persicaria, P. aviculare *and* P. hydropiper *are common with a little* P. minus *in wetter places and P.* arenastrum *in drier ones.* Stellaria media *is frequent also. All these plants grow in other communities also but there is a suite of more restricted ones:* Filaginella uliginosa, Rorippa islandica, R. palustris, Chenopodium rubrum *and* Juncus bufonius *are the most distinctive. Since the community is an open one many other 'weed' species can get a foothold and* Chamomilla suaveolens, Atriplex patula *and* Capsella bursa-pastoris *are sometimes found. This community grows on silt or clay, often over peat, with a skin of algae that develops in spring. Such sites may be reflooded at any time by wet weather and the water table is never far below the surface. Some of them, e.g. Lough Gash, remain too soft to walk on in places, right through the growing season.*	Between the natural and artificial rivers, within 7A community, containing *Rorippa islandica* (0.1)	Not noted during the 2014 surveys. Likely that this community was inundated by 9A or 10A habitats (0.1)
9A Temporary pond	*In most turloughs water lies into the summer in certain places, whether these are natural or artificial drinking ponds. This community grows in the more eutrophic of such sites, often on a surface of poached mud. The sites dry out eventually in the summer but by that time they carry too dense a vegetation for many annuals to become established. The main species are* Agrostis stolonifera, Glyceria fluitans, Myosotis scorpioides *and* Eleocharis palustris *but the more distinctive ones include* Veronica catenata, Ranunculus trichophyllus, Apium inundatum *and* Rorippa amphibia*. These channel and pond areas often abut both wetter and drier habitats so that species like* Potamogeton natans *and* Alisma plantago-aquatica *may grow beside* Potentilla anserina *or* Rumex crispus *in a mosaic that is difficult to classify.*	Area quoted within Goodwillie (1992) as 51.3. However the area displayed in the accompanying Goodwillie (1992) vegetation community maps represent coverage of 29.6.	Expansive area to the north of the Dunkellin River with isolated pockets located to the south (29.6). Traversed by transects 2, 3, 4 and 5
10A *Oenanthe aquatica*	*Oenanthe aquatica is a feature of many waterbodies in the drift-filled turloughs of the north Midlands. It grows in water that is shallow for most of the spring and summer but dries out eventually in most years. The vegetation is mostly about 50cm high but the* Oenanthe *stands out above this if it is not damaged by cattle. The community includes much* Sparganium emersum*,* Rorippa amphibia, Polygonum amphibium *and* Glyceria fluitans*.* Fontinalis *is abundant and there is often* Ranunculus trichophyllus*,* Alisma plantago aquatica *and* Eleocharis palustris*. The deeper water maintains* Potamogeton natans*,* P. crispus *and* Equisetum fluviatile *while the shallows may have* Hippuris, Veronica catenata, Apium inundatum *and even* Potentilla anserina *and* Ranunculus repens *at times. At Carrowkeel turlough this community contained* Bidens tripartita *and* Alisma lanceolatum*: at Lough Gash both* Bidens *species. The substrate is soft mud, rich in organic material and without any*	At the end of the main water track in shallows which dry out occasionally (11.4)	Located to the north of the Dunkellin River, traversed by Transects 5 & 6. Isolated pockets remain between Transects 3 and 4 and to the south of the Dunkellin River, immediately north-east of Transect 2 (11.4)

Turlough Vegetation Community Types (Goodwillie, 1992)	**Vegetation Community Type General Descriptions (Goodwillie, 1992)[4]**	**Area within Rahasane (Ha) 1992 (Taken from Goodwillie, 1992)**	**Area within Rahasane (Ha) 2014 (as per RPS vegetation surveys 2014)**
	accumulation of marl. Occasionally the peat forms a scraw.		
10B Ditch	*Many turlough have streams flowing into them for most of the year and there also may be moving water in artificial drains and ditches. This habitat brings in a range of species that are not found elsewhere in turloughs though they are of widespread occurrence outside. The community is identified by* Apium nodiflorum *and* Nasturtium officinale *agg. with* Berula erecta*,* Veronica beccabunga *and, more rarely,* V. anagallis-aquatica. *There is much* Glyceria fluitans*,* Myosotis scorpioides*,* Polygonum amphibium *and* Alisma plantago-aquatica*, with* Sparganium erectum *and* S. emersum *scattered at intervals. The habitat varies from peaty to mineral and the most consistent feature is the presence of moving water. In overall area the community covers very little ground but it forms a significant linear feature in many turloughs, for example Rahasane.*	Bands along the main channel of the river, with *B. erecta*, *A. nodiflorum*, and *P. amphibium* occurring (3.4)	No discernible change
11B Peaty pond	*Standing water in turloughs is found either where there has been peat cutting in the past or where natural ponds persist all through the year. The community was at first divided into two types on the basis of substrate but there were so many intermediates that this could not be maintained. It covers little ground overall and is modified sometimes by cattle treading and excavation. The basic community consists of* Equisetum fluviatile, Menyanthes trifoliata *and* Alisma plantago-aquatica *with such species as* Potamogeton natans, Sparganium emersum *and* S. erectum, Polygonum amphibium, Carex rostrata *and* Glyceria fluitans *mixed in depending on habitat conditions. There are traces of the small* Potamogeton *community (see below) and usually much floating* Lemna *(including all four species).* Callitriche obtusangula *is the commonest member of this genus. Around the shore* Carex nigra *and* Polygonum amphibium *take over, sometimes with patches of the Wet annual community (8B).*	A fully aquatic community including *R. circinatus* and *P. pectinatus,* along channel to north of the site (14.25)	Comprises a large channel to the north of the Dunkellin River. Supports an aquatic vegetation community and in places an emergent aquatic macrophyte community (14.25)
12 Open water	*This community consists of submerged or floating-leaved plants found in the deeper areas of permanent water that exist in some turloughs.* Potamogeton *spp are an important segment:* P. natans*,* P. berchtoldii *and* P. crispus *are the most frequent though there is a little* P. pectinatus *and P. pusillus locally.* Polygonum amphibium *also plays a part in this community as it does in most others.* Elodea canadensis *and* Zannichellia palustris *are present in a few sites with* Myriophyllum spicatum*,* Sparganium emersum *and* Chara *spp. more frequent. Both* Nymphaea alba *and* Nuphar luteum *are rare, the former in the more oligotrophic sites, e.g. Carran.*	Dunkellin river channel through the site with some pondweeds (5.4)	The Dunkellin River and a body of open water connecting the large channel correspond to this vegetation community. The river supports abundant emergent macrophytes with consistent occurrences of floating and submerged pondweeds (*Potamogeton* spp.) (5.4)

The vegetation communities mapped in 1992, especially within the turlough basin proper, largely remain unchanged and correspond to conditions present at Rahasane Turlough in June 2014. However there have been noticeable changes in 2A *Lolium* Grassland where this habitat his located on the northern and southern extremities of the turlough basin. Coverage has expanded since the 1992 surveys with areas previously classified as 2B and 2C now corresponding to 2A and the Fossitt 2000 category GA1. A small increase (0.4ha) in the area covered by 3A Tall Herb vegetation was also evident.

Turloughs are listed as a Priority Annex I habitat under the Habitats Directive. Only Rahasane Turlough is included in the Natura 2000 network and so is considered to be of International Importance. Other turloughs are not included in the Natura 2000 network as they do not fulfil the criteria for valuation as of International or National importance. These undesignated turloughs may be however conduits to Rahasane Turlough and are therefore considered sensitive and to be of national importance.

Ecological Interest	Links to Annex I Habitats	Locations within Study Site
International/ National Importance.	Rahasane Turlough is a cSAC and SPA containing turlough habitat, therefore it is classified as of **International Importance**. The other Turloughs found within the study area are not designated for nature conservation however are nonetheless considered to be of **National Importance.**	Rahasane, Dunkellin, Castlegar, Killora, Aggard, Killeeneen, Kilcornan and the turloughs at Lackan.

10.4.7.2 FW1

A section of the Dunkellin River, downstream of Craughwell village as far as Rahasane Turlough, and the Aggard Stream are classified as Eroding Upland Rivers FW1. These watercourses are actively eroding, unstable and occur where there is little or no deposition of fine sediment. The beds of eroding rivers are characterised by exposed bedrock and loose rock.

The characteristic plants of Annex I habitat ‘3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation’ are listed in the Interpretation Manual (EC, 2003) and include a number of *Ranunculus* species and all *Callitriche* species, including other submerged aquatic plants. Extensive *Ranunculus* beds were recorded in the Dunkellin River upstream of the confluence with the Aggard Stream and the species was also recorded at a number of locations in the Aggard Stream.

The Article 17 report for this Annex I habitat highlights the lack of research in defining this habitat and that the EU (2003) definition of this habitat is very broad, especially when the presence of aquatic mosses is taken into account, therefore using this broad definition the habitat will be found in most watercourses in Ireland.

This habitat is considered to be of International Importance because it is directly hydrologically linked with Rahasane Turlough cSAC/SPA.

Ecological Interest	Links to Annex I Habitats	Locations within Study Site
International Importance.	Clear unpolluted rivers can contain the annexed habitat ‘Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (3260)’. This vegetation type was recorded in the Aggard Stream and Dunkellin River.	Downstream of Craughwell town and Aggard Stream.

10.4.7.3 Depositing Lowland River FW2

The Dunkellin River is classified as a Depositing Lowland River FW2 within and downstream of Rahasane Turlough. Much of the proposed works will be located within and adjacent to the Dunkellin

River, which is designated within Rahasane Turlough cSAC/SPA. This habitat is dealt with in detail in Chapter 11, Aquatic Ecology and Water Quality. The Dunkellin River is considered to be of International Importance because it is directly hydrologically linked with Rahasane Turlough cSAC/SPA and with Galway Bay Complex cSAC and Inner Galway Bay SPA.

Ecological Interest	Links to Annex I Habitats	Locations within Study Site
International Importance.	Clear unpolluted rivers can contain the annexed habitat 'Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (3260)'. This vegetation type was recorded upstream of Rahasane turlough within the Dunkellin River.	Throughout study area.

Image 10.1 Dunkellin River, downstream of Rahasane Turlough, classified as a Depositing Lowland River

Image 10.2 View of Craughwell River just upstream of Aggard Stream confluence – note heavy crop of mid-channel *Ranunculus*. Crayfish were utilising marginal macrophytes at this location.

10.4.7.4 Canals

A canalised channel runs through Rahasane Turlough taking flow from the Dunkellin River upstream of Rahasane through the turlough to the Dunkellin River downstream of the turlough. Canals are described as artificial linear bodies of water that lack strong currents and any significant channel or bank erosion. This channel was constructed in the 1850's in order to provide surface water drainage for the turlough. This habitat is considered to be of International Importance because it is directly hydrologically linked with and influences Rahasane Turlough cSAC/SPA.

Ecological Interest	Links to Annex I Habitats	Locations within Study Site
International Importance.	This habitat type does not correspond to any EU Annex I Habitats but is located within Rahasane Turlough cSAC/SPA.	Throughout study area.

10.4.7.5 Drainage Ditches FW4

There is a large drainage ditch in the townland of Killeely Beg. Drainage ditches are usually found around the perimeters of most fields draining Improved Grassland and Wet Grassland adjacent to the Dunkellin River. Drainage ditches are artificial in origin and support wetland vegetation but are maintained and cleared out in order to keep them open and free draining. Although these drains provide no fisheries value they are directly hydrologically linked to the Dunkellin River and provide habitat for invertebrates and amphibians and potential migratory routes for mammals. This habitat is dealt with in detail in **Chapter 11**, Aquatic Ecology and Water Quality.

Ecological Interest	Links to Annex I Habitats	Locations within Study Site
Local Importance (Higher Value).	This habitat type does not correspond to any EU Annex I Habitats.	Throughout study area.

10.4.7.6 Calcareous Springs FP1

There are five records for springs within the study area and its immediate environs listed on the GSI database of karst features in Ireland, see **Table 10.13**. No tufa formations were found within the study area. Calcareous springs with tufa formation are recognised as the Priority Annex I Habitat under the Habitats Directive, 'petrifying springs with tufa formation (Cratoneurion) (7220)'. These karst features may however be hydrologically connected to the Dunkellin River and are therefore considered sensitive and to be of County importance. Further information on springs is provided in Chapter 9 of this document.

Ecological Interest	Links to Annex I Habitats	
County Importance.	This habitat type does not correspond to the EU Annex I habitat 7220 Petrifying springs with tufa formation (Cratoneurion). However, it may be hydrogeological linked to the Dunkellin River. Springs within proximity to the study area are therefore considered to be of international ecological importance.	Townland of Tobernalack approx. 580m east of Kilcolgan refer to **Table 10.13.**

10.4.7.7 Reed and Large Sedge Swamps FS1

This habitat is often associated with lowland rivers, marsh and wet grassland. There are a number of areas of Reed and Large Sedge Swamp FS1 identified during the survey mostly concentrated within 1.5 km upstream of Kilcolgan Bridge. They are located in the townlands of Stradbally East, Killeely More, Killeely Beg and Carrigeen East. Typical components include Common Reed (*Phragmites australis*), Common Club-rush (*Schoenoplectus lacustris*) Reed Sweet-grass (*Glyceria maxima*), Branched Bur-reed (*Sparganium erectum*), and Reed Canary-grass (*Phalaris arundinacea*). A species rich area of this habitat, dominated *P. arundinacea* but with abundant Yellow Iris (*Iris pseudacorus*) and many aquatic species in lower layers, such as Brooklime (*Veronica beccabunga*), Water Forget-me-not (*Myosotis scorpioides*), Water-cress (*Nasturtium officinale*), Fool's-water-cress (*Apium nodiflorum*), also Creeping Buttercup (*Ranunculus repens*), Lesser Spearwort (*Ranunculus flammula*) and Meadowsweet (*Filipendula ulmaria*) was identified in the townland of Killeely More, adjacent to a historically recorded spring.

Ecological Interest	Links to Annex I Habitats	Locations within Study Site
Local Importance (Higher Value).	This habitat type does not correspond to any EU Annex I Habitats.	Stradbally East, Killeely More, Killeely Beg and Carrigeen East.

10.4.7.8 Improved Agricultural Grassland GA1

Improved Agricultural Grassland GA1 is a commonly occurring habitat type within the study area comprising primarily a grassy sward of typical agricultural grassland cultivars, including a dominance of Perennial Rye-grass (*Lolium perenne*) Cock's-foot (*Dactylis glomerata*), Fescues (*Festuca* spp.), Yorkshire Fog (*Holcus lanatus*) and Meadow grasses (*Poa* spp.) occurring, particularly along the field margins.

The herbs, ribwort plantain (*Plantago lanceolata*), white clover (*Trifolium pratense)* and Daisy (*Bellis perennis*) occur abundantly. Herbs occurring less frequently include Thistles (*Cirsium* sp.), Dandelion (*Taraxacum* sp.), Creeping Cinquefoil (*Potentilla reptans*), Silverweed (*Potentilla anserina*), Chickweed (*Stellaria media)*, Common Mouse-ear (*Cerastium fontanum*) and Common Nettle (*Urtica dioica*). This habitat does not correspond to any Annex I Habitats.

Ecological Interest	Links to Annex I Habitats	Locations within Study Site
Local Importance (Lower Value).	This habitat type does not correspond to EU Annex I Habitats.	Widespread throughout the Study Area.

10.4.7.9 Amenity Grassland (GA2)

This habitat occurs just north of Dunkellin Bridge in the townland of Roevehagh and has been subject to intensive improvement for use as amenity grassland. This habitat is for purposes other than grass production and does not correspond to any Annex I Habitats.

Ecological Interest	Links to Annex I Habitats	Locations within Study Site
Local Importance (Lower Value).	This habitat type does not correspond to EU Annex I Habitats.	Roevehagh.

10.4.7.10 Dry Calcareous and Neutral Grassland GS1

This habitat type occurs in well-drained areas that have not been subject to intensive agricultural improvement. Grasslands of this type where they occur within the study area are generally more neutral in character, but some calcareous grassland was found on spoil heaps beside the Dunkellin River where limestone rubble has been deposited, or in areas where there is a shallow soil cover on limestone rock. Grass species such as bents (*Agrostis* spp.), Meadow-grasses (*Poa* spp.), Meadow Foxtail (*Alopecurus pratensis*), Timothy (*Phleum pratense*), fescues (*Festuca* spp.), Sweet Vernal-grass (*Anthoxanthum odoratum*), Crested Dog's-tail (*Cynosurus cristatus*), Cock's-foot (*Dactylis glomerata*) and Yorkshire-fog (*Holcus lanatus*) occur. Common broadleaved herbs include clovers (*Trifolium* spp.), Yarrow (*Achillea millefolium*), Common Knapweed (*Centaurea nigra*), Selfheal (*Prunella vulgaris*), Bird's-foot Trefoil (*Lotus corniculatus*). Species rich examples of this habitat occurred in the townlands of Crinnage or Ballywulash (0.2ha), Shanbally (2.6ha), Rinn (0.6ha), Caherapheepa (0.8ha), Castlegar (1.2ha), Killeely Beg (0.7ha).

Near the townland of Crinnage / Ballywulash, the more diverse grassland habitats are located on the northern fringes of Rahasane Turlough in and amongst areas of thin soils and outcropping calcareous rocks. The more diverse areas support a relatively high forb to grass ratio with species such as Yellow Rattle (*Rhinanthus minor*), Clovers (*Trifolium* spp.), Yarrow, Bird's-foot Trefoil, Black Medick (*Medicago lupulina*), Mouse-Ear Hawkweed (*Pillosella officinarum*), Common Eyebright (*Euphrasia officinalis* agg.), Common Milkwort (*Polygala vulgaris*) and Ox-Eye Daisy (*Leucanthemum vulgare*) occur. Grasses typically include Sweet Vernal grass, Meadow grasses, Red Fescue (*Festuca rubra*), Crested Dog's-tail, Glaucous Sedge (*Carex flacca*) and Carnation Sedge (*Carex panicea*). This vegetation community falls under the 2C Limestone grassland vegetation classification (Goodwillie, 1992).

Another, more diverse area of calcareous grassland, also in the Crinnage / Ballywulash townland supported Common Spotted Orchid (*Dactylorhiza fuchsii*), Quaking grass (*Briza media*), Meadow Vetchling (*Lathyrus pratensis*), Ladies Bedstraw (*Galium verum*), Ladies Mantle (*Alchemillea vulgaris* agg.) and Lesser Butterfly Orchid (*Platanthera bifolia*).

Ecological Interest	Links to Annex I Habitats	Locations within Study Site
Local Importance (Higher Value).	*Calcareous grasslands with either high numbers or diversity of orchids correspond to the priority habitat, 'semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometea*) (*important orchid sites) (6210)'. ***This habitat type was not found within the study area, however.***	Crinnage or Ballywulash, Shanbally, Rinn, Caherapheepa, Castlegar, Killeely Beg.

Image 10.3 Species-rich Calcareous grassland in Crinnage (Ballywulash) Townland

10.4.7.11 Dry Meadows & Grassy Verges GS2

This type of grassland habitat was found to the north (0.3 ha) and south (0.8 ha) of the Dunkellin River in the townland of Caherapheepa. The vegetation was tall (>50 cm) tussocky grassland with dominant Cock's-foot (*Dactylis glomerata*), frequent to abundant False Oat-grass (*Arrenatherum elatius*), abundant Bracken (*Pteridium aquilinum*), frequent Meadow Vetchling (*Lathyrus pratensis*) and occasional Bird's-foot Trefoil (*Lotus corniculatus*), Cowslip (*Primula veris*) and Germander Speedwell (*Veronica chamaedrys*).

A list of the typical species found within the Annex I habitat 'lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*) [6510] The Status of EU Protected Habitats and Species in Ireland (NPWS, 2013). This list was derived from the data collected during the Irish Semi-natural Grasslands Survey (ISGS) 2007-2012 (O'Neill *et al*., 2013). To qualify as the Annex I habitat [6510] the sward should have at least seven of the typical species and a minimum of one high quality species.

Two of these positive indicator species are found within Acid Grassland habitats within the study area, including *Lathyrus pratensis* and *Lotus corniculatus* which is also a high quality species. The ISGS 2013 discusses the presence of *Arrhenatherum elatius* and *Dactylis glomerata* in the sward, as they are character species listed on diagnostic species of the Arrhenatherion elatioris (White and Doyle 1982) for the Annex I habitat [6510], however where their cover is high this would indicate a lack of management, such as mowing and the JNCC (2004) and the ISGS lists both these species as negative indicators for lowland meadows.

Therefore where this grassland occurs within the study area it does not support the botanical species or vegetation communities which correspond to the Annex I Habitat, as per the Interpretation Manual of European Union Habitats - EUR27.

Ecological Interest	Links to Annex I Habitats	Locations
Local Importance (Higher Value).	Annex I habitat, 'Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*)'. ***No examples of this habitat type were found within the Study Area.***	Caherapheepa.

10.4.7.12 Wet Grassland GS4

This habitat is quite common within the study area, occurring regularly along the banks of the Dunkellin River, and on lower slopes where drainage is impeded. This habitat often forms mosaics with marsh and improved grasslands. Most of the wet grassland communities found within the study area are relatively species-poor.

Within the bounds of Rahasane Turlough cSAC / SPA wet grassland habitats typically form distinct vegetation communities that are influenced by environmental variables such as topography, inundation, soil moisture, period, aspect etc. These vegetation communities have been defined and classified by Goodwillie (1992) as part of his survey *Turloughs over 10ha – Vegetation Survey and Evaluation*. The presence distribution and plant composition of these wet grassland vegetation communities including 2A, 3B, 5B, 6A, 6B and 7A within the cSAC bounds are discussed in greater detail in the accompanying Natura Impact Statement.

Throughout the proposed study area, wet grassland occurs in mosaic with improved grassland and marsh habitats and often acts as a transitional habitat between both. For example in the townland of Killeely Beg, Wet Grassland GS4 which appears to be Marsh GM1 from a distance as there was abundant Yellow Iris (*Iris pseudacorus*). However on closer inspection, grasses such as sweet vernal grass (*Anthoxanthum odoratum*) and creeping bent (*Agrostis stolonifera*) and clovers *Trifolium* spp. dominated. There are also patches where Rushes (*Juncus* spp.) and Iris (*Iris pseudacorus*) are co-dominant. The grassland community has affinities to the vegetation community 5b (Goodwillie, 1992) and the ISGS vegetation type *3g. Agrostis stolonifera – Holcus lanatus* and no significant correlation to any Annex I grassland habitat.

Also in the townland of Killeely Beg to the north of the Dunkellin River is an area of relatively species rich wet grassland. This habitat is dominated by Red fescue (*Festuca rubra)* with abundant Meadowsweet (*Filipendula ulmaria*) and Clover (*Trifolium* spp.), Meadow Wood-rush (*Luzula campestris*) and Crested Dog's-tail (*Cynosurus cristatus)* are frequent in the sward. Other grasses include Creeping Bent-grass (*Agrostis stolonifera),* False Oat-grass (*Arrhenatherum elatius),* Quaking-grass (*Briza media*), Cock's-foot *(Dactylis glomerata)*, Perennial Rye-grass *(Lolium perenne),* and the herb component comprises Cuckooflower (*Cardamine pratensis*), Pignut *(Conopodium majus),* Bird's-foot Trefoil *(Lotus corniculatus),* Silverweed *(Potentilla anserina),* Creeping Cinquefoil *(Potentilla reptans),* and Cowslip *(Primula veris).*The orchid species *Dactylorhiza fuchsii* was also recorded. The grassland community has affinities to the vegetation community 3b (Goodwillie, 1992) and the ISGS *1e. Agrostis stolonifera – Festuca rubra* vegetation type, the species present do not meet the criteria for classification as Annex I Habitat '*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)' (6410).

Ecological Interest	**Links to Annex I Habitats**	**Locations**
Local Importance (Higher Value).	The Wet Grassland habitats within the study area do not correspond to EU Habitats Directive Annex I Habitat '*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)' (6410).	Widespread throughout the Study Area.

10.4.7.13 Marsh GM1

The majority of Marsh GM1 habitat occurs on the north and south banks of the Dunkellin River, predominantly in association with other habitats such as Reed and Large Sedge Swamps FS1 and Wet Grassland GS4. Marsh GM1 habitat comprises a diversity of species similar to Wet Grassland GS4; however there is a predominance of herbs including Yellow Iris (*Iris pseudacorus*), Meadowsweet (*Filipendula ulmaria*), Ragged Robin (*Silene flos-cuculi*) and Marsh Pennywort (*Hydrocotyle vulgaris*), with horsetails (*Equisetum* spp.), large sedges (*Carex* spp.) and Reedmace (*Typha latifolia*) also occurring.

In the townland of Crinnage / Ballywulash, areas of marsh habitat comprising dominant Reed Canary-grass (*Phalaris arundinacea*) and abundant Yellow flag Iris (*Iris pseudacorus*) are located on the margins of the Turlough floodplain occurring in mosaic with wet grassland. In addition to this dense macrophyte cover species such as Yorkshire fog (*Holcus lanatus*), Black Medick (*Medicago lupulina*), Cut-leaved Crane's-bill (*Geranium dissectum*), Silverweed (*Potentilla anserina*), Broad-leaved Dock (*Rumex obtusifolius*), Red Clover (*Trifolium pratense*), Spear Thistle (*Cirsium vulgare*), Cow Parsley (*Anthriscus sylvestris*), Greater Plantain (*Plantago major*), Common Chickweed (*Stellaria media*) and Creeping Buttercup (*Ranunculus repens*) also occur. The species present do not meet the criteria for classification as the Annex I habitat, 'hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430].

Ecological Interest	Links to Annex I Habitats	Locations
Local Importance (Higher Value).	Marsh may sometimes contain pockets of the Annex I habitat, 'hydrophilous tall herb fringe communities of plains and of the montane to alpine levels (6430)'. ***No examples of this habitat type were found within the Study Area.***	Occurs predominantly within 1.5 km east of Kilcolgan, along banks of Dunkellin.

Image 10.4 Example of Yellow Iris dominated Marsh Habitat in the Townland of Craughwell

10.4.7.14 (Mixed) Broadleaved Woodland WD1

Two parcels of 'Mixed Broadleaved Woodland' were found within the study area in the townland of Craughwell fringing the southern bank of the Dunkellin River. This area supports native and non-native species and a mix of broadleaved trees (75-100%) and conifer (0-25%) trees. The easternmost sections includes a small area of woodland underneath a road embankment, dominated by Ash (*Fraxinus excelsior*), with frequent Hawthorn (*Crataegus monogyna*). The ground flora here is relatively rich, with Herb Robert (*Geranium robertianum*), Ramsons (*Allium ursinum*) and Hogweed (*Heracleum sphondylium*). This in turn is fringed to the west by another strip of woodland with mature Ash (*Fraxinus excelsior*) and Hazel (*Corylus avellana*), with some Hawthorn (*Crataegus monogyna*) and occasional Sycamore (*Acer pseudoplatanus*). This woodland parcel supported a field layer of Ivy (*Hedera helix*), mosses, Wild Angelica (*Angelica sylvestris*), Hart's-tongue Fern (*Asplenium* *scolopendrum*) and Lords-and-Ladies (*Arum maculatum*). Mallard (*Anas platyrhynchos*) were also recorded within this woodland habitat.

Also in Craughwell, another larger pocket of woodland fringes the northern bank of the Dunkellin River. This is mature woodland dominated by Ash (*Fraxinus excelsior*), with frequent Hawthorn (*Crataegus monogyna*), Hazel (*Corylus avellana*) and occasional Beech (*Fagus sylvatica*). Sycamore (*Acer pseudoplatanus*) saplings are also frequent within the woodlands understorey, though no mature specimens were recorded. The woodland has established upon shallow soils with consistent outcrop bedrock. The woodland's field layer is dominated by Ivy with abundant mosses with occasional Lords and Ladies (*Arum maculatum*), Wood Avens (*Geum urbanum*), Bugle (*Ajuga reptans*) and Hart's Tongue Fern (*Asplenium scolopendrium*).

Ecological Interest	Links to Annex I Habitats	Locations
Local Importance (Higher Value)	This habitat type does not correspond to any EU Annex I Habitats.	Craughwell

10.4.7.15 Oak-Ash-Hazel Woodland WN2

There are a number of areas of Oak-Ash-Hazel Woodland (WN2) habitat present throughout the study area, some of which are within Rahasane Turlough. Areas are located, in particular in the townlands of Stradbally East (3.8ha), Killeely Beg (0.7ha), Castlegar (0.9ha) and Crinnage or Ballywulash (0.3ha). The area at Crinnage or Ballywulash has Ash (*Fraxinus excelsior*), Hazel (*Corylus avellana*) and frequent Hawthorn (*Crataegus monogyna*) and a very large mature Oak (*Quercus* sp.), with ground flora consisting of Lords and Ladies (*Arum maculatum*), Enchanter's Nightshade (*Circaea lutetiana*), Pignut (*Conopodium majus*), Hart's-tongue Fern (*Asplenium scolopendrium*), Bluebell (*Hyacinthoides non-scripta),* Lesser Celandine (*Ranunculus ficaria*), Germander Speedwell (*Veronica chamaedrys*) and Early Dog-violet (*Viola reichenbachiana*).

Another example of this woodland occurred within the townland of Crinnage / Ballywulash supporting co-abundant Ash (*Fraxinus excelsior*) Hazel (*Corylus avellana*) and Hawthorn (*Crataegus monogyna*) with occasional Pedunculate Oak (*Quercus robur*). The ground flora comprised Wood Sanicle (*Sanicula europaea*), Germander Speedwell (*Veronica chamaedrys*), Wood Avens (*Geum urbanum*), Cock's-foot (*Dactylis glomerata*), Barren Strawberry (*Potentilla sterilis*), Enchanter's-nightshade (*Circaea lutetiana*), Lords and Ladies (*Arum maculatum*), Pignut (*Conopodium majus*), Ivy (*Hedera helix*), Rose (*Rosa* sp.) and Bramble (*Rubus fruticosus* agg.).

Ecological Interest	Links to Annex I Habitats	Locations
County Importance	This habitat type does not correspond to any EU Annex I Habitats; however it is very limited in extent in Ireland and is regarded as being of conservation importance.	Stradbally East, Killeely Beg, Castlegar

10.4.7.16 Wet Pedunculate Oak-Ash Woodland WN4

This type of woodland is associated with areas that are flooded or waterlogged in winter but which dry out in summer. The woodland is typically dominated by Pedunculate Oak (*Quercus robur*), and/or Ash (*Fraxinus excelsior*). An area of this habitat is located within the townland of Crinnage and Ballywullash with Ash (*Fraxinus excelsior*) dominating the canopy, and abundant Hawthorn (*Crataegus monogyna*) and frequent Hazel (*Corylus avellana*) in the sub-canopy layer. The field layer is dominated by Enchanter's Nightshade (*Circaea lutetiana*). Herb Robert (*Geranium robertianum*) is abundant. Other common species are Lords and Ladies (*Arum maculatum*), Meadowsweet (*Filipendula ulmaria*), Wood Avens (*Geum urbanum*) and Germander Speedwell (*Veronica chamaedrys*).

This woodland does not correspond to the EU Annex I habitat [91E0]. However, it is of high biodiversity value and semi-natural woodlands are becoming increasingly rare and hence their conservation is of great local significance. The woodland is located on the edge of the turlough and is included within Rahasane Turlough cSAC. It is also likely to be of local importance for fauna, especially as a viable foraging and refuge / nesting habitat and Wet Pedunculate Oak-Ash Woodland WN4 can also support high levels of lichen cover. There are several other patches of similar woodland in the area, and mature treelines provide good connectivity between these habitats. The value of this habitat is somewhat threatened by the invasion of Sycamore.

Ecological Interest	Links to Annex I Habitats	Locations
County Importance	The Wet Pedunculate Oak-Ash Woodland habitats within the study area do not correspond to EU Habitats Directive Annex I Priority Habitat ‘alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-padion*, *Alnion incanae*, *Salicion albae*)’ (91E0).	Stradbally East, Killeely Beg, Castlegar.

Image 10.5 Ash Dominated Woodland in the Townland of Crinnage or Ballywulash

10.4.7.17 Scrub WS1

Scrub habitat is present throughout the study area. They occur on thin soils where agricultural practices have been abandoned and scrub has encroached, and also on areas of Cutover Bog. The species composition of this habitat varies between sites. To be considered scrub, the habitat must comprise 50% of shrubs, low trees and/or brambles with a canopy height of less than 5 m. Species such as Gorse (*Ulex europaeus*) are a common component, with Bramble (*Rubus fruticosus* agg.), Hawthorn (*Crataegus monogyna*), Blackthorn (*Prunus spinosa*) and Guelder Rose (*Viburnum opulus*). In Cutover Bog areas, Scrub habitat occurs on elevated rocky mounds, forming an intimate mosaic with Dry Heath. This habitat does not correspond to any Annex I habitat.

Within and surrounding the environs of the study area, scrub typically takes the form of Hawthorn (*Crataegus monogyna*) and hazel (*Corylus avellana*) dominated habitats that are typically located on thin soils with regular areas of outcropping calcareous rock.

Ecological Interest	Links to Annex I Habitats	Locations within Study Area
Local Importance (Higher Value)	This habitat does not correspond to Annex I habitats, however it can be important for wildlife, particularly insects and birds.	Scattered throughout study area.

10.4.7.18 Recently-felled Woodland WS5

Recently-felled woodland habitats are areas of plantation or other woodland that have been clear-felled but have not been replanted or converted to another landuse. Common colonisers among the of open ground among the tree stumps and brash include Rosebay Willowherb (*Chamerion angustifolium*), Wild Strawberry (*Fragaria vesca*), Field Forget-me-not (*Myosotis arvensis*), Foxglove (*Digitalis purpurea*) and ferns. There is one area of recently-felled woodland in the study area in the townland of Shanbally.

Ecological Interest	Links to Annex I Habitats	Locations within Study Area
Local Importance (Lower Value).	This habitat does not correspond to Annex I habitats, however it can be important for wildlife, particularly insects and birds.	Scattered throughout study area.

10.4.7.19 Hedgerows WL1

Hedgerows criss-cross the study area, often associated with stone walls built in the vernacular style. The majority of these are dominated by Ash (*Fraxinus excelsior*) and Hawthorn (*Crataegus monogyna*). Other species noted in hedgerows were Holly (*Ilex aquifolium*), Gorse (*Ulex europaeus*), Hazel (*Corylus avellana*) and Bramble (*Rubus fruticosus*). The hedgerows are generally well-maintained and stock-proof. This habitat does not correspond to any Annex I habitat, but are considered to be of Local Importance (Higher Value) due to their function as wildlife corridors and navigational routes for bats.

Ecological Interest	Links to Annex I Habitats	Locations within Study Area
Local Importance (Higher Value).	This habitat does not correspond to Annex I habitats.	Throughout the study area.

10.4.7.20 Treelines WL2

Field boundaries with trees over 5 metres are rare in the study area. Ash (*Fraxinus excelsior*) is the most common species in these treelines, but other common species are Alder, Crack Willow (*Salix fragilis*), Hawthorn (*Crataegus monogyna*), Blackthorn (*Prunus spinosa*), Field Maple (*Acer campestre*) and Sycamore (*Acer pseudoplatanus*). Treelines do not correspond to any Annex I habitats but are considered to be of high local ecological importance due to their function as wildlife corridors and navigational routes for bats.

Ecological Interest	Links to Annex I Habitats	Locations within Study Area
Local Importance (Higher Value).	This habitat does not correspond to Annex I habitats.	Occasional, scattered distribution.

Image 10.6 Mature Treeline Adjacent to Dunkellin River in the Townland of Craughwell

10.4.7.21 Exposed Calcareous Rock ER2

This habitat includes all natural and artificial exposures of calcareous bedrock and loose rock and may support small pockets of species-rich calcareous grassland, heath or scrub vegetation. There are a number of substantial areas of exposed calcareous rock west of Rahasane Turlough, both north and south of the river in the townlands of Caherapheepa and Rinn. A small area of Exposed Calcareous Rock (ER2) fringes the Dunkellin River, upstream of Dunkellin Bridge. This supports abundant Wood Sage (*Teucrium scorodonia*), Herb Robert (*Geranium robertianum*), Wild Thyme (*Thymus polytrichus*), Rue-leaved Saxifrage (*Saxifraga tridactylites*), Common milkwort (*Polygala vulgaris*), Stonecrops (*Sedum* spp.), Rusty-back fern (*Ceterach officinarum*), Red Fescue (*Festuca rubra*).

Downstream of Dunkellin Bridge, another section of Exposed calcareous rock (ER2) corresponding to the Annex I habitat limestone pavement supported abundant Stonecrops (*Sedum* sp.), mosses, Red Fescue (*Festuca rubra*) with frequent Wood Sage (*Teucruim scorodonia*), *Cladonia* spp., Mouse-ear-hawkweed (*Pilosella officinarum*), Black Medick (*Medicago lupulina*), Herb Robert (*Geranium robertianum*), Common Mouse-ear (*Cerastium fontanum*), Quaking-grass (*Briza media*), Yorkshire-fog (*Holcus lanatus*), Lady's Bedstraw (*Galium verum*), Rue-leaved Saxifrage (*Saxifraga tridactylites*), Dove's-foot Crane's-bill (*Geranium molle*) and Shining Crane's-bill (*Geranium lucidium*).

Ecological Interest	Links to Annex I Habitats	Locations within Study Area
Local Importance (Higher Value).	Examples of exposed Calcareous Rock corresponds to the priority Annex I habitats, 'Limestone pavements (8240)'.	Caherapheepa and Rinn.

10.4.7.22 Recolonising Bare Ground ED3

This habitat classification is used to describe areas of bare ground or derelict sites that have been colonised by herbaceous plants. The vegetation cover must exceed 50% to be considered under this classification. This habitat can support a diversity of early pioneer plants and ruderal species including Nettle (*Urtica dioica*), Dandelion (*Taraxacum* spp.), Colts Foot (*Tussilago farfara*), Teasel (*Dipsacus fullonum)*, Willowherbs (*Epilobium* spp.) and grasses favouring disturbed ground such Annual Meadow Grass (*Poa annua*) may also occur. One area of this habitat type was found within the study area in the townland of Caherapheepa.

Ecological Interest	Links to Annex I Habitats	Locations within Study Area
Local Importance (Lower Value).	This habitat does not correspond to Annex I habitats.	Caherapheepa.

10.4.7.23 Stone Walls and Other Stone Work BL1

Stone walls, built in the vernacular style, are scattered throughout the study area. These often occur in association with Hedgerows WL1. This habitat type is very species poor, but can be important for lichens and mosses.

Ecological Interest	Links to Annex I Habitats	Locations within Study Area
Local Importance (Lower Value).	This habitat does not correspond to Annex I habitats.	Scattered throughout the study area.

10.4.8 Summary of Habitats within each Area for the Flood Relief Works

The existing habitats within the scheme's zone of influence and within each of the nine areas and sub areas are discussed below. The Dunkellin River runs through the entire study area, the majority of which can be classified as Depositing Lowland River FW2 except for that area upstream of Rahasane Turlough where the river corresponds to the Eroding Upland River FW1 classification. Although riverine habitats can contain the Annex I habitat 'Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation (3260)' there was no evidence of this protected habitat throughout the entirety of the site. Aquatic habitats are dealt with in detail in **Chapter 11,** Aquatic Ecology and Water Quality.

Works Item 1: Main Channel (Craughwell Village)

The main channel will be depended from 17.85 mOD (35 m upstream of the road bridge in Craughwell) to 14.66 mOD (610 m downstream of the railway bridge).

Works Item 2: R446 Bridge

The channel will be deepened by approximately 0.6 m at the R446 Road Bridge (underpinning of the bridge will be required). On the southern bank, this bridge is flanked by unmanaged dry grassland immediately downstream with improved grassland upstream. On the northern bank the bridge is flanked by individual semi-mature trees, immediately downstream with linear dense scrub located upstream.

Works Item 3: Masonry Arch Pedestrian Bridge

The channel will be deepened by approximately 0.6 m at each arch (underpinning of the arches will be required). There is Amenity Grassland GA2 habitat immediately adjacent to proposed works at the masonry arch pedestrian bridge.

Works Item 4: Bypass Channel (Craughwell Village)

The channel will be graded from an upstream level of 18.5 mOD to a downstream level of 18 mOD.The bypass bridge will require underpinning to match proposed bed levels.

Works Item 5: Railway Bridge

The channel will be deepened by up to 0.75 m (underpinning/ scour protection of the railway bridge will be required).

Within the vicinity of the railway bridge in Craughwell habitats with low ecological value include Recolonising Bare Ground ED3, Improved Agricultural Grassland GA1 and Scrub WS1. There is an area of Wet Grassland GS4 on the north bank of the river immediately downstream of the bridge which may be of higher ecological value than other adjacent habitats.

Works Item 6: Works at Rahasane Turlough

There are no works proposed within Rahasane Turlough cSAC. The various habitats and turlough vegetation communities that comprise Rahasane Turlough are discussed in greater detail as part of the accompanying Natura Impact Statement.

Works Item 7: Channel Works from Rinn Bridge to Rahasane Turlough

It is proposed to construct a two stage channel typically 20 m wide from approximately 50 m upstream of Rinn Bridge to approximately 50 m downstream of the bridge.

Habitats between Rinn Bridge and Rahasane Turlough comprise predominately Improved Agricultural Grassland GA1 and Scrub WS1. Dry Calcareous and Neutral Grassland GS1 can be found along the south bank of the river; however these are susceptible to invasion by adjacent scrub.

Works Item 8: Works at Rinn Bridge

It is proposed to provide three flood eyes measuring 3.1m wide x 2.1m deep at this location.

The habitats at Rinn Bridge are generally of low ecological value and comprise Improved Agricultural Grassland GA1 and Scrub WS1. There is an area of species-rich Dry Calcareous and Neutral Grassland GS1 on the north bank immediately downstream of the bridge. This area of Dry Calcareous and Neutral Grassland GS1 although not linked to Annex I habitat is however species-rich.

Works Item 9: Channel Works beginning upstream of Dunkellin Bridge

Works will commence approximately 175 m upstream of the Dunkellin Bridge and consist of the construction of a two stage channel typically 20 m wide.

Habitats between Dunkellin and Rinn Bridges comprise of Improved Grassland GA1, Turlough FL6, Dry Calcareous and Neutral Grassland GS1, Dry Meadows and Grassy Verges GS2, Scrub WS1, Exposed Calcareous Rock ER2 and Recolonising Bare Ground ED3. The predominant habitat is 5B Turlough vegetation community which makes up Dunkellin Turlough. This corresponds to the Annex I habitat Turloughs [3180].

It is proposed to increase the top of bank width from an average of 20 m to 38 m. These works, to be carried out on the south bank of the river will affect semi-natural habitats including Turlough, Dry Calcareous and Neutral Grassland and Dry Meadows and Grassy Verges through direct removal and land-spreading of riverbank material. The works will commence approximately 175 m upstream of the Dunkellin Bridge and consist of the construction of a two stage channel allowing an additional width of up to 20 m.

Works Item 10: Works at Dunkellin Bridge

In conjunction with localised channel widening to facilitate the proposed bridge works (30 m), the existing flood eyes shall be replaced with two new box culverts each measuring 13 m wide x 2.3 m deep.

The south bank of the river at Dunkellin Bridge is dominated by Improved Agricultural Grassland GA1 habitat. The north bank of the river, immediately downstream of the bridge comprises areas of Oak-Ash-Hazel Woodland WN2 habitat and Wet Grassland GS4 habitat. None of these habitats correspond to Annex I habitat.

Works Item 11: Channel Works from Dunkellin Bridge to Kileely Beg Bridge

Two stage channel works will continue from Dunkellin Bridge to Kileely Beg Bridge with a typical channel with of up to 20 m.

Habitats within this area are dominated by Improved Agricultural Grassland GA1 immediately upstream of Killeely Bridge then Turlough FL6 habitat (Castlegar Turlough), with extensive areas of Dry Calcareous and Neutral grassland GS1 further upstream some of which is quite species-rich. Immediately south of Dunkellin Bridge there is an area of Improved Agricultural Grassland GA1 on the south bank of the river with Oak-Ash-Hazel Woodland WN2 on the north bank. There are also extensive areas of Scrub WS1 occurring in mosaic with GS1 on both sides of the river.

The only habitat with links to Annex I habitat is the Turlough habitat, which correspond to the Annex I priority habitat Turloughs [3180], but this is not included in the Natura 2000 network. Much of this turlough habitat is further classified as 5B *Potentilla reptans* (sp. poor) under Goodwillie's turlough vegetation community classification.

Works Item 12: Works at Killeely Beg Bridge

In conjunction with localised channel widening to facilitate the proposed bridge works (14 m), a new bridge will be provided with an 18 m span and a soffit level of 7.8 mOD.

Immediately south of the river at Killeely Bridge there is an area of Improved Agricultural Grassland GA1. On the north bank of the river immediately downstream of the bridge there is an area of Oak-Ash-Hazel Woodland WN2 while upstream there is an area of Dry Calcareous and Neutral Grassland GS1.

Works Item 13: Salmon Counter

The salmon counter will be relocated to a position upstream of Kileely Beg Bridge as part of the river enhancement works.

Works Item 14: Channel Works from Kileely Beg Bridge to the N18 Bridge

It is proposed to undertake a two stage channel works from Kileely Beg to the N18 Bridge with a typical channel width of up to 20 m. From a distance of 400 m upstream of the N18 Bridge the two stage channel will be tapered back to match existing channel widths.

This area is not designated for nature conservation or any other statutory designations. Habitats in this area include Marsh GM1, Improved Agricultural Grassland GA1, Reed and Large Sedge Swamps FS1, Wet Grassland GS4, Oak-Ash-Hazel Woodland WN2, Dry Calcareous and Neutral Grassland GS1 and Scrub WS1. None of the habitats found here correspond to Annex I habitat but there are some semi-natural habitats such as marsh, swamp and wet grassland which are considered to be of Local Importance (Higher Value).

Marsh GM1 has links to the Annex I habitat 'hydrophilous tall herb fringe communities of plains and of the montane to alpine levels (6430)'. The Marsh habitat at this location does not correspond to this protected habitat type.

Dry Calcareous and Neutral Grassland GS1 has links to the Annex I habitat ‘*Calcareous grasslands with either high numbers or diversity of orchids correspond to the priority habitat, 'semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometea) (*important orchid sites)’ (6210)’. The Dry Calcareous and Neutral Grassland habitat at this location does not correspond to this protected habitat type, however.

Works Item 15: Works at Kilcolgan & N18 Bridges

The boundaries of Galway Bay Complex cSAC and Inner Galway Bay SPA are located approximately 135 m downstream of the N18 roadbridge in Kilcolgan village. No works are proposed at or on the N18 roadbridge.

10.4.9 Fauna in the Existing Environment

The likelihood of faunal species occurring in the existing environment is discussed in this section. Species which are afforded statutory protection, whether under International, European or National legislation, are considered in detail. Relevant legislation is as follows:

- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive) and Directive 2009/147/EC (codified version of Directive 79/409/EEC as amended) (Birds Directive) – transposed into Irish law as European Communities (Birds and Natural Habitats) Regulations 2011 (SI 477/2011); and

- Wildlife Act 1976 and Wildlife (Amendment) Act 2000.

10.4.9.1 EU Habitats Directive (as transposed)

Species protected under the EU Habitats Directive can be separated into two categories: Annex II of the Directive lists species that require protection of their habitats, for which Special Areas of Conservation (SACs) are designated, while Annex IV of the directive lists species which are afforded strict protection, wherever they occur in the country (inside or outside SACs).

10.4.9.2 EU Birds Directive (as transposed)

The EU Birds Directive requires member states to identify and classify Special Protection Areas (SPAs) for rare or vulnerable species listed in Annex I of the Directive, as well as for all regularly occurring migratory species, paying particular attention to the protection of wetlands of international importance (Article 4).

10.4.9.3 Irish Wildlife Act

Under the Wildlife Act 1976 (as amended) certain species are afforded statutory protection and as such there is a requirement that any proposed development assesses the likelihood of impacting such species. Under Schedule 5 of the Act it is an offence for any person to intentionally:

- kill, injure or take any wild animal listed;

- damage or destroy, or obstruct access to, any structure or place which any wild animal uses for shelter or protection;

- damage or destroy anything which conceals or protects any such structure; or

- disturb any such animal while it is occupying a structure or place which it uses for shelter or protection.

Surveys were completed in Spring/Summer/Autumn 2011 while faunal signs were also noted where encountered during the Rahasane Turlough vegetation surveys completed in 2014. Surveys were undertaken to identify those species listed under Schedule 5 of the Wildlife Act 1976 and which could, bearing in mind the habitats found, occur on the site. All surveys met with standard recommended methodologies (subject to seasonal constraints). Those species identified are discussed in the following sections.

10.4.9.4 Bats

All Irish bat species are protected under the Wildlife Act (1976) and Wildlife Amendment Act (2000). Also, the EU Habitats Directive, seeks to protect rare species, including bats, and their habitats and requires that appropriate monitoring of populations be undertaken. Across Europe, they are further protected under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention 1982), which, in relation to bats, exists to conserve all species and their habitats. The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention 1979, enacted 1983) was instigated to protect migrant species across all European boundaries. The Irish government has ratified both these conventions.

Bat Conservation Ireland's (BCI) website was consulted for bat records in the area (Records presented in **Table 10.15**). Species recorded in the vicinity of study area include Common Pipistrelle (*Pipistrellus pipistrellus*), Leisler's Bat (*Nyctalus leisleri*), Daubenton's Bat (*Myotis daubentonii*), Soprano Pipistrelle (*Pipistrellus pygmaeus*), Natterer's (*Myotis nattereri*), Whiskered (*Myotis mystacinus*) and Brown Long-eared Bat (*Plecotus auritus*).

Table 10.15 Adjudged status of Irish Bat Species Within the Study Area

Common name	Scientific name	Occurrence	Known roosts	Source
Common pipistrelle	*Pipistrellus pipistrellus*	Present	No	Bat Conservation Ireland
Soprano pipistrelle	*Pipistrellus pygmaeus*	Present	No	Bat Conservation Ireland
Nathusius' pipistrelle	*Pipistrellus nathusii*	Absent	No	Bat Conservation Ireland
Leisler's	*Nyctalus leisleri*	Present	No	Bat Conservation Ireland
Brown long-eared	*Plecotus auritus*	Present	No	Bat Conservation Ireland
Lesser horseshoe	*Rhinolophus hipposideros*	Absent	No	Bat Conservation Ireland
Daubenton's	*Myotis daubentonii*	Present	No	Bat Conservation Ireland
Natterer's	*Myotis nattereri*	Present	No	Bat Conservation Ireland
Whiskered	*Myotis mystacinus*	Present	No	Bat Conservation Ireland
Brandt's	*Myotis brandtii*	Absent	No	Bat Conservation Ireland

The key locations of importance for bats for commuting and foraging along the study area include waterbodies, watercourses, treelines and hedgerows. Additional habitats include areas of woodland, scrub and scattered trees. Older, mature trees in the area also offer roosting opportunities for bats. Some of these and indeed younger trees also have ivy (*Hedera helix)* cover that may be used for roosting by bats on occasion.

Daubenton's Bat in particular is likely to utilise the Dunkellin River and other larger watercourses as foraging habitat. It is possible that any bridges, old buildings and large trees in the area are used as roosting sites by bat species.

An assessment was carried out of all bridge structures and trees within the study area which could potentially be used by roosting or foraging bats (**See Appendix B.2**). There are a number of areas of 'Mixed Broadleaved Woodland WD1' and 'Oak-Ash-Hazel Woodland WN2' found within the study area in the townland of Stradbally East, north of the river and also strips north of the river in the townlands of Killeely Beg and Castlegar. One of these areas is in close proximity to Dunkellin Bridge. There are areas of 'Mixed Broadleaved Woodland WD1' both north and south of the river between the town of Craughwell and Rahasane Turlough. These mature trees may offer some occasional roosting potential. Mature Treelines WL2 can be found on the north and south bank of the Dunkellin River between the Railway Bridge and Craughwell town and also in the townland of Killeely Beg, immediately upstream of Killeely Beg Bridge. These trees may also provide some suitable habitat for local bat species. Bridges within the study area found to be suitable for roosting bats include Killeely Bridge, Dunkellin Bridge and the Masonry Arch Pedestrian Bridge at Craughwell.

10.4.9.5 Hares (*Lepus timidus subsp hibernicus*)

The Irish Hare is listed as an 'animal species of community interest whose taking in the wild and exploitation may be subject to management measures' in Annex V of the EU Habitats Directive and as a 'protected fauna species' in Annex III of Bern Convention. The Irish population is also listed in the 'Irish Red Data Book 2: Vertebrates' (Whilde, 1993) as being of international importance. The Irish Hare is present in all counties both in lowland and upland habitats. It is generally found in open habitats including upland heath and pasture. The habitats on site provide local hare populations with suitable habitat. Hares were identified in the townland of Crinnage or Ballywulash south of the river at the east end of Rahasane Turlough during 2011 and 2014 surveys. Irish Hare was also identified on the southern fringes of the Rahasane Turlough basin during the 2014 surveys in the townland of Carrigeen West. It is highly likely therefore that this species is found throughout the study area.

10.4.9.6 Red squirrel (*Sciurus vulgaris*)

The Red squirrel is listed on Appendix III (protected fauna) of the Bern Convention, and is afforded legal protection in Ireland under the Irish Wildlife Acts, 1976 and 2000 as amended. They are found in mixed coniferous forests composed of Pine, particularly Scots pine, and where grey squirrels are absent. The habitats on site provide local red squirrel populations with suitable habitat. Red squirrel signs were identified in an area of 'Oak-Ash-Hazel Woodland WN2' in the townland of Crinnage or Ballywulash north of the river at the east end of Rahasane Turlough during 2011 surveys. Red squirrel was also identified on the margins of 'Oak-Ash-Hazel Woodland WN2' in the townland of Rahasane during the June 2014 site walkover survey. There are a number of areas of woodland in the vicinity of the flood relief scheme providing Red Squirrels with suitable foraging habitat.

10.4.9.7 Pine marten (*Martes martes*)

The Pine marten has in recent times begun to colonise coniferous and mixed forest, particularly in the west of Ireland. They also like to hunt in areas of clear felled conifer plantation. The Pine marten is listed in Annex IV of the Habitats Directive as a species of European interest. This requires a system of strict protection of the species. It is also listed in Appendix III of the Bern convention. Given the extent of woodland habitat in the area and the previous NPWS record from within Grid Square M52 it is possible that this species would occur in the area. During the 2014 vegetation surveys, a pine marten was identified on the outskirts of the scrub / calcareous grassland mosaic on the northern fringes of Rahasane turlough.

10.4.9.8 Badgers (*Meles meles*)

Badgers are listed in the 'Irish Red Data Book 2: Vertebrates' (Whilde, 1993) as being of international importance. Badgers prefer farmland/woodland mosaics but are sometimes found in upland areas up to 500 m in elevation and solitary badgers can occupy territory in open upland, which is dry and not susceptible to flooding. There were no badger setts found within the study area but there are NPWS records from all relevant grid squares and there was suitable habitat in the area. Therefore it is considered likely that Badger do occur in the area, principally for foraging / commuting purposes.

10.4.9.9 Otter (*Lutra lutra*)

Otter are listed on Annex II and Annex IV of the EU Habitats Directive and are also protected by the Wildlife Act (1976 and 2000 as amended). Annex II species under the Habitats Directive; require the designation of protected areas by Member States (Special Areas of Conservation) as set out in Article 3, 4 and 6 of the Directive. Annex IV species require strict protection measures by Member States in accordance with Article 12 of the Directive, the Eurasian Otter is also listed on Appendix 1 of CITES and Appendix II of the Bern Convention. The Irish population is also listed in the '*Irish Red Data Book 2: Vertebrates*' (Whilde, 1993) as being of international importance. The NPWS online database contains records of otters from the Dunkellin River near Rinn Bridge.

Otters are largely solitary, territorial and nocturnal animals and in many areas their distribution is scarce. They are rarely found far from water and tend to occupy linear home ranges along watercourses and coasts. In general, however, otters exploit a narrow strip of habitat at the aquatic – terrestrial interface (O'Neill, 2008). The extent of otter habitat in Ireland has been estimated on the basis of four classes of water bodies: rivers, streams, lakes and coast (high water mark). In addition to the aquatic habitat, a 10 m riparian buffer (both banks) is considered to comprise part of the otter habitat as discussed in the Threat Response Plan for otter prepared by the National Parks and Wildlife Service (NPWS, 2009).

They require suitable bankside vegetation as cover for their burrows or rest sites. Their underground shelters are called *holts* and above ground sites are called *couches*. Otters may dig their own holts but they very often make use of other structures ranging from enlarged rabbit holes and cavities amongst tree roots to rock piles and man-made structures.

Otters mark their home ranges by depositing their droppings termed "spraints", at distinct landmarks such as grassy mounds, large rocks or ledges under bridges. These favoured sites are known as seats and are usually found at important locations, i.e. access points to the water, good fishing grounds. Other signs, such as footprints, fish remains, slides, etc. are also recorded.

Although there are no seasonal requirements for otter surveying, dense vegetation in areas along the riverbanks may reduce success in the identification of otter holts and couches. In addition spraints may also have been washed away following a period of heavy rain fall or flooding.

Otter slides and spraints were identified during a Kingfisher survey in 2011, and during the multidisciplinary surveys 2011 and 2014 during the spring/summer months all signs of otter were recorded. Signs were searched for on the banks of rivers and streams during terrestrial surveys. Holts and signs were searched for in the banks of the rivers and islands within the watercourses during aquatic surveys. The observations of otter activity within study area are provided in **Table 10.16.**

Table 10.16 Observations of Otter Activity within Study Area

Ref. on Drawings	Type of Sign	Location and Activity
OS1	Otter Slide & Spraint.	280m west of Craughwell Railway Bridge (M 50597, 19820) on southern bank of Dunkellin River.
OS2	Otter Spraint & Prints.	Carrigeen West, Rahasane Turlough southern basin (M 47706, 19402). Otter prints and signs recorded at edge of woodland.
OS3	Otter Slide & Spraint.	340m upstream of Killeely Beg Bridge (M 43484, 18438) on southern bank of river.
OS4	Spraint.	Otter spraint with crayfish remains on southern bank, 620m downstream of Killeely Beg Bridge (M 42580, 18691).
OS5	Spraint.	Otter spraint with crayfish remains on northern bank, 720m downstream of Killeely Beg Bridge (M 42469, 18685).

10.4.9.10 Stoat (*Mustela erminea*)

The Irish stoat can be found in a number of habitats, including; woodlands, heathlands and farmlands. The stoat is the smallest of Ireland's carnivorous mammals, is about a foot long, and like the badger, is nocturnal. No signs of stoat were found within the study area during site surveys but it is likely to occur in the area due to the presence of suitable habitat.

10.4.9.11 Deer

All deer species are protected under the Irish Wildlife Acts 1976 and 2000 as amended. The Red Deer (*Cervus elaphus*) is Ireland's only native deer species. However, most of the Red Deer in Ireland today is descended from introduced animals, and some are thought to be hybrids of red deer and Japanese Sika Deer. The only fully native herd is in Killarney National Park, Co. Kerry. Some animals from this herd have been transplanted to Connemara National Park in an effort to increase the native population in Ireland. There is a record for Red Deer in Grid Squares M41 but no signs of deer were noted during site surveys.

10.4.9.12 Hedgehog (*Erinaceus europaeus*)

The Hedgehog is listed in Appendix III (protected fauna) of the Bern Convention, and is afforded legal protection in Ireland under the Irish Wildlife Acts 1976 and 2000 as amended. Hedgehogs are found in woodlands, hedgerows, gardens, and meadows. Hedgehogs are mostly nocturnal, but juvenile or sick animals can sometimes be seen during the day. It is quite likely that this species occurs within the study area.

10.4.9.13 Pygmy Shrew (*Sorex minutus*)

The Pygmy Shrew is Ireland's smallest mammal, ranging in weight from 3g in winter when food sources are low, to 6g for breeding adults in the summer. The pygmy shrew is common throughout the country where there is good ground cover in grassland, woodlands, hedgerows, and bogs. They build spherical nests from dried grass under ground cover, dead wood or rocks. The Pygmy Shrew is listed in Appendix III (protected fauna) of the Bern Convention, and is afforded legal protection in Ireland under the Irish Wildlife Acts, 1976 and 2000 as amended. The habitats on site would provide this species with suitable habitat.

10.4.9.14 Reptiles and Amphibians

There is quite widespread availability of suitable amphibian habitat along the banks and riparian zone of the Dunkellin River.

There are numerous records for Frog (*Rana temporaria*) within Grid Squares M42, M51, and M52.

The habitat of the Smooth Newt (*Lissotriton vulgaris*) ranges from large lakes to densely weeded ditches and so is likely to occur in the area.

There are no records for Common Lizard (*Zootica vivipara*) within the study area but it is likely to occur in the area due to suitable habitats.

10.4.9.15 Terrestrial Invertebrates

Marsh Fritillary (*Euphydryas aurinia*), considered one of the most threatened species in Europe and the only Irish butterfly species protected under Annex II of the EU Habitats Directive and has been recorded in the 10 x 10 km square M51 in 2004 and more recently in 2012. Marsh Fritillary adults or larvae were not recorded during the site surveys for the species. Suitable habitats for foraging Marsh Fritillary adults or for its larval stage are not present within the scheme or its immediate environs.

10.4.9.16 Aquatic Species

Aquatic species present within the scheme and its environs in addition to potential impacts to these species are described in further detail in Chapter 11.

Fish Species

The fish community of Dunkellin and Craughwell Rivers includes Atlantic salmon (*Salmo salar*), Brook/River Lamprey (*Lampetra* spp.), seatrout, brown trout (*Salmo trutta*), European eel (*Anguilla anguilla*) and the likelihood of coarse fish species in the turlough drainage channel reach. There is a report of a sea lamprey (*Petromyzon marinus*) caught on camera while ascending the salmon counter just below Killeely Bridge (pers comm. IFI), although it's distribution in the system is unknown. Of these, salmon and all three lamprey species are listed in Annex II of the Habitats Directive.

Crayfish

Crayfish were found in the turlough drainage channel at the western end and were also abundant in the Craughwell River at the eastern end of the turlough. The aquatic vegetation of the Rahasane drainage channel is ideal habitat for juvenile crayfish, providing shelter and an abundant macroinvertebrate food source. Given the presence of suitable habitat throughout the turlough drainage channel (Dunkellin River) it is reasonable to assume that crayfish occur all the way through Rahasane Turlough cSAC.

Waterbeetles

A number of specialists have sampled the waterbeetle community at Rahasane, e.g., Bilton (1989), O'Connor (2001), Waldron (2003/ 2004). Using Biltons 1989 records, Foster *et al*. (1992) found that Rahasane Turlough fell within Community Type Group F of their classification system. Group F is generally described as "turloughs and more permanent, large, shallow, water bodies on base-rich substrata", with characteristic species including the "moss dweller" community of the turloughs (Foster *et al*., 1992). Waldron collected a number of species characteristic of turloughs including the "moss dweller" species, *Graptodytes bilineatus*, listed as Near Threatened on the Irish Waterbeetle Red List (Foster *et al*., 2009). *G. bilineatus*, is likely to be vulnerable to disturbance and sensitive to alterations in flooding (Sheehy Skeffington *et al*., 2006). Other species characteristic to turloughs were *Agabus nebulosus*, *Hygrotus quinquelineatus, Hygrotus impressopunctatus*. Each of these species are considered as Least Concern in the Irish Red List (Foster *et al*., 2009), although *H. quinquelineatus* is "nationally notable B" in Great Britain (Foster *et al*., 1992). O'Connor's records of 2001/2002 produced an MQS of 6, ranking Rahasane as below average compared to other Group F sites (Foster *et al*., 1992). Again, the characteristic turlough species *Agabus nebulosus, Hygrotus quinquelineatus, Hygrotus impressopunctatus* were recorded.

In summary, though Rahasane is occupied by commonly occurring species that are found as part of other waterbeetle community types, it does support a number of characteristic turlough species, including the "Near Threatened" *G. bilineatus*.

Waterbugs

During sampling undertaken in 2000, Rahasane Turlough had a diverse coroxid community comprised of common species indicative of temporary and permanent waters (Tobin & McCarthy, 2004).

Fairy Shrimp

The freshwater fairy shrimp, *Tanymastix stagnalis*, was first recorded in the smaller, southeastern basin at Rahasane in 1974 (Young, 1976) and has since been found at other locations (Ecofact, 2008). As a slow moving invertebrate, it requires seasonal or temporary pools, such as turloughs, in order to escape predation (Porst, 2006). It is well adapted to exploit temporarily flooded environments, with the ability to hatch, grow and produce eggs within a very short time-frame, e.g., < 15 days in August 1974 (Young, 1976).

Terrestrial beetles of water dependent habitat

Terrestrial invertebrate communities of turloughs are also primarily governed by the flooding regime of a particular turlough (e.g., Regan, 2005; Moran *et al*., 2012). Regan (2005) sampled the terrestrial carabid and staphlinid beetle communities of Rahasane, which ranked it eighth out of eleven turloughs in terms of conservation importance based on the carabid community. Found at Rahasane during that study were the carabid *Bembidion bipunctatum*, a British Red Data Book nationally scarce species (Hyman & Parsons, 1992), and the silphid beetle *Thanatophilus dispar* (superfamily: Staphylinoidea), a Red Data Book Endangered species (RDB1) in Britain.

10.4.9.17 Birds

Bird species recorded during field walkover surveys conducted during spring/summer 2011 and in Rahasane Turlough in summer 2014 are shown in **Table 10.17**. The conservation status of these birds is also provided, whether the species is on the BoCCI List or listed on Annex I of the Birds Directive. Birdwatch Ireland (BWI) and the Royal Society for the Protection of Birds (RSPB), have compiled a list of bird species suffering decline in the Irish/European and global context. These Birds of Conservation

Concern in Ireland are published in a list known as the BoCCI List (Colhoun and Cummins, 2013). In this BoCCI List, birds are classified into three separate lists (Red, Amber and Green), based on the conservation status of the bird and hence conservation priority. The Red List birds are of high conservation concern, the Amber List birds are of medium conservation concern and the Green List birds are not considered threatened.

Table 10.17 Bird Species Recorded within the Zone of Influence for the Scheme

Common Name	Scientific Name	Conservation Status
2011		
Blackbird	*Turdus merula*	Green-listed*
Chaffinch	*Fringilla coelebs*	Green-listed*
Mallard	*Anas platyrhynchos*	Green-listed*
Swallow	*Hirundo rustica*	Amber-listed*
2014		
Blackbird	*Turdus merula*	Green-listed*
Blackcap	*Sylvia atricapilla*	Green-listed*
Chaffinch	*Fringilla coelebs*	Green-listed*
Chiffchaff	*Phylloscopus collybita*	Green-listed*
Common Gull	*Larus canus*	Amber-listed*
Coot	*Fulica atra*	Amber-listed*
Cormorant	*Phalacrocorax carbo*	Amber-listed*
Goldcrest	*Regulus regulus*	Amber-listed*
Great Tit	*Parus major*	Green-listed*
Grey Heron	*Ardea cinerea*	Green-listed*
House Martin	*Delichon urbica*	Amber-listed*
Jack snipe	*Lymnocryptes minimus*	Amber-listed*
Linnet	*Carduelis cabaret*	Amber-listed*
Little Egret	*Egretta garetta*	Green-listed*$
Long-Tailed Tit	*Aegithalos caudatus*	Green-listed*
Mallard	*Anas platyrhynchos*	Green-listed*
Moorhen	*Gallinula chloropus*	Green-listed*
Mute Swan	*Cygnus olor*	Amber-listed*
Robin	*Erithacus rubecula*	Amber-listed*
Rook	*Corvus frugilegus*	Green-listed*
Sparrowhawk	*Accipter nisus*	Amber-listed*
Starling	*Sturnus vulgaris*	Amber-listed*
Swallow	*Hirundo rustica*	Amber-listed*
Willow warbler	*Phylloscopus trochilus*	Green-listed*
Wren	*Troglodytes troglodytes*	Green-listed*

* Birds of Conservation Concern Ireland (BoCCI)
$ EU Birds Directive

Kingfisher

Kingfisher, a species listed on Annex I of the EU Birds Directive, has been recorded within hectads M41 and M51. The Bird Atlas 2007-2011 (Balmer *et. al*., 2013) holds a breeding record for Kingfisher in Grid Square M52 with an unconfirmed breeding record for grid square M51.

A habitat suitability survey of the study area was carried out for Kingfisher between the 14th and 16th November 2011 (results are presented in **Table 10.18**). The aim of this survey was to assess river and bank side habitat for potential to support Kingfisher on the three rivers in the study are and to search for signs of use by Kingfisher (*Alcedo atthis*). The survey methodology included walking the banks of The Dunkellin River, The Aggard Stream and The Monksfield River searching for signs or calls of Kingfisher utilising the habitat while completing a visual assessment of the habitat and recording suitable habitat for this species.

Table 10.18 Locations of Suitable Perches and Banks for Kingfisher

Section	Location	Suitable perch	Suitable Bank
1	Dunkellin River: 1km east of Craughwell to the Aggard Stream confluence and the Aggard Stream to Aggard Bridge on the R347	Suitable perches at M51451 20010 and M50319 19664	Banks unsuitable for nesting as too rocky.
2	Rahasane townland to Dunkellin Bridge (Caherapheepa)	Suitable perch at M45316 18428	2 banks suitable for nesting at M44773 18674 (south river bank) and M44763 18697 (north river bank)
3	Dunkellin Bridge to Killeely Beg Bridge	Some perches suitable but river current was too strong	No banks suitable as section was too rocky
4	Killeely Beg Bridge to N18 Bridge	Some perches suitable but river current was strong	Banks not suitable for nesting.
5	Monksfield River	Suitable perches at M50065 15051 and M50415 15419	Banks not suitable for nesting as were sloping banks of clay.
6	Aggard Stream, 1km east of bridge at Ballylin West	M51225 15950	Banks not suitable for nesting.
7	Aggard Stream from Aggard Bridge to Aggard Beg Bridge (Aggard Beg)	Some perches suitable at M50097 18212, M50350 17945, M50359 17462, M50312 17393, M50331 17233, and M50540 16788.	Possible nesting banks at M50350 17945, M50346 17825
8	Aggard Stream from the Bridge at Ballynamannin to Ballylin West Bridge	Some perches suitable at M50378 16359, M50344 16133 and M50797 15960.	Banks not suitable for nesting.

No nest holes were seen on any of the watercourses surveyed and for the most part the surveyed sections of the Dunkellin River were considered unsuitable for Kingfisher nesting due to rocky banks and thick scrub.

Bridges for Birds

Bridges are considered to be important sites for wildlife (Smiddy and O'Halloran, 2004), especially bats and birds. Masonry bridges are generally more appealing than modern bridges because of the higher frequency of ledges, holes and crevices, and more varied vegetation which provides both shelter and food. These holes and open ledges are used as nesting and roosting sites by Dippers, Grey Wagtails and Pied Wagtails. Nests are usually located at least one metre above water level, and are often built in holes in the masonry joints or where stones have been eroded or are missing.

The bridges within the study area are likely to be of importance for nesting birds, especially the Masonry Arch Pedestrian Bridge downstream of the R446 road crossing. These bridges should be checked by a suitably qualified ecologist for nesting birds prior to the initiation of the drainage maintenance works on these bridges.

10.4.10 Ecological Importance of Habitats

There are three turloughs in the area only one of which is designated as a Natura 2000 site; i.e., Rahasane Turlough cSAC and SPA. Each of the turloughs correspond to the priority Annex I habitat '3180 Turloughs'. As Rahasane Turlough is designated as part of Rahasane Turlough SPA / SAC and supports the priority Annex I habitat it is considered to be of **International Importance.**

The other two turloughs in the area, Kilcolgan Turlough and Dunkellin Turlough, although not within cSAC boundaries are considered to be 'viable areas' of Annex I habitat so are considered to be of **National Importance**.

Woodlands classified as WN2 and WN4 found within the study area do not correspond to Annex I habitats. However semi-natural woodlands are very limited in extent in Ireland, have a high degree of naturalness and high biodiversity value and are regarded as being of conservation importance and are therefore of **County Importance**.

Dry Calcareous and Neutral Grassland GS1 occur throughout the study area. Although they do not correspond to an Annex I habitat, these habitats are semi-natural and many locations have high species richness. Therefore these habitats are classed as **Local Importance (Higher Value).**

Much of the terrestrial habitat on either side of the river is Improved Agricultural Grassland GA1. In places, this grades into Wet Grassland GS4 which is mainly species-poor and are considered to be of Local Importance (lower value). However some of these Wet Grasslands are considered to be of **Local Importance (Higher Value)** due to the diversity of botanical species; however these habitats are common and widespread throughout the region. Marsh GM1 is also found throughout the study area, mostly fringing those areas of the Dunkellin River (with a high density just east of Kilcolgan). They typically occur adjacent to or in mosaic with Wet Grassland and are therefore considered to be of **Local Importance (Higher Value).** Other habitats considered to be of **Local Importance (Higher Value)** include dry calcareous and neutral grassland GS1 and exposed calcareous rock ER1. Both of these habitats support semi-natural species assemblages that are widespread but not abundant within the locality.

Hedgerows WL1 and Treelines WL2 comprise the majority of those field boundaries adjoining and fringing the study area. These are considered to be of **Local Importance (Higher Value)** as they provide connectivity between habitats in addition to providing commuting routes and shelter for species such as bats, badger and smaller mammals.

The only plant listed as requiring protection in either Annex II of the EU Habitats Directive or the Wildlife Act 1976 and recorded within one of the four hectads covered by the study area was Small White Orchid (*Pseudorchis albida*). This was recorded from Grid Square M42 during the 1987-99 BSBI Flora Atlas survey. However this species was not recorded within the study site and is usually found on open, well-drained upland pastures and heaths, neither of which are located within the study area or the study area's zone of influence.

Many of the habitats found within the site provide local mammal species such as Bat, Badger, Hare, Otter and Stoat with suitable foraging habitat. Otter are listed under Annex II of the Habitats Directive. Several potential otter slides and spraints were found in the river bank and around the margins of Rahasane Turlough.

10.4.10.1 Ecological Receptors

Sensitive habitats are identified as 'Ecological Receptors' (ERs), while sensitive habitats of higher importance on a geographical scale are known as 'Key Ecological Receptors'.

Annex I habitats within the study area are evaluated at different geographic scales, depending on whether they are considered to be 'best examples' or 'viable areas'[5]. 'Best examples' of Annex I Priority habitats are considered to be of International Importance, 'viable areas' are of National Importance, while areas of habitat that do not fulfil the criteria for valuation as of International or National Importance are considered to be of County Importance.

[5] The *Guidelines for Assessment of Ecological Impacts of National Road Schemes* state that *'A 'viable area is defined as an area of habitat that, given the particular characteristics of that habitat, was of sufficient size and shape, such that its integrity (in terms of species composition, and ecological processes and function) would be maintained in the face of stochastic change (for example, as a result of climatic variation).*

A total of thirteen Ecological Receptors were recorded within the study area. **Table 10.19** provides a description and valuation of these ecological sites, intersected by the proposed works. The Ecological Receptor valuation system follows the NRA Geographic Context for Determining Value set out in the Guidelines for Assessment of Ecological Impacts of National Road Schemes (NRA, 2009). In the context of the proposed works, ecological resources of below '**Local Importance (Higher value)**' should not be selected as 'Key Ecological Receptors', for which detailed assessment is required. A total of thirteen of these Ecological Receptors were selected as Key Ecological Receptors on this basis.

Table 10.19 Ecological Receptors Potentially Subject to Impacts from the Scheme

Ecological receptors subject to impacts associated with the proposed flood relief scheme	Summary descriptions of ecological receptors	Value of the ecological receptors	Selection as key ecological receptors	Locations
ER1: Rahasane Turlough cSAC (Site Code: 000322) and SPA (Site Code: 004089)	This is a site of major ecological significance as it is one of only two large turloughs which still function naturally (NPWS, 2013b). It is the most important turlough for birdlife in the country. It encompasses a number of Turlough vegetation communities and the Dunkellin River flows through it. This site is designated for its Annex I '3180 *Turlough' priority habitat. Rahasane Turlough is also designated as an SPA; supporting important numbers of wintering birds, three of which are listed on Annex I of the EU Birds Directive; i.e. Whooper Swan, Greenland White-fronted Goose and Golden Plover.	Rahasane Turlough is designated under the EU Habitats and Birds Directives as such it is of **International Importance.**	Yes	Works to be carried out both upstream and downstream but not within cSAC/SPA boundary.
ER2: Galway Bay Complex cSAC (Site Code: 000268)	This is a large coastal site which is of immense conservation importance, with many habitats listed on Annex I of the EU Habitats Directive, four of which have priority status (lagoon, *Cladium* fen, turloughs and orchid-rich calcareous grassland).	Galway Bay Complex is designated under the EU Habitats as such it is of **International Importance.**	Yes	Works to be carried out upstream but not within cSAC/pNHA boundary.
ER3: Inner Galway Bay SPA (Site Code: 004031)	This is a very large, marine-dominated site. It is of immense ornithological importance, with two wintering species having populations of international importance and a further sixteen species having populations of national importance.	Inner Galway Bay is designated under the EU Birds Directives as such it is of **International Importance.**	Yes	Works to be carried out upstream but not within SPA boundary.
ER4: Dunkellin Turlough, EU Annex I habitat '3180 *Turloughs', not designated.	This is an area of turlough habitat within the study area which due to the presence of *Cinclidotus fontinaloides* can be described as EU Annex I habitat '3180 *Turloughs'. It is located approximately 1.5 km downstream of Rahasane Turlough.	Dunkellin Turlough is not designated as a Natura 2000 site but is considered a viable area of Priority Annex I habitat and so is considered of **National Importance.**	Yes	Dunkellin townland

Ecological receptors subject to impacts associated with the proposed flood relief scheme	Summary descriptions of ecological receptors	Value of the ecological receptors	Selection as key ecological receptors	Locations
ER5: Castlegar Turlough, EU Annex I habitat '3180 *Turloughs', not designated.	This is an area of turlough habitat within the study area which corresponds to the EU Annex I habitat '3180 *Turloughs'. It is located approximately 2.5km downstream of Rahasane Turlough.	Castlegar Turlough is not designated as a Natura 2000 site but is considered a viable area of Priority Annex I habitat and so is considered of **National Importance.**	Yes	Castlegar townland
ER6: Otter Annex IV species (EU Habitats Directive) Otter (*Lutra lutra*) is the only species listed on Annex IV of the EU Habitats Directive while there are two non-aquatic species listed on Annex I of the EU Birds Directive which occur within the study area. Therefore ER has been subdivided to adequately assess each of these species separately.	**ER6a - Otter:** A number of otter slides and otter spraints were identified during the various site walkover surveys within the study area.	Otter is protected under EU law and is considered to be of **International Importance**	Yes	Slides and spraints recorded at Craughwell, Carrigeen West, Dunkellin and Kilcolgan. (see Table 10.16)
ER7: Kingfisher EU - Bird's Directive Annex I Species	Kingfisher was not recorded during site surveys. However suitable nesting banks and perches were located during Kingfisher surveys of the flood relief scheme.	Kingfisher is protected under EU law and is considered to be of **International Importance**	Yes	Suitable bank nesting habitat at Caherapheepa and Aggard Beg (see Table 10.18)
ER8: Faunal Species protected under the Irish Wildlife Acts.	**ER8a: Barn Owl**: Has been confirmed as breeding in Grid Square M51 at Lakyle Castle but suitable nest sites or evidence of the species were not recorded during survey.	All of these species are protected under Irish Law. Where	Yes	N/A

Ecological receptors subject to impacts associated with the proposed flood relief scheme	Summary descriptions of ecological receptors	Value of the ecological receptors	Selection as key ecological receptors	Locations
Species protected under Schedule 5 Wildlife Act 1976 (as amended), include Badger, Bat species, Deer species, Hare, Hedgehog, Otter, Pine Marten and Red Squirrel. Therefore, ER8 has been subdivided to adequately assess each of these species separately.	**ER8b - Badger:** No evidence of badger was found within the study area but there are historical records from all relevant grid squares and this species is likely to be found in the area. In any event badgers are likely to use the study area and environs as a foraging habitat, especially during the summer months. The NBDC holds records for badger for Grid Squares M41, M42, M51 and M52.	they occur they are considered to be of **National Importance**[6].		Likely to forage and commute throughout study area, however no evidence found.
	ER8c - Bat Species: Seven bat species have been recorded within or in the vicinity of the study area. The key locations of importance for bats for commuting and foraging within the proposed flood relief works area include water bodies, watercourses, woodlands, treelines and hedgerows. Additional habitats include areas of scrub and scattered trees. Older, mature trees in the area also offer roosting opportunities for bats. Some of these and indeed younger trees which have ivy cover may be used for roosting by bats on occasion. Older buildings and structures such as bridges offer potential for summer and winter roosting and underground structures have potential as hibernation roosts.			Forage and commute throughout study area, no roosts found.

[6] The *Guidelines for Assessment of Ecological Impacts of National Road Schemes* state that *'It is suggested that, in general, 1% of the national population of such species qualifies as a nationally important population. However, a smaller population may qualify as internationally important where the population forms a critical part of a wider population or the species is at a critical phase of its life cycle.'* Given that relatively little is known about the local populations of these species within the study area, however, all populations are considered to be of International Importance, as per the Precautionary Principle.

Ecological receptors subject to impacts associated with the proposed flood relief scheme	Summary descriptions of ecological receptors	Value of the ecological receptors	Selection as key ecological receptors	Locations
	ER8d - Irish Hare: The habitats within the study area would provide local hare populations with suitable habitat. There are records for this species in the NPWS Rare and Protected Species Records in all relevant Grid Squares. Several hares were recorded in the on the south bank, in a species-rich wet grassland field in the townland of Crinnage or Ballywulash at the east end of Rahasane Turlough. During the June 2014 site surveys Irish Hare was identified within the southern basin of Rahasane Turlough within the townlands of Carrigeen, Aggard More and Rahasane.			Throughout the study area. Sightings in townland of Crinnage or Ballywulash and Aggard More
	ER8e - Stoat: The species was not recorded during site visits and there are no records for this species in the NPWS Rare and Protected Species records for the area. The NBDC holds records for Irish Stoat within the Grid Squares M42, M51 and M52. It is likely that this species occurs within the study area, due to the presence of suitable habitat.			Throughout the study area
	ER8f - Hedgehog: It is quite likely that this species occurs within the study area. There are no records for hedgehog in the NPWS Rare and Protected Species Database from Grid Squares M42, M51, and M52. The NBDC holds records for Hedgehog within the Grid Square M41. It is very likely that this species occurs within the study area, due to the presence of suitable habitat.			Throughout the study area
	ER8g - Pygmy Shrew: The species was not recorded during site visits. There are no records for pygmy shrew in the NPWS Rare and Protected Species Database for the study area. The NBDC supports records for Pygmy Shrew for Grid Squares M41 and M51. Furthermore, the habitats recorded within the study area provide suitable refuge and foraging habitat for Pygmy Shrew.			Throughout the study area

Ecological receptors subject to impacts associated with the proposed flood relief scheme	Summary descriptions of ecological receptors	Value of the ecological receptors	Selection as key ecological receptors	Locations
	ER8h - Common Frog: There are records for common frog in the NPWS Rare and Protected Species Database from grid squares M42, M51, M52 but it was not recorded during site visits. In addition, the NBDC holds records for Common Frog in Grid Squares M42, M51 and M52. It is likely that this species occurs in the various permanent and ephemeral waterbodies throughout the study area.			Throughout the study area
	ER8i - Smooth Newt: There are no NPWS Rare and Protected Species Database records within the study area for smooth newt. It is likely that this species occurs in water bodies throughout the study area.			Throughout the study area
	ER8j: - Pine Marten was identified on the northern margins of Rahasane Turlough within an area of rank grassland / scrubland. In addition, the NBDC supports records for Pine Marten in Grid Squares M41, M42 and M52.			
	ER8k: - Red Squirrel was identified along the southern margins of Rahasane Turlough during the June 2014 site walkover surveys. In addition, the NBDC supports records for Red Squirrel in Grid Squares M41, M42, M51 and M52. They are highly likely to utilise the pockets of woodland and scrub proximal to the flood relief scheme.			
ER9: Birds of Conservation Concern in Ireland (BoCCI) Bird Species (not included as qualifying interest of Rahasane Turlough SPA)	Outside of qualifying interests of SPAs or Annex I bird species there were 13 species listed on the BoCCI amber list that were recorded within the study area during site surveys. Bird species on the amber list are considered to be of medium conservation concern. There were no birds recorded on the BoCCI red list during the site walkover surveys.	As these species are considered to be of conservation concern in Ireland, they are of **National Importance**	Yes	Throughout the study area
ER10: Hedgerow Network throughout the study area	Hedgerows are scattered throughout the study area.	These hedgerows provide links between habitats of higher ecological value, allowing easier migration for	Yes	Throughout the study area

Ecological receptors subject to impacts associated with the proposed flood relief scheme	Summary descriptions of ecological receptors	Value of the ecological receptors	Selection as key ecological receptors	Locations
		species. They may also act as navigation routes for bat species in the locality. They are therefore considered to be of **Local Importance (Higher Value)**.		
ER11: Treelines throughout the study area	Treelines have a scattered distribution within the study area, occurring as field and property boundaries and along the Dunkellin River. Treelines are generally dominated by Ash, with some Oak and Crack Willow.	Treelines within the study area are moderately species-rich, and provide links between habitats of higher ecological value, such as the woodlands within the site. They may also act as navigation routes for bat species in the locality. They are therefore considered to be of **Local Importance (Higher Value)**.	Yes	Throughout the study area
ER12: Floodplain dependent vegetation including Wet Grassland and Marsh	Wet grassland GS4 and Marsh GM1 habitat is scattered throughout the study area. There is a concentration of this habitat however upstream of the N18 Bridge.	As wet grassland/marsh is a semi-natural habitat with some species rich areas and part of the natural floodplain of the Dunkellin River it is therefore	Yes	Throughout the study area

Ecological receptors subject to impacts associated with the proposed flood relief scheme	Summary descriptions of ecological receptors	Value of the ecological receptors	Selection as key ecological receptors	Locations
		considered to be of **Local Importance (Higher Value)**.		
ER13: Dry Calcareous / Neutral Grassland and outcropping siliceous rock throughout the study area.	There are a number of small pockets Dry Calcareous / Neutral Grassland areas throughout the study area, often found adjacent to or surrounding limestone outcropping, with species-rich examples adjacent to turloughs.	As Dry Calcareous / Neutral Grassland is a semi-natural habitat with some species rich areas it is therefore considered to be of **Local Importance (Higher Value)**.	Yes	Throughout the study area.

10.5 POTENTIAL IMPACTS

Impacts have been assessed according to the methodology outlined in **Sections 10.3.13** to **10.3.14**. The scheme comprises a mosaic of terrestrial and aquatic habitats, including lowland rivers, streams and drains, turloughs, semi-natural grassland communities, marsh, swamp, woodlands, improved agricultural grassland and amenity grassland. Areas of turlough habitat have been identified which correspond to the priority Annex I habitat 'Turloughs (3180)'. However, some of these turlough habitats occur outside the bounds of Natura 2000 sites. The precautionary principle is used if there is any reasonable doubt as to whether an impact on a Natura 2000 site is likely. Potential impacts associated with the proposed scheme on Natura 2000 sites is considered in greater detail in the accompanying Natura Impact Statement (NIS). Under the Environmental Liability Directive (2004/35/EC) undermining the maintenance and long-term viability of the relevant protected biodiversity amounts to biodiversity damage, irrespective of whether the protected biodiversity, be it habitats or species, is within or outside a designated site.

In addition, Article 10 of the Habitats Directive refers to features of the landscape which are of major importance for wild flora and fauna, by virtue of their linear and continuous structures (such as rivers with their banks or the traditional systems for marking field boundaries), or their function as stepping stones (such as ponds or small woods). These features are essential for the migration, dispersal and genetic exchange of wild species. Member States are required to endeavour, where they consider it necessary, in their land use planning and development policies, to encourage the management of these features of the landscape, with a view to improving the ecological coherence of the Natura 2000 network.

The proposed works will have direct impacts on species diversity and loss of feeding habitat for local animal populations. The Zone of Influence in ecological terms extends beyond the works proposed, particularly in relation to water dependant habitats within the Dunkellin River floodplain. The scheme has the potential to disrupt the hydrological regime of wetlands.

The thirteen Key Ecological Receptors impacted by the scheme, and the significance of these impacts, are set out in **Table 10.20**. Each of the Key Ecological Receptors is assessed in terms of impacts upon the 'principal elements of ecological value' within the site, in the absence of mitigation measures.

Table 10.20 Characterisation of Ecological Receptors and Determination of Significance of Impacts

Ecological Receptors	Direct Effects of Proposed Works	Indirect Effects of Proposed Works	Ecological Significance of Impact in the Absence of Avoidance or Mitigation Measures
ER1: Rahasane Turlough cSAC (Site Code: 000322) and SPA (Site Code: 004089)	No works are proposed within Rahasane Turlough cSAC/SPA itself therefore any direct impacts are extremely unlikely.	Indirect effects on Rahasane Turlough cSAC/SPA may include increased sediment flow into the turlough during the construction phase. Without mitigation measures there exists the potential due to increased sediment impacts on Rahasane Turlough cSAC and if they occur they would be '**Temporary Negative**'. Other indirect effects include potential disturbance to SPA qualifying bird species during the construction works. Disturbance effects on SPA birds during the construction phase would be '**Temporary Negative**'. In the absence of mitigation, potential indirect effects on the functioning of Rahasane Turlough such as flooding extent and duration would likely alter the structure and functioning of the site. Such impacts on both the cSAC and SPA would be considered to be '**Permanent Negative'**. Further analysis of proposed changes to the flooding regime of Rahasane Turlough is considered in greater detail in the accompanying Natura Impact Statement.	This ecological receptor is considered to be of international ecological importance as it is part of **Rahasane Turlough cSAC/pNHA/SPA**. If unmitigated, a major environmental incident such as a large scale spillage of a contaminant such as silt, diesel or cement would have an impact on this habitat and its associated species and thus significantly affect its integrity. Any change in the natural hydrologic conditions of the turlough could affect reaching the targets necessary to achieve favourable conservation status, thus significantly affecting its integrity. Such a potential impact is therefore considered to be '**Significant on an International Level'** in the absence of avoidance and mitigation measures.
ER2: Galway Bay Complex cSAC (Site Code: 000268)	No works are proposed within Galway Bay Complex cSAC itself therefore any direct impacts are extremely unlikely.	Indirect effects on Galway Bay Complex cSAC may include increased sediment flow into the Dunkellin River estuary during the construction phase. Other indirect effects include potential disturbance to otter, a qualifying species, during	This ecological receptor is considered to be of international ecological importance as it is part of **Galway Bay Complex cSAC/pNHA**. If unmitigated, a major environmental incident such as a large scale spillage of a contaminant such as silt, diesel or cement would have an

Ecological Receptors	Direct Effects of Proposed Works	Indirect Effects of Proposed Works	Ecological Significance of Impact in the Absence of Avoidance or Mitigation Measures
		the construction works. Without mitigation measures there exists the potential for impacts on Galway Bay Complex cSAC and if they occur they would be '**Temporary Negative**'. Further analysis of proposed changes to flow volumes of the Dunkellin River entering Galway Bay is considered in greater detail in the accompanying Natura Impact Statement.	impact on this habitat and its associated species, and thus significantly affect its integrity. This impact is therefore considered to be '**Significant on an International Level'** in the absence of avoidance and mitigation measures.
ER3: Inner Galway Bay SPA (Site Code: 004031)	There is potential for direct impacts on any species which would migrate along the Dunkellin River between Inner Galway Bay SPA and Rahasane Turlough. This could potentially include Wigeon, Golden Plover, Black-tailed Godwits and Lapwing. It is likely that any impacts would be temporary over the period of construction and when the aforementioned species are migrating between the two SPAs. Without mitigation measures there exists the potential for impacts on Galway Bay Complex cSAC and if they occur they would be '**Temporary Negative**'.	Indirect effects on Inner Galway Bay SPA may include increased sediment flow into the Dunkellin River estuary during the construction phase. Other indirect effects include potential disturbance to qualifying bird species, during the construction works. Without mitigation measures there exists the potential for impacts on Inner Galway Bay SPA and if they occur they would be '**Temporary Negative**'. Further analysis of proposed changes to flow volumes of the Dunkellin River entering Galway Bay is considered in greater detail in the accompanying Natura Impact Statement.	This ecological receptor is considered to be of international ecological importance as it is part of **Inner Galway Bay SPA**. If unmitigated, a major environmental incident such as a large scale spillage of a contaminant such as silt, diesel or cement would have an impact on the sites associated bird species and wetland habitat, and thus significantly affecting its integrity. This impact is therefore considered to be '**Significant on an International Level'** in the absence of avoidance and mitigation measures.

Ecological Receptors	Direct Effects of Proposed Works	Indirect Effects of Proposed Works	Ecological Significance of Impact in the Absence of Avoidance or Mitigation Measures
ER4: Dunkellin Turlough, EU Annex I habitat '3180 *Turloughs', not designated	No works are proposed within Dunkellin Turlough itself therefore any direct impacts are extremely unlikely.	Indirect effects on Dunkellin Turlough would include the alteration of flood regime due to channel widening immediately downstream of the turlough for approximately 2.7 km. The widening and installation of new flood eyes at Dunkellin Bridge could potentially lead to significant indirect changes in Dunkellin Turlough. Such impacts would be considered '**Permanent Negative**'. However, although the proposed works are considered to reduce surface water flooding (both extent and duration) at Dunkellin Turlough they are not predicted to impact on the hydrogeology of the feature (See **Chapter 9**). To this end, the groundwater flooding of the turlough will be maintained at the same levels as this will be driven by recharge and up-stream hydraulic gradient acting on the bedrock fissures. Therefore, the flood waters contained within the turlough as a result will be more representative of groundwater (e.g. high calcium, harder water and more mineralised). This could influence an expansion of calcicole flora within those turlough sections that remain flooded.	Any change in the natural hydrologic conditions of the turlough could affect the functioning of the turlough. Given that this habitat is considered to be of National Importance, permanent negative impacts are considered to be '**Significant on an National Level'** in the absence of avoidance and mitigation measures.
ER5: Castlegar Turlough, EU Annex I habitat '3180 *Turloughs', not designated.	It proposed to remove 0.05 ha of Castlegar Turlough along the entirety of its left bank boundary with the Dunkellin River. This loss is '**Permanent Negative**' and equates to 6.4% of the whole turlough.	Indirect effects on Castlegar Turlough would include the removal of turlough habitat due to the alteration of flood regime and consequential drawdown of water on-site. It is unclear how much this might impact upon the overall extent of Castlegar Turlough or its structure and functions however it is probable that there will be a significant '**Permanent Negative**' at least on that part of the turlough on the left bank of the Dunkellin River.	Any change in the natural hydrologic conditions of the turlough could affect the functioning of the turlough habitat. Given that this habitat is considered to be of National Importance, permanent negative impacts are considered to be '**Significant on an National Level'** in the absence of avoidance and mitigation measures.

Ecological Receptors	Direct Effects of Proposed Works	Indirect Effects of Proposed Works	Ecological Significance of Impact in the Absence of Avoidance or Mitigation Measures
		However, although the proposed works are considered to reduce surface water flooding (both extent and duration) at Castlegar Turlough they are not predicted to impact on the hydrogeology of the feature (See **Chapter 9**). To this end, the groundwater flooding of the turlough will be maintained at the same levels as this will be driven by recharge and up-stream hydraulic gradient acting on the bedrock fissures. Therefore, the flood waters contained within the turlough as a result will be more representative of groundwater (e.g. high calcium, harder water and more mineralised). This could influence an expansion of calcicole flora within those turlough sections that remain flooded.	
ER6: Otter Annex IV species (EU Habitats Directive) Otter (*Lutra lutra*) is the only species listed on Annex IV of the EU Habitats Directive while there are two non-aquatic species listed on Annex I of the EU Birds Directive which occur within the study area.	The proposed works will involve in stream works and the probable direct removal of riparian habitat used by otter. There is also the possibility for the removal and / or degradation of suitable foraging habitat as a result of the proposed works. Another direct impact is the land spreading or stockpiling of material removed from the Dunkellin River, which may directly impact on foraging or resting locations for otter. Any impacts on otter in this regard are likely to be **Temporary Negative**.	Indirect impacts include alteration of flow, interruption of food chains including removal of prey items and removal and degradation of suitable habitat for otter. Any impacts on otter in this regard are likely to be '**Temporary Negative'**.	Without mitigation it is likely that there will be direct and indirect impacts on the otter population on the Dunkellin River. However these impacts are likely to be on a local scale and the population is highly likely to recover in the short term after any impacts. Therefore in the absence of avoidance or mitigation measures any impact on otter is likely to be **'Significant on a Local Level.**

Ecological Receptors	Direct Effects of Proposed Works	Indirect Effects of Proposed Works	Ecological Significance of Impact in the Absence of Avoidance or Mitigation Measures
ER7: Kingfisher	The proposed works will involve instream works and the probable direct removal of riparian habitat used by Kingfisher. Another direct impact is the landspreading and stockpiling of material removed from the Dunkellin River and Aggard Stream and removal of bankside trees, which may directly impact on foraging or perching locations for otter. Any impacts on Kingfisher in this regard are likely to be **Temporary Negative**.	Indirect impacts include alteration of flow, interruption of food chains including removal of prey items for Kingfisher and removal of suitable habitat. Although not currently a nesting location, the suitable bankside nesting habitat on the Dunkellin's southern bank at M44773 18674 is proposed to be removed. Any impacts on Kingfisher in this regard are likely to be '**Temporary Negative'**.	Without mitigation it is likely that there will be direct and indirect impacts on the Kingfisher population on the Dunkellin River and Aggard Stream. However these impacts are likely to be on a local scale and the population is highly likely to recover in the short term after any impacts. Therefore in the absence of avoidance or mitigation measures any impact on Kingfisher is likely to be **'Significant on a Local Level.**
ER8: Faunal Species protected under the Irish Wildlife Acts. Species protected under Schedule 5 Wildlife Act 1976 (as amended), include Badger, Bat species, Hare, Stoat, Hedgehog. Therefore, ER8 has been subdivided to adequately assess each of these species separately.	The proposed works will involve instream works and the probable direct removal of habitat and possible mortality of individuals, for a number of Schedule 5 species. Direct impacts may also include removal of treelines and hedgerows which interrupts migratory routes for species in particular species such as bats and badgers. Removal of bankside material and landspreading or stockpiling may interfere with Badger Setts.	Species protected under Schedule 5 of the Wildlife Act 1976 may be indirectly affected by the landspreading of material removed from the Dunkellin River, which may impact on breeding or resting locations. Species dependent on the Dunkellin River as a source of prey e.g. Daubenton's bat, will be impacted through interruption or degradation of current food chains. There are likely to be indirect impacts on aquatic and semi-aquatic species following the release of suspended sediment. Impacts on aquatic species are discussed in **Chapter 11**.	Without mitigation it is likely that there will be direct and indirect impacts on the faunal species protected under the Irish Wildlife Acts. In particular it is considered that bat species, frog and newt are the most likely to be impacted as a result of the proposed works. However these impacts are likely to be on a local scale and the population is highly likely to recover in the short term after any impacts. Therefore in the absence of avoidance or mitigation measures any impact on kingfisher is likely to be **'Significant on a Local Level.**

Ecological Receptors	Direct Effects of Proposed Works	Indirect Effects of Proposed Works	Ecological Significance of Impact in the Absence of Avoidance or Mitigation Measures
	Bats: The installation of flood eyes or bypass/over culverts at the Dunkellin Bridge and Rinn Bridge and the removal of mature trees at various locations in the study area could result in mortality of individual bats roosting at these bridges. There are likely to be mortalities of frog and smooth newt during the works in areas where riparian vegetation is to be removed and where sluggish waters are proposed for some silt removal.		
ER9: Birds of Conservation Concern in Ireland (BoCCI) Bird Species (not included as qualifying interest of Rahasane Turlough SPA)	No direct effects likely.	Indirect effects on BoCCI Bird Species associated with the flood relief scheme may include potential disturbance to SPA qualifying bird species during the construction works. Disturbance effects on SPA birds during the construction phase would be '**Temporary Negative**'. In the absence of mitigation, potential indirect effects on the functioning of Rahasane Turlough such as flooding extent and duration would likely alter the structure and functioning of the site. Such alterations may impact upon wintering and breeding BoCCI bird species not designated as part of Rahasane Turlough SPA.	Without mitigation it is likely that there will be direct and indirect impacts on the BoCCI Birds not included as a qualifying interest of Rahasane Turlough SPA. If unmitigated, a major environmental incident such as a large scale spillage of a contaminant such as silt, diesel or cement would have an impact on the feeding habitats of birds using the site. In addition, any change in the natural hydrologic conditions of the turlough could also impact upon feeding regimes and foraging areas for those BoCCI Bird species. Therefore in the absence of avoidance or mitigation measures any impact on BoCCI Birds is likely to be **'Significant on a Local Level.**

Ecological Receptors	Direct Effects of Proposed Works	Indirect Effects of Proposed Works	Ecological Significance of Impact in the Absence of Avoidance or Mitigation Measures
ER10: Hedgerow Network throughout the study area	It is proposed to remove 260 m of hedgerow ca. 400 m downstream of Rinn Bridge. This is considered a direct '**Permanent Negative**' impact.	Potential indirect impacts to treelines and other linear woodland habitats could include abrasion, root and limb damage and disturbance of adjoining or nearby treeline habitats during the proposed improvement works.	This ecological receptor is considered to be of *Local importance (Higher level)* as it provides refuge and foraging habitat and migratory paths for many species, including protected species. Overall, it is considered likely that the potential impacts of the scheme on hedgerows in the area, if unmitigated, would affect the integrity of this habitat. The loss of hedgerows within the study area is therefore considered to be '**Significant on a Local Level'** in the absence of avoidance and mitigation measures.
ER11: Treelines throughout the study area	Approximately 600 m of treeline will be removed downstream of Craughwell on both sides of the Dunkellin River and 250 m of treeline will be removed on the south bank immediately downstream of Craughwell Turlough. The proposed works will result in the direct loss of these linear features. This will result in a '**Permanent Significant Negative**' impact. If the felling of Treelines and Hedgerows WL1 / WL2 is not timed appropriately, nests containing eggs or young chicks could be destroyed. This will	Potential indirect impacts to treelines and other linear woodland habitats could include abrasion, root and limb damage and disturbance of adjoining or nearby treeline habitats during the proposed improvement works.	This ecological receptor is considered to be of *Local Importance (Higher Value)*. The loss of any number of mature trees is considered to be significant, as these are uncommon in the local landscape and provide nesting/roosting potential for birds and bats – '**Significant**'. Inappropriate timing of felling would directly impact upon local bird populations – '**Significant**'. Potential loss of bat roosts during felling would also be very significant – '**Significant**'. Treelines WL2 play an important role in acting as 'ecological corridors' and navigational/foraging routes for bats – '**Significant**'.

Ecological Receptors	Direct Effects of Proposed Works	Indirect Effects of Proposed Works	Ecological Significance of Impact in the Absence of Avoidance or Mitigation Measures
	result in a '**Permanent Significant Negative**' impact. The role of treelines as navigational and foraging routes for bats is an important element of their ecological value. The proposed works would result in the direct loss of some of these navigational/ foraging routes. This will result in a '**Permanent Significant Negative**' impact. There is a near certain chance that this impact will occur.		The loss of Treelines WL2 within the study area is therefore considered to be '**Significant on a Local Level**', in the absence of avoidance and mitigation measures.
ER12: Wet Grassland and Marsh Habitats throughout the study area	There will be direct removal of 0.1 ha of Wet Grassland and 0.8 ha of Marsh. In addition landspreading will result in the infill and temporary disturbance of 0.2ha Wet Grassland.	Wet grassland habitats are particularly vulnerable to reduction in water table, increased or in the case of Rahasane Turlough reduced flooding regimes. Indirect effects on wet grassland as a result of the proposed works include the alteration of hydrological regime. Increasing or reducing flood levels may result in wet grassland habitat drying out with wet indicator species being lost under the growth of dense aquatic macrophytes.	Overall, it is considered likely that the potential impacts of the scheme on Wet Grassland habitats in the area, if unmitigated, would affect the integrity of the habitat. This ecological receptor is considered to be of *Local Importance (Higher Value)*. Therefore this impact is considered to be significant, on a local level – '**Significant at a Local Level'**.
ER13: Dry Calcareous / Neutral Grassland throughout the study area.	Dry Calcareous / Neutral Grassland is likely to be directly affected by removal of this habitat at locations where it exists adjacent to the Dunkellin River on spoil heaps. Other direct impacts include the spreading or stockpiling of spoil	It is unlikely that there will be indirect impacts on this habitat.	This ecological receptor is considered to be of *Local Importance (Higher Value)* as it is semi-natural and is more species rich than those adjacent areas of improved agricultural grassland. Overall, it is considered likely that the potential impacts of the scheme on Dry Calcareous /

Ecological Receptors	Direct Effects of Proposed Works	Indirect Effects of Proposed Works	Ecological Significance of Impact in the Absence of Avoidance or Mitigation Measures
	taken from the Dunkellin River over areas of this habitat which would result in a direct loss of this habitat and therefore a permanent significant negative impact. This is likely to have a '**Permanent Significant Negative**' impact on dry calcareous/neutral grassland habitats.		Neutral Grassland habitats in the area, if unmitigated, would affect the integrity of the habitat. Therefore the impact is considered to be significant, at a local level – '**Significant at a Local Level'**.

10.6 MITIGATION MEASURES

10.6.1 General

Mitigation measures are proposed to address the adverse effect on the ecological receptors identified within the zone of influence of the works. These measures will allow any potential impacts affecting the conservation status of Natura 2000 sites and other sensitive ecological receptors to be minimised and avoided where possible. General mitigation measures are outlined below. Specific measures for each of the ecological receptors are detailed in the following sections.

An over-arching objective will be for Galway County Council to draw up a **Method Statement** that includes detailed mitigation measures as outlined below in relation to the implementation of all measures proposed. This method statement will be strictly adhered to by Galway County Council staff and contractors involved in the works and will be overseen by the Galway County Council's site representative/foreman. Galway County Council's Environmental Management Protocols and Standard Operating Procedures in addition to the Office of Public Works Standard Operating Procedures for Arterial Drainage Maintenance (OPW, 2011) will form the backbone of the method statement, supplemented by specific additional measures proposed below. The method statement will detail how these mitigation measures will be monitored for effectiveness by Galway County Council and independently through water quality monitoring proposed. There will be ongoing consultation by Galway County Council with Inland Fisheries Ireland (IFI) and National Parks and Wildlife Service (NPWS) throughout all phases of the works which will include attendance at progress meetings at stages agreed in advance by the Galway County Council and designated IFI and NPWS representatives. A mechanism for reporting of pollution incidents will be agreed in advance between the contractor(s) and the IFI. Further details on mitigation for the aquatic environment and aquatic species are provided in **Chapter 11**. Detailed mitigation safeguarding Natura 2000 sites supporting connectivity with the proposed flood alleviation scheme are also detailed in the accompanying Natura Impact Statement. As the Dunkellin River and the Aggard Stream provide direct conduits to these Natura 2000 sites, many of the mitigation measures outlined below are also designed to safeguard those downstream and proximal Natura 2000 sites.

10.6.2 Mitigation Measures for the Control of Airborne Pollutants During Construction Activities

To protect sensitive receptors in the vicinity of the proposed flood relief scheme works the following measures are proposed. Measures to mitigate the emission of dust due to construction activities include:

- wind breaks and barriers;
- control of vehicle access;
- vehicle speed restriction;
- bed of gravel at site exit points to remove caked on dirt from tyres and tracks;
- washing of equipment at the end of each work day, if they are to be moved off site;
- prevention of on-site burning;
- hard surface roads will be wet swept to remove any deposited materials;
- unsurfaced roads will be restricted to essential site traffic only; and
- wheel-washing facilities will be located at all exits from the construction site.

10.6.3 Mitigation Measures for Protection of Waterbodies

The proposed project has been identified as potentially giving rise to adverse effects on water quality in the Dunkellin River with consequential effects on Rahasane Turlough cSAC/pNHA/SPA, Galway Bay Complex cSAC and Inner Galway Bay SPA. This has further potential for indirect impacts on the water-dependant Annex I habitats or Annex II species adjacent to or downstream of the scheme. The effective protection of water quality within the scheme during the construction and operation phases will minimise the risk to the qualifying interests of this site. Water quality mitigation measures for avoidance, reduction and remediation of impacts are prescribed below.

Release of suspended solids to all surface waters will be controlled by interception and management of site run-off. Dewatering and surface water runoff discharges from the excavation and landspreading areas will be controlled, collected and routed via appropriate treatment measures. These measures will be in accordance with the CIRIA publication C648, 'Control of Water from Linear Construction Project' (CIRIA, 2006). Silty water shall be treated using ponds and temporary interceptors and silt traps will be installed. An interceptor drain will be located at the edge of the access track to intercept runoff.

These facilities will be maintained on a daily basis and the maintenance record will be maintained and available for inspection by Galway County Council and other statutory organisations.

Standard pollution control and mitigation measures, as outlined below, will be employed where relevant when working in and near the watercourse affected by the scheme to prevent the transport of deleterious substances to the Dunkellin River and connected Natura 2000 sites and associated water-dependent habitats and species.

All two-stage channel works are proposed to be carried out outside of the existing channel thereby retaining the average annual flow within the existing channel. Excavation is to be undertaken along the bank with minimal interference with water quality.

10.6.3.1 General

As outlined, a detailed design and method statement will be drawn up by Galway County Council indicating what standard measures will be taken to avoid (i) sediment or soil loss and (ii) cement and hydrocarbon release, associated with all aspects of the construction phase. The statement must include how these will be monitored for effectiveness. Given the scale of the works, the method statement must include details of the response strategy and chain of command in the event of flooding occurring during works. A mechanism for reporting of pollution incidents will be agreed in advance between the contractor(s) and the IFI and NPWS. Given the scale of the works, it will be detailed as to how, in the event of flooding occurring during construction, water quality will be protected.

The method statement will be drawn up by Galway County Council listing in detail the methods which will be used for the proposed bank widening and associated spoil spreading. This needs to be sufficiently detailed to allow interested parties, in particular the IFI and NPWS, to understand the extent and location of the works and the exact limits of what is being proposed and where. This will mean that non-scheduled or non-approved works will not take place and will allow more focussed mitigation in areas which are considered more sensitive or more prone to risk than others. Furthermore, there must be ongoing consultation by the contractor(s) with IFI and NPWS throughout all phases of the works which will include attendance at progress meetings at stages agreed in advance by the contactors and designated IFI and NPWS representatives.

A mechanism for reporting of pollution incidents will be agreed in advance between the appointed contractor(s) and Galway County Council.

The work flow on site must be designed to minimise damage to the edge of the banks by heavy construction vehicles or cause rutting which would increase the risk of gully erosion or solids wash-out during intense rainfall.

Further General Mitigation

- Prior to any works, all personnel involved with the flood relief works will receive an on-site induction or "tool-box talk" relating to operations within and adjacent to watercourses and the environmentally sensitive nature of working within and in proximity to the Natura 2000 site and re-emphasise the precautions that are required as well as the mitigation to be implemented.

- Galway County Council will ensure that their engineer setting out the works is fully aware of the study areas ecological constraints and the consequent mitigation requirements.

- All matters relating to the flood relief works within and in the vicinity of Natura 2000 sites or the vicinity of watercourses connected to the Natura 2000 sites will be reported on a regular basis to Galway County Council for ongoing review.

- Any incident or observation of anything that may be considered as causing or likely to cause disturbance or damage to the cSAC will be reported to Galway County Council immediately.

- Galway County Council will take immediate action to prevent or limit the impact and contractors on site will notify Galway County Council of the incident and the actions taken.

- The amount of bare ground created by excavation and vegetation removal will be minimised through the delineation of defined working areas and working practices.

- In-stream works will be carried out outside of the salmonid spawning season; i.e. 1st May to 31st September inclusive, and the times that early life stages of salmonid fish will be present. In-stream work will only be undertaken with the advanced approval of IFI and the NPWS.

10.6.3.2 Pollution of Watercourses

Drainage Channels & Minor Streams

- All drainage maintenance operations will be carried out in accordance with the OPW's Environmental Management Protocols and Standard Operating Procedures (SOPs[7]). It will be noted that maintenance of these channels and minor streams means the removal of silt entrenched vegetation and other organic material such that the channel is returned to its design grade and cross section. It is then proposed to spread this material thinly along the banks.

- Drainage maintenance operations will ensure general good practice in road building with particular respect to silt control, especially at small land drain crossing points.

Dunkellin River

- The embankment will be seeded to stabilise it and the areas proposed for landspreading will be returned fit for purpose to the landowner.

- Furthermore, until the embankment/landspreading sites have stabilised, surface water runoff will be collected via a shallow interceptor ditch with check dams to provide short term attenuation and serve as an additional silt-trap. The interceptor ditch will be excavated prior to works commencing for a distance of 100 m even if the working area is confined to 20 m. The number of check dams to be provided will have to be determined once the ditch is constructed and surveyed to determine the slope. In addition at 100 m intervals along the 'dam' retained, a filtered outfall will be provided to accommodate any surface water runoff retained by the works. Similar stone filters will be constructed intermittently along the works area to further filter any runoff.

[7] The Office of Public Works (2011) Arterial Drainage Maintenance Service Environmental Management Protocols & Standard Operating Procedures

General

- All access scaffolding used within watercourses and all footwear/ waders, etc. used within watercourses must be steam cleaned prior to arrival on site to prevent the spread of invasive aquatic or terrestrial species such as Zebra Mussel or Japanese knotweed in accordance with OPW Environmental SOPs. A sign off sheet must be maintained to confirm cleaning.

- The Contractor shall prevent any silting/erosion of water courses and pollution of the water that may adversely affect water quality or cause obstruction or interference with the flow.

- Establish site boundary markings to safeguard features of interest/value.

- Tools and equipment are not to be cleaned in watercourses or near karst features.

- Chemicals used shall be stored in sealed containers in the site lockup / site compounds prior to use.

- The chemicals shall be applied in such a way as to avoid any spillage or leakage. Any and all excavated material is NOT to be temporarily stored adjacent to watercourses or karst features.

- Temporary gangways will be erected if required between river banks and working platforms to avoid the need for walking through watercourses or any karst features.

Fuel/Lubricant Spillage from Equipment

- Fuelling and lubrication will not be conducted within 50 m of the watercourse or karst feature.

- Storage areas, machinery depots and site offices will be located at least 50 m from the watercourse and any karst features.

- Foul drainage from the site offices and facilities will be properly treated and removed to a suitable treatment facility.

- Spill kits will be made available close to streams and all staff will be properly trained on correct use.

- All fuels, lubricants and hydraulic fluids will be kept in secure bunded areas at a minimum of 50m from the watercourse and any karst features. The bunded area will accommodate 110% of the total capacity of the containers within it. Containers will be properly secured to prevent unauthorised access and misuse. An effective spillage procedure will be put in place with all staff properly briefed. Any waste oils or hydraulic fluids will be collected, stored in appropriate containers and disposed of offsite in an appropriate manner.

- All plant shall be well maintained with any fuel or oil drips attended to on an ongoing basis.

- Any minor spillage during this process will be cleaned up immediately. In the event of an incident occurring, the situation will be dealt with and coordinated by the nearest supervisor.

Concrete

- Measures relating to concrete management will mostly apply to the construction of the proposed salmon counter, upstream of Killeely Beg Bridge.

- Wet concrete and cement are very alkaline and corrosive and can cause serious pollution to watercourses.

- The contractor will draw up a detailed method statement that addresses Best Practice in liquid and/or mortar management addressing batching on site (if that is proposed), pouring and handling, secure shuttering / form-work, adequate curing times and management of spills. No washings will be allowed to enter nearby drains. Works will occur in the dry.

- Disposal of raw or uncured waste concrete will be controlled to ensure that the watercourse or karst features will not be impacted.

- Best practice will be employed in bulk-liquid concrete management addressing pouring and handling, secure shuttering / form-work, adequate curing times.

- Where shuttering is used, measures will be put in place to prevent against shutter failure and control storage, handling and disposal of shutter oils.

- Wash water from cleaning ready mix concrete lorries and mixers may be contaminated with cement and is therefore highly alkaline. Due to the size of the site and the proximity of sensitive watercourses, it is recommended that lorries and mixers are washed out offsite at a pre-determined washout area.

- Cement dust must be controlled as it is alkaline and harmful to the site's surrounding ecology. Activities which result in the creation of cement dust will be controlled by dampening down areas.

- The timing of the works must be specified and agreed in advance with the IFI in relation to fish migration and spawning periods.

10.6.3.3 Construction Waste

- All construction related waste, e.g., plastics, cable ties, geotextile etc. must be collected and disposed of correctly so that they don't enter the river channels. Given the size of the construction area overall, the amount of this kind of construction related foreign material may be considerable and care will be taken that they do not end up in the waterbodies.

10.6.3.4 Fill Material

- The rock type underlying much of the site is karstified limestone. Where rock fill is required, such as at Rinn Bridge, it will be recovered and reused from any excavations within the site. The importation of foreign material will be limited, however if it is required it will be the same rock type as found on site.

10.6.3.5 Timing Restrictions

- Where out of river works are of a risky nature, such as large scale excavation works for the channel widening measure, restrictions also, generally, apply. Restrictions must, ultimately be agreed with IFI (salmonids) and NPWS (crayfish, lampreys).

- Furthermore, until the spoil sites have stabilised, surface water runoff from the spoil heaps and landspreading sites will be collected via a shallow interceptor ditch with check dams to provide short term attenuation and serve as an additional silt-trap. The interceptor ditch will be excavated prior to works commencing for a distance of 100 m even if the working area is confined to 20 m. The number of check dams to be provided will have to be determined once the ditch is constructed and surveyed to determine the slope.

- Stockpiling of any soil will be placed on flat ground on the Dunkellin River bank or at least 5m from the nearest drainage ditch and preferably in a grassed area, so that any run-off can filter through the grass and prevent sediment run-off. Stone will be stockpiled since it will not be suitable for landspreading. There will be no soil spreading / piling within the bounds of Rahasane Turlough SPA / SAC.

- Spoil spread on adjacent lands will be kept at least 5 m back from the edges of land drains and 10 m from larger watercourses. All spoil will be re-seeded as soon as it has been spread in order to stabilise it and reduce the possibility of solids wash-out to surface waters.

- All fuel and hydraulic fuels stored on the worksite will be in a locked and bunded container. Refuelling will only take place well back from the edge of watercourses and all stationary plant will be placed on drip trays to prevent leaking oils reaching the river or entering groundwater.

10.6.3.6 Sediment and Pollution Control

- Stockpiling of spoil will be will be restricted to the proposed spoil heaps/ flood embankments at Rinn Bridge, Dunkellin Bridge and between Dunkellin Bridge and the N18 Bridge. Should stockpiling of spoil be necessary in other areas, it will be placed on flat ground at least 10 m back from the edge of the river bank or nearest drainage ditch and preferably in a grassed area, so that any run-off can filter through the grass and prevent sediment run-off. Spoil heaps must also be placed on high ground so they cannot be inundated during floods. Silt fences will be used where there is a danger of soil wash-out from stockpiled spoil or from earth works.

- Spoil spread on adjacent lands will be kept at least 5 m back from the edges of land drains and 10 m from larger watercourses. All spoil will be re-seeded as soon as it has been spread in order to stabilise it and reduce the possibility of solids wash-out to surface waters. Silt fences will be used where there is a danger of soil wash-out from stockpiled soil or from earth works.

- The work flow on each site in association with the scheme must be designed to minimise damage to the edge of river banks by heavy construction vehicles, with avoidance of rutting which would increase the risk of gully erosion or solids wash-out during intense rainfall.

- The timing of the works must be specified and agreed with the IFI in relation to fish migration and spawning periods.

- Mitigation for the construction of the two-stage channel will essentially be the same for each zone involved on all three of the lower Dunkellin River reaches involved between N18 and Rinn Bridge. As identified in the impacts section, the principal risk will be from solids washout either directly from the edge of the bank or via drains traversing the new two-step channels. The contractor must specify specific sediment control measures in relation to the extensive excavations proposed for the two-stage channel. This may include, for example, specifying the approach to excavations such that works begin away from and work towards the channel with a buffer zone left between the excavation area and the channel to prevent diffuse wash off. Flow paths to the river, in that case, can be more adequately protected with appropriate sediment control measures.

- The sections of bank to be lowered will be surveyed in detail to identify surface drains or recognisable karst features which might act as conduits or preferential flow routes for solids-contaminated run-off to the Dunkellin during and after construction. The use of heavy machinery beside or over these drains will be avoided and excavations will be away from the edges as much as possible. The outlets from the drains will be blocked with straw bales wrapped in terram or silt fencing, especially larger ones when they are being deepened, which is often likely to be necessary. Crossings of active drains will as much as possible be over existing culverts if available or else over crushed stones or other coarse rubble, possibly accumulated from earlier bank works. In any event, drains, wet or dry, will be recognised as potential preferential flow paths of contamination to the Dunkellin River and managed accordingly, particularly where they are active and also after sustained heavy rainfall that raises the level of the water table. Check dams and other silt control measures may be required in these drains where they occur.

- In areas where soil overlays rock or rubble, then all the former will be removed in advance to reduce the risk of solids washout when the deeper rubble and rock layers are being removed.

- Soil, shrubs and vegetation will not be stockpiled near the water's edge or beside active or potentially active drains on the new stepped channel.

- When working the very edge of the new channel, care will be taken not to destabilise it or to leave it sloping toward the existing channel in a way that would increase the risk of erosion or solids run-off.

- In areas where the base material is soil, this will be re-seeded with a suitable species mix to allow rapid stabilisation of the surface. Where this would help to stabilise loose soil or other bed material, the new channel will also be rolled. This work will run in parallel to the widening works.

- If the water table rises to the level of the works area then all works will cease in the affected areas until it drops again.

- Whilst rainfall in the catchment can result in significant flows in the Dunkellin River, advance warning of such flood events is possible and the contractor will be required to monitor both long and short term weather forecasts so that machinery and personnel can be prevented from entering the channel or its environs during periods of peak flow. Monitoring of the flow in the upstream catchment may also be used as an aid to predict high flow events. All heavy machinery traffic will be avoided along the outer edge of the new channel in order to minimise soil damage and ground damage.

- After completion of the works, the site will be continually monitored, particularly during wet weather, for evidence of preferential flows area where solids are entering the river. These will be blocked with straw-bales, silt fences or a combination of both to help reduce solids wash-out.

- It is recommended that before commencement and after completion of the works, the known salmon spawning areas would be monitored by the IFI to ensure that they have not been silted up. In the event that they have been these will be raked to remove deposited fines. This will be undertaken for at least two years after the works have been completed.

- Any fringing stands of reeds (i.e. of *Sparganium* and *Phalaris*) will not be removed nor damaged during construction, unless specifically agreed in advance by the IFI. This is because these beds will act as partial protection against erosion of the edges of the new bank, and help to trap escaped solids from the earth works and provide bankside cover for fauna on the newly exposed left bank where overhanging riparian vegetation will be removed.

10.6.3.7 Culvert Installation

- The pollution prevention controls to be adopted during the installation of culverts for the Aggard Stream are critical. If temporary or permanent diversion of any watercourses is required, this will be carried out prior to the removal of bankside vegetation.

- Temporary stream diversions will be made on geotextile surfaces with a surface layer of coarse aggregate to hold it in place. Operation of machinery instream will be kept to an absolute minimum. All construction machinery operating instream will be mechanically sound to avoid leaks of oils, hydraulic fluid, etc. Machinery will be steam-cleaned and checked prior to commencement of instream works. Such works would preferentially be done during the dry period of the year when flows are low and the risk of suspended solids release is minimal. All dewatering flow will be passed through settlement ponds to remove sediments.

10.6.3.8 Noise and vibration from use of equipment

- All works at the watercourse will make a ‘short-start’ to activities to allow salmon and other fish to move away before the full intensity of works begins.

- Work will be undertaken during daylight hours, starting no earlier than two hours after dawn and finishing no later than two hours before dusk, between March and October; and to start no earlier than one hour after dawn and finish one hour before dusk from November to February; and shall not continue for periods of more than 12 hours, to prevent disturbance to nocturnal species.

- Specific measures in relation to protected species or habitats where they occur within the proposed works are detailed below.

10.6.3.9 Exhaust Emissions from Equipment

- Vehicles and plant shall be properly maintained and shall not be left idling when not in use.

10.6.3.10 Contaminated Surface and/or Groundwater

- Contaminated surface water runoff will be treated prior to entering the main channel of the Dunkellin River and any drains or watercourses adjacent to flood relief works.

10.6.3.11 Vegetation and Soil Protection Measures

- General mitigation will involve implementation of the OPW's Standard Operating Procedures (OPW, 2011).

- Embankment material with low silt content will be selected.

- Works will be carried out ideally during a period of settled weather with no flood risk which will allow sufficient time for construction materials to settle. A continuous geo-textile silt curtain at the foot of the embankment heap will be in place surrounding the structure as it develops and for a settling period following completion.

- Any currently existing drains that may be direct conduits to the Dunkellin River will require additional silt traps. These mitigation measures in combination with the considerable buffer area between the works and the river will to reduce the likelihood of silt mobilisation.

- There are no works proposed for Rahasane Turlough SPA / SAC or its component EU Annex I Priority habitat 'Turloughs' (3180)'. This area will be fenced off and machinery will not enter this area. Works near this area will be supervised by a suitably qualified ecologist.

- General mitigation will involve but will not be limited to the implementation of the OPW's Standard Operating Procedures (OPW, 2011). The OPW's Environmental Management Protocols (EMPs) and Standard Operating Procedures (SOPs) (see **Appendix B.3**) were produced to ensure that the environment is protected during maintenance activities. The SOPs include a guidance note detailing ten steps to Environmentally Friendly Maintenance.

- Locations where proposed channel maintenance works are to be carried out will be individually assessed to ascertain whether there are potential ecological vectors in the vicinity though pre-construction surveys. For example, any works carried out in proximity to Otter holts or Kingfisher nests will either be avoided, or minimised or timed in order to minimise potential disturbance to these and other species.

- Galway County Council and its contractors will ensure that introduction of material such as rock armour and log poles for bank protection will not result in accidental introduction of non-native invasive species.

- The cumulative effects of ongoing maintenance will also be assessed. For example, removal of stream bank trees may result in a significant reduction in potential habitat for otter holts. Therefore it will be ensured pre-construction surveyed is carried out and suitable trees marked for retention as potential otter holts.

- Additional channel maintenance, especially silt and vegetation management, will not occur until after the second stage channel has been completed, bedded in and re-vegetated.

- Mitigation measures for aquatic species and habitats are contained in **Chapter 11**.

- The proposed works from the N18 Bridge to approximately 175 m upstream of Dunkellin Bridge and at Rinn Bridge will consist of channel widening to create a second stage channel along approximately 2.8 km of the Dunkellin River to increase its conveyance capacity during flood events. The excavation will generally consist of between 10 m to 30 m wide second stage channel excavated at a level above the annual average flow of the existing first stage channel. The level of the second stage channel will be such that it will generally not flood during normal summer flows.

- The two-stage channel works will result in a large amount of material being excavated. Approximately 70,000m^3 of overburden, rock and riverbed will be removed as part of the channel deepening and widening works. The channel deepening works will occur in the vicinity of Craughwell with approximately 17,000 m^3 of material removed while the two-stage channel excavation works will generally occur on the south bank of the river from 180 m upstream of Dunkellin Bridge to the N18 Bridge and around Rinn Bridge.

- Some of the material excavated as part of the two-stage channel works will be used to create the embankment on the south bank of the river. This will be located adjacent to the aforementioned two-stage channel on both banks from immediately downstream of the Railway Bridge and on the north bank upstream of the R446 Road Bridge.

- Alternatively the material will be spread adjacent to the river on the bank. However, removal off site may also be required at various locations and this will be disposed of at a licensed premises.

- The remaining material may be added to existing spoil heaps by increasing the width of the spoil heaps but not the height. Alternatively the material will be spread adjacent to the river on the bank. Due to the various types of river bank material which will be excavated it is proposed to replace ‘like with like’, as follows:

    1) Where a mixture of soil and rock is encountered, or just soil, it is proposed to stabilise the second stage channel through the compaction of the bed material or reseeding; and

    2) Where rock is encountered during excavations, it is proposed to stabilise the second stage channel using recycled crushed stone from the excavation.

- The working area is to be limited to 20 m stretches to reduce the area of exposed river bank.

- The excavation will commence at the furthest edge of the excavation and work towards the river channel, retaining a dam at the river edge. The second stage channel will be stabilised through the compaction of the bed material. The dam will assist in controlling runoff from the exposed excavation.

- It is proposed to landspread or stockpile excavated material to the furthest edge of the excavation from the River – on the bank.

- An interceptor ditch with check dams will be provided at the toe of the land spreading areas and/or spoil heaps to collect and treat surface water runoff. Release of suspended solids to all surface waters will be controlled by interception and management of site run-off. Dewatering and surface water runoff discharges from the excavation and landspreading areas will be controlled, collected and routed via appropriate treatment measures. These measures will be in accordance with the CIRIA publication C648, ‘Control of Water from Linear Construction Projects’ (CIRIA, 2006).

- These facilities will be maintained at least on a daily basis and the maintenance record will be maintained and available for inspection by statutory organisations.

- The landspreading sites will be reseeded and returned fit for purpose to the land owner. Any fines within the spoil heaps will also wash out and will be collected and treated, prior to discharge to the Dunkellin River.

- Turlough and Marsh habitats will be avoided and excluded from landspreading. A habitat boundary will be delineated on the ground to prohibit access by machinery. Works in proximity to these areas will be supervised by a suitably qualified ecologist.

10.6.4 Fauna

10.6.4.1 Bats

Standard mitigation measures, as would apply to any development, will be adopted within the proposed work plan. These include limiting season of disturbance to reduce impacts on breeding species and implementing measures to prevent pollution and sedimentation into watercourses during construction works. As no bats have so far been identified as roosting within the study area no specific mitigation is recommended. General bat mitigation measures are provided in Kelleher & Marnell (2006).

Bridges

It will be necessary to carry out a bat activity survey and full assessment of each bridge identified as having any potential for bat use (See **Appendix B2**). If bats are found to be roosting at any of these locations Galway County Council will consult with NPWS and if necessary a derogation licence for the removal of the bats will be applied for.

It will be necessary to install bat boxes under bridges which have been deemed as suitable bat roosting habitat. Bridges will also be checked for bird nests and nesting activity prior to beginning of any bridge upgrade works.

Potential bat roosts in trees

Where possible, treelines, woodland and mature trees that are located immediately adjacent to Dunkellin River or are not directly impacted shall be avoided and retained intact. Overall impacts on these sites shall be reduced through modified design and sensitivity during construction. Any existing mature trees adjacent to the works or construction sites to be retained shall be protected from root damage by machinery by an exclusion zone of at least seven metres or equivalent to canopy height. Such protected trees shall be fenced off by adequate temporary fencing prior to other works commencing.

Mature trees, which are to be removed, shall ideally be felled in the period late August to late October, or early November, in order to avoid the disturbance of any roosting bats as per NRA guidelines. Tree felling shall be completed by mid-November at the latest because bats roosting in trees are very vulnerable to disturbance during their hibernation period (November – April). Ivy- covered trees, once felled, shall be left intact on-site for 24 hours prior to disposal to allow any bats beneath the foliage to escape overnight.

Landowners shall be advised that the timber from felled trees will remain for their use. This will prevent trees being felled prematurely.

10.6.4.2 Otter (*Lutra lutra*)

There were no otter holts found within the study area however it is considered that a further otter survey will be carried out prior to the commencement of construction to ensure no new otter holts have been created. This otter survey will include at least the length of bankside channel which is proposed to be removed from Dunkellin Bridge to the N18 Bridge.

If any otter holts are found these will then be monitored, excluded (if necessary) and excavated under licence from the NPWS, prior to the commencement of the flood relief works. Mitigation measures will be undertaken to avoid the following potential impacts:

- Direct Habitat Loss,
- Severance,
- Loss of Life,
- Physical disturbance, and
- Noise disturbance.

The OPW's EMPs and SOPs (see **Appendix B3**) were produced to ensure that the environment was protected during maintenance activities. The Protocols and SOPs were last revised in April 2011 and have been issued to all OPW operational staff. The SOPs include a guidance note detailing ten steps to Environmentally Friendly Maintenance. Four of these steps significantly lessen the potential impacts of proposed works on otters.

These include:

- Leave section untouched (if channel capacity is not effected, then leave intact and only maintain if environmental works are required) - This will ensure that unnecessary impacts are avoided, and overall potential impacts on otter will be minimised.
- Management of trees (leave intact if no reduction in channel capacity is caused, remove overhanging branches to flood level and use a saw or secateurs for removal, not an excavator). This will ensure that suitable riparian habitat, for otters, will not be removed unnecessarily, and potential destructive impacts on otter sites from machinery will be avoided.
- Replace boulders (reinstate boulders and gravels as removed by maintenance operations, reinstate boulders into channel from spoil heaps, and place boulders below low flow level and staggered). This will ensure that features are available for otters to use as territorial sign posts, and substrate is available for fish (spawning/hiding places). Sustaining populations of fish will provide a valuable food source for otters.
- Steps to enhance fisheries (loosen bed gravels and if channel bed is composed of suitable material, excavate pools and create riffles). This will ensure that fisheries habitat, fish populations and food availability for otters are improved.

10.6.4.3 Birds

No scrub clearance, tree felling or other removal of vegetation will occur during the bird breeding season from 1st March to 31st August.

In order to avoid impacts on wintering birds no works will be carried out in proximity to Rahasane Turlough or at Rinn Bridge during the period 1st September to 31st March.

The RSPB/ NRA/ RSNC (1994) advocated measures which may be implemented to benefit riparian wildlife. A number of similar environmentally friendly measures have also been advocated by the OPW (OPW 2007) in order to comply with its commitments to the European Communities (Natural Habitat) Regulations 1997, and by the Central Fisheries Board aimed at minimising the impacts of arterial drainage maintenance on fish (King *et al*. 2002). These measures are largely aimed at minimising damage to habitats and improving habitat quality through the construction of river features, and are particularly beneficial to birds, especially during the breeding season, when most birds are constrained to nesting areas. Many of these measures have been implemented by OPW as standard procedure, while others are carried out on a case by case basis, in consultation with the relevant foreman (OPW 2007). These Best Practice Guidelines include:

- The use of a modern mechanical fleet with specialised equipment such as long armed hydraulic excavators with weed cutting attachments and dredging buckets has facilitated more targeted excavation and vegetation removal.

- Leaving sections of channel and bankside vegetation (trees, scrub etc.) untouched if capacity is not affected, and removing branches to flood level using a secateurs (instead of an excavator). This serves to retain most of the habitats, including branches for foraging Kingfishers, and to minimise disturbance to nesting birds. A significant loss in bankside vegetation would decrease soil stability, which would result in increased sediment loads into the river system (Brooker 1985).

- Clearing vegetation from one bank only, preferably the bank with least vegetation, which allows many of the habitats to remain intact. Minimising the scraping of the working bank, and where possible, retention of stools, would speed up the regeneration of bush, scrub and reed vegetation. Additional seeding of banks would further enhance this regeneration process, especially where severe maintenance has taken place.

- Sensitive removal of emergent and marginal vegetation. Typically, most Bulrush *Typha latifolia* and Water Celery *Apium graveolens*, which tend to block the channel flow, are removed. Bulrush is particularly favoured nesting habitat of both Sedge and Reed Warblers which breed during late April through to the end of July.

- The creation of riffles and pools and loosening of bed gravels to remove fine silts to accommodate fish spawning. This improves foraging conditions for birds feeding on aquatic invertebrates and/ or fish prey.

- As is the case for the scheme between Dunkellin Bridge and the N18 Bridge, creation of two-stage channels would serve to increase habitat diversity and growth of emergent vegetation which is required by some bird species, especially Moorhen and Sedge Warbler, for nesting and feeding.

- The retention of scrub on areas of bank that were formed by the spoil heap and bedrock removed from channels are important for breeding bird species, particularly finches such as Linnets and Goldfinches, along with Stonechats.

- New riffles and pools can significantly improve the ecological interests of a river, especially plants, invertebrates and riffle-spawning fish, which in turn benefit foraging birds. BirdWatch Ireland encourages the continuous expansion of this type of river enhancement works.

- Marginal planting on berms with wildflower mix, or Willow / Salix sp. (the latter on higher berms), would further improve habitat diversity for wildlife, especially birds. Wildflower seed mixes used will be of native local provenance.

- Retention of a strip of marginal and emergent vegetation would ensure that suitable nesting habitat is available to certain species without significantly reducing channel capacity. This would especially benefit Sedge Warbler and Reed Bunting, and also possibly Mallard and Moorhen on wider rivers.

- Where possible, additional seeding of banks would further enhance the regeneration process, especially where severe maintenance has taken place.

- Working from downstream up would improve the rate at which plants and animals can recolonise damaged areas.

Kingfisher

- Kingfisher breeding season is between February and July with two to three broods produced during this time. Work on the Dunkellin River, Aggard Stream and Monksfield River will take place outside this time so as not to disturb any breeding birds.

- It is recommended that the possible nest banks be avoided where possible. Since there were no nest holes seen during this survey supervision of sensitive areas during the work may be possible, or target surveys of sensitive sites if the work has to be carried out during the breeding season.

- Kingfisher nests were found predominantly in clay banks (as opposed to sand) and where this habitat is to be removed as part of the works an artificial replacement bank suitable for Kingfisher nesting will be installed on the south bank at M44773 18674.

- At least some marginal vegetation will be retained on suitable Kingfisher nesting banks. These are mostly vertical banks over one metre in height, composed of soft material into which they can dig their burrows. Occasionally, small nest holes may be visible if the bank has been used for nesting before.

- Nesting banks may be created by excavating a bare vertical section (using a hydraulic excavator) in areas where these banks are greater than one-metre in height and composed of a soft material. Care will be taken to ensure that the banks do not collapse when doing so.

10.6.4.4 Bridges

- Masonry bridges are likely to have ledges, crevices and holes in the masonry joints or where stones have been eroded or are missing. These features will be retained during bridge maintenance. Furthermore, when working during the spring and summer months, particular care will be taken not to disturb nests.

- Where it is proposed to remove masonry bridges it will be necessary to install replacement nest boxes.

- In order to mitigate for the loss of nesting habitat provided under the bridge for riparian species such as Dipper and Grey Wagtail the bridge shall be examined by a qualified ecologist immediately prior to the commencement of works. If there are any nesting birds under the bridge, work shall be postponed until all birds have fledged.

- On the completion of works two nest boxes shall be provided underneath the new bridge deck. The nest box will be installed by a qualified ecologist and shall be of a type approved by NPWS/Birdwatch Ireland.

- Wrens and other songbirds also often nest around bridges, especially where vegetation (mostly Ivy *Hedera* sp.) is available for cover. This associated vegetation also provides a diversity of invertebrates on which a wide variety of bird species will prey. Thus, efforts will be made to retain as much vegetation as possible during bridge replacement and repair works.

- Encourage the nesting of colonies of Sand Martins through identification of suitable natural sites; i.e. sandy banks > 2 m in height and possibly the creation of new banks where other have been damaged by previous works and the appropriate mitigation measures to ensure that any engineering works do not coincide with the nesting period of these migrants.

10.6.4.5 Wintering Birds - Monitoring at Rahasane, Dunkellin and Castlegar Turloughs

- Impacts on wintering birds are unlikely to be significant. However it is recommended that a full monitoring programme be implemented for Rahasane Turlough to ensure that impacts on the turlough and consequentially on the wintering bird population at the turlough are not significant. This monitoring programme will include vegetation/habitat monitoring as well as hydrological monitoring as well the continuation of the counts carried out as part of the IWeBS monitoring scheme.

- Consultation with the official Birdwatch Ireland IWeBS recorder for Rahasane will be continued in order to ascertain species distribution and abundance within Rahasane Turlough and its environs.

10.7 RESIDUAL IMPACTS

10.7.1 Habitats

Habitats either removed to accommodate the two-stage channel or infilled as part of the landspreading of excavated material will be negatively impacted. While the scheme has been developed with an overall objective of minimising the impact on ecologically sensitive habitats, the permanent loss of these habitats is unavoidable. However, through post implementation of avoidance measures, and measures to prevent drainage of hydrologically connected habitats, disturbance to these habitats will be minimised. Many of these habitats will either be replaced naturally or through planting with equivalent vegetation therefore impacts will not be significant on these habitats. Some habitats within the footprint of the proposed works are unlikely to re-establish satisfactorily and therefore these impacts will remain permanent.

Habitats Removed During Two-stage Channel

- Wetland Habitats: GM1 Marsh, GS4 Wet Grassland, FS1 Reed and Large Sedge Swamps, FL6 Turloughs

  Average annual flow will be contained within the existing channel however it is considered likely that the two stage channel will be flooded relatively frequently and therefore either GM1 Marsh or more likely FS1 Reed and Large Sedge Swamps will develop within the two-stage channel. Therefore those wetland habitats GM1 Marsh, GS4 Wet Grassland, FS1 Reed and Large Sedge Swamps, which are to be removed under the footprint of the works, are likely over time to be replaced with similar habitat within the two stage channel. Residual impacts on these habitats will be '**Temporary Negative'** which will persist until the regeneration of wetland vegetation on the two-stage channel, likely to happen within a decade; i.e. the short to medium term.

- Improved Habitats:GA1 Improved Agricultural Grassland

  This habitat is of low ecological value and widespread and therefore impacts on this habitat will be '**Not Significant**'.

- Woodland Habitats: WL1 Hedgerows, WL2 Treelines, WS1 Scrub, WN2 Oak-Ash-Hazel Woodland

  It is proposed to replace the removed woodland habitats with planting of native species similar to those which occur prior to removal. Although these habitats will not be replaced within the footprint of where they have been removed they will be planted on habitats of low ecological value, e.g. GA1 Improved Agricultural Grassland, thereby providing an adequate medium to long-term replacement of these habitats. Residual impacts therefore on these habitats are '**Temporary Negative**' over a period of decades until the trees and shrubs have matured to the level at which previous vegetation existed.

- Other semi-natural habitats: GS1 Dry Calcareous and Neutral Grassland.

  0.3 ha of this habitat will not be replaced and therefore there will be a residual impact which '**Permanent Negative**' impact on this habitat. This not however considered **Significant** as this habitat is widespread within the study area.

Habitats Removed During Land Spreading

- Wetland Habitats: GS4 Wet Grassland

  0.8 ha of Wet Grassland will not be replaced and therefore there will be a residual impact '**Permanent Negative**' impact on this habitat. However these impacts are considered to be '**Not Significant'** as Wet Grassland is widespread within the study area.

- Improved Habitat: GA1 Improved Agricultural Grassland

  It is proposed that this habitat be returned to the existing use therefore an agricultural grass seed mix will be used to revegetate land spread grounds on these habitats. There will be a '**Temporary Negative**' impact on this habitat but this will be '**Not Significant**' and will not persist over the long term.

- GS1 Dry Calcareous and Neutral Grassland.

  1.3 ha of this habitat will not be replaced due to landspreading and will therefore present a '**Permanent Negative**'. This is not however considered **Not Significant** as this habitat is widespread within the study area.

Habitats Impacted by Change in Dunkellin River Hydraulics

At Dunkellin Turlough, the predicted reduction in the November 2009 peak flood level will be from 10.44 mOD to 9.68 mOD at the bridge. The removal of obstructions from the bridge and installation of the new flood eyes will reduce the incidence of surface flood waters backing up and entering the turlough. This will return the turlough to a more natural flood cycle where the flood water composition, flooding levels and flood frequency/duration are more dependent on the groundwater levels and more characteristic of baseline conditions before the construction of the bridge and the later blockage of the flood eyes. Therefore proposed works are considered to have a **Slight Positive Impact** on the hydrogeology of the turlough during operation.

It proposed to remove 0.05 ha of Castlegar Turlough along its southern bank boundary where it crosses the Dunkellin River. Although the proposed works are considered to reduce surface water flooding (both extent and duration) at Castlegar Turlough they are not predicted to impact on the hydrogeology of the feature (see **Chapter 9**). To this end, the groundwater flooding of the turlough will be maintained at the same levels as this will be driven by recharge and up-stream hydraulic gradient acting on the bedrock fissures. Therefore, the flood waters contained within the turlough as a result will be more representative of groundwater (e.g. high calcium, harder water and more mineralised). This could influence an expansion of calcicole flora within those turlough sections that remain flooded.

10.7.2 Species

It is considered that if mitigation measures are implemented as outlined then residual impacts on rare or protected terrestrial and semi-aquatic species will be '**Temporary Negative**'.

10.8 CONCLUSION

There is a number of flood alleviation measures proposed on the Dunkellin River from Craughwell to the N18 Bridge at Kilcolgan and on the Aggard Stream. The most significant direct measure will be the widening of the main Dunkellin River channel to create a second stage channel and landspreading of spoil on adjacent lands.

Potential direct ecological impacts include loss of habitat, mortality of individuals, severance of connectivity, physical disturbance to species and noise disturbance to species. Impacts on aquatic ecology and fisheries are dealt with in **Chapter 11**.

The proposed river channel widening will result in the direct loss of bankside riparian habitat, which includes treelines, hedgerows, marsh, wet grassland, marsh, turlough and dry calcareous grassland. The proposed landspreading of material removed from the river bank and construction of embankment will result in the direct loss of wet grassland and dry calcareous grassland.

The expected reduction in floodplain area has the potential to degrade the water dependant terrestrial habitats, such as turloughs, although these habitats are likely to be mostly groundwater dependent.

Species potentially affected include otter, avifauna (breeding and wintering) and bats.

Robust and effective mitigation measures have been proposed for the avoidance of any impacts affecting water quality within the Dunkellin River which runs through or feeds into Rahasane Turlough cSAC/pNHA/SPA, Galway Bay Complex cSAC and Inner Galway Bay SPA. Specific mitigation measures have been proposed for the prevention of impacts to species. Likewise, precautions will be taken in relation to non-native invasive species during the construction phase.

With regard to impacts on Natura 2000 sites the primary concern during construction would be sediment loss associated with individual flood relief scheme measures. The timing and sequencing of upstream flood relief scheme measures coupled with mitigation applied with respect to each measure will reduce the potential for silt generation at source and stem the potential for losses. Moreover, all of the instream works will be undertaken during the May to September low flow period but even then only when water levels allow. It is worth noting that all of the study area has a low gradient so that a substantial amount of silt generated by instream works associated with drainage channel cleaning and regrading will tend to settle within the channels themselves. That, combined with the episodic nature of suspended solids transport suggests that the proposed works, after mitigation, are unlikely to have an adverse impact on the receiving habitats and species of Galway Bay Complex cSAC and Inner Galway Bay SPA. Such impacts are discussed in greater detail as part of the accompanying Natura Impact Statement.

The OPW SOPs will form the backbone of the method statement, supplemented by mitigation measures provided in **Section 10.5**. The method statement will detail how these mitigation measures will be monitored for effectiveness by Galway County Council and independently through water quality, hydrology, vegetation, birds and invertebrate monitoring proposed. There will be ongoing consultation by Galway County Council with IFI and NPWS throughout all phases of the works which will include attendance at progress meetings at stages agreed in advance by Galway County Council and designated IFI and NPWS representatives. A mechanism for reporting of pollution incidents will be agreed in advance between the contractor(s) and the IFI. The residual impact of the proposed flood relief works will be direct loss of riparian, bankside vegetation.

The primary concern during the operational phase for impacts on Natura 2000 sites is the change in flooding levels and hydraulic regime of the Dunkellin River. Significant impacts on Galway Bay Complex cSAC and Inner Galway Bay SPA are not considered likely as there will be a minimal increase in flow rate and time to peak discharge. It is predicted through the hydraulic modelling that the natural flooding regime will not be altered within Rahasane Turlough and therefore no adverse effect on the integrity of these European sites. Potential impacts to Rahasane Turlough SPA / SAC in addition to those other proximal and connected Natura 2000 sites are considered in greater detail in the accompanying Natura Impact Statement (NIS).

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11 AQUATIC ECOLOGY AND WATER QUALITY

11.1 INTRODUCTION

This section assesses the potential impact of the scheme on aquatic ecology and fisheries.

The main objectives of the environmental impact assessment were:

- To assess, through desk top study and consultation, existing water quality, aquatic ecological and fisheries values along the scheme areas;
- To conduct walk over surveys in order to produce broad habitat maps within the scheme's rivers and streams and establish primary habitat types;
- To assess the main habitat types along the scheme's reaches with a focus on fisheries and invertebrtaes, including white clawed crayfish;
- To undertake baseline biological water quality surveys at three sites, one on each of the Dunkellin and Craughwell Rivers and the Aggard Stream;
- To carry out standard and presence/absence crayfish surveys (manual searching) on Dunkellin and Craughwell Rivers and the Aggard Stream;
- To predict potential direct, indirect and cumulative impacts of the scheme on aquatic ecology and fisheries; and
- To recommend mitigation measures in relation to the design and construction of the scheme.

The study area for aquatic ecological investigations included the Craughwell / Dunkellin River between approximately 250 m upstream of the Craughwell R446 Bridge and the N18 Bridge at Kilcolgan. The entire Aggard Stream catchment was included, from its confluence with the Dunkellin River, upstream to, and including, Monksfield Stream and the connecting Cregaclare arterial drainage channels that extend further to the southwest.

Habitat was mapped along all of the potentially affected stretches of the main channels. The artificial drainage channel within the Rahasane Turlough cSAC (000322) / SPA (004089), was also investigated just upstream of the outlet to the Dunkellin River,

Field investigations underpinning the aquatic Ecological Impact Assessment (EcIA) were conducted in July and August 2011, and September 2012. Preliminary impact assessments made following those studies showed, most critically, that there was potential for significantly negative ecological impact on Rahasane Turlough as a result of the proposed scheme. This was owing to projected changes to the existing hydrological regime, including reduction of maximum water levels and changes to water depth–duration relationships. Given the international and national importance of Rahasane Turlough as an SAC and SPA, these changes were deemed unacceptable. The scheme was then revised in such a way that modelled changes to existing turlough hydrology remained virtually unaffected. The hydrological model for the revised scheme shows that the turlough will continue to function naturally as it currently does (See **Appendix A**).

It was noted that when fieldwork was conducted in Dunkellin and Craughwell Rivers, on the 20th and 21st July, 2011, water levels were below mean annual. Flow was estimated to be at approximately, the 65th percentile (see **Figure 11.1**) of flow based on data from Kilcolgan Hydrometric Station, 29011[8].

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[8] Mean annual flow Kilcolgan Station 29011 = 6.71m/s. Flow on July 21st, 2011 = 3.03 m/s (OPW Hydrometric data).

The present assessment included the collation of information sourced through public online resources and consultation, either in person or by written request, with:

- Inland Fisheries Ireland (IFI) – onsite meeting, July 20th, 2011;
- National Parks and Wildlife (NPWS);
- National Biodiversity Data Centre (NBDC);
- Environmental Protection Agency (EPA); and
- Office of Public Works (OPW).

11.2 METHODOLOGY

11.2.1 Desktop Study

As part of the EcIA the following data was accessed:

- Design descriptions and drawings of proposed measures;
- Maps and aerial photography of the affected area and relevant associated watercourses;
- Site synopses and qualifying interests for all of the protected areas within or adjoining the proposed development;
- Scoping comments by Inland Fisheries Ireland;
- A wide range of guidelines and best practice published by the OPW regarding the potential environmental impacts of drainage on the aquatic environment; and
- A range of peer-reviewed literature and reports of scientific research carried out in Ireland, the UK and Europe in relation to potential impacts of such measures on aquatic ecology.

Various online resources were used to assist the desktop study including:

- National Biodiversity Data Centre Live Maps: http://www.biodiversityireland.ie/biodiversity-data/access-biodiversity-data/;
- EPA ENVision Mapping: http://maps.epa.ie/InternetMapViewer/mapviewer.aspx;
- NPWS Maps and Data: http://www.npws.ie/mapsanddata/;
- WFD and River Basin Management site: http://www.wfdireland.ie/ including WaterMaps http://www.wfdireland.ie/maps.html;
- OSI Mapviewer: http://maps.osi.ie/publicviewer/#V1,591271,743300,0,10; and
- Geological Survey of Ireland online mapping: http://www.gsi.ie/mapping.htm.

11.2.2 Aquatic Survey and Habitat Assessment

11.2.2.1 Study Site Selection

All watercourses that were highlighted as being subject to measures under the scheme were investigated. Walkover surveys of as much of each watercourse as were accessible were undertaken for the purpose of habitat characterisation with a focus on fish, invertebrates and plants. Specific sites for benthic macroinvertebrate collection and crayfish survey were selected based on habitat suitability.

11.2.2.2 Habitat Characterisation and Fisheries Assessments

General physical characteristics and hydromorphological features were recorded and included substrate type, flow type and aquatic vegetation type (based on River Hydromorphology Assessment Technique (RHAT) (Anon., 2009)). The main channel of the Dunkellin River, Craughwell River and the Aggard Stream were assessed with respect to fisheries and white clawed crayfish habitat. Detailed notes and photographs for fisheries assessments and targeted searches for crayfish were made within representative habitat units of each watercourse along stretches examined. Detailed maps showing locations of target notes are available to view in **Appendix C.2.**

Fisheries and crayfish habitat assessments involved consideration of flow characteristics and geomorphology of the site, combined with desk top studies and IFI consultation.

11.2.2.3 Benthic Macroinvertebrate Sampling

Three sites were assessed using the Quality Rating System (Q-value) scheme, developed by the Environmental Protection Agency (EPA): (1) - Dunkellin River at Rinn Bridge; (2) - Craughwell River just downstream of the old stone arch bridge in the town, and; (3) - Aggard Stream, downstream of Aggard Bridge on the R347 near Craughwell.

Benthic macroinvertebrate communities were sampled using standard two-minute kick-samples in the fast flowing (riffle) areas of the rivers using a long-handled pond net (250 mm width, mesh size 1 mm; adhering to ISO Standard for kick sampling and utilising the EPA/WRBD protocols). Stonewashing was also employed to detach clinging species. One sample was taken at each site. Samples were preserved with 70% IMS alcohol and were analysed in the laboratory. All collected specimens were identified to the lowest taxonomic level possible. The biological indices calculated were Q value (EPA quality rating system), BMWP (British Monitoring Working Party) and ASPT (Average Score Per Taxon), %EPT (Ephemeroptera/Plecoptera/Trichoptera) and EQR (Ecological Quality Ratio). **Table 11.1** shows the relationship between Q-values, water quality and Water Framework Directive (WFD) ecological status.

The BMWP Score and ASPT are biotic indices, developed in Britain, based on aquatic macroinvertebrate assemblages. They are useful in an Irish context since each involves a precise calculation using scores that reflect species sensitivity to eutrophic conditions. Scores range from 1 (most tolerant) to 10 (most sensitive). This is in contrast to the Q-value assessment, which is not invariably calculable to the same value, and whereby assignment to water quality classes can vary between operators.

The EPA quality rating system (Q-value) was intercalibrated[9] in 2006 in order to ascribe Environmental Quality Ratios (EQR[10]s) for the benthic invertebrate fauna element in the rivers National Monitoring programme (McGarrigle & Lucey, 2009) under the WFD. When the EQR is derived from the Q-value the site is assigned to one of five ecological status classes on the scale: ‘High’, ‘Good’, ‘Moderate’, ‘Poor’, ‘Bad’ (EPA, 2009). The WFD requires “good ecological status” for rivers by 2015, to be achieved through integrated catchment management (EPA, 2006), although some waterbodies have extended deadlines. Note that sites are classified in the present study by “potential” WFD status. The use of the term “potential” is a technicality based on the fact that data from outside the formal WFD monitoring

[9] In order to achieve consistent implementation of the WFD across the EU the intercalibration process was undertaken to ensure a common understanding of 'high', 'good', ‘moderate’, ‘poor’ and ‘bad’ status was used in making water body status assessments.
[10] EQR = Environmental Quality Ratio (Observed/Reference)

programmes are not included in reporting of ecological status at a national level. Formal EU classification of ecological status is carried out by public bodies designated by the Regulations (S.I. 272 of 2009), at nominated monitoring sites. All other data would be considered to have "potential" WFD status based on the criteria set out in the Fifth Schedule to the S.I. 272 of 2009. **Table 11.1** summarises the relationship between Q-values and water quality classifications.

Table 11.1 EPA Water Quality Status Summary

Biotic Index	EQR[11]	EPA Quality Status	Water Quality	WFD[12] Status
Q5	1.0	Unpolluted	Good	High
Q4-5	0.9	Unpolluted	Fair-to-Good	High
Q4	0.8	Unpolluted	Fair	Good
Q3-4	0.7	Slightly Polluted	Doubtful-to- Fair	Moderate
Q3	0.6	Moderately Polluted	Doubtful	Poor
Q2-3	0.5	Moderately Polluted	Poor-to-Doubtful	Poor
Q2	0.4	Seriously Polluted	Poor	Bad
Q1-2	0.3	Seriously Polluted	Bad-to-Poor	Bad
Q1	0.2	Seriously Polluted	Bad	Bad

11.2.2.4 White-clawed Crayfish Survey

Presence/absence crayfish surveys were carried out on the Dunkellin River and Craughwell River in 2011 (20th/21st July and 17th August) and on the Aggard Stream on 4th September, 2012. Surveys were conducted using a standard manual search approach as outlined by Peay (2003). Survey methodology was specifically adapted to the type of habitat encountered. For example, Rahasane Turlough cSAC drainage channel was too deep to enter safely, so weed sweeping was undertaken from the banks for a limited time period. Generally, suitable habitat patches within representative stretches of each watercourse were targeted with timed manual searches. Spot searches were also undertaken whilst walking the channel during habitat characterisation.

Inland Fisheries Ireland Biosecurity Protocol for Field Survey Work (IFI, 2010) was adhered to and surveys were conducted under conditions of NPWS License No. C096/2011. Surveys were carried out within the recommended annual window for white-clawed crayfish surveys, i.e., June to October, inclusive (Peay, 2003). An estimate of population density was made using the abundance criteria as shown in **Table 11.2.**

Table 11.2 Grading the Abundance of Crayfish by Standard Method (from Peay (2003))

Average no. per 10 refuges	Population Abundance
> 5	A: Very high
>= 3, <= 5	B: High
>= 1, < 3	C: Moderate
> 0, < 1	D: Low
0	E: Absent or undetected

11.2.2.5 Waterbeetle Community Assessment

According to Foster *et al.* (1992) aquatic Coleoptera possess, as a group, a range of attributes required
According to Foster *et al.* (1992) aquatic Coleoptera possess, as a group, a range of attributes required
to evaluate the conservation status of wetlands. Foster *et al*. (1992) devised a classification system to assess water beetle assemblages in order to rank sites by community significance. The analysis produces a simple metric that can demonstrate the quality of different wetland habitat types and, thus, identify sites of highest ecological value. Individual Species Quality Scores (SQS) were assigned based on how commonly or rarely the species occurred in ceratin habitat types. The Mean Quality Score (MQS) for a site is calculated by dividing the total of individual SQS by total number of scoring species.

[11] EQR = Environmental Quality Ratio (Observed/Reference)
[12] WFD = Water Framework Directive (EPA, 2006)

It must be noted that SQSs were derived using a relatively small database of circa 2,500 records. There is now >38,000 records in the Irish database (Regan *et al*., 2008; Foster *et al*, 2009), and whilst the classification system is now somewhat out of date, it is a useful tool, and the only one available, for classification of wetland habitat using waterbeetle diversity. The MQS was used to assess the waterbeetle communities of Rahasane Turlough using existing datasets of Bilton, O'Connor and Waldron of 1988, 2001 and 2003/2004, respectively - see Appendix C5, Waterbeetle records (Dr A. O'Connor, NPWS, *pers.comm*).

11.2.3 Valuation of Ecological Resources

Ecological value was assigned to the receiving watercourses on the basis of their known (or perceived) rarity, status and distribution. This involved, in as much as possible, consideration of contextual information for the resource at a geographic level (NRA, 2009). It was also appropriate to take account of considerations of social value (access and amenity) with regard to the Dunkellin River fishery, as far as this relates to ecology. The evaluation criteria used to classify sites is shown in **Appendix C.1.** Observations and biological sample results were assessed in the context of national trends, guidelines and standards and EU Water Framework Directive (WFD) standards, as appropriate. In the absence of any standards or guidelines, scientific literature was consulted for direction.

11.2.4 Impact Assessment

All direct, indirect and cumulative impacts that could arise from the proposed measures were assessed. The assessments were carried out in line with International and National Guidelines for EcIA[13] , including EPA (2002), IEEM (2006) and NRA (2009). The magnitude, extent, timing and duration of potential impacts have been considered as well as their likelihood of occurring using the following scale: Certain/near-Certain: probability estimated at 95% chance or higher; Probable: probability estimated above 50% but below 95%; Unlikely: probability estimated above 5% but less than 50%; Extremely Unlikely: probability estimated at less than 5% (IEEM, 2006).

Impact types and levels of significance were assigned according to the terminology of EPA (2002).

Special consideration was given to the prediction of how proposed measures may affect the integrity of Rahasane Turlough cSAC and the conservation status of Annex I habitats and Annex II species. Even though no works are proposed in the cSAC, potential indirect effects were given strong consideration.

11.2.5 Timing of Aquatic Surveys

Field studies and macroinvertebrate sampling were carried out on 20th and 21st July, 2011, at selected sites on Dunkellin River and Craughwell River and at the western side of Rahasane Turlough at the Dunkellin River outflow. Further site visits to the Craughwell/Dunkellin River were made on 9th and 17th August , 2011, the latter to search for crayfish at a location upstream of Craughwell. A detailed walkover survey of the Aggard Stream system was conducted in January 2012 and crayfish searches were carried out in September, 2012.

11.2.6 Flow Estimate During Aquatic Surveys

The daily mean flow recorded on the Dunkellin River at Kilcolgan (Station 29011) on July 21st was 3.03 m^3/s (Kenneth Freehill, OPW Hydrometric, *pers. comm*.). Mean annual flow for the Dunkellin is estimated to be 6.71 m^3/s (OPW Hydrometric data), a level that is at the 35th percentile of flow as shown in **Figure 11.1**. Fieldwork was, therefore, undertaken when river flow was below mean annual, at approximately 65th percentile flow conditions, i.e., 65% of flows are predicted to be greater than that observed on July 21st, 2011. Given that mean annual flow is the proposed level of the two-stage

[13] EcIA = Ecological Impact Assessment

channel cutting along the Dunkellin River between Rinn Bridge and the N18 bridge, the conditions surveyed were representative of normal in-channel flow and would not be expected to alter as a result of proposed bank height alterations.

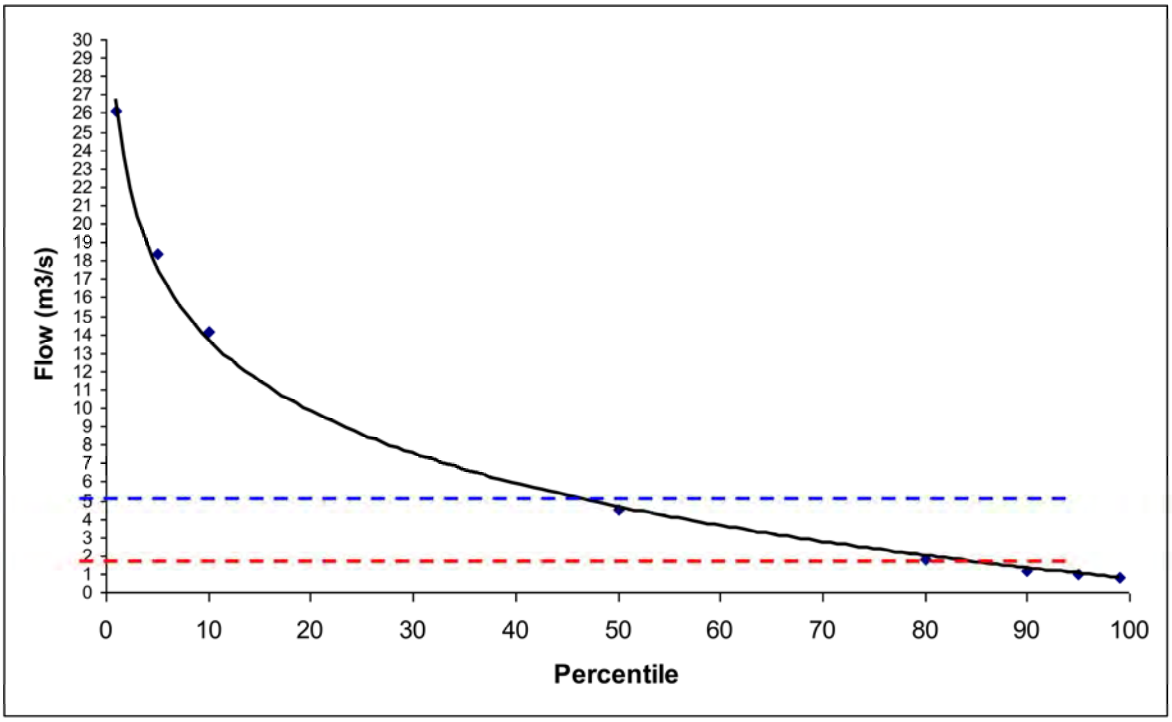


Figure 11.1 Mean Daily Flow on Day of River Surveys 21/7/11 (red) Shown in Comparison to the Mean Annual Flow (blue) on the Dunkellin River at Kilcolgan (Hydrometric Station 29011)

11.3 EXISTING ENVIRONMENT

11.3.1 Overview

The Dunkellin catchment drains about 400 km² of lowlands in south County Galway and discharges to Galway Bay. In the upper catchment, flowing in a westerly direction through East Galway, the Craughwell River is joined by a number of significant tributaries (e.g. Raford, Dooyertha, St, Clerans) not far upstream of Craughwell. The Craughwell River then flows through the town until, at the confluence of the Aggard Stream, it becomes the Dunkellin River. From there the Dunkellin continues in a westerly direction passing through Rahasane Turlough (SAC 000322) and onwards to Galway Bay, near Kilcolgan.

Prior to drainage of the catchment the Craughwell/Dunkellin River sank at swallow holes within Rahasane Turlough, re-emerging at the surface near the coast at Kilcolgan (GSI, 2004). It was an (unsuccessful) attempt to drain Rahasane in the 1850s that established the Dunkellin River as an entirely artificial channel from the point where it enters the turlough (at the eastern boundary of the SAC) all the way, west, to Galway Bay. Since that original drainage attempt some of the waters that would previously have sunk at the turlough now flow as surface water along the artificial Dunkellin River channel. Drainage has significantly altered the relationship between surface water and groundwater in the Dunkellin system (Drew & Coxon, 1988), however, the turlough still functions naturally. Rahasane Turlough is, in fact, the largest remaining naturally functioning turlough in Ireland and is of international conservation importance. It is an SAC (000322) and SPA (0004089) and covers 257 ha, flooding seasonally. The channel through Rahasane Turlough is not subject to proposed measures and no works will be carried out within the SAC/SPA, however, the potential for indirect effects on the aquatic ecology of the turlough have been given strong consideration.

Watercourses affected by particular measures proposed are listed in **Table 11.3** and marked in **Figure 5.1**. **Section 11.3.2** to **Section 11.3.4** provide details of fisheries and white-clawed crayfish habitat and general hydromorphology within the Dunkellin River, Craughwell River and the Aggard Stream. **Section 11.3.5** presents current and historical water quality data for Dunkellin River and Craughwell River. **Appendix C.3** contains site photographs that are referred to in the text. **Appendices C.4** and **Appendix C.5** contain aquatic macroinvertebrate survey results and a list of historical waterbeetle records, respectively.

Table 11.3 Watercourses Affected in Relation to the Scheme.

Area Name	Recommended measures	Watercourse directly affected
Between Kilcolgan & N18 Bridges.	No measures considered.	
Channel Works from the N18 Bridge to Killeely Beg Bridge.	Two stage channel works with a typical channel width of up to 20 m. From a distance of 400 m upstream of the N18 Bridge the two stage channel will be tapered back to match existing channel widths.	Dunkellin River.
Salmon Counter.	Relocate Salmon Counter to location upstream of KIleely Beg Bridge.	Dunkellin River.
Works at Killeely Beg Bridge.	Full bridge replacement in conjunction with channel widening.	Dunkellin River.
Channel Works from Killeely Beg Bridge to Dunkellin Bridge.	Two stage channel works continue from Killeely Beg Bridge, downstream to Dunkellin Bridge, with a typical channel width of up to 20m.	Dunkellin River.
Works at Dunkellin Bridge.	In conjunction with channel widening - replace existing flood eyes with two new box culverts measuring 13 m wide x 2.3 m deep.	Dunkellin River.
Channel Works between Dunkellin Bridge and Rinn Bridge.	Construction of a two stage channel with an additional width of up to 20 m from Dunkellin Bridge upstream for 175 m.	Dunkellin River.
Works at Rinn Bridge.	Provide three flood eyes measuring 3.1 m wide x 2.1 m deep.	Dunkellin River.
Channel Works between Rinn Bridge and Rahasane Turlough	Construct a two stage channel, typically 20 m wide, from approximately 50 m upstream of Rinn bridge to approximately 50 m downstream of the bridge.	Dunkellin River.
Rahasane Turlough.	It is not proposed to complete any works within or adjacent to the main body of Rahasane Turlough cSAC.	N/A.
Between Aggard Stream and upstream of the R446 Bridge.	Deepen main channel from 35 m upstream of the road bridge in Craughwell to 610 m downstream of the railway bridge. The reduction in bed level will be in the range 1 to 1.5m.	Craughwell River.
Railway Bridge in Craughwell.	Deepen channel by 0.75 m - underpinning and scour protection will be necessary.	Craughwell River.
R446 (R446) Bridge.	Deepen channel by 0.6m - underpinning will be required.	Craughwell River.
Masonry Arch Pedestrian Bridge.	Deepen channel by 0.6m at all arches - underpinning and will be required.	Craughwell River.
Bypass channel in Craughwell.	Regrade channel and underpin bypass bridge to match proposed bed levels.	N/A.
Aggard Stream.	Channel maintenance works along the Aggard Stream to Monkfield Stream.	Aggard Stream.
Aggard Stream and Cregaclare drainage channels.	Replacement of fourteen culverts.	Aggard Stream and Cregaclare drainage channels.

11.3.2 Dunkellin River

11.3.2.1 Overview

The Dunkellin River can be broadly divided into two sections, based broadly on hydromorphology:

1. The stretch between Rahasane Turlough and Galway Bay; and

2. Rahasane Turlough drainage channel.

The canalised reach through Rahasane Turlough is of low gradient, characterised by sluggish flows, while the canalised reach downstream to Galway Bay is more dynamic with variable flow characteristics owing to a steeper gradient. Target notes are referred to in the text as Points and their locations are shown in **Appendix C.2.** Photographs (Plates) referred to in the text are shown in **Appendix C.3.**

The majority of the Dunkellin River in the stretch downstream of Rahasane Turlough is an artificial channel that was cut from limestone bedrock as part of the 19th century drainage scheme. Banks were generally vertical, and in many places armoured by stone cut block or boulder (see Plate 11). Owing to the nature of the rock substrate the channel gradient in many places dropped in discreet steps, the sequence being that of short cascades over a rock or rubble weir followed by a short turbulent stretch or longer run. That flow gradually gave way to shallow or moderately deep glide, with the sequence repeating itself, varying only in gradient and the length of each of the individual sections. Instead of meandering as might be expected of a river in this setting, the engineering of the river has meant that only straight stretches and broad curves were observed. There were a few places along the channel where the river broadened somewhat to form more typical pool and glide areas where floating, submerged and emergent aquatic vegetation was common. One such area was the broad stretch extending several hundred meters upstream of Kilcolgan N18 Bridge (Plate1). Another was the large pool at Point 19 upstream of Dunkellin Bridge, another at Point 10 just below Dunkellin Bridge and near Point 9 upstream of Killeely Bridge. Outside of these areas of softer bank material in-channel vegetation was primarily confined to mosses, liverworts and filamentous algae. Another feature of the channel in this section was the general lack of fine and medium gravels, which would be important for spawning with the exception of the broader pool areas mentioned above areas immediately above or below which tended to have suitable gravels for spawning, even though enhancement could probably improve them considerably. Apart from these specific areas most of the substrate was very coarse ranging from small cobble through to boulders with cobbles. Bedrock also dominated the substrates in some stretches, particularly where the channel was confined by rock cut or reinforcement on both banks. Considerable water velocity is likely during floods flows, which might explain the scarcity of finer substrates observed.

For the purpose of detailed descriptions, the Dunkellin, downstream of Rahasane, has been further divided into four sections delineated by the position of bridges. **Section 11.3.2.2 to 11.3.2.5** describe, in sequence, Kilcolgan N18 Bridge to Killeely Beg Bridge; Killeely Beg Bridge to Dunkellin Bridge; Dunkellin Bridge to Rinn Bridge and Rinn Bridge to Rahasane Turlough.

The Dunkellin River (drainage channel) through Rahasane Turlough differs significantly in its hydromorphological character compared to the reach downstream of the turlough. When the turlough is not flooded, the river is contained within a low gradient, wide, generally straight channel that forms a long, uniform glide conveying water downstream. During high flows some water escapes the drainage channel and flows into the northern and western swallow-hole systems within the turlough. **Section 11.3.2.6** describes the character of the Dunkellin River within the Rahasane Turlough drainage channel.

11.3.2.2 Kilcolgan N18 Bridge to Killeely Bridge

The lower 600 m of the Dunkellin River (upstream of Kilcolgan N18 Bridge) were generally a lot wider than the rest of the channel between there and Rahasane Turlough. Close to the bridge the flow was moderate to swift but waters were slacker further upstream (Plate 1). There was dense submerged macrophyte cover, including *Apium nodiflorum, Sparganium emersum*, and mosses in shallow (< 1m) glide/run (Plate 2) type flow. This extended upstream to Point 2 where the channel narrowed at the first of a series of steps that occur in the bed up to Killeely Beg Bridge. The first step was a short cascade

(Plate 3) above which extended a shallow run followed upstream by a shallow glide/run (Plate 4) up to a bend in the river which broadened to a glide/pool fringed by emergent macrophytes (Plate 5). Filamentous algae was abundant, coating boulders and forming mats throughout this reach. The channel then narrowed considerably at M 42787 18661, forming a step/cascade (Plate 6) – run - glide (Plate 7) sequence, which repeated up to Killely Beg Bridge. The last step before the bridge was in the form of a salmon counter that included a weir (Plate 8) that created a glide/run upstream of it and beneath the bridge. The channel banks through this reach were either rock cut or unmortared boulder rip-rap reinforcement (Plate 9). The substrates within the step-run-glide sequences were generally coarse comprising a mixture of cobble and bedrock with variable, often low cover of mosses, and filamentous algae in the glides but higher cover at some of the faster flowing, shallow steps. Small numbers of juvenile salmonids were observed in the stretch below Killeely Beg Bridge taking cover behind large cobbles. Eels were very common, observed under boulders and in crevices downstream of Killeely Beg Bridge.

White-clawed crayfish were actively sought under boulders and in clumps of aquatic vegetation throughout this section, but none were found. Crayfish habitat was considered optimal from Point 3 upstream for about 100 m, where there were plenty of available refuges (boulder; cobble; clumps of aquatic vegetation) for adults and juveniles. Crayfish remains were observed in otter spraints on rocks at the channel margins near Point 3, and again at Point 4. From the narrowing up to Killeely Beg Bridge, crayfish habitat was less optimal, but not poor. Block armouring on channel banks would provide good refuges, but stable refuges were lacking in the mid-channel where bedrock often dominated the substrates (Plate 10). Greater channel velocities that would occur through the more canalised section downstream of Killeely Beg Bridge (especially during high flows) may limit crayfish success there. It is possible that crayfish were present, but not detectable owing to their use of inaccessible refuges and/or a low population density.

11.3.2.3 Killeely Beg Bridge to Dunkellin Bridge

Immediately upstream of the Killeely Beg Bridge, for about 150 m, the channel was heavily shaded and comprised a step-run glide sequence (Plate 11). The banks in this section were either steep/vertical rock cut or block armour. Substrates were predominantly bedrock with some boulder, large cobble and little plant cover (Plate 12). Upstream of this sequence a long glide section extended for 250 m broadening at its upper end to form a shallow pool (Point 7, Plate 13) about 60 to 80cm deep with slightly silted boulder and cobble substrate which merges upstream into a shallow shoaling area with emergent and submerged macrophytes. Upstream of this a deep rock-cut pool (~1.5m deep) occurred at a point where the channel narrowed abruptly (Point 8, Plate 14). It is possible that the area below this pool may be suitable for salmon spawning. Above this is a short run-cascade (Point 9) and above that again a very long (150 to 200 m) shallow (~30 cm) run (Plate 15); with cobbles and boulders with an abundance of moss and algae in turbulent water; an area that would be ideal for 0+ and 1+ salmonids. The step-run-glide habitat continues up through overgrown banks for another 200 to 250 m until a point where the channel widens again about 80 to 90 m below Dunkellin Bridge (Plate 16). In this last stretch below the bridge the substrate was finer again with silt and algal covered coarse gravel and small cobble where several salmon redds have been recently observed in the substrate (Mr. Sean Francis, IFI, pers. comm.). The channel between there and the bridge upstream comprised a shallow run / glide with coarse substrate in a moderate flow (Plates 17 and 18).

A reach about 50 m upstream of Killeely Beg Bridge and another 50 m downstream of Dunkellin Bridge were actively searched for white-clawed crayfish, but none were found. Habitat was considered optimal in places, particularly downstream of Dunkellin Bridge where the run became a shallow glide with many boulder and cobble refuges. Of note was the very high density of Eel (*Anguilla anguilla*) of various size classes throughout this stretch. Almost every boulder lifted in search of crayfish harboured an eel. The reach upstream of Killeely Beg Bridge was less optimal for crayfish given that mid-channel substrates were quite scoured, however there were ideal refuges in block armour bank material and stone cut banks with cracks and crevices. It is possible that crayfish were present, but not detectable owing to their use of inaccessible refuges and/or a low population density.

11.3.2.4 Dunkellin Bridge to Rinn Bridge

The first 500 m stretch upstream of Dunkellin Bridge, comprised a long glide which terminated in a broad pool and above that about another 900 m of narrowed channel; of steeper gradient with many steps in the rock cut channel as far as Rinn Bridge upstream. The latter is often overhung from the banks with dense riparian shrubs and trees.

A bouldery run (Plate 19) just above Dunkellin Bridge became a deeper (0.5 to 1 m) glide, the first part of which was narrow with slow flows and substrates of large cobble and bedrock with little plant cover (Plate 20). Above this the channel gradually widens, but still forms a slow-flowing glide with rooted macrophytes both in-stream and marginally (Plate 21). Further upstream the channel broadens into a large shallow (< 1 m) pool at Point 19, fringed on the true right bank by *Sparganium erectum* and yellow Water Lilly (*Nuphar lutea*) (Plate 22), while on the left bank there was a cattle drinking area. Immediately upstream of the pool the channel narrowed into a riffle (Plate 23). This riffle marks an important point on the lower Dunkellin River for two reasons: (1) the occurrence of spawning gravel where IFI officers have recorded salmon redds (Plate 24); and (2) it was the most downstream location where crayfish were captured. This stretch is also known as a popular angling spot. Upstream of that, a sequence of short, step/cascade-run-glides began, continuing most of the way up to Rinn Bridge. The first few between Point 21 and Point 26 were more typical in length for the river to that point (Plate 25) but from Point 26 through Point 27 they became shorter and more frequent, presumably because of the greater gradient, so that the glides were short or non-existent (Plate 26). Coarse substrate in the shallower runs (20 to 25 cm) was heavily coated in moss and algae (Plate 27) in open stretches, but in deeper or shaded areas plant cover was minimal. Closer to Rinn Bridge the gradient decreased and a short riffle section immediately downstream of the bridge then formed a long glide (Plate 28) that connected with the step-run-glide sequence described above. Much of the short, turbulent-then-still water sequence was highly suitable for juvenile and 1+ salmonids. Older fish probably utilise the slower, deeper water in the first 500 m upstream of Dunkellin Bridge that was headed by the large pool at Point 19.

Targeted manual searches for crayfish were undertaken at a number of locations between Dunkellin and Rinn Bridges. These revealed that crayfish were easily detectable at the riffle (Plate 23) about a third of the way upstream between the two bridges. Crayfish were then present all the way from there upstream to Rinn Bridge. Below that point however, no crayfish were found. Crayfish habitat was considered optimal at, and upstream of, that riffle. There was also a considerable amount of optimal and sub-optimal habitat downstream of the riffle towards Dunkellin Bridge, so the reason for their absence or non-detection there is unknown. It is possible that the riffle marks the downstream limit of crayfish habitation on the Dunkellin River. It is also possible that, downstream of that point, crayfish were present but not detectable owing to a low population density and/or their use of inaccessible daytime refuges. Numerous eels were observed during crayfish surveys, particularly in the reach just upstream of Dunkellin Bridge. See **Section 11.3.8** for details of crayfish surveys and distribution.

11.3.2.5 Rinn Bridge to Rahasane Turlough

The channel from Rinn Bridge to the outlet from Rahasane Turlough follows a similar pattern as the Dunkellin Bridge to Rinn Bridge stretch but the gradients were not so steep with a sequence of a few short steps and a dominance of longer riffle-run-glides (Plate 29). The channel tended to be uniformly narrow, not widening out beyond the rock-cut or reinforced banks to form any significant pools. Banks were more or less inaccessible because of trees and shrubs, although the shade wasn't complete and light penetrated to the bed at regular intervals. This was attested to by the moderately high cover of filamentous algae in places (Plate 30). According to the IFI, the reach is very good for salmon parr. Numerous juvenile salmonids were observed both upstream and downstream of Rinn Bridge during the current survey, with larger fish (probably 1+ trout) occupying the deeper glide/pool areas. Immediately upstream of the bridge a series of riffle/ run sequences extends upstream to Point 32 (Plate 31), beyond which a shallow glide (30 to 40 cm and up to 1m+ in places) extends upstream for at least 100 m (Plate 32). The same pattern repeats itself farther upstream toward the turlough. The final stretch entering Rahasane Turlough comprises a shallow, cobbly glide (Plate 33) that became deeper with much coarser substrates at the entrance to the Turlough proper (Plate 34). Substrates in this stretch were predominantly angular cobbles, but bedrock was also evident in places.

White-clawed crayfish (Plate 37) were captured by manually searching the riffle/ run upstream of Rinn Bridge and were detected in spot checks upstream as far as Point 32. Crayfish habitat was considered optimal between Rahasane Turlough and Rinn Bridge, with plenty of mid-channel and bankside refuges, and good tree cover, it is reasonable to assume crayfish occur along this entire reach.

11.3.2.6 Rahasane Turlough Drainage Channel

The Dunkellin River crosses the turlough floodplain as a low gradient, artificial channel which was generally deep and very slow moving (Point 35). Low, slightly set back embankments ran parallel to the channel along both banks (Plate 35) and bank and bottom substrates were completely obscured by floating, submerged and emergent aquatic macrophytes. Instream submerged vegetation observed was comprised mainly of *Nasturtium officinale, Callitriche* spp*., Myosotis scorpioides, Nuphar lutea, Oenanthe fluviatilis, Berula erecta*. A 15 minute weed sweep amongst aquatic vegetation near the outlet from Rahasane Turlough towards Rinn Bridge revealed a number of small, juvenile crayfish (Plates 37 & 38). Various aquatic molluscs, e.g. *Lymnaea stagnalis*, plus corixids, e.g., *Sigara* spp., and a number of water beetle species were collected. **Section 11.3.9** contains a review of the aquatic communities of Rahasane Turlough. The site visit took place ten days after a period of heavy rainfall had flooded the turlough and, although it had drained considerably, there were some very wet, low lying areas behind the channel embankments and further upstream on the floodplain. There were small, and larger, patches of open water visible (Plate 36). The turlough was being grazed by horses during the site visit.

11.3.3 Craughwell River

11.3.3.1 Aggard Stream Confluence to Craughwell

This upper stretch of the study area extends from the confluence of the Aggard Stream upstream through the railway viaduct; the stone arch pedestrian bridge; and the R446 bridge at Craughwell. The channel was generally slightly wider on average than the Dunkellin River and was densely shaded with over hanging trees along much of its length. In general, the substrates were one of the following:

(i) very coarse large cobbles and boulders; or

(ii) smaller cobbles and coarse gravel; or

(iii) bedrock at the fast-flowing mid-channel, with large boulders at the margins.

The pattern of habitats can be broadly described as comprising three extended glide stretches some with deep pools interrupted by shallower, more turbulent and faster flowing water. Much of this part of the river is inaccessible from the banks. Target notes are referred to in the text as Points, and their locations are shown in **Appendix C.2**.

The short run just upstream of the Aggard Stream was unique within the study reach owing to a profuse growth of *Ranunculus* spp. (Plate 39). Substrates there included gravels and finer material among boulders and cobble which had allowed macrophytes to root. The banks were open and unshaded at that point. This led, at Point 37, into a long glide (Plate 40) which continued upstream to Point 39 with one short (~ 20 to 30 m) riffle/run (Plate 41) at Point 38 (ending at 38a). All of that stretch was open with considerable submerged plant growth. A number of small springs were observed at the river margins nearer to Point 39. Upstream from Point 39 to Point 42 the channel comprised a series of runs, step/cascades and pool/glides (~80cm deep). There were cascade/weirs at Point 39a and 41a and a deep pool, good for fish holding at Point 41. The next glide began at Point 42 (Plate 42) and extended upstream to Point 44, where there was a deep holding area at Point 43. From Point 44 to 47 the gradient increased and formed a series of run/cascades and riffle type stretches with turbulent flows over coarse bed material with high levels of algal and moss cover in places (Plate 43). The finer bed material and plant cover in places was considered very suitable for juvenile salmonids. From Point 47 to 49 a long glide, parts of it deep (> 1m), extended up beneath the railway bridge more than half way to the old arch pedestrian bridge, interrupted by a short shallow riffle/run just below the railway bridge at Point 48, where there was moderately high moss and algal cover. The substrate in the glide area (Plate 45) comprised large maerl covered cobbles and boulders with very little attached plant growth owing to the combination of depth and heavy shade. The liverwort *Pellia* sp. was locally common in these areas.

A dipper was observed feeding in the stretch just upstream of the railway bridge. This glide merged upstream into an extended shallow run and riffle/run downstream of the old masonry arch bridge (Plate 46), which was ideal juvenile salmonid habitat. The substrate there was dominated by small cobbles interspersed with patches of gravel and maerl sand, with a moderate covering of filamentous algae (Plate 47). That habitat type extended upstream to the next bridge, but the flow was slightly deeper and less swift closer to the R446 Craughwell Bridge (Plate 48). Crayfish were detected in varying densities along this entire stretch of the Craughwell River. Three, timed searches were conducted between the Aggard Stream confluence and the R446 Bridge, with numerous spot checks conducted as habitat mapping was undertaken.

11.3.3.2 Upstream of Craughwell R446 Bridge

Above the R446 Bridge a boulder and cobble glide extended upstream for over 250 m (Plate 49). This stretch upstream of the bridge is known to be popular with anglers owing to its accessibility, deep waters and good fish holding capacity. About 200 m upstream from the bridge was a large pool which forms during high flows; it drains to the main glide at its downstream end (Point 54). The glide itself at this point was flanked by dense emergent growths of *Sparganium erectum* with *Schoenoplectus lacustris* and *Phalaris* also locally common (Plate 50). At the upstream end of the glide there is a point where the river changed to steeper gradient – a cattle access point (Point 55, Plate 51) marks the stretch which has a gravel substrate and may be suitable for spawning. Just upstream from there was the downstream end of a run at a point where the channel narrowed and the flows became more turbulent (Point 56, Plate 52). Further upstream (Point 57, Plate 53) the gradient levelled slightly again but shortly steepened again into a turbulent torrential run (Point 58, Plate 54 and Plate 55). This stretch was considered ideal for juvenile salmonids but the very heavy shading is probably reducing the potential productivity of the stretch.

A timed search for crayfish was undertaken on the Craughwell River at the bridge c.1.5 km upstream of Craughwell in Caheradangan townland (Plate 56). A number of crayfish were captured, though high flows made survey conditions difficult. Crayfish appear to be present along the entire stretch of the Craughwell River between Aggard Stream confluence and the Bridge at Caheradangan. Population density was dependent upon habitat suitability, with greatest densities occurring in shallow bouldery glides and riffle/runs where there was plenty of cobble and small boulders overlying gravel/sand substrates. The least optimal habitat along this stretch was where flows were very swift over bedrock substrates. Crayfish were confined to the underneath of large boulders at margins under such conditions.

11.3.4 Aggard Stream

11.3.4.1 Overview

The Aggard stream was surveyed by walkover survey on January 8th, 2012. Water levels at the time were elevated; flooding over banks (0.8 m on the staff gauge at Aggard Bridge). Water colour was low but moderately turbid, which made observation of the substrate sub-optimal in deeper water. Target notes points are prefixed with ‘AG’ in the text, and their locations are shown in **Appendix C.2.**

In terms of its geomorphology and general habitats the channel can be divided into two broad sections:

1. Main channel extending upstream from the confluence of the Aggard with the Craughwell River and continuing upstream as far as the divide in the channel ESE of Rathcosgry (AG26) at which point the ‘main’ channel veers due east; and

2. Narrower and shallower branch continuing in a SW direction.

This latter branch further splits with a short branch flowing from Monksfield in the SE, while the longer branch (AG28) flows from the SW from the townland of Ballyboy. The channels upstream of Monksfield often dry out in the summer (Sean Francis, IFI, *pers.comm.*) which naturally limits aquatic ecological value.

The main branch from the Craughwell River as far as the branching near Rathcosgry is dominated by deep, moderate to sluggish flows over a deep narrow channel and deep shoaling beds of fine substrate (sand and silt) held together by the roots of a range of macrophyte species, the latter often toward the channel margins. This main habitat contrasts with two stretches of moderate to swift flows, where the channel is narrower and shallower (generally) and the substrate is much coarser ranging from gravel and pebble to angular cobble. This latter habitat type is present from just upstream of Aggard Bridge (AG4) more or less to the confluence with the Craughwell River (d/s AG1) and also from approximately Aggard Beg (AG20/21) more or less upstream to just below where the channel goes into a right-angle bend to the east near Rathcosgry (AG25). Both these latter stretches are the most suitable for salmonid fish, brown trout predominantly, and are therefore most amenable to fisheries enhancement measures. The wider more sluggish areas in the remaining portion of the main channel are thought less likely to be suitable for enhancement works.

11.3.4.2 Reach (1) – Dunkellin River Confluence to Aggard Bridge

The upstream section of this reach, from Aggard Bridge downstream as far as AG3/AG4 comprises a broad glide/run dominated by a heavy in-stream growth of *Ranunculus* with substrates of fine gravel, sand and scattered cobble (Plates 58 & 59). From AG2 downstream the velocity increased and the bed material became coarse with gravel, cobble and sand. AG1 marks the upstream end of a rapid/riffle type stretch where the substrate comprises gravel and cobble with good *Ranunculus* cover (Plate 57). This habitat continues more or less the whole way to the Craughwell River. The banks were generally heavily overgrown, which reduces light penetration in certain stretches. However, there doesn't appear to be any constriction to conveyance and the site may not require any maintenance work. The site was ideal for trout nursery with possibly patches of suitable spawning substrate also present. The habitat was, in places, optimal for crayfish and they may utilise crevices in the stone wall/quay along the RHS side downstream of the bridge.

11.3.4.3 Reach (2) - Aggard Bridge to farm bridge at Carrageen East

Immediately upstream of Aggard Bridge (AG4) woody debris was collecting drifting macrophytes and forming a partial constriction to flow. The first 30 m or so upstream of the bridge had a gravel bed with scattered coble with heavy *Ranunculus* cover (30 to 40%) with *Apium* and *Callitriche* marginally in what could be described as a deep run (Plates 60 & 61). The area would be suitable for both salmonids and crayfish. At this point the banks were high and steep and a relic of previous drainage works (Plate 62, AG6). The right bank (east) was heavily vegetated in the lower part of this stretch with scrub, while the left bank (west) is more dominated by well-spaced trees with small pockets of scrub. High banks (Plate 63) extend more or less the whole way to a farm road bridge at Carrigeen East (Plate 69, AG11), with occasional gaps where cattle have access to the channel (Plate 64, AG8) the stretch is dominated in the main by deep glide (Plate 65), with swifter flow in the downstream half and fine substrates (sand and silt) often shoaling as submerged 'shoulders' or banks held together by a range of macrophyte species including *Apium*, *Ranunculus* and *Glyceria* spp. (Plate 66, AG9). In areas of slack flow, heavier stands of emergent / partially submerged *Phalaris* were also in evidence. These areas may be suitable for both lamprey ammocoetes and juvenile crayfish. The substrate in general is sub-optimal for trout, although 1+ and 2+ trout are likely to be frequently encountered here. A small metal foot bridge in the upper part of the stretch (Plate 67, AG10) as well as the farm road stone bridge (Plate 69, AG11) at the head of the stretch contain coarser substrate where adult crayfish might find refuge. In general, this channel is already over-deepened as a result of past drainage. It would be amenable to removal of some fine submerged fine-substrate 'shoulders' / shoals to improve capacity and conveyance.

11.3.4.4 Reach (3) - Carrigeen East to Aggard Beg

This reach was generally broader with lower more open banks (e.g., Plates 73, 76 & 77) than the previously described reach. In general the substrate is dominated also by shoaling silty sand beds held together by macrophytes such as *Apium*, *Nasturtium*, *Glyceria*, with *Ranunculus* also prominent. Patches of medium and fine gravel also present throughout this stretch especially from cattle access point (at AG12) to AG13/14 (Plates 71 & 72). The area was not optimal salmonid habitat although larger trout (1+ and 2+) were likely to be present along with younger or juvenile crayfish and lamprey ammocoetes likely to be utilising silt banks. This reach and the previous reach (2) could also hold juvenile pike, as this species is known from the Rahasane Turlough drainage channel (Plate 35).

11.3.4.5 Reach (4) - Aggard Beg to Rathcosgry

The downstream end of this reach was broad and sluggish, continuing from the previous stretch (Plates 77 & 78; AG19/20). However, moving upstream, the channel began to narrow, and substrates became more dominated by gravel beds and from about AG21 (Plate 79) the latter was dominated by a mixture of gravel and cobble forming typical riffle / run stretches all the way upstream under both the railway and byroad bridges (Plate 80, AG22). The channel broadened for a short distance upstream of the by-road bridge (Plate 81, AG23) and then narrowed considerably between high, near vertical banks (Plate 82, AG24), which were completely overgrown by scrub that cast heavy shade on the channel. The substrates were coarse with swift or moderate-to-swift flows. This configuration, more or less, continued upstream as far as AG25, i.e. beyond the point where the railway line came close to the channel. This substrate and habitat was considered optimal salmonid nursery habitat and may well be used also for trout spawning in places. The heavy shading in places would be considered sub-optimal. Fast flows combined with high banks and complete lack of silt beds or shoals, suggests the stretch is unsuitable for maintenance apart, perhaps, from some limited scrub removal. The downstream portion (particularly between AG21 and AG24) may be amenable to some fisheries enhancement measures such as random boulder placement and pool excavation.

11.3.4.6 Reach (5) - Rathcosgry to Stream Fork near Monksfield

This short stretch from AG25 to AG26 was deep, wide and sluggish with much bare clay substrate (Plate 83). It has one relatively deep pool/holding area just downstream of the confluence. The main channel continued toward the east (Plate 84) and, while it was not walked, it was clear that it was sluggish with very low gradient and probably has substrates predominantly of silt/sand or exposed clay. *Apium*, *Callitriche*, Watercress and *Glyceria* are likely to be common. The habitat in the main is likely to be sub-optimal for salmonids and crayfish, although neither species can be ruled out and lamprey ammocoetes may also be present. The substrate immediately upstream and downstream of the bridge at Ballylin may be coarser.

11.3.4.7 Reach (6) - Southwestern Branch to Cregaclare

This smaller, southwestern branch of the Aggard running from Cregaclare (upstream from and including point AG 27 & AG28), will be the subject of all the culvert insertion works on the channel. The channel generally has open low banks, a very sluggish, shallow flow with heavy weed growth including *Callitriche* sp, *Apium nodiflorum*, *Glyceria*, sp, *Nasturtium officinale*. The bottom substrates were soft (Plates 85 & 86).

11.3.5 Water Quality

11.3.5.1 EPA Biological Water Quality Monitoring Data

Table 11.4 summarises historical EPA biological water quality data from two locations on the Dunkellin River, and one location on the Craughwell River. The Craughwell River recorded very good water quality in the early 1970s but deteriorated to Q4 from 1977 onwards and apart from one poor result (Q3) in 1997, has remained consistent at Q4, or ‘Fair’ water through until recent monitoring in 2012. The site is classified under the WFD as Good Ecological Status (GES).

EPA water quality stations on the Dunkellin River have generally rated more poorly than the Craughwell River station since monitoring began. Dunkellin Bridge station recorded slight-moderate pollution (Q3-4) from 1994 to the present, and is currently classified at Moderate Ecological Status (MES). Rinn Bridge appears to show a declining water quality trend, with 2006 EPA data showing the site to be ‘moderately polluted’; (Q3) equating to Poor Ecological Status.

Table 11.4 Summary of EPA Biological Water Quality Monitoring on the Craughwell and Dunkellin Rivers (Source: EPA ENVision online map viewer)

EPA Station	'71	'73	'77	'80	'83	'86	'89	'94	'97	'00	'03	'06	'09	'12
Dunkellin Bridge 29K010600	-	-	-	4	-	-	-	3-4	3	3-4	3-4	3-4	3-4	
Bridge u/s Dunkellin Br. (Rinn Bridge) 29K010500	-	-	-	4	-	-	3-4	4	3-4	3-4	-	3	-	
Old Road Bridge, Craughwell 29K010400	4-5	5	4	4	4	4	4	4	3	4	4	4	4	4

11.3.5.2 Waterbody Status

The study area falls within waterbody IE_WE_29_669 (Dunkellin, Trib of Kilcolgan). The current status of this waterbody is 'Poor' (macroinvertebrates = 'Poor'; fish = 'Moderate'; physico-chemical = 'Good'), with a risk status of 1a 'At Risk' owing to morphological, nutrient and unsewered catchment pressures. The overall objective is to restore to the waterbody to 'Good' status by 2021. The extended timeline is owing to delayed recovery following reduction in agricultural nutrient losses[14].

11.3.5.3 EPA Physico-chemical Water Quality Monitoring Data

Table 11.5 presents summarised water chemistry results for three EPA monitoring stations that occur within the study area on Dunkellin / Craughwell Rivers. Parameters are summarised from four years of sampling data (2007-2010). The results for pH, alkalinity and conductivity reflect the very strong influence of the limestone geology of the catchment, with levels of each parameter showing elevated values overall. The only exception was on February 24th, 2010, when minimum alkalinity and conductivity values were measured at Kilcolgan Bridge and Dunkellin Bridge, presumably during a flood in the river. On the same occasion the lowest pH value was recorded at Dunkellin Bridge (6.3) and the lowest conductivity at Craughwell Bridge (266); alkalinity wasn't reported at this site on that occasion.

Water quality parameters point toward low BOD and ammonia results, which would suggest low levels of point source pollution. At the same time, relatively low levels of nitrate, would suggest low levels of agricultural intensification in the catchment. The only exception relates to phosphate which had fairly consistent, moderate levels at all three sites, the highest being at Craughwell. This suggests a combination of point sources at Craughwell and diffuse sources elsewhere. There may be higher groundwater phosphorous levels in this catchment owing to the limestone / karst nature of the bedrock-geology, which would reduce levels of phosphorus attenuation within the system. These data tie in to some extent with the biological water quality findings for the Dunkellin / Craughwell River between Craughwell and Dunkellin Bridge which indicate slight-to-moderately polluted conditions over the past two to three decades.

[14] Full Report for Waterbody Dunkellin, Trib of Kilcolgan: http://www.wfdireland.ie/maps.html

Table 11.5 Summarised Water Chemistry Data for the Dunkellin / Craughwell River (2007-2010) – EPA Data

Determinand	Location	Mean	Median	Max	Min	(number)
pH	Kilcolgan	7.8	7.8	8.2	7.5	17
	Dunkellin	8.1	8.2	8.4	6.3	17
	Craughwell	8.1	8.1	8.6	7.9	17
Alkalainity	Kilcolgan	261	268	340	8	17
(mg/l, as $CaCO_3$)	Dunkellin	267	256	312	216	17
	Craughwell	258	279	308	110	16
Conductivity	Kilcolgan	573	608	683	77	17
(µS/cm)	Dunkellin	552	574	668	99	17
	Craughwell	544	580	635	266	17
DO	Kilcolgan	90	89	108	64	17
(%sat)	Dunkellin	108	100	153	85	17
	Craughwell	98	97	122	85	17
Orthophosphate	Kilcolgan	0.033	0.036	0.056	<0.012	16
(mg/l, P)	Dunkellin	0.030	0.033	0.055	<0.012	16
	Craughwell	0.044	0.045	0.125	<0.012	16
Nitrate	Kilcolgan	1.2	1.3	2.3	<0.4	17
(mg/l, NO_3)	Dunkellin	1.1	1.0	2.2	<0.4	17
	Craughwell	1.0	1.0	1.6	<0.4	17
BOD	Kilcolgan	<1	<1	1.2	<1	17
(mg/l, O_2)	Dunkellin	<1	<1	2	<1	17
	Craughwell	<1	<1	1.1	<1	17
Ammonia	Kilcolgan	<0.03	<0.03	0.05	<0.03	17
(mg/l, N)	Dunkellin	<0.03	<0.03	<0.03	<0.03	17
	Craughwell	<0.03	<0.03	0.05	<0.03	17

11.3.5.4 Biological Water Quality Sampling Results

Appendix C.4 shows benthic macroinvertebrate species lists and biotic indices calculated from the three samples collected. The Craughwell River (Site 1, sampled July 2011) just downstream of the old masonry bridge, had riffle substrates of small cobbles interspersed with patches of gravel and maerl sand with very little in-stream vegetation other than a moderate covering of FGA. The site merited a Q4 rating, equating to ‘Fair’ water quality and “potential”[15] Good Ecological Status. Total BMWP score was quite high (131) reflecting reasonable taxonomic diversity overall (21 scoring taxa) including a number of sensitive mayfly (e.g., Heptagenidae) and stonefly species (e.g., Nemouridae). ASPT was 6.2 with 45% EPT, both scores indicative of good water quality at the site.

The Dunkellin River (Site 2, sampled July 2011) located immediately downstream of Rinn Bridge merited a Q3-4 rating, equating to ‘slightly polluted’ and equated to “potential” Moderate Ecological Status. Riffle substrates were a combination of small boulders, large and small cobbles, sand and some bedrock. The BMWP was quite low (89), with only 16 scoring taxa and an ASPT of 5.2 - also indicative of slight biological water quality impairment. The presence of FGA[16] in unshaded parts of the channel suggested elevated nutrient levels. The picture was complex, however, because, even though EPT faunal diversity was low, the %EPT in the sample was high at 61%, which usually indicates low levels of organic pollution. Seasonal FGA growth noted is most likely a result of inorganic inputs as opposed to organic enrichment. It must be noted that, in general, the Dunkellin River in the vicinity of Rinn Bridge appeared quite unproductive, with low levels of accumulated silt and very little organic material in the channel. Dense tree-cover probably limits light incidence during summer months, thus affecting plant

[15] Formal EU classification of Ecological Status is carried out by public bodies designated by the Regulations (S.I. 272 of 2009), at nominated monitoring sites. All other data would be considered to have “potential” WFD status based on the criteria set out in the Fifth Schedule to the S.I. 272 of 2009 (Martin McGarrigle, *pers. comm.).*

[16] FGA = Filamentous Green Algae

growth. Swift flows within the confined channel may also be influencing benthic faunal assemblages. Given that the channel is artificial, there is some likelihood that hydromorphological condition limits the macroinvertebrate community at this site.

Site 3 on the Aggard Stream (sampled Sept., 2012) merited a Q3 rating, equating to 'moderately polluted' and "potential" Poor Ecological Status. The stream was 5 m in width and 0.2 m deep. Riffle substrates of cobble, gravel and sand were smothered almost entirely in thick mats of the pollution tolerant FGA, *Vaucheria* spp. (80% coverage), with embedded silt. The macrophytes *Ranunculus* spp. and *Apium nodiflorum* were also relatively abundant. Overall the macroinvertebrate and plant communities observed, pointed towards the presence of organic and, perhaps, inorganic nutrient enrichment in the Aggard system.

11.3.6 Protected Aquatic Species and Habitat

Table 11.6 summarises protected aquatic species and water dependant habitat that occur within the study area. **Table 11.7** and **Table 11.8** show the current national conservation status assessments for Annex II species and Annex I habitat (NPWS 2008; 2013a,b,c,d,e) that occur in the study area.

The only qualifying interest for which a designation exists in the study area is the Annex I habitat "Turloughs" of Rahasane Turlough cSAC. Populations of Annex II species recorded in the study area occur outside of the Natura 2000 network, although the Rahasane Turlough cSAC drainage channel provides a crucial fish migration route to and from spawning habitat in the upper reaches of the Craughwell/Dunkellin system, and is inhabited by white-clawed crayfish.

Table 11.6 Protected Aquatic Species of the Craughwell/ Dunkellin Rivers and Aggard Stream

Protection Mechanism	Species / Habitat
Species listed on Annex II of the Habitats Directive (92/43/EEC) implemented in Ireland by S.I 477 of 2011 – EC (Birds and Natural Habitats) Regulations 2011.	Atlantic salmon [1106] (*Salmo salar*). River lamprey [1099] (*Lampetra fluviatilis*). Brook lamprey [1096] (*Lampetra planeri*). Sea lamprey [1095] (*Petromyzon marinus*). White-clawed crayfish [1092] (*Austropotamobius pallipes*).
Habitats listed on Annex I of the Habitats Directive (92/43/EEC) implemented in Ireland by S.I 477 of 2011 – EC (Birds and Natural Habitats) Regulations 2011.	Turloughs [3180].
Species protected under the Wildlife Act (1976) and Wildlife Amendment (2000) Act.	White-clawed crayfish [1092] (*Austropotamobius pallipes*).
Species protected under the Fisheries (Consolidation) Act (1959).	Atlantic salmon and trout – protection of spawning areas and stocks during spawning/nursery period.
EU Regulation for recovery of eel stock[17].	European eel (*Anguilla anguilla*).

[17] Council Regulation (EC) No 1100/2007 establishing measures for the recovery of the stock of European eel

Table 11.7 Aquatic Annex II Species Present in the Dunkellin / Craugwell Rivers and Aggard Stream Showing Most Recent (2013) National Conservation Status Assessment

Common name	Species Name	Code	Range	Population	Habitat	Future prospects	Overall Conservation Status	Trend
Atlantic salmon	*Salmo salar*	1106	Favourable	Inadequate	Favourable	Inadequate	Unfavourable - Inadequate	Stable
Sea lamprey	*Petromyzon marinus* (L.)	1095	Bad	Bad	Favourable	Bad	Unfavourable - Bad	Stable
Brook lamprey	*Lampetra planeri* (Bloch).	1096	Favourable	Favourable	Favourable	Favourable	Favourable	*N/A*
River lamprey	*Lampetra fluviatilis*	1099	Favourable	Favourable	Favourable	Favourable	Favourable	*N/A*
White clawed crayfish	*Austropotamobius pallipes*	1092	Favourable	Favourable	Favourable	Inadequate	Unfavourable - Inadequate	Stable

Note that the listed species cccur within and outside of Rahasane Turlough cSAC which was designated solely for Turlough habitat (see **Table 11.8**).

Table 11.8 Qualifying Aquatic Annex I Habitats[18] of Rahasane Turlough cSAC Showing Most Recent (2008) National Conservation Status Assessments

Qualifying Habitat	Code	% Cover (approx.)	Range	Area	Structure & function	Future prospects	Overall Conservation Status
Turloughs	3180	93%	Good	Good	Poor	Poor	Poor

[18] Listed in the Habitats Directive (92/43/EEC).

11.3.7 Fish Communities

11.3.7.1 Dunkellin/Craughwell River Fishery

The fish community of Dunkellin and Craughwell Rivers includes Atlantic salmon, Brook/River Lamprey (*Lampetra* spp.), seatrout, brown trout, European eel and the likelihood of coarse fish species in the turlough drainage channel reach. There is a report of a sea lamprey (*Petromyzon marinus*) caught on camera while ascending the salmon counter just below Killeely Bridge (*pers comm*. IFI), although it's distribution in the system is unknown. Of these, salmon and all three lamprey species are listed in Annex II of the Habitats Directive. The current, national conservation status of Atlantic salmon is 'Unfavourable-Inadequate' (NPWS, 2013d). Atlantic salmon populations are presently low in Ireland compared to past decades and whilst marine survival is currently the major concern, vigilance is required to ensure protection of optimal freshwater habitat for spawning and smolt production (NPWS, 2013d). Sea lampreys are currently at 'Unfavourable-Bad' conservation status, nationally, whilst river and brook lampreys at 'Favourable' status. (NPWS, 2013 a, b, c). Sea lamprey are classified as 'Near Threatened' on the Irish freshwater fish red list (King *et al*., 2011). The single largest pressure acting on sea lampreys is that of artificial barriers to migration (NPWS, 2013c) and it is this factor that continues to limit future prospects, and hence conservation status, of the species. European eel (*Anguilla anguilla*) are "critically endangered" on the Irish freshwater fish red list (King *et al*., 2011) on account of declining national and European populations.

Particularly good juvenile salmonid nursery habitat was observed in the Craughwell River within the study area, with the possibility of some localised salmon spawning in the short gravel and cobble run (with *Ranunculus*) just upstream of the confluence with Aggard Stream. There are around 16 known redds on the Dunkellin spread over three spawning sites, one upstream of Killeely Bridge and one upstream and downstream of Dunkellin Bridge (pers comm. Mr. Sean Francis, IFI); there may also be others as yet not observed. This redd count constitutes about 10% of the ~160+ redds known within the wider Dunkellin/Craughwell catchment, the majority of which occur on the main channel upstream of Killtullagh Bridge and in the St Clerans River both upstream of the proposed development (S. Francis, pers comm.). The conservation limit for the system is 1300 to 1400 adult returning salmon. In an effort to improve the current numbers, five draft net licences which operated in the estuary were discontinued in January 2007 and angling for salmon was restricted. The river is mainly a sea-trout angling river but salmon are also taken, with the main activity in the estuary and the 600 to 700 m stretch upstream of Kilcolgan Bridge. There are several other spots for angling farther upstream, e.g. the pool area about 600 m upstream of Dunkellin Bridge (Pt 14), (IFI, pers comm.) however much of the channel is very overgrown, too torrential or shallow to be suitable over most of the study area up to Craughwell. The stretch upstream of the R446 Bridge at Craughwell is a popular angling stretch, with deeper holding areas and much more accessible banks (Pt 54-56).

While the study reach in the main is not considered a stronghold for salmon spawning, salmon parr in great numbers are observed each year within the Dunkellin River, e.g. upstream of Rinn Bridge. Juvenile salmonids were observed along most of the river reaches within the study area during the baseline survey for the EIS. However, the paucity of gravels and finer substrate combined with very heavy shading along large stretches of channel may well mean that productivity within the study area is lower than it could be.

Spawning habitat for lamprey was good in the Craughwell River in the vicinity of the rail bridge and the old masonry bridge, but lamprey nursery habitat was generally lacking there. Lower gradient sections of the Dunkellin, however, between the Aggard Stream confluence and the Rahasane Turlough outlet towards Rinn Bridge had considerable potential habitat for lamprey ammocoetes. If sea lamprey normally spawns in the system then some of the salmon spawning areas may also be utilised by this species. If those upstream of Killeely Bridge and Dunkellin Bridge are utilised, then the nearby ponded areas (Pt 27 and Pt 14) may be used by ammocoetes. If the species spawns in the stretch between Craughwell and Rahasane Turlough, then the drainage canal within the turlough might be an ideal nursery area for ammocoetes.

A large number of eels were observed on the Dunkellin River during crayfish survey work, particularly between Killeely Beg and Dunkellin Bridges, and also up as far as Rinn Bridge. Given the absence of eel barriers and the presence of suitable physical habitat, it is reasonable to assume that eels are common and widespread in the Dunkellin/Craughwell system.

11.3.7.2 Aggard Stream Fishery

Reaches 1 and 4 of the Aggard Stream are the important stretches for both trout nursery and potential spawning because of their coarse substrate and swifter flows. These reaches would also be suitable for lamprey spawning, more suitably river and brook lampreys. Not all of the reaches are optimal for salmonids due to heavy shade in particular, and uniformity of in-channel substrate and flow is several places. Also, there are few pools within either reach. Overall, they don't appear to be suitable for in-channel cleaning and maintenance which would probably be best confined to scrub clearance from either bank.

Reaches 2 and 3 were deeper, wider and generally more sluggish in flow than 1 and 4. They had considerable build-up of marginal and in-channel silty-sand, held together by rooted submerged macrophytes. There were pockets and occasionally more extensive deposits of gravel, so that they may have some value as trout nursery habitat. More likely however, they would be holding areas for older trout (1+ and 2+). The habitat would be suitable for lamprey ammocoetes, although it isn't known at what densities. Both reaches would be amenable to the removal of deep silt deposits and associated rooted macrophytes, preferably avoiding areas of gravel and coarse substrate where feasible.

Reaches 5 and 6 were very sluggish plant-choked channels, with stiff clay or silty sand substrates. They were unlikely to hold even low densities of trout or lamprey ammocoetes, especially Stretch 6. The stretches may occasionally act as a holding area for older trout. Both these channels, including the easterly branch of the main Aggard, can be described as of low ecological value and they can dry out in dry summers.

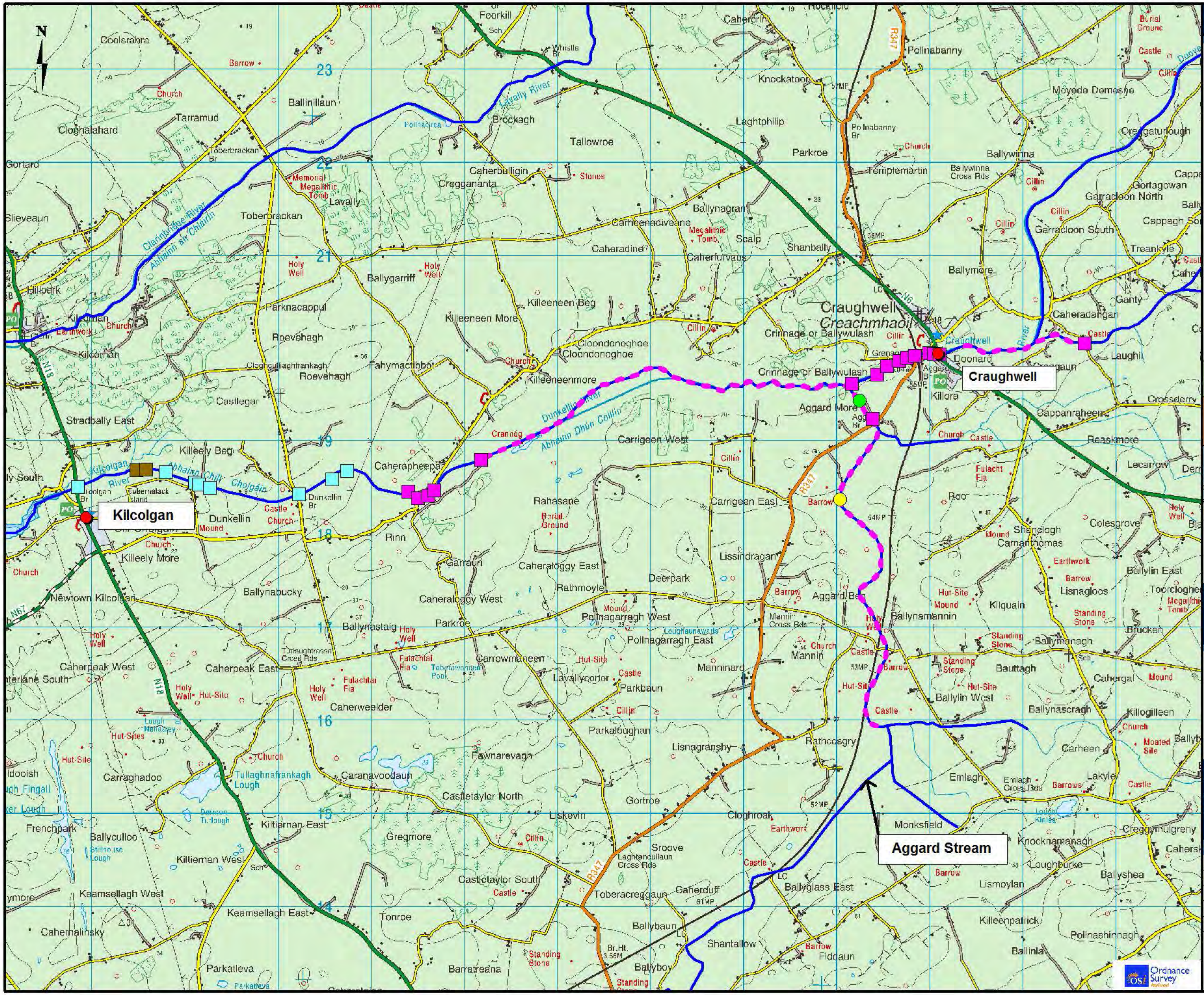
Consultation with the IFI confirmed that, based on electrofishing surveys in the past, they know that Aggard has a has a high density of brown trout from the confluence with the Craughwell River upstream to where the channels branch (Plate 26) and that salmon parr are also present in lower densities. While, there was no record of lamprey being caught, these would not have been the target species at the time (Mr. Sean Francis, *pers.comm*.). There was suitable lamprey spawning habitat on the Aggard Stream in areas where trout would spawn, for example, and there were also suitable ammocoete burrowing sites in reaches of more sluggish flow.

11.3.8 White-clawed Crayfish

Figure 11.2 shows locations where white clawed crayfish were recorded on Dunkellin River and Craughwell River during field surveys conducted in 2011 and 2012 for this assessment. **Figure 11.2** also illustrates the probable distribution of crayfish throughout the Rahasane Turlough drainage channel and on the Aggard Stream, inferred on the basis of presence of suitable crayfish habitat. Refer to **Appendix C.6** for information on evaluation criteria and survey echniques employed.

White-clawed crayfish were recorded on the Dunkellin River from a location approximately 500 m upstream of Dunkellin Bridge all the way upstream to, and within, the Rahasane Turlough drainage channel. They were not found on the lower Dunkellin, but spraints containing crayfish remains were recorded about 250 m upstream of the Kilcolgan N18 Bridge. In contrast, white-clawed crayfish were widely recorded on the Craughwell River during these surveys, with evidence of 'High' population abundance in the 100 m stretch beneath and downstream of the R446 and masonry arch bridges in Craughwell.

Crayfish were recorded on the lower Aggard Stream just downstream of the R347, Aggard Bridge, during survey work for this project in September 2012. Ecofact (2008) also recorded crayfish on the lower Aggard, a short distance upstream of Dunkellin River confluence. The IFI regularly capture crayfish on the Aggard when conducting electrofishing surveys (Mr. Sean Francis, *pers.comm*.) although survey locations were not specified. Aquatic habitat was considered optimal for crayfish along most of the stretch between Aggard Bridge and the Craughwell/Dunkellin confluence. Further to that, reaches 1 and 4 (See **Section 11.3.4**) provide the most optimal crayfish habitat on the Aggard. Reaches 2 and 3 of the Aggard were less suitable owing to the more sluggish flows, but may support



Legend

- Confirmed White-clawed Crayfish Locations
- Probable but Unconfirmed White-clawed Crayfish Locations
- No Crayfish Recorded
- Otter Spraint With Crayfish Remains
- O' Connor (2008) Record (Approx. Location)
- IFI Records (pers. comm.) (Approx. Location)

Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Crayfish - Confirmed Records and Probable Distribution Based on Habitat Suitability

Figure 11.2

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some crayfish, particularly juveniles within macrophyte stands. Stretches 5 and 6 were least suitable for crayfish, however, presence cannot be entirely ruled out in any of the reaches described.

Even though the Craughwell/Dunkellin crayfish populations occur, primarily, outside of the cSAC, and are not a qualifying interest of Rahasane Turlough cSAC, they are significant populations of this Annex II species and are protected at national level under the Wildlife Act (1976) and Wildlife Amendment Act (2000). The current national conservation status of white clawed crayfish is "Unfavourable – Inadequate". The species range, habitat quality and population are favourable, but there is an ongoing threat from disease (crayfish plague) and invasive crayfish species (NPWS, 2013e)

The 1st riffle (c. 500 m) upstream of Dunkellin Bridge appears to represent a lower limit of detectable crayfish distribution in the system. It is possible that crayfish were present downstream of that point, but that they utilise inaccessible refuges by day. There was, in fact, an abundance of optimal bankside habitat on the Dunkellin downstream of that point in the form of unmortared-rock armour reinforcement and stone cut banks with deep cracks and crevices – but these potential refuges were impossible to manually search. Otter spraint containing crayfish remains were observed on the lower river stretches between Kilcolgan N18 and Kileely Beg Bridges, suggesting that crayfish were present there. However, otters display large home ranges (Ó Néill *et al*., 2009) depending on factors such as sex and distribution of conspecifics, therefore crayfish remains in spraint near Kilcolgan may have been the result of upstream feeding forays (only 2.5 km to nearest known crayfish presence). Crayfish may be absent from parts, or all of, the lower stretches with possible explanations being: (i) sub-optimal habitat availability during low flows, or (ii) periods of drying out on parts of the lower channel. It has been suggested that parts of the lower Dunkellin River dry out for a period each year, i.e. "*Despite the construction of the artificial channel for the Dunkellin River to the sea, the lower courses of the river sink underground some distance from the sea for approximately 1.5 months of the year*" (p.10, GCC, 2008).

The smaller Dunkellin Turlough, upstream of Dunkellin Bridge was marked on a historical, pre-drainage map (from Coxon & Drew, 1983, cited GSI, 2004) and there may be an active swallowhole in that vicinity. The apparent patchy distribution of crayfish on the lower Dunkellin (or absence in the reach from 500 m upstream of Dunkellin Bridge down to Galway Bay) may be as a result of intermittent flows; their distribution governed by the permanence of water levels influenced by rainfall and the presence of ground water springs and sinks along the Dunkellin channel between Rahasane Turlough and the sea.

11.3.8.1 Turloughs

There are two turloughs in the study area – Rahasane, which is protected within Ireland's Natura 2000 network and Dunkellin, about which little is known. Rahasane Turlough SAC (000322). Is designated for the Annex I habitat 3180, Turloughs. The conservation objective for the SAC is to maintain / restore this Annex I habitat to 'favourable' conservation condition. The present conservation status of Annex I habitat "Turloughs" [3180] in Ireland is 'Poor' and the main threats are listed as nutrient enrichment and inappropriate grazing regimes (NPWS, 2008).

Rahasane Turlough is Ireland's largest and is one of only two remaining large turloughs that continues to function naturally. It generally begins to flood in autumn, remaining flooded until late spring (Young, 1976). It periodically supports large numbers of birds (refer to Chapter 10 of EIS), for which it is a designated SPA (Site code: 004089) and is the most important wintering waterfowl site in the country.

Turlough ecology varies in relation to hydrology, water chemistry and in relation to land use practices within the basin, on adjoining slopes and within the ground water catchment (Mayes, 2008). In the case of a partially surface water fed turlough like Rahasane surface water quality is also a factor. Although of international importance, Rahasane Turlough has received relatively little study in terms of aquatic ecology. Its conservation importance and subsequent candidacy for SAC and SPA designation, was largely based on botanical (e.g., Goodwillie, 1992) and avian ecological values (see Sheehy Skeffington *et al*., 2006). The following **Section 11.3.9.1** to **Section 11.3.9.3** draw together available information on aspects of Rahasane Turlough's aquatic communities based on observation, consultation and literature review. Though by no means a complete account, it can be seen that in addition to ecologically significant bird and plant communities, Rahasane Turlough's invertebrate community also holds considerable conservation value.

11.3.8.2 Aquatic Vegetation

Rahasane Turlough has been described in a previous report (Ecofact, 2008) in relation to the proposed new Craughwell wastewater treatment plant (WWTP). In addition to aquatic species we observed during fieldwork in 2011 (see **Section 11.3.2.6**), other fully aquatic plant species of Rahasane Turlough were listed in Ecofact (2008) as including Fan-leaved Water Crowfoot (*Ranunculus circinatus*), pondweeds (*Potamogeton* spp.), Fat Duckweed (*Lemna gibba*), Whorled Water-milfoil (*Myriophyllum verticillatum*), Needle Spike-rush (*Eleocharis acicularis*), Waterplantain (*Alisma plantago-aquatica),* Amphibious *Bistort (Polygonum amphibium)* and Fools Watercress *(Apium nodiflorum)* (Ecofact, 2008). Goodwillie (1992) listed *Ranunculus circinatus, Potamogeton pusillus* and *Lemna gibba* as rare plant species present in the turlough and the NPWS site synopsis listed the Red Data Book species, Northern yellow-cress (*Rorippa islandica*) amongst the semi-aquatic plant community. It was reported by Galway County Council (GCC, 2008) that there are two fully aquatic plant communities at Rahasane Turlough covering 15 to 20% of the turlough area, these being: (1) Dunkellin River channel dominated by pondweeds (*Potamogeton* spp.) and Waterplantain (*Alisma plantago-aquatica*)*;* (2) Permanent standing water with an abundant stonewort (*Chara* spp.) community. A semi-permanent standing water community, as well as 'frequently' and 'occasionally' flooded plant communities make up the remaining 80 to 85% of the turlough area (GCC, 2008).

11.3.8.3 Invertebrates

Crayfish

Crayfish were found in the turlough drainage channel at the western end and were also abundant in the Craughwell River at the eastern end of the turlough (see **Section 11.3.4**). The aquatic vegetation of the Rahasane Turlough drainage channel is ideal habitat for juvenile crayfish, providing shelter and an abundant macroinvertebrate food source. Given the presence of suitable habitat throughout the turlough drainage channel (Dunkellin River) it is reasonable to assume that crayfish occur in the all the way through the Rahasane Turlough SAC.

Waterbeetles

A number of specialists have sampled the waterbeetle community at Rahasane Turlough, e.g., Bilton (1989), O'Connor (2001), Waldron (2003/ 2004). **Appendix C.5** provides details of waterbeetle records from these sources. Using Biltons 1989 records, Foster *et al.,* (1992) found that Rahasane Turlough fell within Community Type Group F of their classification system. Group F is generally described as "turloughs and more permanent, large, shallow, water bodies on base-rich substrata", with characteristic species including the "moss dweller" community of the turloughs (Foster *et al*., 1992). An MQS of 3 was calculated for the Rahasane waterbeetle community, which was the poorest out of 38 Group F sites in terms of quality rankings.

Using Waldron's records of 2003 and 2004, the MQS for Rahasane was 7 and 10, respectively (MQS = 11 for the two datasets combined). Given that the median MQS was 8 for the 38 Group F Community Type sites (Foster *et al*., 1992), Waldron's records, therefore, rank Rahasane Turlough as above average in comparison to other Group F sites. Waldron collected a number of species characteristic of turloughs including the"moss dweller" species, *Graptodytes bilineatus*, listed as Near Threatened on the Irish Waterbeetle Red List (Foster *et al*., 2009). *G. bilineatus*, is likely to be vulnerable to disturbance and sensitive to alterations in flooding (Sheehy Skeffington *et al*., 2006). Other species characteristic to turloughs were *Agabus nebulosus, Hygrotus quinquelineatus, Hygrotus impressopunctatus.* Each of these species are considered as Least Concern in the Irish Red List (Foster *et al*., 2009), although *H. quinquelineatus* is "nationally notable B" in Great Britain (Foster *et al*., 1992). O'Connor's records of 2001/2002 produced an MQS of 6, ranking Rahasane Turlough as below average compared to other Group F sites (Foster *et al*., 1992). Again, the characteristic turlough species *Agabus nebulosus, Hygrotus quinquelineatus, Hygrotus impressopunctatus* were recorded.

In summary, though Rahasane Turlough is occupied by commonly occurring species that are found as part of other waterbeetle community types, it does support a number of characteristic turlough species, including the "Near Threatened" *G. bilineatus*.

Waterbugs

During sampling undertaken in 2000, Rahasane Turlough had a diverse coroxid community comprised of common species indicative of temporary and permanent waters (Tobin & McCarthy, 2004).

Fairy Shrimp

The freshwater fairy shrimp, *Tanymastix stagnalis,* was first recorded in the smaller, southeastern basin at Rahasane in 1974 (Young, 1976) and has since been found at other locations (Ecofact, 2008). It is the only member of the order Anostraca in Ireland, and is listed as being a slow moving invertebrate. It requires seasonal or temporary pools, such as turloughs, in order to escape predation (Porst, 2006). It is well adapted to exploit temporarily flooded environments, with the ability to hatch, grow and produce eggs within a very short time-frame, e.g. < 15 days in August 1974 (Young, 1976).

Terrestrial Beetles of Water Dependent Habitat

Terrestrial invertebrate communities of turloughs are also primarily governed by the flooding regime of a particular turlough (e.g., Regan, 2005; Moran *et al*., 2012). Regan (2005) sampled the terrestrial carabid and staphlinid beetle communities of Rahasane Turlough, which ranked it 8th out of 11 turloughs in terms of conservation importance based on the carabid community. Found at Rahasane during that study were the carabid *Bembidion bipunctatum*, a British Red Data Book nationally scarce species (Hyman & Parsons, 1992), and the silphid beetle *Thanatophilus dispar* (superfamily: Staphylinoidea), a Red Data Book Endangered species (RDB1) in Britain.

Fish

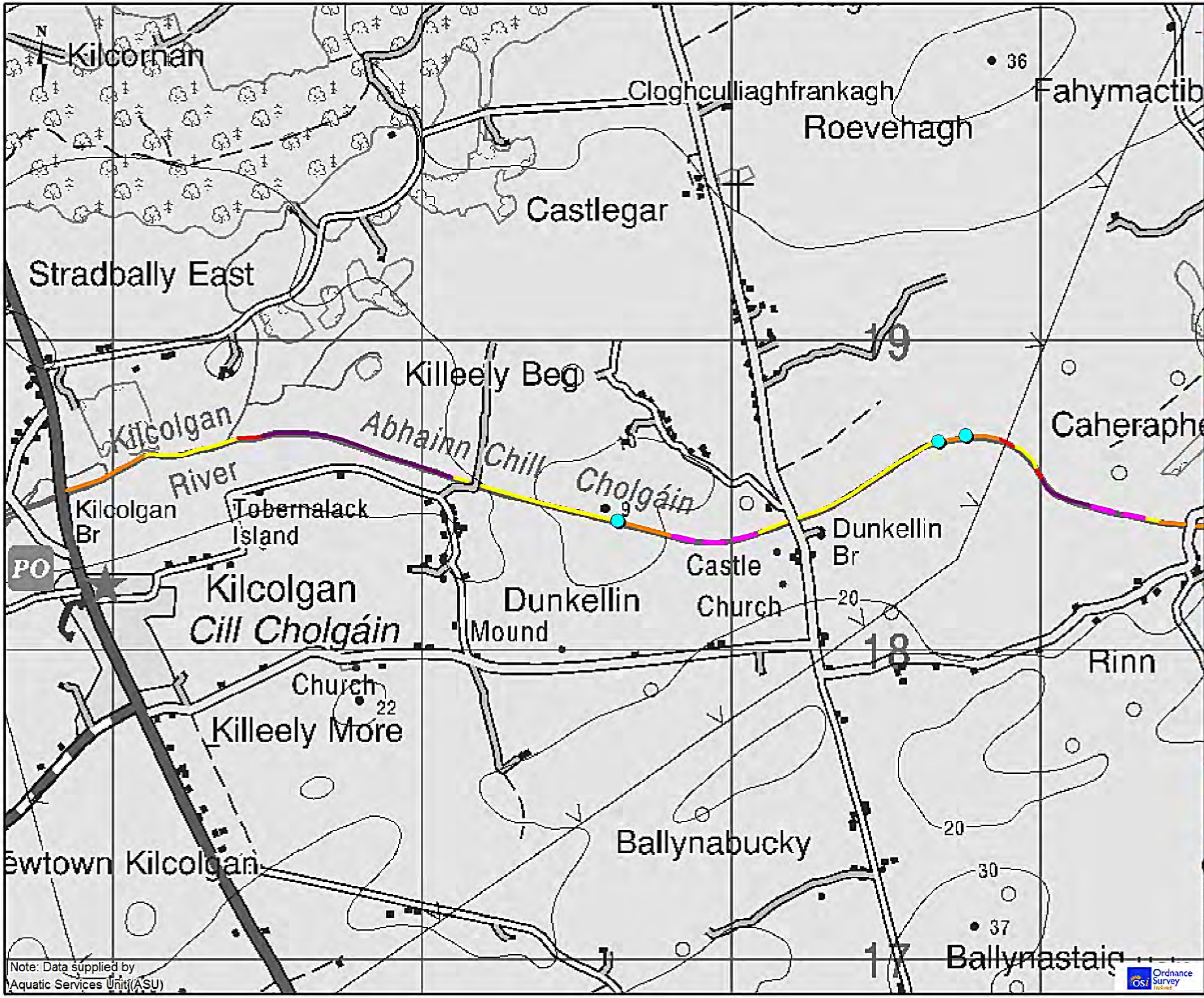
According to the IFI the channel holds pike and, most likely, some larger trout also reside in the channel. It is the conduit for juvenile salmonids (salmon and trout) - the progeny of the adults which spawn in the upper reaches of the Craughwell River and its tributaries - that migrate downstream to the Dunkellin River. It also acts as a conduit for the upward migrating adult salmon and sea trout which spawn in the headwaters.

11.3.8.4 Ecological Evaluation of Aquatic Resources

Figure 11.3 to **Figure 11.6** show the locations of each of the broad habitat types on the Dunkellin / Craughwell Rivers and on the Aggard Stream. An ecological valuation of each habitat type was undertaken in accordance with criteria shown in **Appendix C.1**. Habitat evaluations are summarised in **Table 11.9** for the Dunkellin and Craughwell Rivers and **Table 11.10** for the Aggard Stream.

The following areas were identified as being of particular ecological and/or conservation value:

- **Rahasane Turlough** - International Importance: SAC/SPA;
- **Dunkellin / Craughwell River**: High local importance – Habitat of Annex II species (Atlantic salmon, lampreys, white clawed crayfish) and trout; and
- **Aggard Stream** between Dunkellin River and Monksfield: High, local importance – Habitat of Annex II protected species (lampreys, white clawed crayfish) and trout.



Legend

- Glide
- Run
- Riffle / Cascade
- Step weir/pool/run/glide
- Pool
- Step weir/run/pool sequence (inferred - not surveyed)

Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Habitat Types - Kilcolgan to Upstream of Dunkellin Bridge

Figure 11.3

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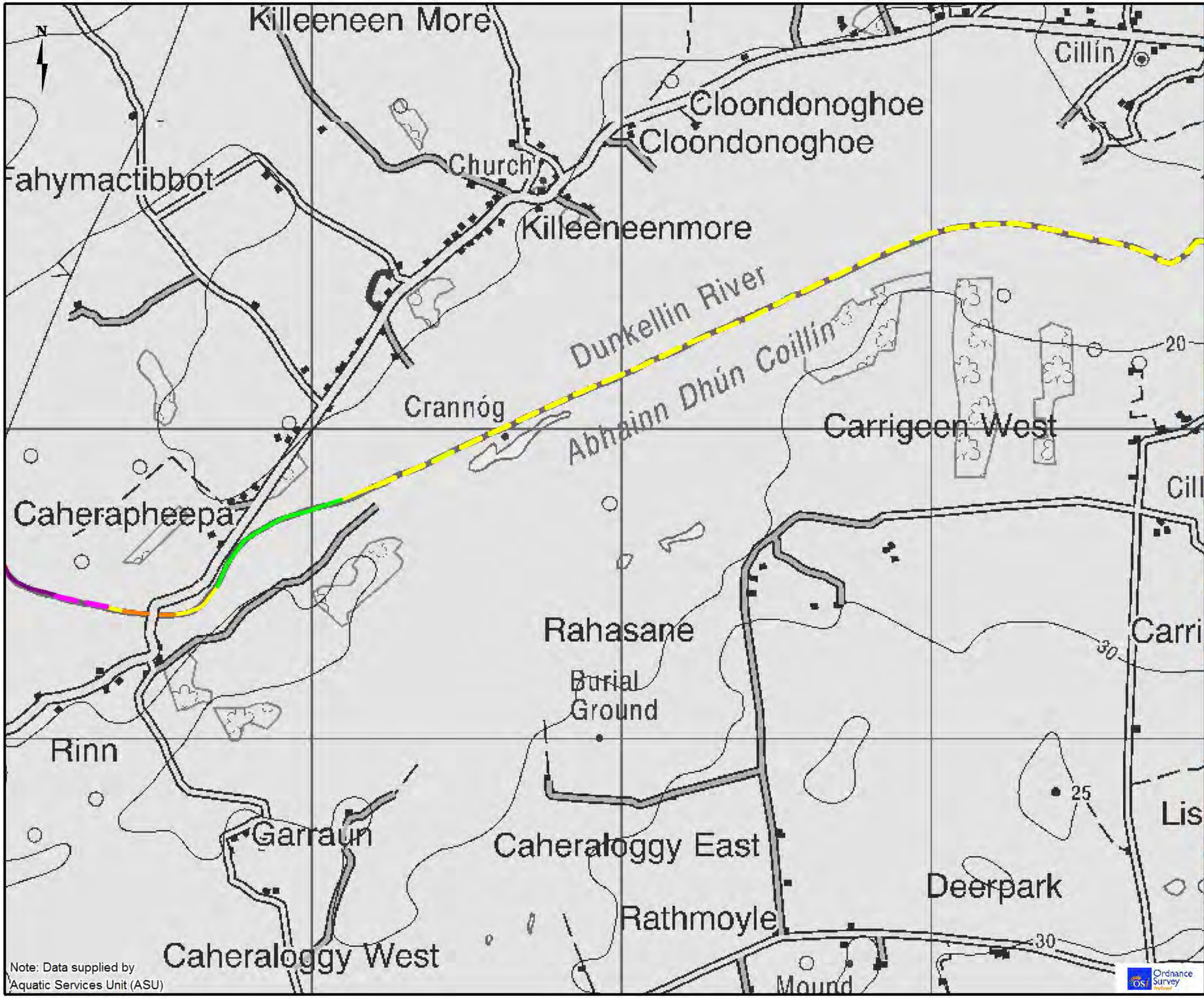

Legend

- Glide
- Run
- Step weir/pool/run/glide
- Glide / step weir
- Glide (Inferred - not surveyed)
- Step weir/run/pool sequen (inferred - not surveyed)

Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Habitat Types - Upstream of Dunkellin Bridge to Rahasane Turlough

Figure 11.4

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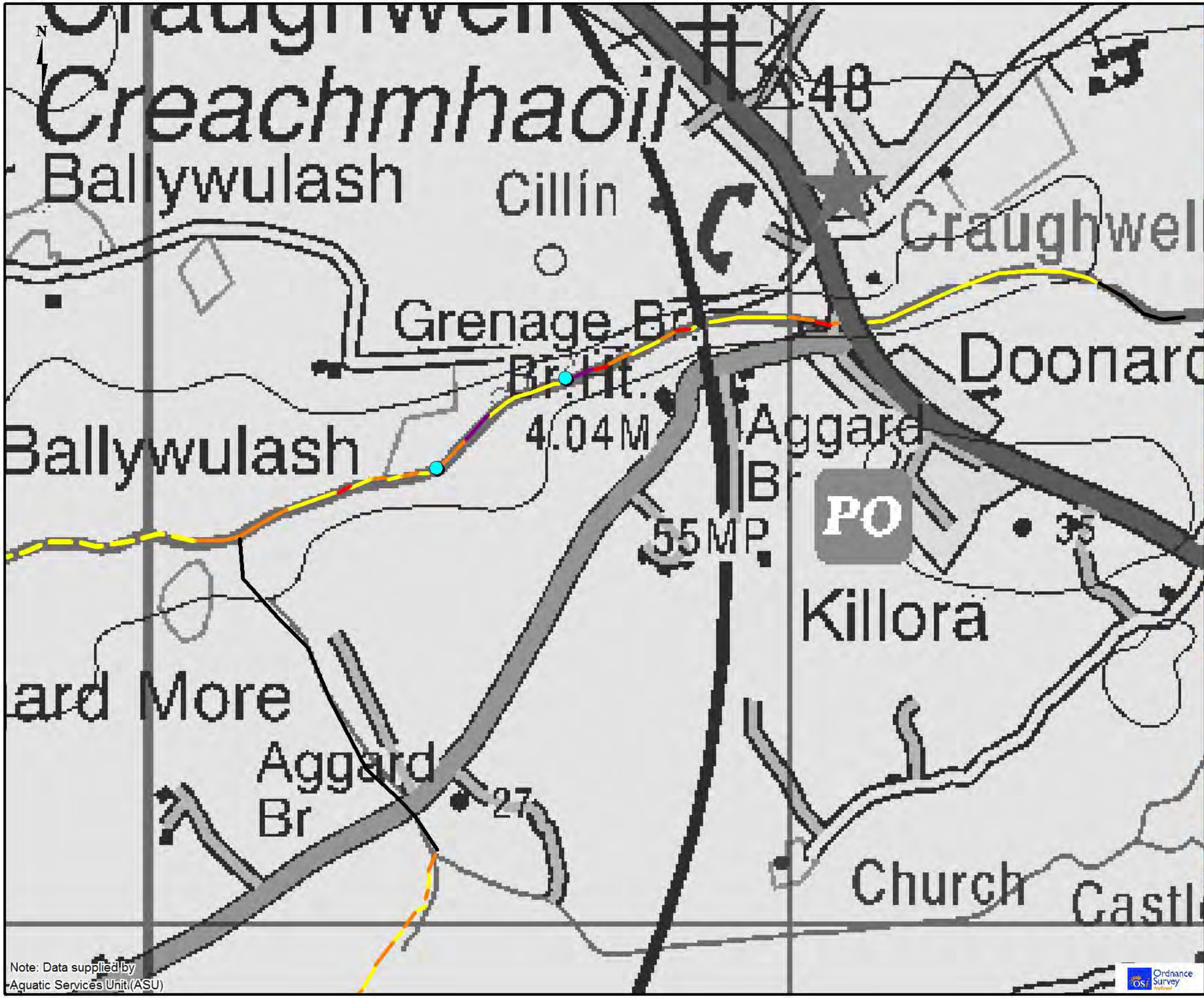

Legend

- Glide
- Run
- Riffle / Cascade
- Step weir/pool/run/glide
- Riffle (Run/Glide)
- Pool
- Glide
- (Inferred - not surveyed)

Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Habitat Types - Rahasane Turlough to Craughwell

Figure 11.5

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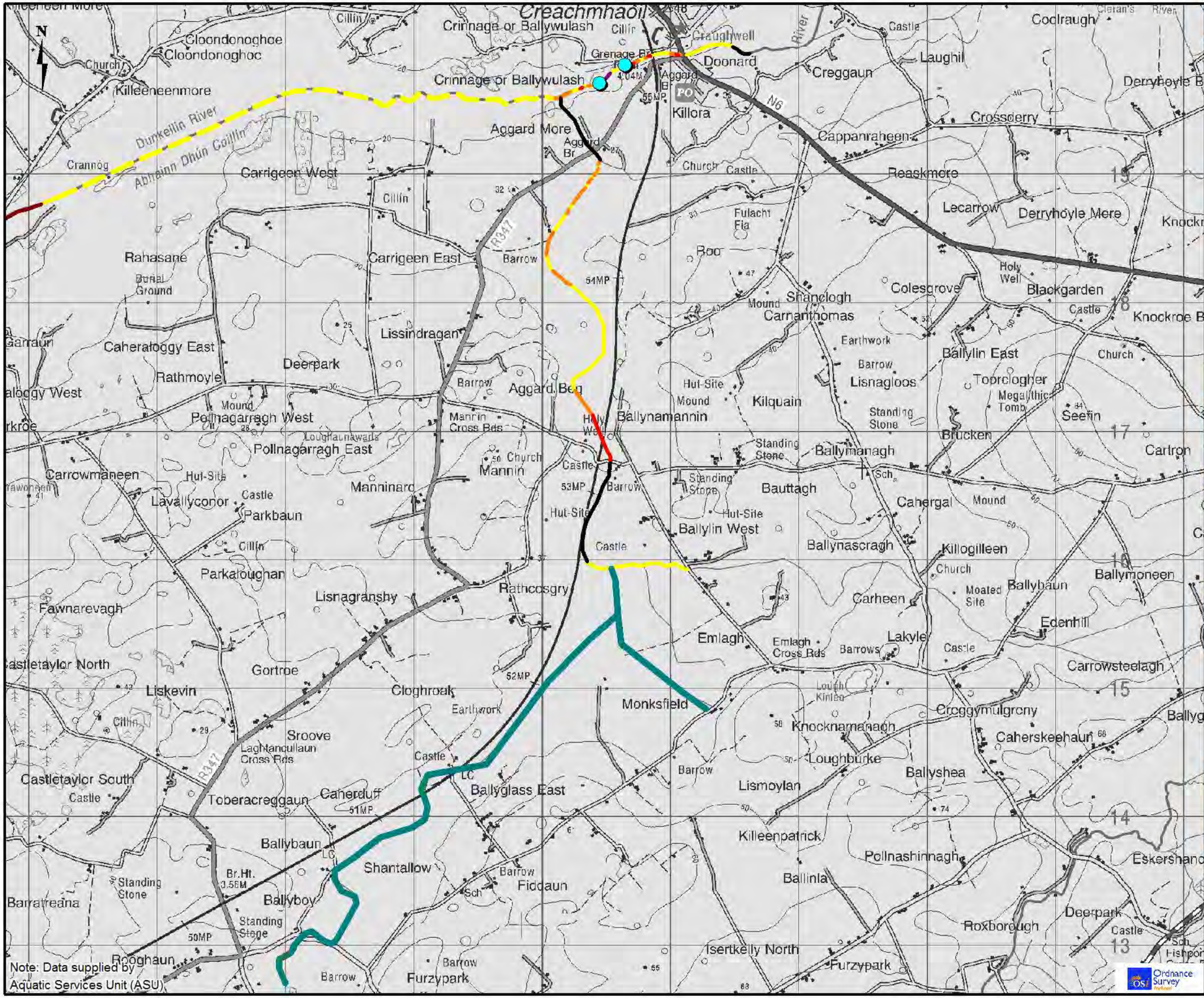

Legend

Riffle (Run/Glide)

Glide

Run

Riffle / Cascade

Drainage Ditches

Client

Galway County Council

Project

Dunkellin River and Aggard Stream Flood Relief Scheme

Title

Habitat Types - Aggard Stream

Figure 11.6

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Table 11.9 Dunkellin / Craughwell River Habitat Types Evaluation

Habitat Type	Aquatic habitat type description	Fisheries values	Relevant aquatic protected habitats and species	Evaluation	Class.
Glide	Slow flowing glide over cobble and/or bedrock in the main (dearth of finer materials). General absence of rooted aquatic vegetation except in limited places where the channel is wider and some localised deposition has occurred (marginal in the main).	- Holding areas for larger trout and inward migrating salmon; - Migration routes of adult salmon; - Lamprey ammocoetes utilising marginal soft sediments (likely to be very limited, particularly on the Dunkellin downstream of Rahasane Turlough owing to general lack of deposition of fine material).	Annex II species: • Atlantic Salmon • Brook/river lampreys • Sea lamprey possible • White-clawed crayfish (upstream of 1st riffle above Dunkellin Bridge) Trout & European eel	High local importance.	D
Run	Similar to glide, but with higher turbulence and velocity, slightly shallower than glides.	-Generally good nursery/holding areas for juvenile salmonids.	Annex II species: • Atlantic Salmon • White-clawed crayfish (upstream of 1st riffle above Dunkellin Bridge). Trout & European eel.	High local importance	D
Riffle / Cascade	Shallow, fast flowing water over various combinations of boulder, cobble and gravel.	- Possibility of patchy spawning for salmon and lamprey; - Nursery area for salmonids; - Migration routes of adult salmon	Annex II species: • Atlantic Salmon • Brook/river lampreys • Sea lamprey possible • White-clawed crayfish (upstream of 1st riffle above Dunkellin Bridge) Trout & European eel	High local importance	D
Run/ (Riffle / Run)	Less dynamic and generally slightly deeper than Riffle/ Cascade.	- Nursery and holding area for juvenile salmonids. - Patches of salmon spawning. - Migration routes of adult salmon.	Annex II species: • Atlantic Salmon • Brook/river lampreys • Sea lamprey possible • White-clawed crayfish (upstream of 1st riffle above Dunkellin Bridge) Trout & European eel	High local importance	D
Pools and Ponded areas	Deeper areas (up to 1m). Pools generally with bedrock/cobble substrates. Ponded areas have stands of marginal aquatic vegetation and finer sediments where deposition occurs.	- Holding areas for older fish; - Migration routes of adult salmon; - Lamprey ammocoetes utilising marginal soft sediments.	Annex II species: • Atlantic Salmon • Brook/river lampreys • Sea lamprey possible • White-clawed crayfish (upstream of 1st riffle above Dunkellin Bridge) Trout & European eel	High local importance	D

Habitat Type	Aquatic habitat type description	Fisheries values	Relevant aquatic protected habitats and species	Evaluation	Class.
Step weir / pool/run/glide.	Most in evidence on the artificial Dunkellin channel between Rahasane and Kilcolgan. Combination of the above habitat types but with obvious rock-cut steps to the channel morphology. Distance between steps determined by gradient with with more frequent steps on steeper gradients. Diminutive pools only.	- Nursery and holding area for juvenile salmonids; - Migration routes of adult salmon	<u>Annex II species:</u> • Atlantic Salmon • Very low lamprey densities likely • White-clawed crayfish (upstream of 1st riffle above Dunkellin Bridge) Trout & European eel	High local importance	D
Rahasane Turlough Drainage Channel	Low gradient, slow flowing deep glide with submerged and emergent macrophytes.	- Migration routes of adult salmon; - Holding area for pike and trout; - Lamprey ammocoetes utilising soft sediments.	<u>Annex II species:</u> • Atlantic Salmon • Lampreys • White-clawed crayfish <u>Annex I Habitat:</u> • 3180 - Turloughs Trout & European eel	International Importance (Rahasane Turlough SAC)	A

Table 11.10 Aggard Stream Habitat Type Evaluation

Habitat Type	Aquatic habitat type description	Fisheries values	Relevant aquatic protected habitats and species	Evaluation	Class.
Glide	Slow flowing glide, deeper water with sandy/silty substrates. Patchy distribution of marginal emergents and some submerged macrophyte beds. Patches of bare, stiff clay substrates where overlying substrates have been removed by previous drainage or scour.	- Holding areas for larger trout; - Lamprey ammocoetes utilising marginal soft sediments.	Annex II species: • Atlantic Salmon (lower reaches) • Brook/river lampreys • Sea lamprey possible • White-clawed crayfish Trout & European eel.	High local importance.	D
Run	Similar to glide, but with higher turbulence and velocity, slightly shallower than glides. Patches of gravel and extensive *Ranunculus* beds that may form braided channel at low flow. .	-Generally good nursery/holding areas for juvenile salmonids; -Lamprey ammocoetes in patches of silt deposition.	Annex II species: • Atlantic Salmon (lower reaches) • Brook/river lampreys • Sea lamprey possible • White-clawed crayfish Trout & European eel.	High local importance.	D
Riffle	Shallow, fast flowing water over various combinations of small cobble and gravel. Patches of *Ranunculus*.	-Generally good nursery areas for juvenile salmonids; - Patches of salmonid and lamprey spawning habitat.	Annex II species: • Atlantic Salmon (lower reaches) • Brook/river lampreys • Sea lamprey possible • White-clawed crayfish Trout & European eel.	High local importance.	D
Run/ (Riffle / Run)	Less dynamic and generally slightly deeper than riffle, sometimes with heavy macrophyte cover. Substrate similar to riffle with some finer material.	- Nursery and holding area for juvenile salmonids; - Patches of salmonid and lamprey spawning habitat.	Annex II species: • Atlantic Salmon (lower reaches) • Brook/river lampreys • Sea lamprey possible • White-clawed crayfish Trout & European eel.	High local importance.	D
Drainage ditches	Clay and silty sand bottomed drainage ditches with sluggish flows and heavy macrophyte cover. Periodic drying out reported.	No significant fisheries values.	N/A – but presence of lamprey ammocoetes and European eel cannot be entirely ruled out.	Low, local importance.	E

11.4 POTENTIAL IMPACTS

11.4.1 Characteristics of the Proposal

Table 11.3 outlines proposed measures as they relate to sections of river channel and structures. The project description is contained in **Section 6** of this EIS as are the specific methodologies with respect to channel widening, channel deepening and works at bridges. Further, detailed information is contained in **Appendix A** to this EIS.

The proposed measures have the potential for direct and/or indirect impacts on aquatic ecology of the Craughwell and Dunkellin Rivers, Rahasane Turlough and the Aggard Stream. Even though no works are proposed within Rahasane Turlough SAC, the potential for indirect impacts, owing to works upstream and downstream, are taken into consideration. **Section 11.4.2** outlines the general types of impacts that may arise during the construction phase of the scheme. **Section 11.4.3** to **Section 11.4.10** provide details of specific impacts in relation to measures along different river reaches, and rank the quality and significance of general and specific impacts in those reaches. Impact quality, significance, duration and type follows definitions set out in EPA (2002). Potential impacts, mitigations and residual impacts are summarised in **Table 11.11.**

11.4.2 General Impacts

11.4.2.1 Release of sediment

The nature of the project means that there is a potential for the release of sediment during the construction phase. The potential for sediment loss would primarily arise as a result of earth movement and excavation associated with channel widening and channel regrading (deepening). Such an effect would be more likely during very heavy rain giving to slumping of the bank edges or run-off of silt-laden water. Sediment loss to watercourses may also result from other instream works as part of the scheme including bridge works and channel maintenance/culvert replacement on the Aggard Stream. Sediment loss can give rise to increased bottom sedimentation, which, in turn, can adversely impact macroinvertebrates and aquatic habitat quality. Elevated suspended solids levels within the water column can damage the gills of salmonid fish, white-clawed crayfish and benthic macroinvertebrates and can smother fish spawning areas when deposited. The habitat of the Dunkellin River below Rahasane Turlough is such that juvenile salmon and trout will be present in varying densities depending on specific habitat type. Riffles, runs and shallow glides are likely to be important nursery areas for salmonids with some pockets of localised spawning present, whist pools and deeper glides will hold older fish. Juvenile fish are likely to be more susceptible to gill damage than older fish as a result of temporary increases in suspended solids. Lamprey ammocoetes would not be expected to be adversely impacted by sediment release as a result of works since they inhabit areas of silt deposition during their nursery stage. The magnitude and severity of this impact is highlighted in relation to proposed measures at different locations in **Section 11.4.3** to **Section 11.4.10** below.

11.4.2.2 Loss of cement and hydrocarbons

The nature of the project means that there is a potential for the loss of cement or hydrocarbons such as diesel and hydraulic fluids during the construction phase. Bulk liquid concrete will be used to construct new bridge bank seat abutments (Killeely Beg) and underpin bridge structures (Craughwell River) and this gives rise to the possibility that spills could occur and reach the river. Cement is highly alkaline and can give rise to very serious fish kills with similar effects on invertebrates, including white-clawed crayfish. Wash off from poorly cured cement can also be highly alkaline and potentially dangerous to fish. Careful supervision of cement handling, curing times, and general good engineering practice can greatly reduce the risk from concrete-related impacts so that the likelihood of impacts is best described as low. Hydrocarbon spills from poorly secured or non-bunded fuel storage areas, leaks from vehicles or plant or spills during re-fuelling can all give rise to the escape of hydrocarbons from construction sites to water courses. These spills can give rise to tainting of fish or, if large enough, fish kills and invertebrate kills. Just like cement, the likelihood of their occurrence in a well-equipped, maintained and managed construction site is low.

11.4.2.3 Timing of works

Direct instream works such as channel deepening (Craughwell) and channel maintenance (Aggard), or large scale out of stream works with the potential for excessive sediment wash out (such as channel widening on lower Dunkellin River) have the greatest potential for negative impacts during spawning / breeding and early nursery periods for aquatic protected species in the study area. No instream or potentially significantly damaging out of river works should occur during restricted periods (see **Table 11.11**) for relevant species in relation to individual measures.

11.4.3 Channel Widening: Dunkellin River

11.4.3.1 Channel Widening from Kilcolgan Bridge (N18) to Killeely Bridge – Construction Phase

This stretch of the Dunkellin River comprises three broad habitat types, a glide and glide/pool stretch at the downstream half with heavy submerged macrophyte cover in places and a shallow stepped section covering most of the upstream half comprising low stepped weirs leading in to short riffle/runs followed by more extended glide – glide/run sequences, with generally coarse cobble and small cobble substrate and moderate amounts of attached bryophytes and algae. Both of these long sections are separated by a short torrential section.

The two-stage channel which will be constructed along the left bank has the potential to generate suspended solids washout to the Dunkellin River during periods of heavy rainfall. This may cause siltation in the main channel, impacting plants, invertebrates and fish. The site is not known to contain spawning habitat, so there is only a very low risk that any such site will be impacted. The works are scheduled for May to July. Overall the potential impact on this stretch is a **temporary moderate negative**, depending on the levels of solids washout and standard of construction site management which will be addressed by standard mitigation measures (see **Section 11.5.1**).

11.4.3.2 Channel Widening from Killeely Bridge to Dunkellin Bridge – Construction Phase

This stretch of river comprises a lower moderate to slow flow half with glides and pools and an upper half with steeper average gradients with step weir, pool, run, glide/run sequences. The downstream half has some emergent macrophytes marginally and toward the upper end a few salmon redds, another small cluster of salmon reds are reported about 50 m downstream of Dunkellin Bridge.

The two-stage channel which will be constructed along the left bank has the potential to generate suspended solids washout to the Dunkellin River during periods of heavy rainfall. This may cause siltation in the main channel, impacting plants, invertebrates and fish. The presence of a small number of known salmon redds raises the sensitivity of the site somewhat. The works are scheduled for May to July, which observes fisheries restrictions. Overall the potential impact on this stretch is a **temporary moderate negative**, although the presence of spawning habitat increases the sensitivity. Potential impact ultimately depends on the levels of solids washout and standard of construction site management which will be addressed by standard mitigation measures (see **Section 11.5.1**).

11.4.3.3 Channel Widening from Dunkellin Bridge to Rinn Bridge - Construction Phase

Similar to the previous stretch, the lower half of this stretch starts with a long glide, cobble bedded for most of its length but terminating at the upstream end with more silted substrate and patch heavy growths of emergent aquatic vegetation. The upstream half, which will only be widened in the final 50m downstream of Rinn Bridge, comprises a shallow step weir, riffle/run/glide sequence of generally steeper gradient than the previous such sequence. Between these two reaches a short stretch of coarse gravel is used by salmon for constructing a small number of redds, but this area is not directly subjected to channel widening.

The two-stage channel which will be constructed along the left bank for the first 175 m upstream of Dunkellin Bridge and the last 50 m downstream of Rinn Bridge has the potential to generate suspended solids washout to the Dunkellin River during periods of heavy rainfall. This may cause siltation in the main channel, impacting plants, invertebrates and fish further downstream. The presence of a small number of known salmon redds and a moderately high white-clawed crayfish population downstream of Rinn Bridge raises the sensitivity of the reach. Overall the potential impact on this stretch is a **temporary moderate negative**, although the presence of spawning habitat and crayfish increases the sensitivity. Potential impact ultimately depends on the levels of solids washout and the standard of construction site management which will be addressed by standard mitigation measures (see **Section 11.5.1).**

11.4.3.4 Channel Widening from Rinn Bridge to Rahasane Turlough - Construction Phase

The lower half at least of this stretch has high quality parr holding areas (IFI pers comm.) and, indeed, substrate and habitats observed confirm this. Parr drop down from the main spawning tributaries above Craughwell as they mature and populate these well sheltered stepped, pools, glide run sequences with a diversity of flow forms and good cover. Closer to the turlough the gradient is flatter and the habitat possibly not as densely occupied, although of good quality nonetheless.

The two-stage channel which will be constructed along the left bank, only along the first 50 m upstream of the bridge, has the potential to generate suspended solids washout to the Dunkellin River during periods of heavy rainfall causing siltation in the main channel and impacting plants, invertebrates and fish. There is salmonid spawning habitat some distance downstream, but works are scheduled for May to September, which observes fisheries restrictions. Overall the impact in this stretch can be described as a **temporary**, **moderate negative.** Potential impact ultimately depends on the levels of solids washout and the standard of construction site management which will be addressed by standard mitigation measures (see **Section 11.5.1**).

11.4.3.5 Channel widening - Operational and Maintenance Phase

Changes in Channel Velocity During Peak Flow

During rare, extreme flooding (> 100 year return) post-works in-stream velocity is modelled to decrease slightly in the main channel downstream of Rinn Bridge but increase slightly downstream of Dunkellin and Killeely Beg Bridge. Predicted reductions between pre- and post-works channel velocities during extreme flooding, downstream of Rinn Bridge, are likely owing to the effect of the two-stage channel allowing for over bank flow. This can have **long-term, slight positive** impact on juvenile salmonids and white-clawed crayfish in that reach owing to reductions in hydraulic stress during high flow.

In contrast, predicted increases between pre- and post-works channel velocities during extreme flooding, downstream of Dunkellin and Killeely Beg Bridges is the result of floodplain constriction in that reach and could have long term **slight negative** impacts compared to the current situation, because of increased scour and hydraulic stress on flora and fauna.

Extreme flooding, however, is rare. The predicted post-works impact during “normal”, high return period, flood events is actually to decrease peak water velocity which probably be **slightly positive** for aquatic ecology in the long-term. The hydrological model shows slight decreases in post-works water velocities (c.15 to 30% reductions) in the main channel between Dunkellin and N18 Bridges during 2 and 5 year return period events, i.e. during more normal flooding. Predicted velocity decreases are more dramatic during normal flooding downstream of Rinn Bridge since the two-stage channel will reduce severe channel constriction in that reach. Overall, the introduction of the two-stage channel on the lower Dunkellin River will, effectively, relieve an element of morphological pressure on this artificial, canalised river channel by reducing bank constriction during normal flood events; allowing out-of-bank flow to the newly created (artificial) floodplain; and thus decreasing hydraulic stress on in-stream fauna and habitats. The range of post-works channel velocities should be sufficiently high to keep the channel silt-free and prevent excessive plant growth in areas used by juvenile salmonids.

It is very likely, therefore, that for the majority of flows, including normal high return period flood events, post-works velocity effects on aquatic ecology are likely to be **positive** in the long term.

Loss of Riparian Tree Cover

Loss of true left bank riparian cover as a result of this measure will result in increased light incidence to the channel and may encourage greater in-stream productivity, i.e. increased algal growth and benthic macroinvertebrate density. At low levels, this may be favourable for juvenile salmonids and crayfish, since the channel is presently of quite low productivity. On the other hand, a decrease in channel shading can also impact negatively on fish and crayfish distribution. Riparian tree cover plays an important role in regulating stream ecology, e.g. stream temperature, carbon inputs, in-stream vegetation cover. Recent IFI research, for example, shows the importance of channel shading in avoiding lethal stream temperatures for salmonids in Irish rivers (Rossa O'Briain, IFI, *pers comm*). Lack of shade has been shown to be correlated with absence of crayfish in habitat that would otherwise be optimal for the species (Besson *et al*., 2007). Aerial photography and site visits showed that both left and right banks have a fairly equal distribution of generally narrow, linear riparian tree cover, therefore a 50% reduction in riparian cover along affected reaches is expected. Retention of full riparian cover by the existing canopy on one bank, as proposed under this measure, will be critical to reducing the impact on in-stream fauna. If we assume that, at least full canopy cover is retained on the right bank, the impact of loss of riparian cover could be **long term slight negative**.

Maintenance of Two-Stage Channel

Light, out of channel vegetation trimming on the true left bank (two-stage channel) is proposed for every five years, as well as the trimming back of any encroaching terrestrial riparian vegetation into the channel at the right bank. Accumulation of silt is unlikely on the lower Dunkellin River as river morphology and flows will generally favour regular flushing of bed substrates. The impact of recurring maintenance is likely to be **neutral** as it is not envisaged that instream silt removal will be necessary and any out-of channel vegetation trimming will be carried out using OPW's Standard Operating Procedures (SOPs) which limit trimming to 1.5 m above the waterline and does not involve removal of canopy.

11.4.3.6 Cumulative Impacts

The channel widening measure on the Dunkellin River has cumulative impacts in association with other measures proposed in relation to the scheme, particularly Dunkellin River bridge works. The scheduling of construction works shows that channel widening works from the N18 to Dunkellin Bridge (c. 2.5 km of channel in total) overlap with bridge works at Killeely Beg and Dunkellin. The scale of works occurring all in one season (May to September), means that, in the absence of stringent mitigations, the overall construction phase cumulative impact of these measures could be temporarily **moderately negative** at least**.**

11.4.4 Bridge works: Dunkellin River Downstream of Rahasane Turlough

11.4.4.1 Overview

The scheme includes works to three bridges crossing the Dunkellin River downstream of Rahasane Turlough. Bypass flood eyes will be constructed at both Dunkellin and Rinn Bridges, whilst Killeely Beg Bridge will be replaced with a new clear span structure. The scheme does not interfere with the existing river bed and no other in-stream works are proposed. Channel widening is proposed in conjunction with bridge works at all three locations and involves creation of a two-stage channel by excavation of the left bank.

11.4.4.2 Killeely Beg Bridge Replacement

Construction Phase

At Killeely Beg Bridge new concrete abutments will be set back from the channel edge and will support precast beams. All the work will be undertaken on the banks with no in-channel works required. With good engineering practice this work should have no adverse impact on the Dunkellin River. The main area of risk would be from the washout of loose soil and sediment during floods or heavy rainfall and the possible use of bulk liquid concrete in the construction of the bridge abutments. Unlike Rinn Bridge and Dunkellin Bridge, the works on one of the Killeely Bridge abutments (right bank) will be immediately beside the channel with ground sloping steeply toward the river on that bank. The works therefore present a greater risk for sediment wash-off to the river. On their own the works are likely to result in a **neutral impact** over and above the impact of channel widening on the Dunkellin River provided good engineering practices are adopted.

Operational and Maintenance Phase

During rare, extreme flooding (> 100 year event), post-works channel velocity is modelled to slightly increase in the vicinity of this bridge, although for normal and high return period (2 and 5 year event) flooding the effect on aquatic ecology is likely to be **positive** in the long term.

Cumulative Impact

Each of the maintenance measures have cumulative impacts in association with other measures proposed in relation to the scheme. Bridge works over the Dunkellin River contribute a **neutral incremental impact** over impacts arising from the Dunkellin River channel widening measure.

11.4.4.3 Dunkellin Bridge – Flood Eye Insertion

Construction phase

All the work will be undertaken on the banks during a period of low flow with no in-channel works required and coincide with channel widening work downstream. With good engineering practice, therefore, this work should have a **neutral impact** over and above the channel widening impact on the Dunkellin River. The main issues during construction at the site is (i) washout of loose soil and sediment during floods or heavy rainfall as a result of associated channel widening beneath the new flood eyes, and (ii) release of cement and hydrocarbons.

Operational and maintenance phase

During rare, extreme flooding (> 100 yr event), post-works channel velocity is modelled to slightly increase in the vicinity of this bridge, although for normal and high return period (2 and 5 year event) flooding the effect on aquatic ecology is likely to be **positive** in the long term.

Cumulative impact

Each of the maintenance measures have cumulative impacts in association with other measures proposed in relation to the scheme. Bridge works over the Dunkellin contribute a **neutral incremental impact** over impacts arising from the Dunkellin River channel widening measure.

11.4.4.4 Rinn Bridge – Flood Eye Insertion

Construction Phase

All the works will be undertaken on the banks during a period of low flow with no in-channel works required. Ideally, Rinn Bridge flood eye insertion and channel widening of 50 m upstream and downstream of the bridge should occur simultaneously. The expected impact on habitats and species of Dunkellin River could then be expected to be **temporary and slight-moderate negative**, since the scale of works is not significant and the measures do not occur in conjunction with other bank and bridge works on the lower Dunkellin. The main issues during construction at this site are (i) washout of loose soil and sediment during floods or heavy rainfall as a result of associated channel widening beneath the new flood eyes, and (ii) release of cement and hydrocarbons.

Operational and Maintenance Phase

Post-works channel velocity is modelled to decrease in the vicinity of Rinn Bridge during all flood events, most considerably during normal, high return period (2 and 5 year return) flood events. This represents a potential **long-term positive** impact on aquatic fauna (crayfish, macroinvertebrates and fish) since substrate scouring and hydraulic stress effects in the main channel will be reduced.

Cumulative Impact

Each of the maintenance measures have cumulative impacts in association with other measures proposed in relation to the scheme. Bridge works, when undertaken concurrently with channel widening are likely to contribute a **neutral incremental impact** over impacts arising from the channel widening measure.

11.4.5 Salmon Counter Relocation: Dunkellin River

11.4.5.1 Overview

The structure will be constructed using cast in-situ concrete and installed at a location upstream of Killeely Beg Bridge. It will be inserted using cofferdam construction that alternately confines flow to one half of the channel while works occur in the dry in the isolated half. The removal of the existing salmon counter would have an overall beneficial impact on the movement of salmonids and sea lamprey if they are present in the system. Its mechanical removal will result in a certain amount of suspended solids but in general this is expected to be small given that the structure is made of concrete, probably with stone hard-core. The impact of removal is a **temporary significant positive**.

11.4.5.2 New Salmon Counter Construction Phase

The new salmon counter is proposed to be an exact replica of the existing one, so it is assumed it will be at least as passable as the existing structure. However, recent evidence suggests that weirs of the same or similar design as the existing Dunkellin salmon counter have potential to be migrational barriers to lamprey species (e.g., Russon *et al*., 2011), and possibly eels. The plunging and streaming flow types created over a uniform concrete slope result in hydrodynamics across a range of flow velocities that can be an impediment to upstream passage. Lampreys and eels have poor swimming ability compared to salmonids (Russon & Kemp, 2011) and, furthermore, lampreys have limited climbing ability (e.g., Reinhardt *et al*., 2009). We recommend that, prior to finalising the design of the new structure, a review of recent literature and information on the effects of similar weirs on lamprey and eel passage is carried out and that alternative weir designs are considered. The Water Framework Directive (WFD) requires mitigation of existing morphological impacts in waterbodies in order to ensure Good Ecological Status. Given the Dunkellin is currently at Poor Ecological Status and 'At Risk' owing to morphological pressures, every effort must be made to reintroduce a structure that is likely to have high passage efficiency for protected Annex II fish species (sea, river and brook lampreys) and red listed, "critically endangered" European eels.

The location of the new structure has not yet been agreed, but the river upstream of Killeely Beg Bridge is relatively deep and wide with step-run-glide type habitat which suggests that solids will not be generated due to river erosion, and any which do evolve will settle out rapidly. Poor management of cement casting on site could result in leaching out of highly alkaline cement or cement washings with serious adverse impacts for the downstream fish population. This eventuality on a well-managed site is considered a low risk, but the potential impact level without good site management and mitigation would be **significantly negative** in terms of potential for downstream toxic effects for fish and invertebrates.

Loss of Flora and Invertebrates as a Result of Dewatering Using Cofferdam Construction

All in-stream flora and macroinvertebrates will be removed along a short section of channel. If crayfish are present they may emerge during draw down of the isolated section of channel, at which stage it would be easy to collect and relocate them to suitable habitat further upstream. Crayfish removal and relocation should be overseen by an ecologist under license from NPWS. This **temporary negative** impact would be of **imperceptible** significance, overall.

Loss of Instream Habitat

A short stretch of existing instream habitat will be permanently replaced, most likely by a concrete slipway type structure. Habitat along the proposed reach is generally a step-run-glide sequence, a habitat type well represented in the lower Dunkellin, such that this long term impact is of **imperceptible** significance.

11.4.5.3 Operational and Maintenance Phase

Lampreys cannot pass many structures that are passable by salmonids and there is evidence that current crump weir designs, for example, are significant barriers for river and sea lamprey and possibly eels. If a high level of lamprey and eel passage success is not achieved by the new design, the impact would be **significantly negative**, particularly given that sea lamprey are currently at 'Bad' conservation status and eels are critically endangered. This can be avoided through correct design informed by recent literature on structures that ensure both river and sea lamprey passage (see Mitigations - **Section 11.5.4**).

11.4.5.4 Cumulative Impacts

Each of the maintenance measures have cumulative impacts in association with other measures proposed in relation to the scheme. The phasing of the salmon counter relocation works is not specified, but ideally, removal should occur in early May and reconstruction should occur at least one year after all channel widening works are complete and bedded in.

11.4.6 By-pass Channel Deepening: Craughwell River

11.4.6.1 Overview

Bypass channel deepening and bridge underpinning can occur in the dry when flood events are unlikely to occur. Though not stated in the methodology, no works are envisaged within the Craughwell River as part of this measure.

11.4.6.2 Construction phase

The main issues during construction are (i) sediment and silt release from the newly excavated channel, and, (ii) release of cement and hydrocarbons. Both (i) and (ii) will wash out to the Craughwell River if not properly managed. Increased suspended solids and release of concrete and hydrocarbons would give rise to the impacts already described in **Section 11.4.2**. This measure will be timed for May to October, but should occur in the earlier of these months to allow for settling of any loose sediment prior to the winter spawning period in the Craughwell channel. High levels of sediment or uncured concrete washout could have **significant, negative** impacts on the Craughwell River fishery and crayfish downstream of the bypass exit.

11.4.6.3 Operational and maintenance phase

No additional impacts are envisaged, although there may be a higher frequency of flooding in the channel depending on the level at which overflow is managed at the upstream end. For that reason any future maintenance of the channel should occur during dry months when there will be sufficient time for settlement of loose sediment before the channel is likely to flood.

11.4.6.4 Cumulative impacts

Each of the maintenance measures have cumulative impacts in association with other measures proposed in relation to the scheme. Bypass deepening is phased to occur prior to other instream works in the Craughwell reach, thus limiting cumulative impacts. The combined impact of bypass deepening prior to other in-stream works can be limited by ensuring the potential for contaminated washout from the bypass channel to the Craughwell is avoided through good engineering and good site management.

11.4.7 Channel Deepening and Bridge Works: Craughwell River

11.4.7.1 Overview

There are two combined methods to approaching the deepening of c. 950 m of the Craughwell River channel:

1. A c. 350 m section of the Craughwell River will be temporarily dewatered by diverting the river into the newly deepened by-pass channel at Craughwell village. This stretch encompasses the R446 and masonry pedestrian bridges which will be excavated and underpinned in conjunction with the deepening measure. Craughwell River works will then occur in the dry.

2. A c. 600 m stretch of the Craughwell River, downstream of (1), between the bypass channel outlet and upstream of the Aggard Stream confluence, will be regraded using short sections of cofferdam that isolate 50 m sections of channel on alternate banks. Underpinning of the Railway Bridge will occur in conjunction with deepening of this reach. Flow will be temporarily confined to the opposing half of the channel whilst excavations occur on one half of the channel. This will, we deduce, necessitate the stepwise isolation of at least 12 x 50 m sections of river on each bank.

11.4.7.2 Construction Phase

The construction phase for deepening of the Craughwell main channel is sequenced to occur over two subsequent summers. The proposed sequencing of the works in **Fig 5.1 in Appendix A** shows that item (1), above, occurs prior to (2). This means that in the summer of 2016, for instance, the river can be diverted through the bypass channel for works to proceed in the Craughwell area in the dry, as well as works occurring downstream of the railway bridge. Potential impacts are considered under individual headings below. Given the scale of works, the overall impact of the construction phase for these combined measures, in the absence of mitigation, is potentially **significantly negative**.

Mortality of Fish and Invertebrates as a Result of River Diversion

When 350 m of channel is dewatered by diverting the Craughwell River through the bypass channel this will result in the exposure and death of large numbers of white-clawed crayfish, large numbers of juvenile salmonids, smaller numbers of eel and possibly lamprey and many thousands of aquatic macroinvertebrates. The impact, without mitigations, would be **significantly negative**.

Salmonids will be amenable to fish rescue using electrofishing immediately in advance of the works (assuming that the stretch is dammed off at its upstream and downstream ends). Lamprey and, to a lesser extent, eel may be more difficult to capture by this method especially in the deeper water upstream of the R446. It is not possible to remove crayfish prior to dewatering given the lengths of channel involved. Crayfish will have to be rescued when they begin to crawl out of their burrows as waters are being drawn down and immediately afterwards when the channel becomes completely dry. A very high percentage of salmonids are likely to be rescued, (> 90%), but a great number of juvenile crayfish will be missed. Rescue methods for fish and crayfish are addressed in more detail in Section 5.6 (Mitigations).

Mortality of Fish and Invertebrates as a Result of Cofferdam Insertion

Isolation and death of potentially large numbers of white-clawed crayfish, lamprey ammocoetes (only in limited silty reaches) and thousands of aquatic macroinvertebrates will occur within the footprint of each cofferdam (50 m length x half river width). The impact on salmonid fish, eel and adult lampreys is likely to be **slight** provided they can move out of the area during draw downs and provided instream works do not occur during salmonid and lamprey spawning periods (i.e. October to April and March to July). It is noted that there is likely to be just one location (a short distance upstream of the Aggard Stream confluence) where sea lamprey could spawn up to the month of July and as long as this area is not directly impacted by channel deepening and stringent sediment control measures are used upstream, instream works could occur in the Craughwell reach between June and September, inclusive. Drying out of sections of the channel will cause crayfish to emerge from refuges and these will need to be collected as they emerge during the drawdown and relocated to suitable habitat upstream of the works. The impact on crayfish, without mitigation, would be **significantly negative**.

Changes in Hydromorphology of the Channel when Flows are Confined to one Half of the River

Use of 50 m sections of cofferdam to confine flow to one half of the channel during in-stream works over 600 m of the Craughwell River will result in temporary increase of water volume and therefore flow dynamics, alternately, in one or other half of the channel during works. This is likely to cause localised, increased bed disturbance downstream of the coffer-dammed sections, removal of filamentous algae and dislodgement and increased downstream drift of macroinvertebrates. Crayfish may also be dislodged and their foraging ability may be negatively affected owing to increased channel velocities where flows are temporarily confined within the narrowed channel. In the case of fish, the duration and timing of the impact in terms of spawning potential or migration can be managed to reduce impacts. Given the short stretches affected, sediment mobilisation would constitute a **slight negative** impact. If works take place only in very low flow conditions the impacts on fish and in-stream flora are likely to be **slight negatives.** In the case of crayfish, the disturbance, occurring over this long, linear length of channel in increments, the impact is potentially a **moderate negative**.

Changes in River Morphology and Fluvial Dynamics when the Deepened Half of the Channel is then Opened to Flow Whilst the Opposing Half is Cofferdammed and Deepened

The sequencing of cofferdam insertion, moving in a upstream direction as proposed, means that as the construction moves upstream a cascade of up to one metre (depending on required bed levels) will occur from the undeepened reach to the newly deepened reach downstream. This has potential as a fish migration barrier, although fisheries timing restrictions will avoid any potential negative impacts on fish migration.

Release of Sediment

Once the surface layers of the current channel bed are removed there may be increased scouring of fines, if present, from the bottom. This effect will be noticeable during the construction phase but will likely continue afterwards as well until the channel bed has been exposed to several heavy floods, during which time the more easily erodible fines will be released. A portion of these fines are likely to be deposited in the glide leading into Rahasane Turlough, the turlough’s drainage canal, and its flood plain.

An increase in suspended sediment associated with the works is likely to force fish away from the works and move downstream from where the excavation is being undertaken at a particular time. Short-term exposure to very high suspended solids loads is unlikely to be an issue because fish will avoid such areas, but has the potential to affect crayfish more significantly. Any unhealthy or stressed fish may become more susceptible to disease if exposed over an extended period to lower levels of solids. This would therefore be considered a **moderate negative** impact affecting salmon, trout and crayfish in particular, within the first few hundred meters downstream from the works. This impact is likely to be avoided however given that significant bed re-instatement is proposed, using similar or recycled bed materials (stockpiled during excavations) as part of the fisheries enhancement measures.

Any sediment deposited in the channel downstream of the works (upstream of Rahasane Turlough) may reduce macroinvertebrate productivity, although this is unlikely to be a major issue because these depositing stretches are likely to be less sensitive to deposition. Overall, this is a **slightly negative, short-term** impact. The potential impact of sediment deposition in the turlough is addressed in **Section 11.4.10.**

Toxicity Associated with Use of Concrete at Bridge Underpinnings

The two bridges at Craughwell village can be underpinned in the dry so concrete spillage to the main channel is unlikely to occur, though best practise in concrete usage should be carefully applied. Adequate curing times must be used before reopening the main channel to flow in the case of the R446 and Masonry Bridge. The situation for the Craughwell Railway Bridge is more critical since cofferdams isolate the works area only a short distance from the main flow. There is a minor additional risk at the Craughwell Railway Bridge associated with the use of bulk liquid concrete and with generation of additional solids from the bank-side works areas on both banks. Good engineering practice and the use of coffer dams to undertake the works in the dry during the May to September window will reduce the impact**,** but in the absence of mitigations the impact is potentially **significantly negative.** See general mitigation, **Section 11.5.1**, for best practise in concrete usage.

Fisheries Restrictions

The scheduling of works observes salmonid spawning restricted periods (October to April), but overlaps with sea lamprey spawning period that peaks mid-June to July (Igoe *et al.*, 2004). A short reach of potential sea lamprey spawning habitat occurs just upstream of the Aggard Stream confluence, however, this reach is not subject to deepening and it is not known for certain whether lamprey spawn here. So long as localised disturbance and suspended sediment levels associated with upstream works are kept low, as they are expected to be considering works occur in the dry, the potential for impact on sea lamprey spawning is considered to be a **short-term, slight, negative** locally.

11.4.7.3 Operational and Maintenance Phase

Habitat and Fisheries

Currently, there is a diversity of habitats in this 950 m stretch of the Craughwell River including small cascades, riffle/runs, runs, riffles, glides and pools. The river bed substrate ranges from coarse sand, gravels and small cobbles particularly in the stretch below the R446 Bridge, to cobble, boulder and bedrock along the remaining reach. It must be noted that in the absence of EREP, the potential exists for the channel deepening operation to result in a uniform cross-sectioned channel with unknown substrate types (e.g. bedrock, erodible fine substrates) and no bankside cover or vegetation. Water levels could potentially be lower on average without some of the pool or pool/glide stretches which are present in the existing stretch; therefore likely to contain shallow and possibly laminar flow with a paucity of microhabitats for salmonids and aquatic invertebrates.

IFI have, however, presented initial details of a fisheries enhancement plan which is to be implemented in concurrence with channel deepening under the EREP as part of this scheme (Appendix 3 contained within **Appendix A** to this EIS). This will at least maintain, and in all probability enhance, habitat diversity along the regraded Craughwell River reach very likely resulting in suitable residual fisheries, crayfish and macroinvertebrate habitat.

The EREP measures proposed will almost certainly increase the diversity of fish size classes which will inhabit the stretch by introducing more regularly spaced, stable holding (pool) areas while maintaining, or increasing suitable habitat for 0+ and 1+ salmonids. The EREP measures proposed will increase the capacity of the stretch for holding inwardly migrating adult salmon and seatrout, thus improving its angling amenity. There will be a temporary loss of invertebrate feeding in the stretch following regrading, both from instream production and material dropping in from the over-hanging and bankside vegetation, although this latter impact is probably only likely to last for the first year after the construction.

Although deepening of river channels can render hydrological conditions unsuitable for lampreys (Igoe *et al*., 2004) the EREP measures proposed may increase habitat opportunities for the species through, for example, introduction of pools that can accumulate fine sediments and be utilised by juvenile lampreys. This stretch of the Craughwell River currently supports moderate-to-high densities of white-clawed crayfish which will temporarily be lost during the deepening, but the proposed EREP measures are likely to recreate suitable habitat for the species to recolonise in time. Stable refuges and foraging areas will be dependent on the level of substrate reinstatement and resulting flow diversity.

Overall, with the successful inclusion and implementation of EREP measures included in the channel deepening design, as set out by the IFI and described by Dr. Martin O'Grady (Senior Research Officer, IFI) in Appendix 3 contained within **Appendix A** to this EIS, the outcome in terms of aquatic habitat for crayfish, lampreys, macroinvertebrates and fisheries is likely to be at least **neutral**, and at best **positive** and **long-term**.

Loss of Riparian Tree Cover

The Craughwell reach is currently a heavily shaded watercourse over most of its length and removal of bankside vegetation during construction has the potential to render the channel open and unshaded. Riparian tree cover helps regulate in-stream temperatures, controls algal blooms (through reduction of light incidence), provides carbon inputs, and protects fish and crayfish by providing cover. Migrating lampreys, in particular, are secluded and nocturnal, preferring shaded river reaches during the day (Igoe, *et al.,* 2004). Presence of shade has been shown to contribute positively to habitat preference by crayfish during recolonisation studies (Broquet *et al.,* 2002). The river in this reach appears reasonably productive meaning that reduction of tree cover is unlikely to add anything to the existing river ecology, although it is noted that Dr. Martin O'Grady predicts some benefit to the fishery arising from limited tree removal. In line with IFI requests and EREP proposed under this scheme bankside vegetation will be retained where possible and any necessary removal of trees will be carried out following consultation with a qualified arborist. This impact, overall, is likely to be **neutral** in the **long-term**.

Increase in Channel Velocity During Flooding

The hydrological model predicts increased post-works water velocities during flooding between Craughwell Village and downstream of the Railway Bridge. The predicted changes during extreme events (> 100 year return) are slight along the reach, however, during more "normal" or high return period floods (2 and 5 year events) the predicted increases are more significant. Compared to the current situation, the reach between the Masonry Arch Bridge and the Railway Bridge is likely to experience considerably greater post-works channel velocity during flooding. There is a modelled 80% velocity increase (up from 0.98 m/s pre-works to 1.78 m/s post-works) during 5-year return events and 70% increase (up from 1.03 m/s pre-works to 1.75 m/s post-works) during 2-year return events. The reach between the R446 Bridge and the Masonry Arch Bridge is predicted to experience lesser velocity increases ranging beetween 18% and 25% for 2 and 5 year return period events respectively.

The impact for salmonids is likely to be slightly negative, but could be moderately negative for crayfish and migrating adult lamprey if there is a lack of suitable, stable refuges available. Jensen & Johnson (1999) showed that intermittent peak discharges can negatively impact on Atlantic salmon and trout by increasing wash out and mortality of young fish (0+) and by decreasing growth rates of older life-stage (1+, 2+, 3+) Atlantic salmon. Given that annual peak pre-works water velocities appear to already be quite high in these reaches, the area is possibly more likely to be a nursery area for 1+ fish and over, and thus, while growth rates of any young salmon may be affected to some extent, the potential for wash out and/or mortaility of alevin stage (0+) fish may not be so critical. Presence of 0+ fish cannot, however, be entirely ruled out. Mid-channel boulder and coarse material replacement as part of fisheries enhancement work can aid salmonids by providing hydraulic refuges during floods and these should definitely be incorporated into the EREP and deepening works design in the reach between the R446 Bridge and downstream of the Railway Bridge. Boulder placements or boulder/large cobble deflectors at low flow channel margins would be more effective as refuges for crayfish, since crayfish tend to avoid the faster mid-channel flows.

Velocity changes during non-flood flows are unlikely to have overly negative impacts provided the new channel form and structure allows for a diversity of flow types, i.e. areas of slower glide and faster run/riffle, and there are larger stones and small boulders carefully replaced into the channel to provide stable refuges.

Loss of EPA Water Quality Monitoring Station

The EPA water quality monitoring station (29K010400) at Old Road Bridge, Craughwell, is included in Ireland's formal WFD monitoring and water quality reporting programme. The change in hydromorphology associated with channel deepening has the potential to alter channel substrates and water depths and render the current monitoring site unsuitable for Q-rating assessment. The site may need to be relocated once habitat reinstatement is completed.

11.4.7.4 Cumulative Impacts

Each of the maintenance measures have cumulative impacts in association with other measures proposed in relation to the scheme. In the absence of mitigations, the cumulative impacts of the various approaches and steps required to complete bridge underpinning and channel deepening represent, at worst, **significant negative** impacts over c. 950 m. In the absence of mitigations, the potential for sediment mobilisation to Rahasane Turlough as a result of these measures in combination with deepening of the by-pass channel represents a **slight-to-moderate, negative** cumulative impact.

11.4.8 Culvert replacements –Aggard Stream

Each of the proposed culvert replacements are upstream of the Monksfield confluence and are, thus, within habitat considered to be of low ecological value that, reportedly, dry out periodically.

11.4.8.1 Construction phase

In stream works associated with culvert replacement have the capacity to give rise to significant amounts of silt especially if there is heavy rain and increased flows during culvert insertion. The latter will result in deposition in the channel downstream, potentially impacting on trout and lamprey (river/brook) spawning gravel, crayfish habitat and macroinvertebrates and without mitigation could, therefore, be **significantly negative**, locally. In the case of the Aggard Stream, reaches 1 and 4 would be the most vulnerable to fisheries impacts, since respiration of fish and white-clawed crayfish in these reaches could be negatively affected by temporary increases in suspended solids and spawning areas could be smothered.

11.4.8.2 Operational and maintenance phase

If the bases of the new culverts remain above the drain/stream bed then the passage of fish upstream and downstream may be prevented during periods of low flow. However, fisheries values are low or insignificant in this upper part of the system so the potential for this impact is, at most, **slightly negative**.

11.4.8.3 Cumulative impacts

Each of the maintenance measures have cumulative impacts in association with other measures proposed in relation to the scheme. Culvert replacement could be phased with other measures within the scheme to minimise release of silt to the Dunkellin River, however the likelihood of silt reaching the Dunkellin River from high in the Aggard drain network is very low.

11.4.9 Drainage maintenance – Aggard Stream

Drainage maintenance as part of this scheme does not include significant dredging, channelisation or arterial drainage works. Proposed works are described as "*minor in nature*" (**p.46, Appendix A**) and mainly involve removal of obvious obstructions to conveyance, e.g. gates, fences and excessive silt deposits. Encroaching bankside vegetation will be trimmed rather than removed.

Removal of in-stream aquatic vegetation and silt is likely to be the primary activity that could impact on aquatic ecology of the Aggard Stream as part of this scheme. The Aggard system was not found to have aquatic plant communities of significant conservation value but there were reasonably extensive stretches of habitat identified that support aquatic fauna protected under national and international legislation (see **Table 11.10**). The potential impacts are listed below.

Loss of biodiversity through removal of instream flora and fauna

It is considered that white-clawed crayfish and lamprey ammocoetes are the most likely Annex II species to be directly affected by the kind of maintenance proposed. Studies have shown that maintenance in depositing areas of watercourses, including those with silt and aquatic macrophytes, e.g. *Phalaris arundinacea*, have the potential to remove large numbers of juvenile lamprey and their habitat (King *et al*., 2008a; Williams 2009, 2010). White-clawed crayfish also regularly utilise muddy habitat and associated aquatic macrophyte stands (Holditch, 2003; Williams 2009, 2010). Evidence has shown that crayfish populations can suffer negative impacts as a result of regular channel maintenance including selective in-stream silt and plant removal (King *et al.,* 2008b). Whilst standard channel maintenance would remove all habitats suitable for the above mentioned species, the type of selective, very minor maintenance outlined by the proposed works (as described in the report contained in **Appendix A** to this EIS) is likely to have considerably less impact.

Salmonid and lamprey spawning habitat can be indirectly affected through mobilisation of suspended solids that occurs when upstream silt deposits are disturbed. There is potential for **moderate negative** local impact if maintenance works occur during salmonid and river/brook lamprey spawning periods and **significant negative** impact if sea lamprey spawning was affected by increased suspended solids levels, given its red listed status. As with salmon, it cannot be ruled out that sea lamprey spawn in the lower Aggard, and thus it would be recommended that any in-stream maintenance works occur in August and September, although it is noted that these populations of Annex II species occur outside of the SAC.

Anywhere silt and macrophytes are removed, macroinvertebrates including molluscs and waterbeetles will also be removed and will suffer mortality. Lamprey ammocoetes in silt and white-clawed crayfish in vegetation may be physically removed. Fish tend to escape the excavation bucket, particularly if a slotted bucket is used. Removal of protected species as a result of minor, selective maintenance represents a **short term, moderate, negative** impact on crayfish and lamprey populations, and at most a **slight negative** impact on salmonids, so long as maintenance occurs during low flow conditions outside of spawning periods. Plant communities identified, though not considered to be of conservation importance, are biotic elements of habitat for protected species and macroinvertebrates, however, the plants present would all be expected to re-establish within one or two seasons following light touch maintenance and thus be a **short term, slight negative impact**.

Changes to Habitats and Hydromorphology Associated with Maintenance

Most of the Aggard Stream and connecting drains have been dredged historically, as have the comnnecting drainage network. The Aggard Stream is dominated by three main habitat types, (i) culverted drainage ditches in the upper reaches upstream of the first main branch in the channel at Rathcosgry, (ii) moderately deep glide and glide/run comprising more than 60% of the channel between Rathcosgry and the confluence with the Craughwell River and (iii), riffle, riffle-run and run with predominantly coarse substrate, optimal or moderate for young salmonids (mainly trout) which occupies about 30% of the channel between Rathcosgry and the confluence with the Craughwell River.

Habitat 1 – Drainage Ditches

The first habitat type is earmarked for insertion of 14 culverts and bed cleaning. This work will have an **imperceptible** impact on the habitats which are little more than weed-choked drainage ditches. Any cleaning will reduce the sites' biodiversity in terms of aquatic plants and aquatic invertebrates but none of these are known to be protected and all will re-establish themselves naturally within a few seasons. The sluggish flows and plant chocked nature of the channels indicates that these will not generate large amounts of solids during the works, although some turbidity can be expected. It is recommended that these ditches should be culverted from an upstream to a downstream direction as this will increase the chances of suspended solids being filtered out by submerged/ floating aquatic vegetation, which will in turn be removed by the advancing excavators.

Habitat 2 – Glide and glide/run

In the main this habitat comprises deeper channel sections with submerged accumulated beds of silty sand held together by rooted submerged aquatics. It is ideal holding are of larger trout. Removal of the submerged and marginal shoals of finer material will improve the holding capacity in some areas for larger individuals but the complete removal of cover in the form of macrophyte beds and channel irregularities may reduce the numbers of territories especially for younger fish and thus cause an overall reduction in carrying capacity. Some parts of this habitat, e.g. near AG12 – AG13 may have patches of gravel which would mark an increase in the diversity of habitat locally. Juvenile lamprey are also likely to be present in this stretch in, perhaps, moderate densities. Overall it is expected that works in this stretch would take a number of years to recover to their pre-cleaning character. Overall, any works in this habitat will result in a **moderate negative** impact.

Habitat 3 – Riffle, Riffle/run, Run.

This habitat predominates in two stretches, a downstream stretch from just upstream of Aggard Bridge downstream to the Dunkellin River and upstream stretch from between AG 20-21 upstream to AG25. It isn't known at this stage to what extent limited maintenance will be employed in these stretches. These are probably the most important spawning and nursery stretched within the Aggard Stream. They have areas with substantial in-stream macrophyte beds, mainly *Ranunculus*, but mostly with strong currents and coarse substrates, therefore presenting little conveyance issue. Any significant intervention in these stretches could have a **significant negative** on salmonid and lamprey populations.

Transport of suspended solids to Rahasane Turlough

The nature of the activity is such that maintenance can release previously deposited silt back into suspension in the watercourse. Given the, generally, very low gradients of all of the Aggard Stream and connecting drains there is, at most, a chance of **slight negative** impacts within the Dunkellin River and Rahasane Turlough downstream during proposed maintenance since most silt would settle within the cleaned drains themselves or in more sluggish glides in the Aggard before reaching the Dunkellin. The potential for impact can be limited by undertaking works during lower flow periods.

11.4.9.1 Operational and Maintenance Phase

Repeated channel maintenance is likely to be required on a periodic basis with similar impacts as described above.

11.4.9.2 Cumulative Impacts

Each of the maintenance measures have cumulative impacts in association with other measures proposed in relation to the scheme. The Aggard Stream crayfish population assumes greater significance in this geographic area given the potential for significant, negative impacts on the crayfish population in the 950 m reach of the Craughwell River that will be disturbed (or lost, temporarily or permanently depending on the level of habitat reinstatement) by the channel deepening measure.

11.4.10 Potential impacts on Rahasane Turlough

No works are proposed within Rahasane Turlough SAC, but indirect impacts could potentially arise from: (i) alteration of the turlough hydrological regime; and/or, (ii) effects of upstream works within the Craughwell River.

11.4.10.1 Alteration of Turlough Hydrological Regime

Seasonal fluctuation in water levels is critical to maintaining turlough ecology (Sheehy Skeffington *et al*., 2006), and at Rahasane Turlough retaining the existing natural hydrological regime is, therefore, essential to maintaining the conservation status of the designated Annex I habitat [3180] "Turloughs".

The proposed alterations to the Dunkellin River and its bridges have been designed to have virtually no impact on the hydrological regime of Rahasane Turlough. There are very slight predicted changes to turlough water levels, but these are not significant under flood conditions. Maximum flood levels remain unchanged and predicted surface water profiles for various flow scenarios (e.g. 5th percentile, 10th percentile) show no, or, at most, imperceptible changes between the pre- and post-works situations.

Depth exceedance models (based on four years of data, 2008 to 2011) predict only a 2 cm reduction in depth at the 5th and 10th percentile flows and a 6 cm reduction at 50th percentile flow. The 50th percentile flows calculated using the short term (2008-2011) dataset (14.74 mOD) are equivalent to mean annual flows (14.77 mOD or 30th percentile) calculated using the long term (1970 to 2002) dataset. Water levels are currently overbank via breaches in the turlough drainage channel embankments at mean annual (long term) flow and also at the modelled (short term) 50th percentile level.

Small, post-works depth reductions predicted during turlough flooding were examined with regard to potential impact on Fairy shrimp, *Tanymastix stagnalis*. This species is dependent on overflow from the main Rahasane basin to the smaller Rinn basin to stimulate a rapid breeding phase. Young (1976) reported observations of *T. stagnalis* in Rinn basin at Rahasane and made a precise record of the date at which overflow occurred between the two basins (August 18, 1974). We examined historical OPW hydrometric data (Rahasane Turlough Station, 29002), which showed that the level at which overflow occurs between the basins is, therefore, 14.70 mOD (Malinhead). This equates to approximately 35th perecentile flow using the long-term depth exceedance curve in **Appendix A, Figure 3.13**. This water level is equalled or exceeded in the turlough 35% of the time - meaning Rinn basin can be expected to flood for, on average, 128 days of the year. The predicted, slight, post-works reduction of levels in the turlough during similar floods may, therefore, mean a very slight reduction in the average number of days per year that overflow begins to Rinn. This would, likely, result in an imperceptible impact on the flooding regime at Rinn and would have a **neutral** impact on the ecology of *T. stagnalis*, which can complete a breeding cycle (hatch, grow and produce eggs) in less than 15 days (Young, 1976).

Dr Roger Goodwillie reviewed the proposed scheme and commented: "*it seems that flood heights in the turlough will not be affected in a way that will change the ecology significantly*". By this we can assume that there are likely to be no significant impacts on vegetation zonation in the turlough and we can deduce that aquatic invertebrates associated with turlough floodplain vegetation, such as the "moss dweller" waterbeetles such as the red listed *Graptodytes bilineatus*, will not be significantly affected.

On the basis that the short term hydrological model (2008 to 2011) output shows insignificant changes to Rahasane Turlough hydrological regime, it appears that the impact on the fully aquatic elements of the SAC would be **imperceptible** and **neutral**. Careful monitoring of post works water levels is critical along with a commitment to detect and remedy any hydrological changes that may arise as a result of the scheme. A feasible, remediation strategy to correct turlough hydrological function (should it be found to have been altered by the scheme) must be presented at the final design stage of the project (see Mitigations - **Section 11.5.9**).

11.4.10.2 Suspended Sediment Effects

Activities proposed in the Craughwell River and Aggard Stream, upstream of Rahasane Turlough have the potential to generate increased suspended solids that may reach the turlough. Levels are envisaged to be low given that much of the upstream work occurs in the dry and will be conducted during low flow periods. High levels of suspended solids could cause turbidity changes in Rahasane and, if they did eventuate, could cause decreased light penetration to aquatic plants. Any excessive deposition could affect aquatic communities through smothering.

Smothering is unlikely to be a significant impact for the majority of the permanent aquatic plant community, which is comprised of species that generally thrive in soft sediments. Stonewort (*Chara* spp.), reportedly present in permanent standing waters of the turlough, is possibly the most sensitive to consider, however, deposition of suspended solids in the turlough are unlikely to negatively affect the stability of the *Chara* spp. community, so long as water clarity is good. *Chara* are typical pioneers that lack true roots, attaching to the substrate by fine rhizoids. They can colonise exposed or new benthic sediments very successfully and can form stable communities over time owing to the production of bulbils and bird-grazing resistant oospores (Van den Berg *et al*, 2003). *Chara* is, however, sensitive to water clarity (Curtis *et al*., 2009) which affects the depth at which they are found growing in lakes. Van den Berg *et al. (*2003) found during studies of shallow Dutch lakes that water depth and light extinction were critical factors determining the succession and zonation of macrophytes. The occurrence of *Chara* was negatively correlated with both increased turbidity and water depth.

It is important to note that periodic alterations to turbidity / transparency in Rahasane Turlough would ordinarily be expected, since the habitat depends on periodic flooding. Water clarity in the turlough is likely to be affected by a combination of turbidity generated by high run-off events, phytoplankton growth (chlorophyll levels), as well as the effects of various activities and operations in the catchment that may generate turbidity. The temporary upstream works proposed as part of this scheme, which occur in the dry using river diversion/ cofferdamming techniques, are expected to represent an **imperceptible**, or at most, **very slight, temporary** change in suspended solids levels at the turlough. Significant adverse impacts on *Chara* beds are not envisaged to occur because in order to change the current situation, silt generated by the proposed works would have to significantly reduce the transparency within the turlough for extended periods during the growing season, which does not seem likely. The turlough standing waters are considered reasonably shallow in terms of habitat for *Chara* (which can occur at depths of many metres in clear lakes) and, thus, light penetration levels are expected to be adequate over the summer months when upstream works are scheduled. It is also worth noting that long sections of glide on the Dunkellin River upstream of the SAC, as well as the turlough drainage channel itself, are likely to be places where the majority of suspended solids settle, thus reducing turbidity.

11.4.11 Fisheries Enhancements

The works description identified two areas with high potential for fisheries enhancement under the OPW's Environment River Enhancement Programme (EREP). These areas are:

1. The channel stretching from the N18 at Kilcolgan to the Rahasane Turlough, and

2. The channel reach stretching from Rahasane Turlough to the Railway Bridge in Craughwell Village and upstream to Craughwell Village.

EREP is expected to not only benefit the aquatic communities of the Dunkellin system, but, most importantly, is essential to offset significant negative impacts that are very likely to arise if enhancements were not included in the works design. Following consultation, site visit and appraisal conducted by Dr. Martin Grady of IFI, fisheries enhancements have been placed central to the mitigation strategy for channel deepening operations on the Craughwell River upstream of the Aggard Stream confluence. Further details will be agreed at detailed design stage. EREP engineering works will occur in tandem with channel deepening works in the Craughwell reach which will (i) reduce the duration of potentially negative impacts by carrying out all river engineering operations once, at the same time; amd ,(ii) ensure that desired bed levels are achieved in terms of the dual goals of EREP and increased conveyance.

EREP, if included for correctly in terms of underpinning at detailed design stage the methods and habitat reinstatement goals has the potential for **long-term** or **permanent positive,** impacts on aquatic ecology of the Dunkellin River downstream of Rahasane Turlough and for at least **neutral** or **long-term positive** impacts on the reach upstream of Rahasane Turlough.

11.5 MITIGATION MEASURES

11.5.1 Standard Mitigation

A detailed design and method statement should be drawn up by the contractor indicating what standard measures will be taken to avoid (i) sediment or soil loss and (ii) cement and hydrocarbon release, associated with all aspects of the construction phase. The statement must include how these will be monitored for effectiveness. Given the scale of the works, the method statement must include details of the response strategy and chain of command in the event of flooding occurring during works. A mechanism for reporting of pollution incidents should be agreed in advance between the contractor(s) and the IFI and NPWS. Given the scale of the works, it should be detailed as to how, in the event of flooding occurring during construction, water quality will be protected.

Fisheries enhancement measures proposed under OPW's Environmental River Enhancement Programme (EREP) are included in the suite of mitigation measures proposed as part of the Scheme, as these will be introduced to benefit aquatic ecology.

Sediment

- Stockpiling of spoil should be avoided. If it has to occur the spoil should be placed on flat ground at least 10 m back from the edge of the river bank or nearest drainage ditch and preferably in a grassed area, so that any run-off can filter through the grass and prevent sediment run-off. They must also be placed on high ground so they cannot be inundated during floods. Silt fences should be used where there is a danger of soli wash-out from stockpiled soil or from earth works.

- Spoil spread on adjacent lands should be kept at least 5 m back from the edges of land drains and 10 m from larger watercourses. All spoil should be re-seeded as soon as it has been spread in order to stabilise it and reduce the possibility of solids wash-out to surface waters. Silt fences should be used where there is a danger of soli wash-out from stockpiled soil or from earth works.

- The work flow on each site in association with the scheme must be designed to minimise damage to the edge of river banks by heavy construction vehicles, with avoidance of rutting which would increase the risk of gully erosion or solids wash-out during intense rainfall.

- The timing of the works must be specified and agreed with the IFI in relation to fish migration and spawning periods.

Concrete

- Wet concrete and cement are very alkaline and corrosive and can cause serious pollution to watercourses.

- Disposal of raw or uncured waste concrete must be controlled to ensure that the watercourse or karst features will not be impacted.

- Best practice in bulk-liquid concrete management addressing pouring and handling, secure shuttering / form-work, adequate curing times.

- Where shuttering is used, measures should be put in place to prevent against shutter failure and control storage, handling and disposal of shutter oils.

- Wash water from cleaning ready mix concrete lorries and mixers may be contaminated with cement and is therefore highly alkaline. Due to the size of the site and the proximity of sensitive watercourses, it is recommended that lorries and mixers are washed out off site.

- Cement dust must be controlled as it is alkaline and harmful to the surrounding ecology. Activities which result in the creation of cement dust must be controlled by dampening down areas.

- The timing of the works must be specified and agreed with the IFI in relation to fish migration and spawning periods.

Hydrocarbons

- Fuel and hydraulic fluids should not be stored on site, but if absolutely necessary, they must be stored in a locked and bunded container.

- Refuelling should only take place well back from the edge of watercourses and all stationary plant should be placed on drip trays to prevent leaking oils reaching the river or entering groundwater.

- No washings or waste materials of any kind can be directed into the stream.

- Machinery on site must have pollution control kits on hand in the event of an emergency.

Construction waste

All construction related waste, e.g. plastics, cable ties, geotextile etc. must be collected and disposed of correctly so that they do not enter the river channels. Given the size of the construction area overall, the amount of this kind of construction related foreign material may be considerable and care should be taken that they do not end up in the waterbodies.

Timing restrictions

Timing restrictions for aquatic species are imposed to protect sensitive breeding periods, including fish migration and spawning. **Table 11.11** clarifies restrictions with respect to conservation interests of protected aquatic species within the study area. It shows that instream works should, ideally, only occur in the months of August and September. Where out of river works are of a risky nature, such as large scale excavation works for the channel widening measure, restrictions also, generally, apply. Restrictions must, ultimately be agreed with IFI (salmonids) and NPWS (crayfish, lampreys).

Table 11.11 Timing Restrictions for Protected Aquatic Species in the Study Area

Species	Period of no instream disturbance (inclusive)	Likelihood of presence in the affected areas and comments	Period instream works allowed (inclusive)
Salmon.	October to April - spawning, nursery (IFI).	Distributed throughout study area: Craughwell River instream deepening works – very sensitive - spawning, nursery, holding area. Dunkellin River – no instream works proposed/migration – less sensitive – limited spawning, but good nursery habitat. Aggard Stream – few salmon – no deep dredging works proposed.	May to September.
Brook and River Lamprey.	March to May - spawning / hatching (Igoe et al., 2004).	Distributed throughout study area, depending on localised habitat, i.e. spawning in riffles, nursery in silty deposits.	June to February.
Sea Lamprey.	Mid June to July - peak spawning period (Igoe *et al*., 2004).	Presence confirmed on lower Dunkellin River at least. Spawning and juvenile nursery habitat abundant throughout the study area, depending on localised habitat, i.e. spawning in riffles, nursery in silty deposits.	August to April.
White clawed crayfish.	November to late June (breeding / berried females + hatching) (Peay, 2000).	Population abundant on Craughwell River and Aggard Stream upstream of Rahasane Turlough. Present / moderate abundance on Dunkellin River between Dunkellin Bridge and Rahasane Turlough, inconclusive evidence of presence downstream of Dunkellin Bridge.	July to October.
Trout.	October to May - spawning, nursery (IFI).	Distributed throughout study area.	June to September.
Combined/ overall timing restrictions.	No instream works allowed between October and July.		Instream works allowed August to September.

11.5.2 Channel Widening: Dunkellin River

Sediment and Pollution Control

Mitigation for the construction of the two-stage channel will essentially be the same for each zone involved on the lower Dunkellin River between N18 and Rinn Bridge. As identified in the impacts section, the principle risk will be from solids washout either directly from the edge of the bank or via drains traversing the new two-step channel. The contractor must specify specific sediment control measures in relation to the extensive excavations proposed for the two-stage channel. This may include, for example, specifying the approach to excavations such that works begin away from and work towards the channel with a buffer zone left between the excavation area and the channel to prevent diffuse wash off. Flow paths to the river, in that case, can be more adequately protected with appropriate sediment control measures.

It is assumed here that the area of bank to be lowered will have been surveyed in detail to identify surface drains or recognisable karst features which might act as conduits or preferential flow routes for solids-contaminated run-off to the Dunkellin. In that case the main potential drains and flow routes will be known for each stretch. However, in advance of works on individual stretches a careful walk-over prior to commencement of each portion of the works should be undertaken so that smaller field drains and ditches are known in advance and these should be managed in such a way that minimises the possibility of solids run-off during and after construction. Heavy traffic beside or over these drains should be avoided and excavations should be away from the edges as much as possible. The outlets from the drains should be blocked with straw bales, especially larger ones when they are being deepened, which is often likely to be necessary. Crossings of active drains should as much as possible be over existing culverts if available or else over crushed stones or other coarse rubble, possibly accumulated from earlier bank works. In any event, drains, wet or dry, should be recognised as potential preferential flow paths of contamination to the Dunkellin River and managed accordingly, particularly where they are active and also after sustained heavy rainfall that raises the level of the water table. Check for dams - other silt control measures may be required in these drains where they occur.

In areas where soil overlays rock or rubble, then all the former should be removed in advance to reduce the risk of solids washout when the deeper rubble and rock layers are being removed.

Soil, shrubs and vegetation should not be stockpiled near the water's edge or beside active or potentially active drains on the new stepped channel.

When working the very edge of the new channel, care should be taken not to destabilise it or to leave it sloping toward the existing channel is a way that would increase the risk of erosion or solids run-off.

In areas where the base material is soil, this should be re-seeded with a suitable species mix to allow rapid stabilisation of the surface. Where this would help to stabilise loose soil or other bed material, the new channel should also be rolled. This work should run in parallel to the widening works.

If the water table rises to the level of the works area then all works should cease in the affected areas until it drops again.

All heavy machinery traffic should be avoided along the outer edge of the new channel in order to minimise soil damage and ground damage.

After completion of the works, the site should be continually monitored, during wet weather in particular for evidence of preferential flows area where solids are entering the river. These should be blocked with straw-bales, silt fences or a combination of both to help reduce solids wash-out.

It is recommended that before commencement and after completion of the works, the known salmon spawning areas would be monitored by the IFI to ensure that they have not been silted up. In the event that they have been these should be raked to remove deposited fines. This should be undertaken for at least two years after the works have been completed.

Any fringing stands of reeds (i.e. of *Sparganium* and *Phalaris*) should not be removed or damaged during construction unless specifically agreed in advance by the IFI. These beds will act as partial protection against erosion of the edges of the new bank, help to trap escaped solids from the earth works and provide bankside cover for fauna on the newly exposed left bank where overhanging riparian vegetation will be removed.

See **Section 11.5.1** for general mitigation in relation to hydrocarbons.

Riparian Vegetation Enhancement

Any fringing stands of reeds (i.e. of *Sparganium* and *Phalaris*) on the left bank should not be removed or damaged during operation and maintenance phases, unless specifically agreed in advance by the IFI. These beds will provide bankside cover for fauna on the continually exposed left bank where overhanging riparian vegetation was removed. Additional broadleaved tree planting and, perhaps fencing, of the right bank riparian corridor is recommended to offset loss of riparian vegetation (and ecological function provided by riaparian cover) on the left bank.

Fisheries Enhancement

The IFI have proposed a range of fisheries enhancement (EREP) measures for the stretch with an emphasis of pool construction and gravel importation, to offset the dearth of both these important features within the channel currently. The details of exactly where these measures will be undertaken have yet to be drawn up in full.

Given there are predicted post-works increases in extreme flood velocities downstream of Dunkellin and Killeely Beg Bridges, EREP in these reaches could be focused to help mitigate hydraulic stress on fauna. For example, secure boulders, carefully placed, or deflectors, can provide refuges for fish and crayfish, which tend to drop down to the bed level during high flows.

Monitoring

Fisheries monitoring within selected reaches of the lower Dunkellin River is recommended, not least to gauge the effectiveness of EREP. Pre-works (baseline) and post-works (Year 1 and 3) surveys should be included.

11.5.3 Bridge Works: Dunkellin River

Standard mitigations (**Section 11.5.1**) will apply in relation to sediment control, prevention of release of cement and hydrocarbons, and timing restrictions. In the case of Rinn and Dunkellin Bridge, flood eyes are set back from the water's edge such that there should be very little risk of sediment from the bridge sites themselves entering the channel, except during heavy rainfall. As a precaution however, the works area should be fitted with silt fences and straw bales to act as barriers to silt escapement in the event of heavy rainfall or a flood. Floods are not uncommon during our wet summers of recent years so that this eventuality should be taken as likely. Another precaution should be the retention of a vegetated layer on the surface between the works and the river bank for as long as this is practicable, as this will act as a grassed swale to filter out solids. If the latter is chosen and even in its absence, heavy vehicular traffic between the works and the river's edge should be avoided as much as possible, and should never occur during wet weather. This will prevent the surface becoming rutted and more easily erodible. As soon as the works area is complete it should be re-seeded with a suitable, rapidly growing species which will bind the surface and reduce the possibility of erosion. All the usual precautions in the handling of bulk liquid cement should also be taken if it is intended to use any mass concrete on the site.

All the same precautions as above should apply to the Killeely Bridge reconstruction, but with particular care being taken on the right (northern) bank as the works there are very close to the existing channel and the ground slopes very steeply. In this regard, consideration should be given to inserting a sheet pile or similar barrier along the riverside edge to prevent soil and other debris from the works falling into the channel.

With regard to timing of bridge works, they should coincide in each reach with channel widening works. This reduces the risk of re-disturbing ground near the channel to insert flood eyes or set abutments. All works on bridges that could result in solids wash-out to the river should be completed in the May to September period.

11.5.4 Salmon Counter Relocation: Dunkellin River

Most importantly, the design of the salmon counter weir structure must be carefully reviewed with regard to the ability of lampreys and eels to pass this potential upstream migration barrier. Although a sea lamprey has been observed passing the existing counter, the level of lamprey passage success, overall, is unknown. Recent literature and information on passage efficiency for lamprey and eels at similar structures must be consulted before agreeing on a design that ensures a high level of passage for Annex II protected and red-listed fish species (lampreys and eel), e.g. Russon *et al*. (2011) Reinhardt, *et al.* (2009) and, for instance, publications from the International Centre for Ecohydraulics Research (ICER)[19].

With regard to the weir construction it is proposed to use cofferdams to isolate the instream works, allow construction in the dry and to prevent solids and cement from entering the channel. These mitigations should be carefully monitored while underway to ensure that they are operating correctly. Particular care will be required when discharging bulk liquid concrete from the bank in order to avoid accidental spills. The operation should be monitored by IFI or an agent to ensure that all mitigation measures are being adhered to. All contaminated waters which enter the coffer dams will need to be pumped to settlement facilities before they are discharged. See standard mitigations (**Section 11.5.1**) in relation to sediment control and prevention of release of cement and hydrocarbons.

11.5.5 By-pass Channel Deepening: Craughwell River

See General Mitigations (**Section 11.5.1**) in relation to sediment control and prevention of release of cement and hydrocarbons. In addition, as much residual fine sediment as possible should be removed during the construction phase as this will wash off directly to the Craughwell River particularly when the by-pass channel is opened for the river diversion. Works should be phased so that there is a suitable settling period following channel excavation/bridge underpinning prior to flow from the Craughwell River being diverted into the by-pass channel.

11.5.6 Channel Deepening and Bridge Works – Craughwell River

The design of the river enhancement works together with the associated construction works method statements will be the subject of detailed design between Galway County Council, the OPW and IFI upon conclusion of the planning process [**Appendix A** to this EIS]. Initial details suggest that Dr. Martin O'Grady, IFI Senior Research Officer, envisages that habitat reinstatement and fisheries enhancement can be adequately achieved in the Craughwell River reach as part of proposed deepening works. The method and strategy statement should specify the engineering methods necessary to achieve positive outcomes in terms of addressing the combination of mitigating construction phase impacts and habitat reinstatement goals as part of the channel deepening and bridge underpinning measures (which to a large extent will occur simultaneously and share the same suite of potential impacts).

The items that need to be precisely described in the method and strategy statement may include:

- Exact sequencing of works in Craughwell reach – a broad work schedule is presented in Fig 5.1 in **Appendix A** to this EIS but details of the timing of the river dversion through the bypass channel in relation to cofferdam sequencing downstream should be set out to ensure good management of potentially negative aquatic ecological impacts, such as dewatering effects.

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[19] http://www.icer.soton.ac.uk/Pages/Anguilliform/Anguilliform.html

- River diversion strategy needs to be described including the precise method of damming and dewatering the main channel, timing of the diversion in combination with cofferdam works downstream of there, amount of time river diversion is likely to remain in place and contingency plans in the case of unforeseen flooding occurring.

- Details of riverbank access routes and how banks will be protected from machinery damage, i.e. how will deep rutting and erosion, which could contribute to silt run-off to the river, be avoided?

- Cognisance of requirement and strategy for implementing for fish and crayfish rescue and removal works during dewatering of main channel and cofferdammed sections. These mitigations should be carried out by an ecologist under licence from NPWS (crayfish) or IFI (fish).

- Strategy and timing within the sequence of works for placement/ installation of fisheries enhancements / habitat restoration measures. It is the authors understanding that EREP works will occur in concurrence with deepening operations. The IFI's priorities for the stretch should be agreed in detail with the OPW in advance of the works so that the local bed levels and gradients are adapted within the framework of the measure, allowing the IFI to achieve the kinds of gradients they need in particular areas without interfering with hydraulic and other objectives and constraints of the overall measure.

The following more detailed suggestions for mitigations apply:

Habitat and Fisheries

Dr. Martin O'Grady, IFI Senior Research Officer, made an on-site assessment of the affected reach of the Craughwell River downstream of Craughwell Village and set out details of fisheries enhancement (EREP) goals for the reach in a formal report included in Appendix 3 of **Appendix A** to this EIS. The approach is to restore the channel to a "Type C" riffle-pool-glide habitat which will increase the suitability of the stretch for various size classes of salmonids. A total of 13 new, well defined pools will be created in the reach with associated gravelled riffle areas, while glides will be enhanced by boulder and stone deflector placement. Restoration of local habitat diversity, reintroduction of flow and substrate diversity and limiting of riparian cover removal will all assist in maximising residual microhabitats available for fish, crayfish and macroinvertebrates in the deepened stretch.

It is also recommended that enhancement measures (as designed into the works) should be modified afterwards, if and as required, following evaluation of their performance.

To mitigate predicted post-works water velocity increases near Craughwell Village during high return period flooding (2 and 5 year) it is critical to re-introduce stable hydraulic refuges to the deepened channel in order to reduce negative impacts on fisheries and crayfish.

Depending on the priorities for fisheries enhancement in that reach (e.g. pool creation, riffle reinstatement etc.), stable mid channel boulder placements should be incorporated into the EREP in order to provide hydraulic refuges during these normal (higher frequency) floods. The reach between the Masonry Arch Bridge and just downstream of the Railway Bridge requires special focus in terms of creating refuges from hydraulic stress associated with predicted post-works velocity increases. Boulder placements or boulder/large cobble deflectors at low flow channel margins would be more beneficial to crayfish since they tend to avoid faster mid-channel flows.

Sediment Release

It is unknown what the residual substrates will be following regrading but if these are erodible (e.g., gravelly silt) this could lead to suspended solids being temporarily transported downstream to Rahasane Turlough. To prevent this, it has been agreed that the surface 30 to 40 cm of coarse substrates (gravel, cobble, boulder and coarse sand) will be set aside and stored from each 50 m stretch which is being excavated using the advancing cofferdam method, and then replaced when the bed has been excavated. It has been incorporated into the preliminary deepening design that it may be necessary to excavate to a slightly deeper level to accommodate the replacement material and additional EREP materials while retaining the desired, final bed levels. These measures are expected to protect the bed from erosion during floods while at the same time providing cover for parr and older fish.

The use of heavy machinery along the banks, e.g. for both excavation and insertion and removal of sheet-piling, should be managed carefully along the river's edge in order to minimise bankside damage and erosion. In order to facilitate this, a temporary running track or geotextile and hard-core track along one bank should be considered along with silt fences between construction sites and the river as a precautionary measure. This would help prevent heavy rutting of banks and solids washout to the river. Construction vehicles should not enter the channel unless within the confines of a coffer dam.

Substrate Removal & Stockpiling

In the area of riffle downstream of the masonry stone arched bridge in Craughwell the top 30 cm layer of coarser substrate in the channel which will need to be removed prior to deepening should be removed and stockpiled safely on the banks. The substrate should be removed in two layers, i.e. the top coarse layer which consists mainly of small cobbles and scattered small boulders followed by a lower gravel / coarse sand layer. These separated layers should be removed from each area in turn and also stored separately on geotextile on the bank. This substrate should be used in channel reinstatement following deepening.

Fish Rescue during Channel Dewatering on the Craughwell River

The contractor must liaise closely with the IFI at the time that the river is to be by-passed so that they and or their agents are in a position to carry out all necessary fish rescue. The size of the channel would ideally necessitate two electrofishing teams to be present on the day of the damming of the channel, one of which will have to be a boat mounted operation to handle the deeper waters at the upstream end. It is unlikely that all lamprey, and perhaps eel, will be removed during the electrofishing and the teams will have to remain on site until the water levels have fully dropped to see if more fish can be retrieved from the deeper areas upstream. All species should be transported in large bins of oxygenated water to suitable habitats upstream.

Mitigation for Potential Impacts On White-Clawed Crayfish

It is likely that even with stringent mitigation, the construction phase impact is likely to be significant for crayfish as not all of the population can be recovered following dewatering of the main channel. The contractor must liaise closely with the NPWS well before the river is to be by-passed, or cofferdammed, so that they can inform conditions surrounding all necessary crayfish removals. A very high number of crayfish are likely to emerge from dry substrates when the main channel is drawn down. It is not feasible or efficient to attempt advance removal of crayfish from the affected stretch. A strategy must be in place to capture, store and relocate crayfish as they emerge from refuges during the draw down. Such a strategy will require specialist assistance by an ecologist and must be approved by and agreed with the NPWS. A crayfish specialist must be on-site for crayfish removals and relocation along with a team of *crayfish collectors*, plentiful enough to rescue the great numbers that may emerge quickly and be subject to desiccation. Enough time must be allowed for the rescue/removal operation to be carried out. An upstream relocation of crayfish is advisable, so that crayfish don't suffer further impacts that may arise from spills or sedimentation downstream of the construction area. The likelihood of crayfish survival after the relocation is considered moderate, given that there is plenty of suitably diverse habitat present, upstream on the Craughwell River, although a certain amount of mortality through increased predation, for example, is expected. In channel works should be avoided within the sensitive period for crayfish, i.e., November to June, inclusive (Peay, 2000), and this is particularly relevant for the main channel diversion, which should not occur until mid-July at the earliest.

EREP measures proposed are likely to provide for specific habitat requirements of crayfish. The critical factor in crayfish distribution is presence of diverse refuges (e.g. Peay, 2003; Besson *et al.,* 2008; Broquet, 2002) such as cracks and crevices in bedrock, small boulders, groups of larger cobbles and tree roots. Of these, reinstatement of shallow bouldery glides and placing of groups of larger cobbles and small boulders at low flow margins of runs and riffles ought to be achievable in the Craughwell reaches. Besson *et al.* (2008) reported a link between lack of shade and absence of crayfish in habitat that would otherwise have been optimal for their presence, a finding also reported by Broquet *et al*. (2002). Shade from riparian tree cover is very important in this stretch of the Craughwell River since residual channel hydromorphology will not facilitate growth of marginal emergent macrophytes which can offer an alternative to tree shading. It is essential that, at the very least, patches of overhanging tree cover are left in-situ at intervals along the channel banks. Ideally one bank should not be subject to any significant tree removal at all.

Removing and stockpiling substrates from the works area for use in reinstatement will prevent crushing and cracking of larger stone which are important constituents of crayfish habitat in the stretch. If used, pumps in the watercourse should have a mesh screen to avoid intake of crayfish.

Successful EREP measures, as proposed, should increase the success of crayfish recolonisation in the affected reach as long as there is enough focus on placement of rocks and boulders in margins of faster flowing reaches, for example, to offset the impact of increased flood velocities in the new channel. Crayfish populations should be monitored, in agreement with the NPWS, for a two to three year period following works.

Underpinning of Railway Bridge

If bulk liquid concrete is being poured into shuttering within the cofferdams these will need to be well sealed in case of spills and all pouring events need to be carefully supervised in case of spills. All contaminated waters which enter the cofferdams will need to be pumped to settlement facilities before they are discharged to the river. If they are contaminated with cement, they will have to be removed off site for neutralisation and safe disposal.

Monitoring

Fisheries monitoring within selected reaches of the Craughwell River is recommended, to gauge the effectiveness of habitat reinstatement and EREP. Pre-works (baseline) and post-works (Year 1 and 3) surveys should be included. Crayfish presence/absence surveys (with broad abundance scale) should also be carried out within selected reaches. If habitat is suitable, translocation of crayfish into the deepened reach could be considered to assist the rate of recolonisation.

11.5.7 Culvert Replacements – Aggard Stream

It is recommended that culverts should be inserted only during summer low flows, or preferably when these small channels are dry. The drains should be bypassed, piped around or pumped over, so that the culverts can be installed in the dry. Works should occur before any vegetation is cleaned from the drains so that any silt arising from culvert insertion can be trapped in the vegetation in the sections of drainage channel between each. Culverts should be inserted in an upstream to downstream sequence. No culverting should take place during or after heavy rainfall. Good engineering practise would ensure that culverts bed levels are set so that no barriers to upstream and downstream fish movement are created.

11.5.8 Drainage Maintenance – Aggard Stream

General mitigation should involve implementation of the OPW's ten point environmental training programme (OPW, 2011) and Environmental Drainage Maintenance (EDM). Further measures set out under OPW's Environmental Management Protocols & Standard Operating Procedures (EMPs & SOPs) with respect to white-clawed crayfish and lamprey species, should be used, including the requirement to record and report presence of Annex II species (OPW, 2011) and rescue / return any removed fauna to the stream.

In the case that some localised silt and vegetation removal is essential, the general strategy should include:

- 'Minimalist' approach, i.e. remove major obstructions to main channel flow only.

- Work with natural fluvial geomorphic principles rather than against them, i.e. maintain the meander that the river has created through self-narrowing.
- Retain low flow channels within the stream cross-section.
- Reprofile only to minimum low water line.
- Never remove hard substrates from below the water line.
- Maintain bankside vegetation and marginal, overhanging cover of Canary grass (*Phalaris arundinacea*) where possible. This is important for crayfish and for fisheries.
- Leave stretches with no apparent conveyance issues alone, especially stony riffles which often have the highest fisheries and crayfish value - these will act as restocking areas.
- Retain tree cover – cutting lower branches where obstruction is evident.
- Do not remove bank vegetation on working bank.
- Leave far bank untouched as natural refugia and restocking areas.
- Work in an upstream direction.
- Collect crayfish and lamprey from spoil and release them to suitable habitat upstream of works.

The degree of sediment deposition in flowing channels is a key factor for juvenile lamprey. Areas where sediment can accumulate and where juvenile lampreys are likely to accumulate are often targets for removal in channel maintenance but some of these need to be left in situ along the river corridor. Juvenile lamprey have been shown to rapidly recolonise suitable areas of silt following maintenance or disturbance (King *et al.*, 2008).

Pre-works consultation between the IFI and OPW should be undertaken to confirm which stretches of the Aggard Stream should remain completely untouched apart perhaps from bank-side terrestrial vegetation trimming. In other sections which will require localised cleaning, the stretches and approaches should be agreed in detail between both bodies and follow the OPW SOPs. It is worth considering an ecologist being present to supervise lamprey and crayfish rescue work during in-stream maintenance on the lower Aggard, since these species are likely to be abundant there.

The OPW are familiar with walkover surveys to identify important habitat features that should be protected, such as riffles and marginal macrophyte stands that could support juvenile crayfish. These skills need to be applied in the Aggard, and should perhaps be identified by an ecologist, given that cumulative impacts of the scheme are likely to be significant with respect to loss of crayfish populations in the Craughwell River.

Works should follow general timing restrictions with respect to all three lamprey species, salmonids and white clawed crayfish, meaning in-stream works should, ideally, occur in August and September.

11.5.9 Rahasane Turlough SAC

Indirect impacts arising from sediment release from construction sites upstream of Rahasane Turlough must be carefully managed and monitored for effectiveness at source. This is essential in terms of minimising turbidity and ensuring protection of Annex I habitat [3180] “Turloughs” for which the Rahasane Turlough SAC is designated.

Monitoring

Hydrological models predict virtually no changes to the hydrological regime of Rahasane Turlough as a result of the scheme. Careful long-term monitoring of post works water levels must, however, be carried out with the view to detecting any changes to the turlough hydrological regime. Vegetation zonation patterns should be monitored by a turlough specialist for a number of years (to be determined by and carried out by a turlough vegetation specialist) as this will provide the strongest biological indicator of any hydrological alterations that may be occurring which may, in turn, be affecting the fully aquatic elements of the turlough ecology.

Remediation Strategy

A comprehensive remediation strategy must be set out detailing how the hydrological regime of the turlough will be restored in the event that unforeseen post-works changes in turlough hydrology and/or biology are found to occur. A strategy statement should be drawn up and agreed between all parties, including NPWS, at the detailed design stage. The strategy needs to be a feasible engineering solution, e.g. the closure of installed Rinn Bridge flood eye(s), or re-introducing channel constriction (infill of two-stage channel) in the Rinn Bridge reach.

11.6 RESIDUAL IMPACTS

11.6.1 Channel Widening: Dunkellin River

Provided the construction approach is specified and careful mitigation is implemented to address the main issue of sediment loss during construction, the residual impact on aquatic ecology is likely to be **slightly negative** overall, mainly because of the long-term loss of natural riparian cover along the southern (true left[20]) river bank. Additional broadleaved tree and shrub plantings and perhaps fencing on the right bank, if they were included as mitigation may help offset long-term impacts of this measure. The overall **positive** impacts of velocity reductions during normal, high return flood events (2 and 5 year) and appropriate, strategically placed EREP measures are likely to be moderately significant and may also offset the effect of ongoing, long-term, left bank riparian vegetation management.. The effectiveness of EREP measures should be monitored, before and after works, in selected reaches.

11.6.2 Bridge Works: Dunkellin River

Killeely Beg Bridge Replacement

If all mitigation outlined in **Section 11.5.2** is properly implemented, there will be an **imperceptible, neutral** residual impact overall.

Dunkellin and Rinn Bridges – Flood Eye Insertion

If all mitigation outlined in **Section 11.5.2** is properly implemented, there will be an **imperceptible, neutral** residual impact overall.

11.6.3 Salmon Counter Relocation: Dunkellin River

A relatively short stretch of natural habitat on the Dunkellin River will be permanently replaced with a shallower concrete substratum, however the main issue with this structure is to ensure it is fully passable by all three native lamprey species and eels. If all general mitigation outlined in **Section 11.5.3** is properly implemented and high passage efficiency is ensured for all fish species including

[20] Left bank of the river looking downstream

lampreys and eel, there is likely to be an **imperceptible**, **neutral** residual impact overall. Improving/ensuring fish passage efficiency of this structure would, in fact, be considered a **positive** impact compared to the existing situation.

11.6.4 By-pass Channel Deepening: Craughwell River

If all mitigation outlined in **Section 11.5.4** is properly implemented, there will be an **imperceptible, neutral** residual impact overall.

11.6.5 Channel Deepening: Craughwell River

Crayfish Recolonisation

Even with crayfish rescue and relocation factored in (**Section 11.5.6**), a great many crayfish along 950m of river channel will suffer mortality since it is almost impossible to locate and collect all individuals, especially juveniles. Those crayfish not collected during rescue will fall prey to otters and birds on the first night following any draw down period. This represents a moderate negative impact on crayfish populations in the stretch, the effects of which are likely to last for the short-medium term until full recolonisation of the reach occurs.

Crayfish are present both upstream and downstream of the affected stretch and will gradually recolonise the area, though populations may take many seasons to reach pre-construction levels.

The success of recolonisation is entirely dependent upon the level to which habitat is appropriately reinstated. It is difficult to speculate, but over a distance of 950 m, recolonisation can be expected to occur at a slow rate (Demers & Reynolds, 2002). Radio telemetry studies have shown individual crayfish can move up to 300 m in ten days, but mean daily movement in these studies was only 4.6 m +- 3.0 m for males, and 1.5 m +-1.0 m for females (Robinson et al., 2000). Besson *et al.* (2008) showed in telemetry studies that crayfish generally show a low tendency to move over long distances and that males (in particular) show greater mobility. Recolonisation can be expected to occur in both upstream and downstream directions by adult crayfish and by active and passive downstream drift of juveniles. Robinson *et al.* (2000) noted a tendency for large adults to prefer downstream movement. The preservation of the Aggard Stream crayfish population may be important to ensure that recolonisation stock are present downstream, although the extent to which they might move back up into the deepened Craughwell reach is unknown. Capture and relocation of a number of adult crayfish back to reinstated riffle areas a short period of time after the construction period (when some invertebrates and flora have re-established) may speed up recovery of the crayfish population. Relocation and subsequent successful utilisation of new territory by white-clawed crayfish has been shown by Besson *et al.* (2008) in telemetry studies, but they emphasized the importance of presence of habitat features that are conducive to crayfish colonisation. EREP measures in the deepened reach are likely to provide suitable crayfish refuge habitat. The loss of bankside shading may limit crayfish recolonisation along the deepened stretch of the Craughwell River to some extent but this impact will be greatly reduced if regular patches of overhanging tree cover are left in-situ at intervals along the channel banks, and ideally if tree shade on one bank is retained in entirety.

Fish Recolonisation

Fish will begin to recolonise the reach immediately that the channel is re-opened. Full, feeding opportunities in the stretch will reach pre-construction levels in line with recolonisation by invertebrates (one to two seasons).

Aquatic Macroinvertebrates and Plants

Benthic invertebrates and aquatic plants will begin to recolonise immediately and will probably be up to full biomass within one to two seasons. Plants, especially mosses, will take longer to reach pre-construction levels.

Residual Habitat and EREP

Deepening of 950 m of the channel will cause loss of the former habitat type with the residual habitat dependant largely on two things: (i) the setting of bed levels during deepening that allow for a diversity of replacement habitat to be reinstated; and (ii) the adequacy and timing of EREP / fisheries enhancements employed. With (i) and (ii) being designed into the project from the outset, as is proposed, recovery time for aquatic communities in this section of the Craughwell River will be greatly reduced allowing for populations of Annex II species (salmon; lamprey; crayfish) and trout to reach ,at least, pre-construction levels in a relatively short time period. With (i) and (ii) fully accommodated within the detailed design, as is described by Dr. Martin O'Grady, with 13 pool/riffle sequences and adequate boulder and deflector placements, there is potential for the outcome to be very good for all Annex II species. The residual impact, with successful EREP and all mitigations in place is likely to be **neutral** or even **positive** and **long-term** or **permanent** for fish and aquatic invertebrates, including crayfish. It is recommended that the effectiveness of EREP measures be monitored, before and after works, in selected reaches.

11.6.6 Culvert Replacements –Aggard Stream

Provided all mitigations outlined in **Section 11.5.7** are carefully implemented, the residual impact will be **imperceptible.**

11.6.7 Drainage Maintenance – Aggard Stream

Provided all mitigations outlined in **Section 11.5.8** are carefully implemented and in-stream works are confined, as described, to the removal of obvious obstructions only, then the residual impact will be **slight to moderate negative and short term,** locally.

11.6.8 Rahasane Turlough SAC

Hydrological models predict virtually no changes to the hydrological regime of Rahasane Turlough as a result of the scheme, hence the potential for significant impacts on the fully aquatic elements of turlough ecology is low. Even so, long-term monitoring of: (i) post-works water levels/ hydrology, and; (ii) vegetation zonation patterns as indicators of biological change, are essential to the mitigation. There needs to be a feasible remediation strategy in place to restore the hydrological function of Rahasane Turlough in the event that post-works hydrological changes are found to have occurred.

If all mitigation is implemented at upstream construction sites as detailed in **Section 11.5.9**, then residual impact on Rahasane Turlough arising from sedimentation or turbidity are likely to be **imperceptible** and **short term** at worst**.**

The conservation objective for Rahasane Turlough SAC (000322) is to maintain or restore the favourable conservation condition of the Annex I habitat "Turloughs" [3180] for which the SAC has been selected (NPWS, 2011). Favourable conservation status of a habitat is achieved when:

- its natural range, and area it covers within that range, are stable or increasing, and
- the specific structure and functions which are necessary for its long - term maintenance exist
- and are likely to continue to exist for the foreseeable future, and
- the conservation status of its typical species is favourable.

Given that the hydrological model predicts no significant changes to turlough hydrology, it is very likely that, so long as upstream in-channel works are appropriately mitigated and sequenced, the proposed scheme will not negatively affect the structure, function, range or area of Annex I Habitat 3180 "Turloughs" and hence will maintain "favourable conservation condition" of the SAC.

Table 11.12 summarises the potential imapcts arising in the aquatic environment as a result of the scheme.

Table 11:12 **Aquatic Ecology - Potential Impacts, Mitigations and Residual Impacts of Measures Proposed Under the Dunkellin River & Aggard Stream Flood Relief Scheme**

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
Lower Dunkellin River channel widening (two-stage channel): **Between N18 Bridge and Dunkellin Bridge.**	No	**Construction:** Impacts primarily associated with sediment loss to Dunkellin River which can negatively affect fish and fisheries habitat. Presence of white-clawed crayfish cannot be ruled out (though not detected in this reach by manual search) and may also be negatively affected by temporary increases in suspended solids levels. Large scale works involving c. 2.5 km of river channel in total.	Moderate negative	Temporary	A detailed design and method statement should be drawn up by the contractor indicating what measures will be taken to avoid, (a) sediment or soil loss and; (b) hydrocarbon contamination, associated with all aspects of the construction phase, and how these will be monitored for effectiveness. See **Section 11.5.1** for standard mitigations and **Section 11.5.2** for specifics. Timing restriction: Although works are not in-stream – they must occur May to September because risk of sediment loss impacts on fisheries. Lamprey spawning in this period (sea lamprey), though it can not be ruled out, is unlikely to be significantly affected as there is limited suitable spawning habitat available in the reach.	Temporary; slight negative
	N/A	**Operational:** Loss of all mature riparian tree cover on left bank along 2.5 km of channel, with regular, ongoing vegetation management; Introduction of narrow, artificial “floodplain” which, during normal, high return period floods, will allow out-of bank flow thus reducing hydraulic	Slight positives and moderate negatives.	Long-term	Retain all riparian canopy over on true right bank; retain fringing reeds and tall marginal plants on left bank for cover. Recommend additional right bank broadleaf plantings or fencing to encourage natural growth. Implement fisheries enhancement (EREP) as per IFI recommendations, and include random boulder placement	Long-term neutral.

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
		stress on in-stream fauna. The hydrological model predicts slight post-works velocity increases in the main channel during rare extreme event floods (> 100 year return), but peak water velocities predicted to decrease during more normal flooding (2 and 5 year events).			in reaches downstream of Dunkellin Bridge as faunal refuges during extreme flows. Monitoring: Pre- and post- works fisheries surveys are recommended in selected stretches (baseline & post-works Years 1 and 3). Crayfish presence/absence surveys (with broad abundance scale) should also be carried out in selected reaches.	
	N/A	**Cumulative:** Potential impacts in association with other measures proposed under the scheme**.** Large scale of works along considerable channel length. Majority of works phased to occur in same period as works at Killeely Beg, Dunkellin & Rinn Bridges, plus in-stream works upstream of Rahasane Turlough.	Moderate negative.	Temporary.	Rigorous implementation and monitoring of sediment control measures within each construction zone. Note: Simultaneous bridge works not considered an additional risk over channel widening works. Note: Suspended solids mobilised from works upstream of the turlough unlikely to reach or impinge on Dunkellin River downstream of Rahasane Turlough.	Temporary, slight negative.
Lower Dunkellin River channel widening: **Dunkellin to Rinn Bridge to Rahasane Turlough**	No.	**Construction:** Impacts primarily associated with sediment loss to Dunkellin River which can affect fish and fisheries habitat. White-clawed crayfish are present and may also be negatively affected by temporary increases in suspended solids levels. Medium scale works involving c. 275 metres of river channel in	Moderate negative.	Temporary.	A detailed design and method statement should be drawn up by the contractor indicating what measures will be taken to avoid, (a) sediment or soil loss and; (b) hydrocarbon contamination, associated with all aspects of the construction phase, and how these will be monitored for effectiveness. See **Section 11.5.1** for standard mitigations and **Section 11.5.2** for	Temporary slight negative.

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
		total.			specifics. Timing restriction: Although not instream – works must occur May to September because of fisheries restrictions. Lamprey spawning in this period (sea lamprey), though it can not be ruled out, is unlikely to be significantly affected as there is limited suitable spawning habitat available in this reach.	
	N/A	**Operational:** Loss of all mature riparian tree cover on left bank along 275 m of channel, with regular, ongoing vegetation management; Introduction of narrow, artificial "floodplain" which, during normal, high return period floods, will allow out-of bank flow thus reducing hydraulic stress on in-stream fauna. The hydrological model predicts slight post-works velocity increases in the main channel during rare extreme event floods (> 100 year return), but post-works water velocities will decrease during more normal flooding (2 and 5 year events).	Slight positives and moderate negatives.	Long-term.	Retain all remaining riparian canopy cover on true right bank; retain fringing reeds and tall marginal plants on left bank for cover. Recommend additional right bank broadleaf plantings or fencing to encourage further natural growth. Implement fisheries enhancement (EREP) as per IFI recommendations, but include random boulder placement in reaches downstream of Dunkellin Bridge as faunal refuges during high flows. Monitoring: Pre- and post- works fisheries surveys are recommended in selected stretches (baseline & post-works Years 1 and 3). Crayfish presence/absence surveys (with broad abundance scale) should also be carried out in selected reaches.	Neutral, long term.
	N/A	**Cumulative:** Potential impacts in association with other measures proposed under the	Moderate negative.	Temporary.	Rigorous implementation and monitoring of sediment control measures within each	Temporary slight negative.

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
		sscheme**.** Works phased to occur in same period as in-stream works upstream of Rahasane Turlough (extended schedule).			construction zone. Note: Simultaneous bridge works not considered an additional risk over channel widening works. Note: Suspended solids mobilised from works upstream of the turlough unlikely to reach or impinge on Dunkellin River downstream of Rahasane Turlough.	
Salmon counter relocation	Yes	**Construction:** Impacts primarily associated with concrete loss (toxicity), sediment loss and hydrocarbon loss to Dunkellin River. Downstream fish, macroinvertebrate and white-clawed crayfish populations can be negatively affected by toxicity and increased suspended solids levels / silt deposition.	Significant negative.	Temporary.	Works occur in dry within cofferdams on alternate halves of the river. A detailed design and method statement should be drawn up by the contractor indicating what measures will be taken to avoid, (a) sediment or soil loss and; (b) hydrocarbon contamination, associated with all aspects of the construction phase, and how these will be monitored for effectiveness. See **Section 11.5.1** for standard mitigations and **Section 11.5.4** for specifics.	Temporary slight negative.
	N/A	**Operational:** Upstream migration barrier for Annex II protected species – Sea / River / Brook lamprey and, possibly, European eel. Sea Lamprey are 'Near Threatened' and at 'Bad' conservation status nationally,; eels are 'Critically	Significant negative.	Long-term.	Conduct literature review to examine effects of similar weirs on lamprey and eel passage. Design new weir structure to ensure high passage-efficiency for all fish species present.	Long term neutral, imperceptible (as long as passage is ensured). Could also be a long-term, significant positive

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
		Endangered', both on account of current & ongoing threat of barriers to migration.				compared to existing situation - if passage through the weir is currently unfavourable to lampreys and eels.
	N/A	**Cumulative:** Potential impacts in association with other measures proposed the scheme**.** **Phasing of this measure has not been specified.**	Slight negative	Temporary.	Phasing of works – Recommend removal of existing salmon counter just prior to channel widening works. Reconstruct weir at least one year following completion of channel widening. New salmon counter/weir must be designed to ensure high passage efficiency for all species including lampreys and eel.	Temporary neutral imperceptible
Bridge works downstream of Rahasane Turlough (three locations): • **Killeely Beg;** • **Dunkellin; and** • **Rinn.**	No	**Construction:** Impacts primarily associated with sediment and hydrocarbon loss to Dunkellin River. Downstream fish, macroinvertebrate and white-clawed crayfish populations can be negatively affected by toxicity increased suspended solids levels / silt deposition.	Moderate negative.	Temporary.	A detailed design and method statement should be drawn up by the contractor indicating what measures will be taken to avoid, (a) sediment or soil loss and; (b) hydrocarbon contamination, associated with all aspects of the construction, and how these will be monitored for effectiveness. Concrete loss impacts are not envisaged (pre-cast flood eyes), but concrete use, if required should be specified and standard mitigations employed. See **Section 11.5.1** for standard mitigations and **Section 11.5.3** for specifics. Phase Rinn Bridge works to occur at same	Temporary neutral imperceptible.

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
					time as channel widening on that reach (2016).	
	N/A.	**Operational:** N/A	Imperceptible neutral.	Long term.	N/A.	Long term neutral imperceptible.
		Cumulative: potential impacts in association with other measures proposed in relation to the scheme**.** Bridge works scheduled for same period as channel widening construction period.	Slight negative	Temporary to short term (depending on actual phasing of works)	Bridge works, if carried out in conjunction with channel widening at each location, are unlikely to increase risk level over and above those associated with channel widening alone – as long as detailed method statement, mitigations & good site management practise are adhered to.	Short-term neutral –imperceptible.
Rahasane Turlough.	No.	**Construction:** No works within SAC.	N/A.	N/A.	N/A.	N/A.
	N/A	**Operational:** potential for changes to turlough hydrological regime. Note that the scheme has been devised so that turlough hydrology is not significantly affected - models predict only a very slight change to depth exceedance regime at 50 percentile and 5th percentile flows (between 0.02m and 0.06m).	Neutral imperceptible (based on model predictions).	Long-term.	Long term, post-works, monitoring of turlough water levels and vegetation zonation pattern - to detect changes in the case they do arise. . Presentation, at final design stage, of a comprehensive, feasible strategy for restoring turlough hydrological function in the case that post-works hydrological/ ecological changes are found to be occurring.	Long-term neutral imperceptible.
		Cumulative: potential impacts in association with other measures proposed in relation to the scheme**.** Risk of increase in suspended solids originating from upstream works in Craughwell River and Aggard Stream – turbidity being	Slight negative.	Temporary or Short term (depending on actual sequencing of upstream works).	Upstream works to occur in the dry under low flow conditions + standard mitigations for sediment loss. Appropriate sequencing of upstream works to limit potential for suspended solids generation.	Short-term neutral Imperceptible.

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
		the primary factor.			Aggard channel maintenance should not occur when in-stream works are planned within the Craughwell River.	
Channel deepening and bridge works from upstream Aggard **Stream to upstream R446 Bridge**	Yes	**Construction:** Initial details of methods and strategy for executing river deepening and bridge works (which to a large extent will occur simultaneously and share the same suite of potential impacts) are provided by the works desription. Cofferdam sequencing will occur covering alternate halves of the river moving in an upstream direction which is the least invasive method under the circumstances. A river diversion through the bypass channel will occur to facilitate works in the dry near Craughwell Village. Construction impacts include: (1) Dewatering of 950 m of main channel (350 m river diversion at Craughwell + cofferdam sections downstream of bypass channel confluence) causing mortality of fish, white-clawed crayfish, macroinvertebrates and plants. Annex II listed species present include Atlantic Salmon, Sea/River/Brook Lampreys and	Significant negative.	Short term.	A detailed design and method statement should be drawn up by the contractor indicating what measures will be taken to avoid, (a) sediment or soil loss and; (b) hydrocarbon contamination, associated with all aspects of the construction phase, and how these will be monitored for effectiveness. See **Section 11.5.1** for standard mitigations and **Section 11.5.6** for specifics. The design of the river enhancement works together with the associated construction works method statements will be the subject of detailed design between Galway County Council, the OPW and Inland Fisheries Ireland upon conclusion of the planning process. The method and strategy statements should specify the engineering methods necessary during construction phase in order to achieve positive outcomes in terms of the goals IFI have set out for EREP in the Craughwell reach (Appendix 3 contained in **Appendix A** to this EIS). The method statement must address timing and sequencing of river diversion in relation to cofferdam works downstream, plus details of how riverbank access routes will be protected from erosion. All	Long-term neutral to positive.

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
		White-clawed crayfish. Critically Endangered European eel present. (2) Impacts associated with sediment, hydrocarbon and concrete loss to Craughwell / Dunkellin River.			methods should be agreed with NPWS with regard to protection of Annex II species and habitats within their remit. Fish and crayfish rescue and relocation during channel draw down – must be carried out by an ecologist under licence from IFI/NPWS. Timing restrictions on in-stream works: Salmonids – no works Oct.1st to April 31st; Lampreys – avoid major in-stream disturbance just upstream of Aggard Stream confluence (potential sea lamprey spawning location) in June/July.	
	N/A	**Operational:** High likelihood of hydromorphological changes along 950 m of main channel, resulting in loss of fisheries, macroinvertebrate and white-clawed crayfish habitat. Loss of mature riparian tree cover. Considerable increases in peak channel velocities during normal, high return period floods (2 and 5 year events) between R446 and downstream of Railway Bridges.	Significant negative.	Long-term or permanent.	Dr. Martin O'Grady, Senior Reasearch Officer with the IFI has set out details of EREP goals and possibilities for the Craughwell River reach affected. The overall goals is to recreate a "Type C" channel with 13 new pools and associated gravel riffle areas, along with boulder and deflector placements in glides to increase habitat diversity and provide hydraulic refuges. An extra depth has been included in the bed level profile for deepening works to accommodate for EREP materials to be placed or incorporated into the deepening/EREP design. Mature tree cover will be retained where possible, although IFI note there may be benefit from reducing current tunnelling effects.	Long-term or permanent neutral or positive.

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
					Stockpile top layers of removed bed material for use in habitat reinstatement. Reintroduce stable boulder and coarse material into deepened channel to provide hydraulic refuges for fish and crayfish during peak flows. Specify details of EREP design at final design stage of the project and include for works during regrading (as opposed to implementation after regrading). Monitoring: Pre- and post- works fisheries surveys are recommended in selected stretches (baseline, Year 1 and Year 3). Post-works crayfish monitoring could be carried out in post-works Years 1 and 3.	
		Cumulative: potential impacts in association with other measures proposed in relation to the scheme**.** These measures (deepening and bridge works) and by-pass regrading have the greatest potential for cumulative impacts of sediment, hydrocarbon and concrete loss on aquatic habitat downstream of the bypass confluence with Craughwell River.	Significant negative.	Short-term.	Rigorous implementation of measures and strategies to avoid concrete and hydrocarbon loss and avoid / limit sediment release. With good site management practise and good engineering, the risks of significant impact with regard to these issues are likely to be low.	Short-term slight negative.
Regrade bypass channel in Craughwell.	Yes.	**Construction:** primarily impacts associated with sediment loss to Craughwell River. Fish, macroinvertebrate	Moderate negative.	Temporary.	A detailed design and method statement should be drawn up by the contractor indicating what measures will be taken to avoid, (a) sediment or soil loss and;	Temporary imperceptible neutral.

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
		and white-clawed crayfish populations downstream can be negatively affected by increased suspended solids levels / silt deposition.			(b) hydrocarbon contamination, associated with all aspects of the construction phase, and how these will be monitored for effectiveness. Ensure the potential for contaminated washout from the bypass channel to Craughwell River is avoided through good engineering and site management practice. See **Section 11.5.1** for standard mitigations and **Section 11.5.5** for specifics. Works are phased so that there is a suitable settling period following channel excavation/bridge underpinning prior to flow from the Craughwell River being diverted into the channel.	
	N/A	**Operational:** Possibility of higher flooding frequency along by-pass channel increasing risk of sediment loss to Craughwell River when channel maintenance occurs.	Moderate negative.	Temporary.	Any future maintenance of the by-pass channel should occur during dry months when there will be sufficient time for settlement of loose sediment before the channel is likely to re-flood.	Temporary imperceptible neutral.
		Cumulative: impacts in association with other measures proposed in relation to the scheme**.**	Significant negative.	Short-term.	Phased for May to October, but should occur in the earlier of these months to allow for settling of any loose sediment prior to the winter spawning period in the Craughwell channel.	Short-term imperceptible neutral.
Aggard Stream – Channel	Yes	**Construction:** Mobilisation of suspended solids when silt deposits are removed, which	Slight positives and between slight	Short-term	Adhere strictly to the minimalist approach proposed – ought to involve	Short-term moderate negative.

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
maintenance		can lead to negative impacts downstream on fisheries, macroinvertebrates and crayfish and their habitats. Removal of vegetation and fauna, including Annex II species (crayfish, lamprey ammocoetes in reaches where silt deposits & conveyance obstructions are removed. Changes to stream hydromorphology as a result of in-stream reprofiling works.	and significant negatives		very little in-stream work. No maintenance in faster flowing riffle habitats. No dredging or channel re-profiling. Implement OPW's 10-point Environmental Drainage Maintenance (EDM) approach. OPW's Environmental Management Protocols & Standard Operating Procedures (SOPs) with respect to salmonids, white clawed crayfish and lamprey species, should be used, including the requirement to record and report presence of Annex II species and rescue and return any removed fauna to the stream. An ecologist should supervise fauna rescue during any instream works on lower Aggard reaches. See **Section 11.5.8** for specific mitigations.	
	N/A	**Operational:** Loss of in-stream vegetative cover utilised by macroinvertebrates, crayfish and fish in selected reaches. **S**elective, light-touch, maintenance (as proposed) is likely to limit this impact somewhat.	Moderate negative (locally).	Short term.	Leave regularly spaced reaches untouched as refuges for fauna. Leave one bank and marginal vegetation untouched.	Short-term slight negative.

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
		Cumulative: impacts in association with other measures proposed in relation to the scheme**.** Phasing of this measure not specified.	Moderate negative.	Short term.	Maintenance of the Aggard Stream could occur in August/September of 2014 or 2017 in order to avoid cumulative impacts with respect to the potential for mobilisation of suspended solids downstream to Rahasane Turlough.	Short-term slight negative.
Cregaclare drainage channels culvert replacements.	Yes.	**Construction:** potential for generation of suspended sediments during insertion which can lead to negative impacts downstream for fisheries, macroinvertebrates and crayfish and their habitats.	Significant negative (locally).	Short-term.	Insert culverts only during summer low flows - preferably when channels are dry. Or - drains should be bypassed, piped around or pumped over, so that the culverts can be installed in the dry. Works should occur before any vegetation is cleaned from the drains so that any silt can be trapped. Insert culverts in an upstream to downstream sequence. No culverting should take place during or after heavy rainfall.	Short-term slight negative.
	N/A	**Operational:** If the bases of the new culverts remain above the drain/stream bed then the passage of fish upstream and downstream may be prevented during periods of low flow, although fisheries values of these upper catchment channels are low.	Slight negative.	Long-term.	Insert culverts with appropriate bed level so that fish passage is ensured.	Long-term imperceptible neutral.
		Cumulative: impacts in association with other	Slight negative.	Temporary.	These works, in small semi-permanent channels high in the Aggard catchment,	Temporary imperceptible

		Potential Impact without Mitigation			Impact with Mitigation	
Measure	**Instream works**	**Type**	**Quality and significance**	**Duration**	**Mitigation**	**Residual Impact (Duration, quality and significance)**
		measures proposed in relation to the scheme**.**			are unlikely to significantly affect downstream sediment mobilisation to the point that Rahasane Turlough would be affected, although they should be phased to occur prior to drainage maintenance in the Aggard system in order to minimise any potential for cumulative impact.	neutral.

11.7 CONCLUSION

Killeely Beg Bridge replacement, flood eye insertion at Dunkellin and Rinn Bridges, bypass channel deepening in Craughwell village and culvert replacements on the Aggard Stream all have potential for between slight and significant impacts during construction phase, but with careful mitigation the likelihood of significant impacts is low and the residual impact of these works will be slightly negative or imperceptible and neutral.

The removal of the existing and rebuilding of a new salmon counter on the lower Dunkellin River provides an opportunity to ensure that the structure is fully passable by all three lamprey species and eels. This would, potentially, be a significant positive impact compared to the current situation if upstream passage through the existing weir is, in fact, limited. Recent evidence suggests that weirs of the same or similar design as the existing salmon counter have potential to be migration barriers to lamprey species (e.g., Russon *et al*., 2011), and possibly eels. We recommend that, prior to finalising the design of the new structure, a review of recent literature on the effects of similar weirs on lamprey and eel passage is carried out and that alternative weir designs are considered. The Water Framework Directive (WFD) requires mitigation of existing morphological impacts in waterbodies in order to ensure Good Ecological Status. Given the Dunkellin River is currently at Poor Ecological Status and 'At Risk' owing to morphological pressures, every effort must be made to avoid the reintroduction of a structure that is likely to have high passage efficiency for protected Annex II fish species (sea, river and brook lampreys), Critically Endangered European eels and Near Threatened Sea lampreys.

Channel widening on the Dunkellin River downstream of Rahasane Turlough, on account of its extensive scale, has potential for at least moderate negative construction phase impacts, which may be exacerbated cumulatively, given that 2.5 km of channel works are scheduled to be undertaken one season (May to September). However, the impact can be reduced to a temporary slight negative, overall, if the correct approach and mitigations are employed, primarily in the area of controlling and avoiding sediment loss. Operationally, additional planting of the right bank riparian corridor and retention of any existing canopy cover is recommended to offset the long-term loss of riparian cover and the ecological function it currently provides on the left bank of the channel. Models predict post-works increases in channel velocity in the Dunkellin River during extreme (> 100 year event) flooding, that could be slightly negative for aquatic ecology, but, for normal, high return period flood events (2 and 5 year) the effect on aquatic ecology is likely to be positive owing to the effect of over-bank flow which reduces hydraulic stress in the main channel. For the majority of ordinary flows the impact will be imperceptible and neutral. Overall, provided the construction approach is specified and careful mitigation is implemented to address the main issue of sediment loss during construction, the residual impact on aquatic ecology is likely to be long term neutral, as long as right bank riparian canopy cover is not affected and planting is encouraged to compensate for long-term loss of natural riparian cover along true left bank. The positive impacts of velocity reductions during normal flood events and appropriate, strategically placed EREP measures with boulder placements providing additional instream cover are likely to be moderately significant and can offset the effect of long-term, left bank riparian vegetation management.

As long as careful mitigation is applied and works are kept to a minimum, as intended, then the minimalist maintenance proposed on the Aggard Stream will most likely result in slight-to-moderate negative impacts in the short-term. Annex II species (salmon, white-clawed crayfish and lampreys) and some salmonid and lamprey spawning habitat occur within the Aggard system, and, although these populations occur outside of the SAC, the observance of timing restrictions is recommended to cover sensitive periods for all protected species. This means works should ideally occur in August and September. Whilst presence of these species raises the sensitivity of the Aggard sub-catchment it is noted that the overall scale of proposed maintenance works is low - limited to removal of obvious constrictions to flow, with no associated dredging or arterial drainage works. Consideration should be given to having an ecologist present to supervise lamprey and crayfish rescue work during any in-stream maintenance on the lower Aggard as that is where lamprey ammocoetes and crayfish are more likely to be abundant. The scheduling of this measure should occur in August to September and should be scheduled, in order to avoid cumulative impacts, in conjunction with Craughwell River deepening works with respect to the potential for mobilisation of suspended solids downstream to Rahasane Turlough.

Channel deepening and underpinning of bridges on the Craughwell River (which occur simultaneously during successive periods of channel dewatering along the channel) have the potential for significant negative construction, operation and residual impacts on fish and white-clawed crayfish. With respect to the construction phase, whilst fish can be rescued and relocated quite successfully, at least moderate negative impacts on crayfish, locally, are unavoidable. Even including for rescue and relocation of crayfish during channel diversion and cofferdam dewatering, there will be mortality of juvenile crayfish along the 950 m of channel affected by this measure as it is simply impossible to collect all exposed individuals during a recovery operation. No in-stream works should occur between October 1st and July 31st, which takes into account the sensitive periods for salmonid and lamprey spawning and crayfish brooding, although the window could be expanded to include the second half of July if care is taken not to disturb a small, potential lamprey spawning area (unconfirmed) just upstream of the Aggard confluence.

White-clawed crayfish within the Craughwell / Dunkellin River and Aggard Stream occur in abundance outside of the Natura 2000 network (Rahasane Turlough SAC), and are protected, under national legislation, from injury and disturbance and/or damage to their breeding or resting place *wherever they occur* [authors emphasis]. It is important to note that Ireland has a significant conservation responsibility for the species as the only EU country without alien crayfish or widespread incidence of crayfish plague.

The extent to which residual habitat in the Craughwell River is conducive to recolonisation by crayfish and fish will depend on final detail and design of the deepening measure, specifically the extent to which habitat reinstatement and EREP is: (i) feasible, (ii) integrated in the design of works, and; (iii) implemented with regard to fish and crayfish habitat requirements.

Dr. Martin O'Grady, IFI Senior Research Officer, made an on-site assessment of the reach of the Craughwell River affected by the deepening proposal downstream of Craughwell Village, and set out details of fisheries enhancement (EREP) goals for the reach in a formal report included in Appendix 3 of **Appendix A** to this EIS. In his opinion, habitat restoration and reinstatement as a function of fisheries enhancement measures is feasible in this reach. The approach will be to restore the channel to a "Type C" riffle-pool-glide habitat which will increase suitability of the stretch for various size classes of salmonids. A total of 13 new, well defined pools will be created in the reach with associated gravelled riffle areas, while glides will be enhanced by boulder and stone deflector placement. Restoration of local habitat diversity, reintroduction of flow and substrate diversity and limiting of riparian cover removal will all assist in maximising residual microhabitats available for fish, crayfish and macroinvertebrates in the deepened stretch. To mitigate predicted post-works water velocity increases near Craughwell Village during high return period flooding (2 and 5 year) it is critical to re-introduce stable hydraulic refuges to the deepened channel in order to reduce negative impacts on aquatic fauna. The reach between the Masonry Arch Bridge and just downstream of the Railway Bridge requires special focus in terms of creating refuges from hydraulic stress associated with the level of predicted post-works velocity increase during normal flooding.

The success of recolonisation by crayfish and fish in the 950 m stretch of the Craughwell River subsequent to deepening will be entirely dependent upon: (i) the setting of bed levels during deepening that allow for a diversity of replacement habitat to be reinstated; and (ii) the quality and extent of EREP / fisheries enhancements employed. With (i) and (ii) fully accommodated within the detailed design, as is described by Dr. Martin O'Grady, there is potential for the outcome to be very good for all Annex II species. In this case, recovery of habitat and Annex II species populations to near pre-construction levels is likely to be achieved in a relatively short time period following the construction phase. The residual impact, with successful EREP and all mitigations in place is likely to be long-term neutral or positive for fish and aquatic invertebrates, including white clawed crayfish, although the latter will take longer to fully recolonise the deepened reach compared to fish and macroinvertebrates.

Fisheries monitoring within selected reaches of the Craughwell and Dunkellin Rivers is recommended, to gauge the effectiveness of construction phase mitigations, habitat reinstatement and EREP. Pre-works (baseline) and post-works (Year 1 and 3) surveys should be included. Crayfish presence/absence surveys (with broad abundance scale) should also be carried out in selected reaches.

Hydrological models predict virtually no post-works changes to the hydrological regime of Rahasane Turlough, hence the likelihood of significant impacts on the fully aquatic elements of turlough ecology is low. Based on the model predictions, the structure, function, range and area of Annex I Habitat [3180] "Turloughs" within the Rahasane Turlough SAC are not predicted to alter significantly and hence, "favourable conservation status" will be maintained. Turlough specialist, Dr. Roger Goodwillie, reviewed the proposed scheme and commented: "*it seems that flood heights in the turlough will not be affected in a way that will change the ecology significantly*". Even so, long-term monitoring of: (i) post-works water levels / turlough hydrology, and; (ii) vegetation zonation patterns (as the primary indicators of biological change in the turlough) are recommended as essential to the mitigation. A comprehensive and feasible remediation strategy must be set out at the detailed design stage to address how the hydrological function of Rahasane Turlough would be restored in the future in the event that hydrological and/or biological changes are found to have occurred.

If all mitigation is implemented at upstream construction sites and works are sequenced appropriately, negative impacts on Rahasane Turlough arising from export of suspended solids are likely to be imperceptible-to-slight and short term. Suspended solids are likely to settle within glide sections of the Dunkellin River upstream of the turlough and within the turlough drainage channel itself where the impact on the existing habitat will be imperceptible.

11.8 REFERENCES

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12 AIR QUALITY AND CLIMATE

12.1 INTRODUCTION

This section of the EIS assesses the impacts on air quality and climate from the proposed Dunkellin River and Aggard Stream Flood Relief Scheme (the scheme). This chapter should be read in conjunction with the layout plans for the site and project description sections of this EIS (**Chapter 6**).

The assessment identifies the existing ambient air quality and climate in the region and further assesses potential changes to this aspect of the environment as a result of the scheme. Particular attention will be focused on potentially sensitive receptors, such as residential areas in close proximity to the proposed flood relief works. Mitigation measures are also proposed where potentially significant impacts are identified.

12.2 METHODOLOGY

A desktop assessment was carried out to determine the potential impacts of the Dunkellin scheme on the local and regional air quality and on the environment.

12.2.1 Air Quality

Certain combustion products have the potential to affect health and European Union air quality standards are specified to ensure air emissions do not exceed levels that are designed to protect human health and ecosystems.

In May 2008, the European Commission introduced a new Directive on ambient air quality and cleaner air for Europe (2008/50/EC), which has been transposed into Irish legislation through the revised Air Quality Standards Regulations (S.I. 180 of 2011). These regulations are presented in **Table 12.1**. The legislation specifies limit values in ambient air for sulphur dioxide (SO_2), lead (Pb), benzene (C_6H_6), particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), nitrogen dioxide (NO_2) and oxides of nitrogen (NO_x). These limits are mainly for the protection of human health and are largely based on review of epidemiological studies on the health impacts of these pollutants.

The standards presented in **Table 12.1** have been set by environmental and health professionals across Europe following extensive worldwide research and are designed to protect the most sensitive of receptors, including for example elderly humans with existing respiratory ailments and areas valued for their flora and fauna.

Various international initiatives, protocols and directives also exist to limit and reduce emissions at a national level.

The following criteria were considered in the assessment of impact on air quality:

- Air Quality Standards Regulations (S.I. No. 180 of 2011),
- Directive 2001/81/EC on National Emission Ceilings for certain pollutants (NECs) (S.I. No. 10 of 2004), and
- There are no statutory limits for deposition of dusts and industry guidelines are typically employed to determine any impact. The TA Luft (German Government 'Technical Instructions on Air Quality') states a guideline of 350 $mg/m^2/day$ for the deposition of non-hazardous dusts. This value was used to determine the impact of residual dust as an environmental nuisance.

Table 12.1 Air Quality Standards Regulations

Pollutant	Criteria	Value
Nitrogen Dioxide (NO_2)	Hourly limit for protection of human health - not to be exceeded more than 18 times per year	200 $\mu g/m^3$ NO_2
	Annual limit for protection of human health	40 $\mu g/m^3$ NO_2
	Annual limit for protection of vegetation	30 $\mu g/m^3$ NO + NO_2
Benzene (C_6H_6)	Annual limit for protection of human health	5 $\mu g/m^3$
Carbon Monoxide (CO)	Maximum daily 8-hour running mean	10 mg/m^3
Lead (Pb)	Annual limit for protection of human health	0.5 $\mu g/m^3$
Sulphur Dioxide (SO_2)	Hourly limit for protection of human health - not to be exceeded more than 24 times per year	350 $\mu g/m^3$
	Daily limit for protection of human health - not to be exceeded more than 3 times per year	125 $\mu g/m^3$
	Annual limit for protection of vegetation	20 $\mu g/m^3$
Particulate Matter (PM_{10})	24-hour limit for protection of human health - not to be exceeded more than 35 times per year	50 $\mu g/m^3$ PM_{10}
	Annual limit for protection of human health	40 $\mu g/m^3$ PM_{10}
Particulate Matter ($PM_{2.5}$)	Annual target value for the protection of human health (Stage 1 to be achieved by 2015)	25 $\mu g/m^3$ $PM_{2.5}$
	Indicative limit for the protection of human health (Stage 2 to be achieved by 2020)	20 $\mu g/m^3$ $PM_{2.5}$

(Source: S.I. 180 of 2011)

12.2.2 Climate

Reference is made to Ireland's commitment to reduce greenhouse gases nationally. The National Kyoto Target for the first commitment period 2008 – 2012 sets the cap on Greenhouse Gas (GHG) Emissions at 13% above 1990 levels, equivalent to 62.837 million tonnes of CO_2eq. The most recent data submitted by Ireland to the UNFCC in April 2010 indicated that National GHG Emissions in 2008 were 67.44 million tonnes (7.3% above the Kyoto target).

In terms of impacts on climate, the assessment aims to identify and assess the sources and describe the measures in place to minimise releases of compounds with global warming potential. Many natural and human activities generate releases that can contribute to global warming. Due to the diverse and diffusive nature of sources, the effect that the scheme might have on global warming cannot be specifically quantified within this assessment.

Having completed the desktop review, potential impacts resulting from the scheme on existing air quality and greenhouse gas emissions was assessed and where relevant, proposed mitigation measures have been recommended.

In the process of completing this assessment the following publications were consulted:

- Guidelines on the Information to be contained in Environmental Impact Statements', EPA, 2002,

- 'Advice Notes on Current Practice in the preparation of Environmental Impact Statements', EPA, 2003,
- Environmental Protection Agency (EPA) monitoring network assessment, and
- Environment Agency (EA) *Carbon Calculator for Construction Sites*.

12.2.3 Green House Gas Emissions – Carbon Balance

In terms of release of greenhouse gases, the assessment aims to identify and assess the sources and describe the measures in place to minimise releases of compounds with global warming potential. Many natural and human activities generate releases that can contribute to global warming. Due to the diverse and diffusive nature of sources, the effect that the scheme might have on global warming cannot be specifically quantified within this assessment. However, a conservative quantification of the carbon balance for the existing study area site and for the proposed constructions works have been estimated and presented using the carbon calculator for construction activities developed by the Environment Agency (EA) in the UK.

Details of the results of this calculation are presented in **Section 12.4.**

12.3 EXISTING ENVIRONMENT

The Dunkellin River and Aggard Stream Flood Relief Scheme is located over an approximate length of 16 km in total with Craughwell Village and Kilcolgan Village forming the main areas of population. The majority of the scheme will be located in a rural setting with no major industrial undertaking of note operating in the region.

The N18 National Route runs through Kilcolgan and is the primary route between Galway City and Limerick City. The N18 passes over the Kilcolgan River at Kilcolgan Bridge. The N6 National Route which has been reclassified as the R446, runs through Craughwell village in the east of the study area.

The main potential source of air pollution in the area would be emissions from vehicles using this road network. However as the traffic is relatively free flowing the potential for traffic congestion and elevated levels of pollution is not considered high.

The location of the study area is in close proximity to the western coastline and the nature of the prevailing winds, the area is expected to experience clean Atlantic air with only background levels of pollutants. There are no major sources of air pollution in the area, apart from agricultural activities and road traffic.

12.3.1 Air Quality

The Environmental Protection Agency (EPA) carries out ambient air monitoring throughout the Republic of Ireland. They have produced *The Air Quality for Health Index* which divides the island of Ireland into six distinct air quality zones and provides information on current air quality and appropriate health advice for each zone. The six zones are as follows:

- Dublin City,
- Cork City,
- Large Towns,
- Small Towns,
- Rural East, and
- Rural West.

The study area is located in the rural west zone and on the 11/03/2014 this air quality was recorded as being of good quality. Refer to **Figure 12.1** for details.

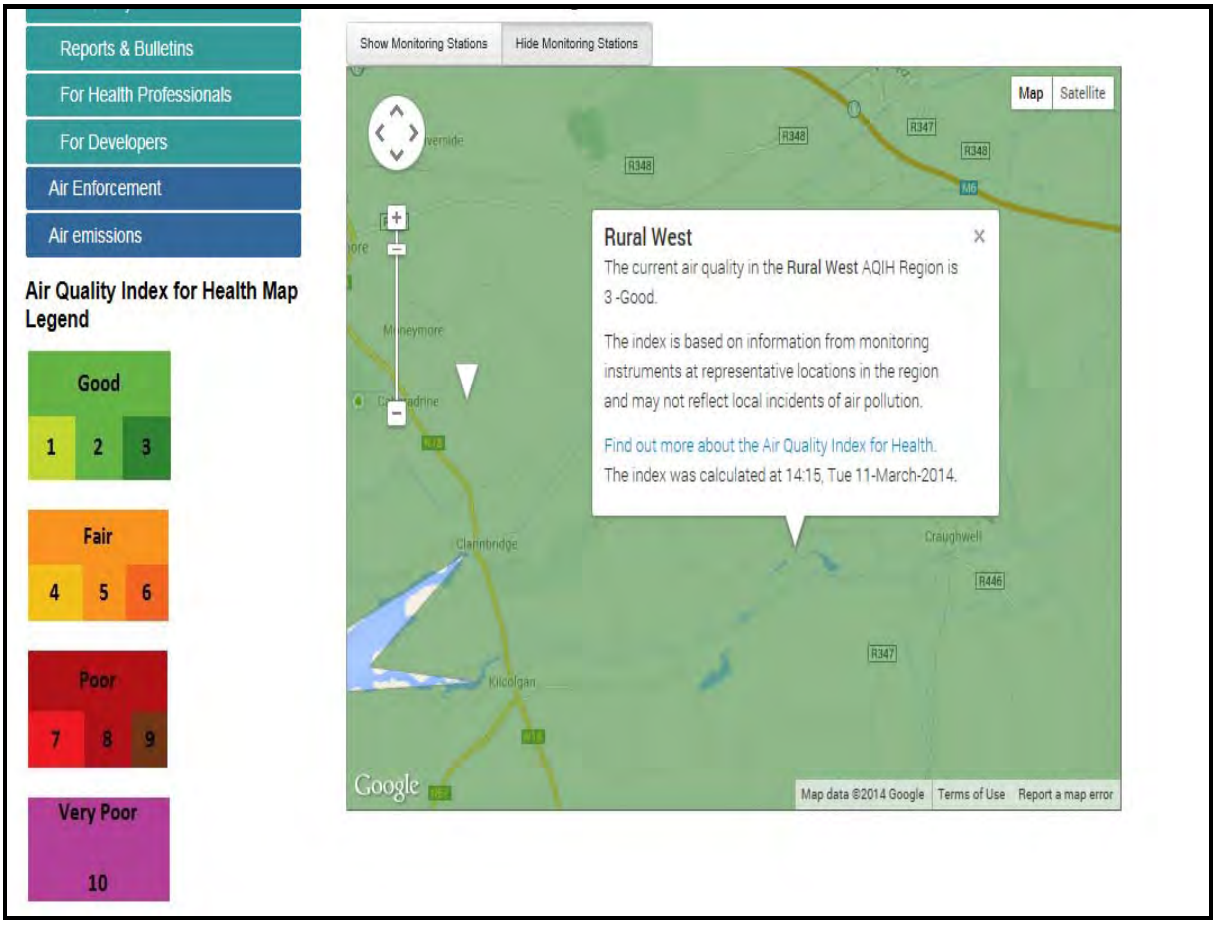


Figure 12.1 The Air Quality for Health Index Map (EPA, 2014)

Further to this the EPA maintain 29 monitoring stations around the country as part of the National Ambient Air Quality Monitoring Network.

There is limited data available from the national air quality monitoring database for air quality specifically in this rural part of County Galway. The nearest air quality monitoring sites to the study area are located at the Bodkin Roundabout in Galway City and in Claremorris, County Mayo. Despite being closer to the study area, the air quality data available from the Bodkin Roundabout monitoring station in Galway City is seen as not being representative of the air quality in the study area as it is located within a large town area. Therefore the site at Claremorris has been used for comparison purposes.

The Claremorris site is located at the wastewater treatment plant approximately 4 km outside the town of Claremorris, County Mayo. Monitoring began at this site on the 17th February 2011. Monitoring is carried out using a continuous monitor for PM_{10} and $PM_{2.5}$. Organic/ elemental carbon and a range of anions and cations are also measured at this site.

Available data from the EPA Monitoring Site at the Claremorris site has been referenced for Nitrogen Oxides, Sulphur Dioxide and PM_{10} levels. The following sub-sections provide details on the sources of these emissions and the background levels at Claremorris.

The major source of air emissions in Ireland is road traffic. There are no major sources of potential air pollution in the study area. The villages of Craughwell and Kilcolgan will generate concentrations of traffic derived pollution due to the existence of the N18 and the R443.

12.3.1.1 Nitrogen Dioxide

Nitrogen dioxide is classed as both a primary pollutant and a secondary pollutant. As a primary pollutant NO_2 is emitted in small concentrations of NO_X from all combustion processes (such as a gas/oil fired boiler or a car engine). As a secondary pollutant NO_2 is derived from the atmospheric oxidation of NO_X. There is currently no NO_2 monitoring at Claremorris.

12.3.1.2 Sulphur Dioxide

Sulphur dioxide is classed as a primary pollutant. It is principally emitted from the combustion of fossil fuels (diesel, coal, oil, etc.). As a traffic based pollutant, SO_2 is mainly emitted from vehicles running on diesel fuel, which will include most light goods vehicles (LGVs) and heavy goods vehicles (HGVs). However, since 2005 sulphur content in diesel fuel has been capped at 50 ppm and this has been reduced further to 10 ppm based on the latest EU Auto-Oil legislation. As such, sulphur dioxide emissions from traffic sources in future years are not considered significant. SO_2 emissions from burning of fossil fuels are the main cause of “sulphurous smog” in urban areas. There is currently no SO_2 monitoring at Claremorris.

12.3.1.3 Particulate Matter (PM_{10})

Particulate matter (PM_{10}) is considered a primary pollutant. It arises from road vehicle exhausts and other machinery. Point sources such as combustion, i.e. domestic fires, industrial boilers etc. are also primary sources of PM_{10}. In addition, natural sources of PM_{10} include re-suspended dusts and sea salts in coastal areas. PM_{10} may also be formed as secondary pollutants from the condensation or reaction of chemical vapours in the atmosphere. Monitoring of PM_{10} commenced at Claremorris on the 17th February 2011. The concentrations of PM_{10} detected at Claremorris indicate an average of 5-20 µg/m^3 for February-March 2014. The PM_{10} daily limit of 50 ug m^{-3} is deemed breached if more than 35 exceedances have occurred. There have been no exceedances to date in 2014. The $PM_{2.5}$ annual target value is 25 ug m^{-3}. There is no daily limit for $PM_{2.5}$ (Refer to **Figure 12.2**).

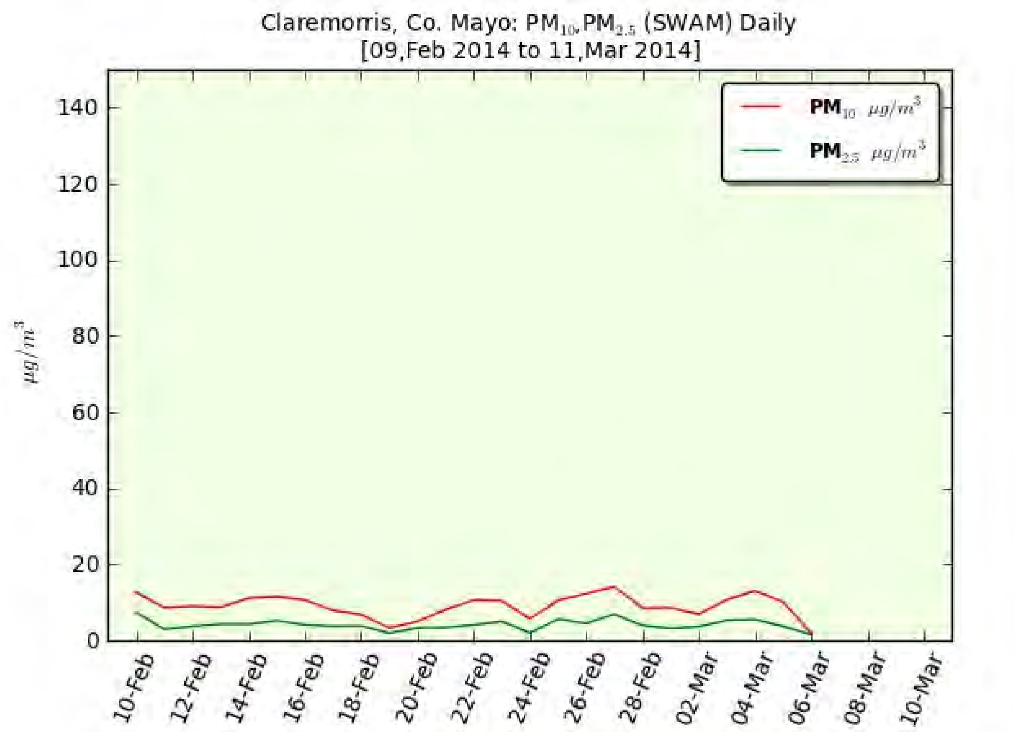


Figure 12.2 Particulate Matter levels at Claremorris (units are microgrammes per cubic meter) (Source: EPA, 2014)

12.3.1.4 Total Suspended Particulates (Dust)

Health affects associated with dusts are typically associated with finer particulates such as PM_{10} discussed above. More commonly, dusts are associated with causing an environmental nuisance to residential, ecological and agricultural receptors. A guideline level for the prevention of dust nuisance is the TA Luft guideline of 350 mg/m^2/day as an annual average of monthly results. Background levels of dust in rural areas would typically demonstrate levels of 50-150 mg/m^2/day, dependent on the weather and agricultural practices in the area (e.g. ploughing, harvest time, etc.). Dust is not a pollutant regulated by national or European legislation and is therefore not included in the national monitoring network.

12.3.1 Climate

This section assesses the existing climatic conditions of the study area taking account of the fact that the most appropriate meteorological and climatological station for comparison to the study area is located at Claremorris, County Mayo.

The scale of the development is such that it will not have any significant effect on the global climate.

The physical nature of the landscape on and immediately surrounding the study area means that the site does not have any distinctive micro-climate in comparison to the larger surrounding area. However, land-sea effects, land to lake effects and the influence of hills on wind direction can be expected.

The nearest meteorological station to the study area is the Met Eireann Station in Claremorris which lies approximately 55 km north of the study area. The weather in the area is influenced by the Atlantic Ocean, resulting in mild, moist weather. The prevailing wind direction for the area is between south to south-west. Northerly and easterly winds tend to be very infrequent. Rainfall is an important factor to consider for the proposed flood alleviation measures. In terms of dust generation, precipitation is a controlling factor, i.e. during wet conditions dust generation is inhibited. **Table 12.2** sets out the average temperature and rain fall recorded at Claremorris Station from 2011 to present.

Table 12.2 Average Rainfall and Temperature Levels Recorded at Claremorris Station for 2011 to Present Day.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)												
2014	218.8	214	34.8									
2013	175.7	56.5	38.4	122.1	121.4	61	94.3	72.3	46.1	110.2	63.7	215.5
2012	126	69.6	39.4	71.2	63	175.1	115.7	100	61	98.4	135.4	160.3
2011	88.8	175.7	50.7	90.5	123	50.4	64.3	82	142.3	158.4	201.4	167.6
Mean	**125.6**	**101.1**	**101.4**	**72.4**	**77.5**	**74.4**	**74.3**	**97.8**	**98.2**	**133.7**	**122.7**	**124.5**
Temperature (^oC)												
2014	5.2	5.2	6.1									
2013	5.2	4.7	3.5	7	9.8	13.3	17.3	15	13.6	11.3	6.5	6.6
2012	6.6	7.2	8.5	7	11.1	12.5	13.4	15.4	11.9	8.1	5.8	5.3
2011	3.4	6.3	6.9	11	11	11.7	14	13.4	13.1	11	9.1	5.5
Mean	**4.8**	**5**	**6.6**	**8.4**	**10.9**	**13.3**	**15.1**	**14.8**	**12.9**	**9.9**	**7**	**5**

The precipitation occurring in the winter period is normally associated with more pro-longed Atlantic frontal weather depressions passing over the region compared to the summer when rainfall is more likely to be associated with heavier showery conditions.

More specific to the study area, **Chapter 7** has highlighted particular rainfall issues recorded in 2009. From 1st to 26th November 2009, a series of fast moving deep Atlantic depressions brought active frontal systems across Ireland, bringing very wet and windy conditions. Spells of rain or showers gave falls of

10mm or more on many days across Connacht and Munster, while all areas received heavy falls on the 1st, 9th, in the period 16th to 19th and on the 21st. The total monthly rainfall for November 2009 at NUI Galway was 329.4mm, which represents 286% (**Figure 12.3**) of the average November rainfall for the period 1961 to 1990.

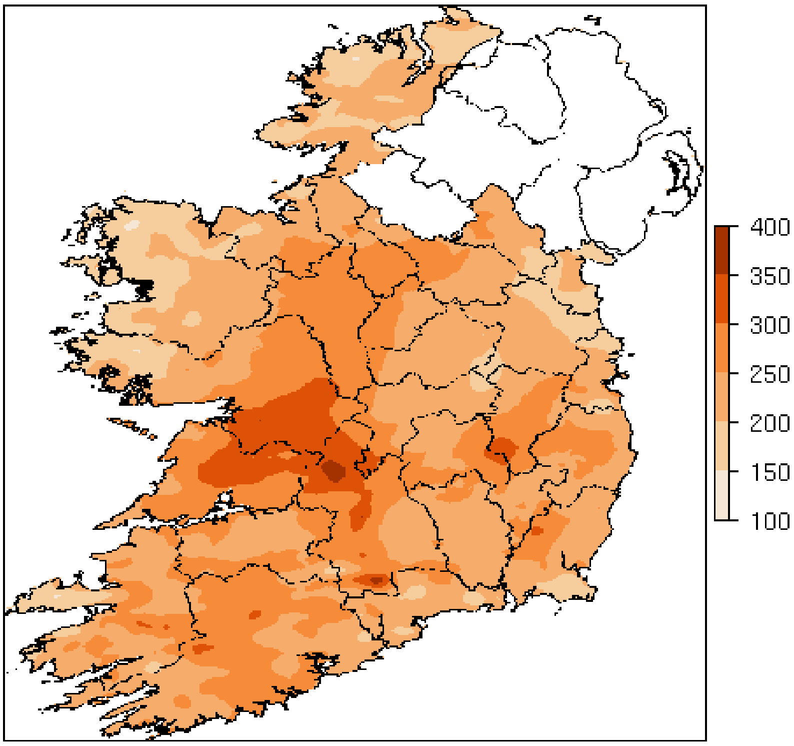


Figure 12.3 Percentage of Normal Rainfall (Met Eireann Monthly Weather Bulletin November 2009)

Daily rainfall amounts for November 2009 are shown in **Figure 12.4** below for NUI, Galway. The heaviest rain fell on the 17th November 2009 with 60.8 mm of rain recorded on this day alone. This is the highest daily rainfall amount on record at this station. A further 28.7 mm fell on the 18th November giving a two day rainfall total of 89.5 mm. Met Eireann agrometeorological data shows that by the 10th November, the soil moisture deficit was zero, meaning that field capacity had been reached.

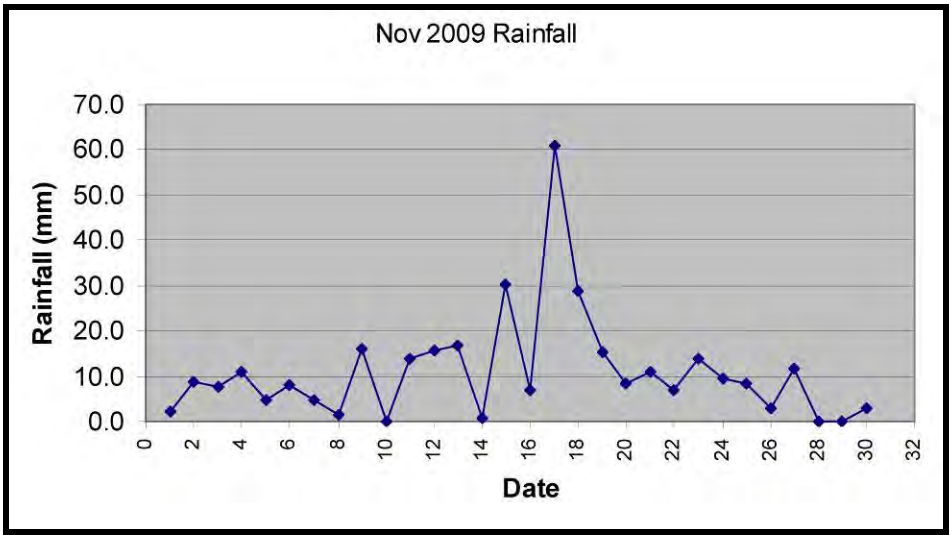


Figure 12.4 Daily Recorded Rainfall Depths Recorded at NUI, Galway – November 2009

12.3.2 Carbon Balance – Greenhouse Emissions

Drainage results in a reduction of CH_4 emissions and an increase in CO_2 emissions due to increased oxidation of soil organic material[21]. As a result the current carbon flux of this site would be expected to include intake through photosynthesis and other biological processes within the ecosystem and its release as CO_2 to the atmosphere resulting from intensive drainage.

The rates of carbon uptake and release will generally be influenced by the climate, nutrient availability and water saturation/oxygen availability. An assessment was carried out using the carbon calculator for construction activities developed by the Environment Agency (EA) in the UK. The carbon calculator calculates the embodied carbon dioxide (CO_2) of materials plus CO_2 associated with their transportation. It also considers personal travel, site energy use and waste management.

12.4 POTENTIAL IMPACTS

The potential impacts that the scheme might have on air quality and climate is further assessed in the following sections.

12.4.1 Do-Nothing Scenario

If the scheme does not proceed, the existing air quality in the vicinity of the study area would remain at ambient levels as are currently typical of the area. The current climate trends will continue to follow current patterns of change.

12.4.2 Construction Stage

Due to the diverse nature of the scheme, and in particular, the length of river channel over which the channel works will occur (approximately 11 km) it is impossible to predict the amount of machinery that will be in operation at any one time.

The movement of machinery will generate exhaust fumes and subsequently contribute to potential emissions of the following compounds; oxides of nitrogen, carbon monoxide, sulphur dioxide, particulate matter (including $PM_{10}/PM_{2.5}$), volatile organic compounds (VOCs) and polyaromatic hydrocarbons (PAHs). While concentrations of these pollutants are expected to increase in the immediate vicinity of the machines during site works it is not anticipated that they will have any impact on the air quality of the region or in turn on the sensitive receptors in the area considering the size and nature of the study area and the number of machines proposed.

It is not envisaged that the scheme works will have any significant impacts on the climate.

All river regrading and widening will be undertaken using tracked vehicles travelling along the temporary works area along the bank of the Dunkellin River and Aggard Stream.

It is anticipated that approximately 69,790 m^3 of overburden (predominantly limestone till), rock and riverbed will be removed from the river and its surroundings as a result of channel deepening and widening.

It is envisaged that different techniques will be adopted with regard to the reuse or disposal of excavated material. However, the overall intention will be to reuse the excavated material as side slope protection, creation of bankside spoil embankments, spreading of the material on adjacent lands and the creation of extended spoil heaps where initial treatment will require removal of topsoil, spreading of excavated material and reinstatement of the topsoil, undertaken with a view to minimising the transport of material off-site.

[21] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4:Agricultre, Forestry and Other Land Use, Chapter 7 – Wetlands.

The construction phase climate assessment was carried out to identify sources and quantify total greenhouse gas (GHG) emissions that will potentially be generated from the construction activities associated with the scheme. This assessment was carried out using the carbon calculator for construction activities developed by the Environment Agency (EA) in the UK (http://www.environment-agency.gov.uk/business/sectors/37543.aspx). The carbon calculator calculates the embodied carbon dioxide (CO_2) of materials plus CO_2 associated with their transportation. It also considers personal travel, site energy use and waste management.

Emissions with the potential to cause climate change include carbon dioxide (the main greenhouse gas), which will arise from excavated materials as well as vehicles moving this material to the spreading or stockpiling areas. These emissions have been quantified as far as possible using the Environment Agency (EA) *Carbon Calculator for Construction Sites* particularly related to the material to be excavated.

The total estimated greenhouse gas emissions associated with the scheme is calculated at 8,857 tonnes of CO_{2eq} compared to the National Kyoto Target of 63 million tonnes of $CO_{2eq.}$ This increase is considered to be negligible (0.014%) in the context of the National Kyoto Target. This estimate is based on 69,790 m^3 of excavated material predominantly being kept on site through stockpiling and spreading, assuming that half of the material is soil and half is stone.

12.4.3 Operational Stage

It is not anticipated that the scheme will have any impact on the current air quality or climatic conditions of the local environment once implemented and functioning.

12.5 MITIGATION MEASURES

Mitigation measures will be implemented during all stages of the scheme where necessary, in order to ensure that the existing air quality and climate are not negatively impacted upon by the proposed flood alleviation works.

To ensure that site machinery at the flood alleviation works stage will not impact on the existing air quality and local sensitive receptors the following measures will be implemented:

- All site preparation and channel widening machinery will have speed restrictions on unsurfaced roads,
- Regular maintenance of plant and equipment will take place including technical inspection of vehicles to ensure they will perform most efficiently,
- Where possible temporary access roads within the temporary working area will be used to minimise traffic on the local road network, and
- Machinery engines will be turned off when not in use for prolonged periods of time.

Table 12.3 sets out the potential air quality and climate impacts, mitigation measures and residual impacts resulting from the scheme.

12.6 RESIDUAL IMPACTS

There will be no residual impact on air quality as a result of the scheme

Table 12.3 Summary of Potential Impacts and Proposed Mitigation Measures Relative to Air Quality and Climate

Potential Impact on Traffic & Transport Environment	Positive/ Negative	Major/ Moderate/ Minor	Area Affected	Duration	Mitigation Measures	Residual Impact
Construction Stage						
Potential emissions of oxides of nitrogen, carbon monoxide, sulphur dioxide, particulate matter (including PM_{10}/$PM_{2.5}$), volatile organic compounds (VOCs) and polyaromatic hydrocarbons (PAHs) from site machinery.	Negative.	Minor.	Proposed flood alleviation works site.	Temporary.	• All site preparation and channel widening machinery will have speed restrictions on unsurfaced roads; • Regular maintenance of plant and equipment will take place including technical inspection of vehicles to ensure they will perform most efficiently; • Where possible temporary access roads within the temporary working area will be used to minimise traffic on the local road network; and • Engines will be turned off when not being used for prolonged periods of time.	None.

12.7 CONCLUSION

This section describes the potential impacts to ambient air quality and climate from the scheme.

The plant and machinery to be used for the proposed flood alleviation works was identified as having potential to produce emissions to the air at a local level. Traffic associated with employees working at on site during the proposed works will also be potential sources of emissions. However given the size of the site, the low populated nature of the majority of the study area and the implementation of mitigation measures, it is not considered that this aspect of the proposal will have a negative impact on air quality or climate.

13 NOISE AND VIBRATION

13.1 INTRODUCTION

This section of the EIS assesses the noise impacts associated with the Dunkellin River and Aggard Stream Flood Relief Scheme (the scheme). The assessment identifies potentially sensitive receptors and identifies the existing noise environment for these receptors. The extent of exposure of these receptors to noise generated in association with the scheme works has also been assessed.

13.2 METHODOLOGY

A desktop assessment was conducted in order to assess the impacts of the scheme on the existing noise environment. The aim of the desktop assessment was to determine the potential impacts of noise generated on the noise sensitive receptors. The following standards and guidelines were used in completing this assessment:

- *BS 5228-1:2009* "*Code of Practice for Noise and Vibration Control on construction and open sites – Part 1: Noise"*,
- *EPA, Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4), April 2012.*
- *Description and measurement of environmental noise*, ISO 1996: Acoustics,
- *Guidance note for noise in relation to scheduled activities*, 2nd edition, 2006, EPA,
- *Guidelines for Community Noise*, 1999, World Health Organisation (WHO),
- *NRA Guidelines for the Treatment of Noise & Vibration on National Road Schemes*, 2004, National Roads Authority (NRA),
- *Guidelines on the Information to be contained in Environmental Impact Statements*, EPA, 2002,
- *Advice Notes on Current Practice in the preparation of Environmental Impact Statements*, 2003, EPA,
- *Environmental Noise Regulations*, S.I. No. 140 of 2006,
- *Noise Action Plan,* 2013-2018, County Galway Local Authorities,
- *BS6472: 1992 Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz), and*
- *BS7385: Part 2 1990*: *Evaluation and Measurement for Vibration in Buildings - Guide to Damage Levels from Ground-Borne Vibration*).

13.2.1 Noise Assessment Criteria

Noise is typically defined as "unwanted sound"; sound being the human sensation of pressure fluctuations in the air. Sound levels are expressed in decibels (dB) on a logarithmic scale, where 0dB is nominally the "threshold of hearing" and 120dB is nominally the "threshold of pain". Depending upon the circumstances and characteristics of the sound in question, a change in level of 3dB is just perceptible, whereas an increase of 10dB is perceived as a subjective doubling of loudness (*NRA Guidelines for the Treatment of Noise & Vibration on National Road Schemes, 2004*).

The frequency of sound is the rate at which a sound wave oscillates, and is expressed in Hertz (Hz). The sensitivity of the human ear to different frequencies in the audible range is not uniform. For example, hearing sensitivity decreases markedly as frequency falls below 250 Hz. A mechanism known as "A-weighting" has been adopted in order to account for this non-linearity of the human ear. Sound levels expressed using "A-weighting" are typically denoted dB(A). An indication of the level of common sounds on the dB(A) scale is presented in **Figure 13.1**.

The indices most commonly used for the assessment of noise impact are L_{Aeq}, L_{A10} and L_{A90} which are defined as follows:

$L_{Aeq,T}$,	the equivalent continuous noise level for the measurement period. This parameter is very sensitive to local high-level short time sources, e.g. local traffic.
L_{A10},	the sound level equalled or exceeded for 10% of the measurement period, the parameter usually used for traffic noise assessment.
L_{A90},	the sound level equalled or exceeded for 90% of the measurement period. This level is sometimes taken to represent the “background” noise level.

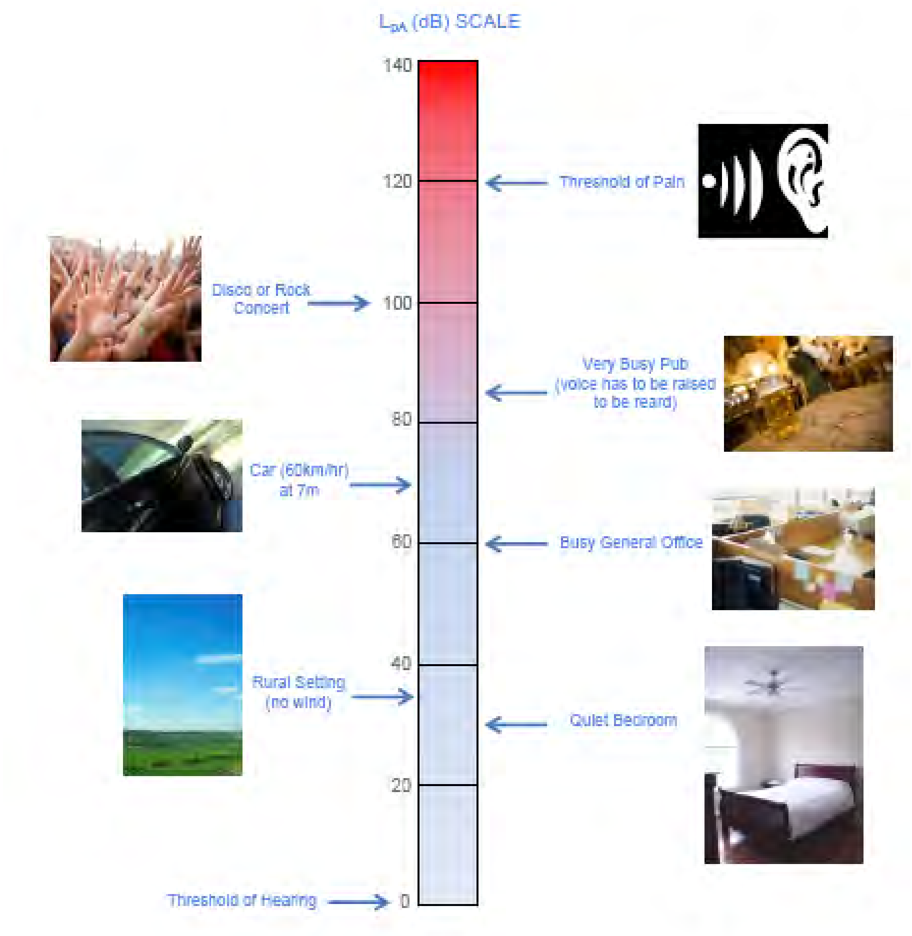


Figure 13.1 LPA (dB) Scale and Indicative Noise Levels

(Source: EPA, Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities NG4, April 2012)

13.2.2 Site Works Criteria

BS 5228 “*Noise and Vibration Control on Construction and Open Sites*” has been used to predict likely site works noise levels during site preparation and flood relief measures. These criteria are used in the absence of specific criteria for flood related activities.

The National Roads Authority outlined construction noise limits in its “*Guidelines for the Treatment of Noise and Vibration in National Roads Schemes*”. This is the only published Irish Guidance and relates to National Road Schemes. These limits, which are presented in **Table 13.1**, represent a reasonable compromise between the practical limitations in a construction project and the need to ensure an acceptable ambient noise level for local residents.

Table 13.1 Maximum Permissible Noise Levels at the Façade of Dwellings during Construction

Days & Times	$L_{Aeq\ (1hr)}$ dB	L_{AMax} dB
Monday to Friday - 07.00 to 19.00	70	80*
Monday to Friday - 19.00 to 22.00	60*	65*
Saturday - 08.00 to 16.30	65	75
Sundays and Bank Holidays - 08.00 to 16.30	60*	65*

**Construction activity at these items, other than that required in respect of emergency works will normally require the explicit permission of the relevant local authority.*

(Source: NRA Guidelines, October 2004)

These noise assessment criteria have been used in this assessment to predict the potential impact of noise from the proposed flood relief scheme works on noise sensitive receptors.

13.2.3 Rating of Impacts

Subjectively, the significance that can be attached to changes in noise levels (perceptible to human beings) can be described as follows in **Table 13.2**.

Table 13.2 Significance Scale for Changes in Noise Levels (Perceptible to Human Beings)

Change in Noise Level	Impact Rating	EPA Glossary of Impacts	Subjective Reaction	Subjective Change	% Change in Loudness
0	No change	n/a	n/a	No change	0%
<3 dB(A)	Not Significant	Neutral, Imperceptible or Slight Impact	Barely perceptible	Negligible	10%
3 – 5 dB(A)	Minor	Significant Impact: Positive or Negative	Perceptible	Noticeable	30%
6 – 10 dB(A)	Moderate		Up to a doubling of loudness	Clearly Noticeable	70%
11–15 dB(A)	Major		Over a doubling of loudness	Substantial	100%
>15 dB(A)	Severe	Profound Significant Impact: Negative only	---	Very Substantial	>100%

13.3 EXISTING ENVIRONMENT

The study area is located in a rural setting and has a low population with the exception of the settlements of Craughwell and Kilcolgan Villages. There are a number of residential dwellings located close to the Dunkellin River and Aggard Stream.

The topography of the study area is relatively low lying and surrounding lands are made up of scrub and improved agricultural grasslands. Throughout the rural region of the study area the noise environment is dominated by noise sources of typical rural environs, i.e. rustling foliage, birdsong and light winds.

Traffic noises will be most prominent at Kilcologan where the N18 crosses the Dunkellin River and at Craughwell where the R446 crosses the Dunkellin River. The Western rail corridor runs almost parallel to the Aggard Stream and crosses it at three locations; Ballynamannin townland, Rathcosgy townland and Ballyglass East and crosses the Dunkellin River at the railway bridge in Craughwell.

In the area within the immediate vicinity of the villages the noise environment is dominated by traffic noise from passing vehicles and would be typical of the noise levels experienced in a medium sized Irish town.

There are no point sources of noise in the existing environment.

In 2008, Galway County Council prepared a Draft Action Noise Plan in accordance with the Environmental Noise Regulations 2006 to address environmental noise from major roads in the county with more than six million vehicles per annum[22]. The action planning area covers sections of the N6, N17 and N18 national primary roads and R336 regional road and adjoining lands.

The N18 from Kilcolgan to its junction with the N6 Dublin Road at Oranmore was identified as a major road in the County of Galway from NRA and Galway County Council traffic counts. Strategic noise maps were created for each major road and show that the area adjacent to the N18 at Kilcolgan adjacent to the N18 road is subjected to noise levels of 55 – 75dB. Noise level is highest on the N18 (75dB) and decreases with distance away from the road as shown in **Figure 13.2.**

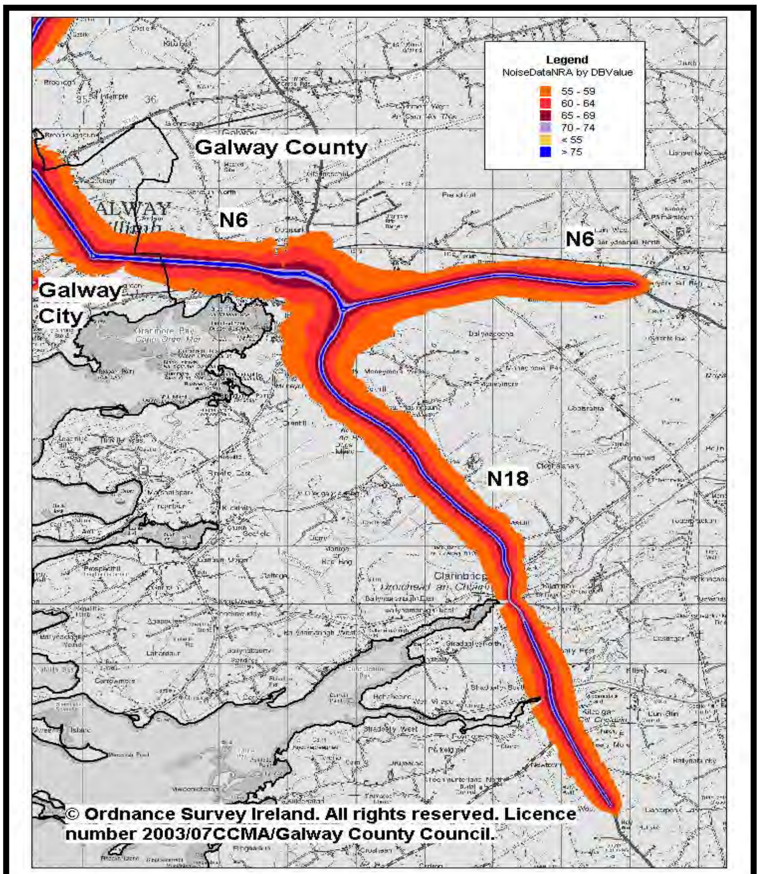
Typical ranges of noise levels are presented in **Table 13.3**. Based on the activities observed and using typical noise levels it is anticipated that the existing noise levels within the study area will fall within 35-55 dB(A).

Table 13.3 Typical Noise Levels in The Environment

Sound levels in decibels dB(A)	Description of Activity
0	Absolute silence
25	Very quiet room
35	Rural night time setting with no wind
55	Day time, busy roadway 0.5km away
70	Busy restaurant
85	Very busy pub, voice has to be raised to be heard
100	Disco or rock concert
120	Uncomfortably loud, conversation impossible
140	Noise causes pain in ears

(Source: Guidance Note for Noise in relation to Scheduled activities, 2nd Edition, EPA 2006.)

[22] It should be noted that noise action plan for Galway City (2009-2018) has also been published in final format but this deals only with the city area.



Lden Contour Plots for N18 & N6 (Excluding N6 Ballinasloe)

Figure 13.2 Strategic Noise Map for N18

(Source: Draft Action Noise Plan, Galway County Council, 2008)

13.4 POTENTIAL IMPACTS

The potential impacts that the scheme might have on the existing noise environment is further assessed under in the following sections.

13.4.1 Do-Nothing Scenario

If the scheme does not go ahead, the general noise level in the vicinity of the study area would remain unchanged from the current environment.

13.4.2 Construction Stage

The scheme will entail the use of different machinery and plant at various locations within the study area, including the potential requirement for delivery of material for upgrade of existing roads, delivery of site machinery and the working of this machinery on the site. One of the main changes to the existing noise environment in the rural locations of the study area will be the additional noise generated by the machinery and plant associated with the works to be undertaken. Traffic associated with employees working at and on site during the proposed works will also be potential sources of noise.

It is envisaged that any works taking place within the more built up areas of Craughwell and Kilcolgan Villlages will not have a significant impact on the existing noise environment as there is already noise generated by traffic and other activities on a day to day basis.

Table 13.4 shows the range of noise levels emitted by machinery that will typically be used on site during the proposed flood alleviation works.

Table 13.4 Sound Pressure Levels of Typical Machinery to be used During the Construction Stage

Noise Source	A-weighted Sound Pressure Level L_{Aeq} dB
Tracked Excavator	77
Wheeled Loader	80
Dump Truck (Tipping Material)	79
HGV (unloading)	112

Source: Sound Pressure Levels taken from (DEFRA) Update of Noise Database for Prediction of Noise on Construction and Open Sites, 2005.

It is not anticipated there will be any significant negative impacts on the sensitive receptors located in the region of the Dunkellin River and Aggard Stream Flood Relief Scheme in terms of increased noise emissions. This takes into consideration the size and nature of the study area and the density and location of the nearest sensitive receptors.

13.4.3 Operational Stage

It is not anticipated that the scheme will have any impact on the current noise environment once implemented and functioning.

13.5 MITIGATION MEASURES

Mitigation measures will be implemented during all stages of the scheme where necessary, in order to ensure that the existing noise environment and associated sensitive receptors are not negatively impacted upon by the proposed flood alleviation works.

The residential, working and visiting communities in the region, who would be considered the sensitive noise receptors must be considered when completing all flood relief measures.

It is not anticipated there will be any significant negative impacts on the sensitive receptors located in the study area in terms of increased noise emissions. To ensure this is the case mitigation measures will be implemented during all stages of the scheme where necessary, in order to ensure that the existing ambient noise environment is not negatively impacted. Measures will include the following:

- There will be no work outside of normal working hours;
- Where practicable the use of quiet working methods will be selected and the most suitable plant will be selected for each activity, having due regard to the need for noise control;
- All contractors will employ the best practicable means to minimise noise emissions and will be obliged to comply with the general recommendations of BS 5228, 1997. To this end all contractors will use “noise reduced” plant and/or will modify their construction methods so that noisy plant is unnecessary;
- Where possible, position potentially noisy plant or operations as far as possible from a noise sensitive receptor to minimise the transmission of sound;

- All mechanical plant used on site will be fitted with effective exhaust silencers and will be maintained in good working order. Where practicable, machines will be operated at low speeds and will be shut down when not in use;

- Where practicable the number of machines in simultaneous operation will be minimised;

- Plant and machinery used on-site will comply with the EC (Construction Plant and Equipment) Permissible, Noise Levels Regulations, 1988 (S.I. No. 320 of 1988);

- All noise producing equipment will comply with S.I. No 632 of 2001 European Communities (Noise Emission by Equipment for Use Outdoors) Regulations 2001;

- Machines in intermittent use shall be shut down in the intervening period between works or throttled down to a minimum;

- Employees working on the construction site will be informed about the requirement to minimise noise and will undergo training on the following aspects:

  - The proper use and maintenance of tools and equipment;

  - The position of machinery on-site to reduce the emission of noise at the nearest noise sensitive receptors;

  - Avoidance of unnecessary noise when carrying out manual operations and when operating plant and equipment;

  - The use and maintenance of sound reduction equipment fitted to power pressure tools and machines, and

  - Reporting defective noise control equipment.

- Cognisance will also be taken from the “Environmental Good Practice Site Guide” 2005 compiled by CIRIA and the UK Environmental Agency. This guide provides useful and practical information regarding the control of noise emissions at construction sites which can be applied to the proposed flood relief scheme.

Table 13.5 presents the potential noise impacts, mitigation measures and residual impacts resulting from the proposed flood relief scheme.

Table 13.5 Summary of Potential Impacts and Proposed Mitigation Measures Relative to Noise

Potential Impacts	Positive/ Negative	Major/ Moderate/ Minor	Area Affected	Duration	Mitigation Measures	Residual Impact
Flood Alleviation Works						
Potential increase in ambient noise levels for noise sensitive receptors in the vicinity of the proposed flood relief scheme.	Negative.	Minor.	Noise Sensitive Receptors.	Temporary.	Put in place measures as listed in **Section 13.5**.	None.

13.6 RESIDUAL IMPACTS

The scheme may temporarily increase the noise levels in the immediate vicinity of site works. With mitigation measures implemented, the scheme will not result in a significant increase in noise levels at any of the noise sensitive locations.

13.7 CONCLUSION

This section describes the potential impacts to the noise environment and more particularly to noise sensitive receptors resulting from the proposed Dunkellin River and Aggard Stream Flood Relief Scheme.

The existing noise environment in the rural region of the study area is typical of a sparsely populated rural area and all relevant potential noise sensitive receptors were also identified. In the area in the immediate vicinity of the villages of Craughwell and Kilcolgan the noise environment is expected to be dominated by traffic noise from passing vehicles and would be typical of the noise levels experienced in a medium sized Irish settlement.

There are no existing point sources of noise in the locality.

The plant and machinery to be used for the proposed flood alleviation works were identified as having potential to make noise emissions which may be perceptible to the noise sensitive receptors identified. However, considering the size and nature of the study area, the density and location of the nearest sensitive receptors, the duration of proposed works and the implementation of mitigation measures it is not considered that the scheme measures will have a negative impact on the noise sensitive receptors identified.

14 ARCHAEOLOGY, ARCHITECTURE AND CULTURAL HERITAGE

14.1 INTRODUCTION

14.1.1 General

Irish Archaeological Consultancy Ltd has prepared this report on behalf of RPS to assess the impact, if any, on the archaeological, architectural and cultural heritage resource of a proposed Flood Relief Scheme along the Dunkellin River and Aggard Stream in County Galway (OS Sheets 96, 103 and 104).

This study determines, as far as reasonably possible from existing records, the nature of the cultural heritage resource within the area of proposed development using appropriate methods of study. Desk-based assessment is defined as a programme of study of the historic environment within a specified area or site that addresses agreed research and/or conservation objectives. It consists of an analysis of existing written, graphic, photographic and electronic information in order to identify the likely heritage assets, their interests and significance and the character of the study area, including appropriate consideration of the settings of heritage assets (Institute of Field Archaeologists 2012). This leads to the following:

- Determining the presence of known archaeological and built heritage sites that may be affected by the proposed development;

- Assessment of the likelihood of finding previously unrecorded archaeological remains during the construction programme;

- Determining the impact upon the setting of known cultural heritage sites in the surrounding area;

- Suggested mitigation measures based upon the results of the above research.

The study involved detailed interrogation of the archaeological, historical and architectural background of the development area. This included information from the Record of Monuments and Places of County Galway, the County Development Plan, the topographical files of the National Museum of Ireland and cartographic and documentary records. Aerial photographs of the study area held by Ordnance Survey Ireland were also consulted. A field inspection was carried out on 12th and 13th December 2011 in an attempt to identify any known cultural heritage sites and previously unrecorded features, structures and portable finds within the proposed development area.

An impact assessment and a mitigation strategy have been prepared. The impact assessment is undertaken to outline potential adverse impacts that the proposed development may have on the cultural heritage resource, while the mitigation strategy is designed to avoid, reduce or offset such adverse impacts.

14.1.2 The Development

Please refer to **Chapter 6** of this report.

14.1.3 Definitions

In order to assess, distil and present the findings of this study, the following definitions apply:

'Cultural Heritage' where used generically, is an over-arching term applied to describe any combination of archaeological, architectural and cultural heritage features, where:

- the term 'archaeological heritage' is applied to objects, monuments, buildings or landscapes of an (assumed) age typically older than AD 1700 (and recorded as archaeological sites within the Record of Monuments and Places)
- the term 'architectural heritage' is applied to structures, buildings, their contents and settings of an (assumed) age typically younger than AD 1700
- the term 'cultural heritage', where used specifically, is applied to other (often less tangible) aspects of the landscape such as historical events, folklore memories and cultural associations. This designation can also accompany are archaeological or architectural designation.

For the purposes of this report the terms 'architectural heritage' and 'built heritage' have the same intended meaning and are used interchangeably.

Impact Definitions

- *Imperceptible Impact*

  An impact capable of measurement but without noticeable consequences

- *Slight Impact*

  An impact that causes noticeable changes in the character of the environment without affecting its sensitivities.

- *Moderate Impact*

  An impact that alters the character of the environment in a manner that is consistent with existing or emerging trends.

- *Significant Impact*

  An impact which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.

- *Profound Impact*

  An impact that obliterates sensitive characteristics.

Impacts as defined by the EPA 2002 Guidelines (pg 23).

14.1.5 Consultations

Following the initial research a number of statutory and voluntary bodies were consulted to gain further insight into the cultural background of the background environment, receiving environment and study area, as follows:

- Department of Arts, Heritage and the Gaeltacht – the Heritage Service, National Monuments and Historic Properties Section: Record of Monuments and Places; Sites and Monuments Record; Monuments in State Care Database; Preservation Orders; Register of Historic Monuments and the database of current licences (2009–2011);
- National Museum of Ireland, Irish Antiquities Division: topographical files of Ireland;
- National Inventory of Architectural Heritage: County Galway
- Galway County Council: Planning Section;

- Trinity College Dublin, Map Library: Historical and Ordnance Survey Maps;

14.2 METHODOLOGY

Research has been undertaken in two phases. The first phase comprised a paper survey of all available archaeological, architectural, historical and cartographic sources. The second phase involved a field inspection of the proposed development area.

14.2.1 Paper Survey

This is a document search. The following sources were examined and a list of areas of archaeological, architectural and cultural heritage potential was compiled:

- Record of Monuments and Places for County Galway;
- Sites and Monuments Record for County Galway;
- Monuments in State Care Database;
- Preservation Orders;
- Register of Historic Monuments;
- Database of current archaeological investigation licences (2011–2014);
- Topographical files of the National Museum of Ireland;
- Cartographic and written sources relating to the study area;
- Galway County Development Plan (2009–2015);
- Craughwell Local Area Plan (2009–2015);
- National Inventory of Architectural Heritage;
- Place name analysis;
- Aerial photographs;
- Excavations Bulletin (1970–2010).

Record of Monuments and Places (RMP) is a list of archaeological sites known to the National Monuments Section, which are afforded legal protection under Section 12 of the 1994 National Monuments Act and are published as a record. Details of all sites located within c. 500m of the scheme are included within **Appendix D.1**.

Sites and Monuments Record (SMR) holds documentary evidence and field inspections of all known archaeological sites and monuments. Some information is also held about archaeological sites and monuments whose precise location is not known, e.g. only a site type and townland are recorded. These are known to the National Monuments Section as ‘un-located sites’ and cannot be afforded legal protection due to lack of locational information. As a result these are omitted from the Record of Monuments and Places. SMR sites are also listed on the recently launched website created by the DAHG – www.archaeology.ie.

National Monuments in State Care Database is a list of all the National Monuments in State guardianship or ownership. Each is assigned a National Monument number whether in guardianship or ownership and has a brief description of the remains of each Monument.

The Minister for the Department of Arts, Heritage and the Gaeltacht (DAHG) may acquire national monuments by agreement or by compulsory order. The State or Local Authority may assume guardianship of any national monument (other than dwellings). The owners of national monuments (other than dwellings) may also appoint the Minister or the Local Authority as guardian of that monument if the State or Local Authority agrees. Once the site is in ownership or guardianship of the state, it may not be interfered with without the written consent of the Minister.

Preservation Orders List contains information on Preservation Orders and/or Temporary Preservation Orders, which have been assigned to a site or sites. Sites deemed to be in danger of injury or destruction can be allocated Preservation Orders under the 1930 Act. Preservation Orders make any interference with the site illegal. Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders with the written consent, and at the discretion, of the Minister.

Register of Historic Monuments was established under Section 5 of the 1987 National Monuments Act, which requires the Minister to establish and maintain such a record. Historic monuments and archaeological areas present on the register are afforded statutory protection under the 1987 Act. The register also includes sites under Preservation Orders and Temporary Preservation Orders. All registered monuments are included in the Record of Monuments and Places.

Database of current archaeological investigation licences is a listed held by the National Monument Section of the DAHG that provides details of licences issued that have yet to appear within the Excavations Bulletin (2011–2014).

Topographical files of the National Museum of Ireland is the national archive of all known finds recorded by the National Museum. This archive relates primarily to artefacts but also includes references to monuments and unique records of previous excavations. The find spots of artefacts are important sources of information on the discovery of sites of archaeological significance. Details of all stray finds recorded within the townlands surrounding the scheme are included within **Appendix D.2.**

Cartographic sources are important in tracing land use development within the development area as well as providing important topographical information on areas of archaeological potential and the development of buildings. Cartographic analysis of all relevant maps has been made to identify any topographical anomalies or structures that no longer remain within the landscape.

- William Larkin, *Map of Galway*, 1819.
- Ordnance Survey 6" maps of County Galway (1840, 1896, 1921 and 1934).

Documentary sources were consulted to gain background information on the archaeological, architectural and cultural heritage landscape of the proposed development area.

Aerial photographic coverage is an important source of information regarding the precise location of sites and their extent. It also provides initial information on the terrain and its likely potential for archaeology. A number of sources were consulted including aerial photographs held by the Ordnance Survey and Google Earth.

Place Names are an important part in understanding both the archaeology and history of an area. Place names can be used for generations and in some cases have been found to have their root deep in the historical past.

Development Plans contain a catalogue of all the Protected Structures and archaeological sites within the county. The Galway County Development Plan (2009–2015) and Craughwell Local Area Plan (2009–2015) were consulted to obtain information on cultural heritage sites in and within the immediate vicinity of the scheme. Details of all RMP sites and Protected Structures located within c. 500m of the scheme are included within **Appendix D.1** and **Appendix D.3.**

The **National Inventory of Architectural Heritage** is a government based organisation tasked with making a nationwide record of significant local, regional, national and international structures, which in turn provides County Councils with a guide as to what structures to list within the Record of Protected Structures. The architectural survey for County Galway was completed during 2011. The NIAH have also carried out a nation wide desk based survey of historic gardens, including demesnes that surround large houses. This has also been completed for County Galway and was examined in relation to the surviving demesnes within the surrounding area of the proposed development. Details of all recorded structures located within c. 500m of the proposed Flood Relief Scheme are included within **Appendix D.3.**

Excavations Bulletin is a summary publication that has been produced every year since 1970. This summarises every archaeological excavation that has taken place in Ireland during that year up until 2008 and since 1987 has been edited by Isabel Bennett. This information is vital when examining the archaeological content of any area, which may not have been recorded under the SMR and RMP files. This information is also available online (www.excavations.ie) from 1970–2010.

14.2.2 Field Inspection

Field inspection is necessary to determine the extent and nature of archaeological and architectural remains, and can also lead to the identification of previously unrecorded or suspected sites and portable finds through topographical observation and local information.

The archaeological and architectural field walking inspection entailed:

- Walking the proposed development area and its immediate environs.
- Noting and recording the terrain type and land usage.
- Noting and recording the presence of features of archaeological, architectural or cultural heritage significance.
- Verifying the extent and condition of recorded sites.
- Visually investigating any suspect landscape anomalies to determine the possibility of their being anthropogenic in origin.

Please see **Appendix D.4** for protective guidelines and legislation that were taken into account during the assessment of the archaeological and architectural heritage of the scheme.

14.3 EXISTING ENVIRONMENT

14.3.1 Results and Analysis – Archaeology

14.3.1.1 Archaeological and Historical Background

General

The area of the scheme runs along a section of the Dunkellin River and Aggard Stream to the east of Kilcolgan and west and south of Craughwell. Galway City is located *c*. 15km north-west of the scheme. The N18 bounds the works to the west while the N6/R446 runs along the eastern limit. The Aggard Stream rises *c.* 8km south of the Dunkellin River in Cregaclare Demesne and runs north where it is crossed by the railway line three times.

Prehistoric Period

Mesolithic Period (c. 7000–4000BC)

The Mesolithic Period is the earliest time for which there is clear evidence of prehistoric activity in Ireland. During this period people hunted, foraged and gathered food and appear to have had a mobile lifestyle. The most common evidence indicative of Mesolithic activity at a site comprises of scatters of worked flint material; a by-product from the production of flint implements or rubbish middens consisting largely of shells (Stout & Stout 1997). The latter are commonly discovered in coastal regions or at the edge of lakes. Although it is likely that the Dunkellin River was an important element for the Mesolithic populations in this landscape, as a food and travelling resource, there are no recorded Mesolithic sites within proximity to the scheme.

Neolithic Period (c. 4000–2500BC)

During the Neolithic period communities became less mobile and their economy became based on the rearing of stock and cereal cultivation. This transition was accompanied by major social change. Agriculture demanded an altering of the physical landscape, forests were rapidly cleared and field boundaries constructed. There was a greater concern for territory, which saw the construction of large communal ritual monuments called megalithic tombs, which are characteristic of the period. Despite the relatively large receiving environment, there are no definite recorded Neolithic sites within the vicinity.

Bronze Age Period (c. 2500–800BC)

The Bronze Age was characterised by the introduction of metalworking technology to Ireland and coincides with many changes in the archaeological record, both in terms of material culture as well as the nature of the sites and monuments themselves. Though this activity has markedly different characteristics to that of the preceding Neolithic period including new structural forms and new artefacts (such as Beaker pottery), it also reflects a degree of continuity. Megalithic tombs were no longer constructed and the burial of the individual became more typical. Cremated or inhumed bodies were often placed in a cist, a small stone box set into the ground, or a stone lined grave. Burials were often made within cemeteries and marked within the landscape with the construction of an earthen barrow or cairn of stones. A cist burial (RMP GA104-119) is located in Cloghroak *c*. 120 m west of the Aggard Stream. A cairn (RMP GA104-110) is recorded in the same townland 750 m north of the cist burial and 500 m west of the Aggard Stream.

A number of ring barrows are located within 500 m of the Aggard Stream. None of these are known along the Dunkellin River. Ring barrows comprise of circular or oval raised area enclosed by a fosse and outer bank, with or without an entrance. These are part of the Bronze/Iron Age burial tradition (*c*. 2400 BC – AD 400). Ring barrows are recorded in the townlands of Aggard Beg (RMP GA104-009), Ballynamannin (RMP GA104-054), Caherduff (RMP GA104-075) and Cloghroak (RMP GA104-285). The ring barrow at Ballynamannin (RMP GA104-054) is located c. 50m east of the Aggard Stream and was reused in the post-medieval period as a children's burial ground (RMP GA104-054001). The example at Cloghroak (RMP GA104-285) is located c. 50m from the Aggard Stream. Other unclassified barrows are recorded in the townlands of Aggard More (RMP GA104-012) and Lackan (RMP GA114-110).

The most common Bronze Age site within the archaeological record is the burnt mound or *fulacht fiadh*. Over 4500 *fulachta fiadh* have been recorded in the country making them the most common prehistoric monument in Ireland (Waddell, 1998, 174). Although burnt mounds of shattered stone occur as a result of various activities that have been practiced from the Mesolithic to the present day, those noted in close proximity to a trough are generally interpreted as Bronze Age cooking/industrial sites. *Fulacht fiadh* generally consist of a low mound of burnt stone, commonly in horseshoe shape, and are found in low lying marshy areas or close to streams or rivers. Often these sites have been ploughed out and survive as a spread of heat shattered stones in charcoal rich soil with no surface expression in close proximity to a trough. The term *fulacht* or *fulacht fiadh* is found in early Irish literature from at least the 9th century AD and refers to open air cooking places often associated with the young warrior hunters of the *fianna* and the legendary *fionn mac cumhail* (Waddell, 1998, 174). Even though they may have functioned as cooking sites, dates in the mid-late Bronze Age (1500–600BC) show that they significantly predate the cooking sites referred to in early Irish literature (Brindley & Lanting, 1990).

Only one *fulacht fiadh* is recorded in the RMP within the current study area in the townland of Killeely More (RMP GA103-134) to the immediate south of the proposed channel widening. The remains of a further poorly preserved burnt mound were recently excavated in advance of the N18 Oranmore to Gort Road Scheme in the townland of Roevehagh (Hegarty, 2010a; Registration Ref.: E3885). The burnt mound was located *c*. 100m north of the Dunkellin River along the line of the flood plain. A calibrated late Bronze Age date of 976–832 BC was obtained from the fill of a large shallow pit on site (*ibid*.). Although there are only two recorded examples of this type within the receiving environment, the presence of the Dunkellin River, Rahasane Turlough and various smaller tributaries make it likely that many further unrecorded examples are located within this landscape.

Standing stones, usually single upright orthostats, are a common feature in the landscape. They are known by various names including *Gallán, dallán, leacht* and long stone. Although it is thought that the standing stones were erected across a wide time span and had multiple functions they are most often associated with the Bronze Age. They are generally unworked stones and often have packing stones around their base providing additional support. A large number of standing stones are orientated on a north-east–south-west axis corresponding with those of other megalithic architecture, such as stone rows or circles. A wide variety of functions have been attributed to these stones, such as burial markers and route or territorial markers. A standing stone is recorded in the townland of Ballyboy (RMP GA114-006) *c*. 250m north of the Aggard Stream. A further standing stone is located at Ballylin West (RMP GA104-035) *c*. 60m east of the Aggard Stream.

Iron Age Period (c. 800BC–AD500)

Compared to the rest of Irish prehistory there is very little evidence in Ireland, as a whole, representing the Iron Age. As in Europe, there are two phases of the Iron Age in Ireland; the Hallstatt and the La Tène. The Hallstatt period generally dates from 700BC onwards and spread rapidly from Austria, across Europe, and then into Ireland. The later Iron Age or La Tène culture also originated in Europe during the middle of the 5th century BC. For several centuries the La Tène Celts were the dominant people in Europe, until they were finally overcome by the Roman Empire. There are no known Iron Age sites located within the vicinity although several recorded enclosures recorded within the landscape have the potential to date from this period.

Early Medieval Period (AD500–1100)

During this period Ireland was not a united country but rather a patchwork of minor monarchies all scrambling for dominance. Borders were ever changing as alliances were formed and battles fought. Kingdoms were a conglomerate of clannish principalities with the basic territorial unit known as a *túath*. Byrne (1973) estimates that there were probably at least one hundred and fifty kings in Ireland at any given time during this period, each ruling over his own *túath*. The study area is characterised by the remains of early medieval activity in the form of secular settlement and ecclesiastical activity.

The most common indicator of settlement during the early medieval period is the ringfort. Ringforts (raths and cashels) are also the most common monument type encountered within the surrounding region, with 28 located within 500m of the proposed development area. Two ringforts (RMP GA103-053001and GA103-055) are associated with house structures, located *c*. 250m and 75m north of the proposed development area respectively. Ringforts, (also known as *rath*, *lios*, *caiseal*, *cathair* and *dún*) are a type of defended homestead comprising of a central site enclosed by a number of circular banks and ditches. The number of ditches can vary from one (univallate) to two or three (bivallate or multi-vallate) and is thought to reflect the status and affluence of the inhabitants. Another morphological variation consists of the platform or raised rath – the former resulting from the construction of the rath on a naturally raised area. Ringforts are most commonly located at sites with commanding views of the surrounding environs which provided an element of security. While raths, for the most part, avoid the extreme low and uplands, they also show a preference for the most productive soils (Stout 1997, 107). The most recent study of the ringfort (Stout 1997) has suggested that there is a total of 45,119 potential ringforts or enclosure sites throughout Ireland. While *rath* and *lios* seem to refer to earthen ringforts, *caiseal* (cashel) and *cathair* refer to their stone-walled equivalents. Cashels are more frequent in the west of the country. Of the 28 ringforts located within 500m of the scheme, nine are designated as cashels. A large multivallate ringfort (RMP GA114-109) is located in the townland of Lackan *c*. 150m west of the southern tip of the Aggard Stream. This site is associated with two souterrains.

Approximately seven of the ringforts and cashels are associated with souterrains (RMP GA103-049001, GA103-178, GA104-074002, GA104-042, GA104-052001, GA104-116001 and GA114-109001–2). A souterrain is located in Castlegar (RMP GA103-104) which is possibly associated with the nearby castle. Two souterrain sites are located adjacent to each other but not associated with a known enclosure in Roo (RMP GA104-256, 001) *c*. 450m east of the Aggard Stream. A souterrain (RMP GA104-151003) is associated with the Killora church and graveyard c. 450m east of the Aggard Stream. Souterrains are underground passageways that are most often associated with ringforts. It has been suggested that they were food stores or hiding places during times of strife, although some of them would have had very obvious entrances. The majority of souterrains comprise of earth cut passageways and chambers that are lined with either stone or wood, although stone cut examples are also known. County Galway has a particularly high recorded density of souterrains.

There are a number of enclosure sites within the study area (RMP GA103-102, GA104-053 and GA104-247). These belong to a classification of monument whose precise nature is unclear. Often they may in fact represent ringforts, which have either been damaged to a point where they cannot be positively recognised, or which are smaller or more irregular in plan than the accepted range for a ringfort. An early medieval date is generally likely, though not a certainty.

A single *crannóg* is located within the townland of Rahasane (RMP GA104-244), *c*. 600m east of the proposed flood relief works. The site is located within Rahasane Turlough and is annotated on the first edition OS map as *Cloghincha*. Crannógs or lake dwellings are normally associated with the early medieval period, although artefacts found during field walking and excavations have revealed occupation as early as the Bronze Age and as late as the post-medieval period. Crannógs are not as numerous as ringforts, but nonetheless represent an important settlement type for this period. It is estimated that there are *c*. 1200 crannógs recorded, confined largely to parts of the country with a large number of lakes and other stretches of shallow water (Edwards 1996, 37). Although sometimes located on natural islands, crannógs are generally constructed on entirely artificial foundations, with the crannóg material kept in place by a ring of close-set vertical piles forming a palisade (Edwards 1996, 34-5). The site locations are naturally defensive and accessed by boat, causeway or wooden bridge. Some of the crannógs on open water survive as small, often wooded islands, while others have been submerged by rising water levels or when the crannóg material has compacted and sunk. Drainage operations have often revealed sunken sites, recognisable in older reclaimed land as grassy or tree-grown hummocks. By their very nature, *crannóga* are waterlogged, thus allowing for the preservation of normally perishable organic material, such as wood, leather and environmental evidence.

There are numerous turloughs within the constraints area and these were an important component of the early medieval, cattle-based economy (Delaney, 2011). Turloughs are seasonal lakes that are filled from the water-table in winter and retreat in the drier summer months, leaving rich pasture. It has been suggested that whoever controlled the turloughs held the upper hand in the territorial power-struggles that were a defining characteristic of the period (Patterson 1994, 113). There are no proposed flood relief works within the turlough as the area is designated as a Special Area of Conservation (SAC).

This period was also characterised by the introduction of Christianity to Ireland. The new religion was a catalyst for many changes, one of the most important being literacy. Irish was written down for the first time using the ogham script. The ogham alphabet is thought to be based on the Latin alphabet of the later Roman Empire and today the majority of the inscriptions that survive are located on pillar stones or boulders. As well as this form of the written word, the church created impressive tomes in their official language, Latin. Examples of these include the Book of Kells and the Book of Durrow as well as other mundane works such as the Annals, which were an account of the history of the church. Monasticism was known in St. Patrick’s time (mid 5th century) but it was not until the 6th and 7th centuries that the famous monastic houses such as Glendalough, Bangor, Clonfert, Clonard, Clonmacnoise and Durrow were founded.

Two recorded church sites are located within 500m of the proposed flood relief works at Dunkellin (RMP GA103-120003) and Killora (RMP GA104-151). The church at Dunkellin is located c. 100m south of the proposed development area and is associated with a medieval settlement (RMP GA103-120001–3). Killora Church and Graveyard is located c. 450m east of the Aggard Stream and is associated with a souterrain (RMP GA104-1510030). Killora church is translated by O’ Donovan as meaning ‘Church of the prayers’ (Holt 1909–1910, 155).

Lewis (1837) records that an abbey was said to have been founded at Kilcolgan in AD580, over which St. Colgan/Colga presided. The Ordnance Survey Letters record that Kilcolgan (*Cill Chólgáin*), was mentioned in the Annals of the Four Masters from AD 1132 (Holt 1909–1910, 139), although there are no remains of the early church. The churches at Kilcolgan (Cill Cholgáin) and Killeely (*Cill Fhaoile*) were reputedly dedicated to or built by St. Colgan and his sister *Faoile* (*ibid*.). An alter (GA103-127), annotated as ‘Toberursaun Alter’ in the first edition OS map, is located on the southern bank of the Kilcolgan/ Dunkellin River *c.* 550m south-west of the area of proposed development. O’ Donovan noted that the church at Killeely had been modernised in the 14th and 15th centuries (Holt 1909–1910, 149) and there are several medieval grave slabs recorded in the RMP.

A single holy well is located within study area near the church at Mannin (GA104-198). Most wells have no artificial features associated with them and where such do occur they can usually be shown to be of recent origin. However veneration of wells is a very widespread and ancient tradition in Ireland.

Medieval Period (AD1100–1600)

The beginning of the medieval period was characterised by political unrest that originated from the death of *Brian Borumha* in 1014. *Diarmait MacMurchadha,* deposed King of Leinster, sought the support of mercenaries from England, Wales and Flanders to assist him in his challenge for kingship. Norman involvement in Ireland began in 1169, when Richard De Clare and his followers landed in Wexford to support *MacMurchadha*. Two years later De Clare (Strongbow) inherited the Kingdom of Leinster and by the end of the 12th century the Normans had succeeded in conquering much of the country (Stout & Stout 1997, 53). The first series of castles in Ireland consisted of earth and timber features and began appearing near the start of the Norman invasion of Ireland and lasted steadily until 1225. These castles were built hastily to establish territorial claims and were later replaced by stone castles.

Three tower houses are recorded within the constraints area in the townlands of Dunkellin (RMP GA103-120002), Mannin (RMP GA104-197) and Cloghroak (RMP GA104-118). Dating to the 16th and 17th centuries tower houses are a fortified residence in the form of a tower, usually four or five storeys high. They were constructed by a lord or landholder and were often partially or completely enclosed by a bawn. A further unclassified castle is located within the townland of Castlegar (RMP GA103-103).

Knox records that the origin for Kilcolgan castle and burgage do not post date 1247 (Knox 1911–1912, 80). O'Donovan records that the castles at Kilcolgan and Dunkellin were mentioned in 1608 as belonging to the Earl of Clanricard (Holt 1909–1910, 143–150). Kilcolgan castle was demolished before the early 19th century in order to build the present house, by Mr. St. George (*ibid*., 143). O'Donovan records the burning of Kilcolgan in 1258 and the encampment in 1598 and 1599 by O'Donnell and his men at the gates Kilcolgan Castle and Roevehagh. The townland of Roevehagh or *Ruaidh Bheitheach*, meaning red birch tree, was reputedly the location of the inauguration tree of the *Hy-Fiachrach Aidhne* which was cut down in 1143 by Turlough O' Brien (Holt 1909–1910, 144). An inauguration site (RMP GA103-102001), comprising of rude stone chair known as the 'Marquis of Clanrickard's chair' (*ibid*., 150) is located in the adjacent townland of Castlegar in association with an enclosure site (RMP GA103-102).

Castlegar Castle (RMP GA103-103), located *c*. 300m north of the Dunkellin River, was built by the de Burgo family to dominate over the lake and all routes by water and land into Galway. The castle, a typical late medieval tower-house which has several 16th century architectural features, is built on a prominent piece of limestone outcrop at the side of the lake. It has no definite bawn wall. The remains consist of a rectangular keep with a stairwell at one side. At several points the stairwell is not keyed into the rest of the structure, but there is no reason to suggest that they were built at separate times. Reclamation and the building of the Dyke Road in the 19th century had succeeded in partially draining the lake, in which a crannog can still be seen. A series of underground streams and races in the local limestone and old river courses which once linked the area with the River Corrib may still be traced in the vicinity (Higgins, 1997).

Post Medieval Period (AD1600–1900)

The 17th century saw dramatic rise in the establishment of large residential houses around the country. The large country house was only a small part of the overall estate of a large landowner and provided a base to manage often large areas of land that could be located nationwide. Lands associated with the large houses were generally turned over to formal gardens, which were much the style of continental Europe. Gradually this style of formal avenues and geometric gardens designs was replaced during the mid 18th century by the adoption of parkland landscapes – to be able to view a large house within a natural setting. Although the creation of a parkland landscape involved working with nature, rather than against it, considerable constructional effort went into their creation. Earth was moved, field boundaries disappeared, streams were diverted to form lakes and quite often roads were completely diverted to avoid travelling anywhere near the main house or across the estate. A number of large demesnes are shown on the first edition OS mapping included within the vicinity of the proposed development area.

These include demesne lands in Kilclolgan, Kilcornan, Rahasane, Aggard and Ballymore. A further unnamed shaded area is shown on the first edition OS map is shown to the north of the Dunkellin River within the townland of Crinnage or Ballywulash. These demesne lands are marked in purple on the accompanying figures.

During the mid 19th century the Dunkellin River was partially canalised and the surrounding flood plains reclaimed. These changes can be clearly seen when comparing the first edition OS map and the later editions. This resulted in the river being narrowed for the most part within the receiving environment. Four eel weirs were noted in the first edition OS mapping (AAP 1, 2 and 4–7) crossing the Dunkellin River which are not shown in later mapping.

A children's burial ground is located to the immediate east of the Aggard Stream in Ballynamannin townland (RMP GA104-054). A further children's burial ground *c*. 175m north of the river to the immediate west of the railway in the townland of Craughwell (RMP GA096-069). Two other children's burial grounds are located within the wider landscape at Carrigeen East (RMP GA104-092001) and at Shanbally (RMP GA096-159001). The practice of burying children and infants in a separately designated place appears to have proliferated in Ireland from the 17th century onwards and continued in some cases into the last century (Donnelly & Murphy 2008, 28). In part this reflects the refusal by church authorities to allow the burial of unbaptised children on consecrated ground, but also perhaps the view that unnamed children had not attained full status within the communities they lived in. Occasionally adults who were viewed as outcasts in one way or another were also buried in such places. Often these places are known as '*cillín*', or '*ceallúnach*'. In many instances burials are marked by low un-inscribed upright slabs and the deaths were not mourned or waked in the traditional ways.

14.3.1.1 Summary of Previous Archaeological Fieldwork

A review of the Excavations Bulletin (1970–2010) and the database of archaeological licences held by the Department of Arts, Heritage and the Gaeltacht (2011–2014) has revealed that a total of nine programmes of archaeological investigation have been undertaken within vicinity of the scheme.

Archaeological investigations in advance of the M18 scheme were undertaken at three locations within 500m of the proposed works. The remains of a poorly preserved burnt mound were excavated within the townland of Roevehagh *c.* 75m north of the Dunkellin River (Hegarty, 2010; Registration Ref.: E3885). A calibrated late Bronze Age date of 976–832 BC was obtained from the fill of a large shallow pit on site (*ibid*.).

A low wide mound of *c*. 60m in diameter was observed on the south bank of the Dunkellin River on agricultural land during inspection of the route. The mound was investigated and found to be a natural gravel ridge deposited during the last glaciation (Hegarty, 2007; Registration Ref.: E3699). Archaeological testing was undertaken to the immediate east of the ringfort and souterrain (GA103-049), *c.* 350m south of the scheme, but nothing of archaeological significance was uncovered (Mullins 2009, Registration Ref.: E3701).

Two programmes of archaeological investigation were undertaken within the vicinity of Castlegar Castle (GA103-103) in advance of development. Nothing of archaeological significance was located within the site to the south-west of the castle (Higgins 1997, Licence Ref.: 97E0341) or the north-west in the vicinity of souterrain GA103-104 (Quinn 1998a, Licence Ref.: 98E0498).

Testing was undertaken to the immediate east of ringfort GA104-0740021 in the townland of Fahymactibbot (Delaney 2004, Licence Ref.: 04E1218) and to the immediate east of ringfort GA103-018 in the townland of Ballynabucky (Quinn 1998b, 98E0570) but nothing of archaeological significance was revealed. Test-trenching was carried out in advance of the proposed railway line level-crossing upgrade at Ballybaun (Fegan, 2008; Licence Ref.: 08E0858) adjacent to the Aggard Stream; however nothing of archaeological significance was identified. Testing was also undertaken in advance of a proposed construction of a dam between two glacial ridges at Lackan near to ringfort GA114-150 and the Aggard Stream (Fitzpatrick, 1996; Licence Ref.: 96E019). Nothing of archaeological significance was identified.

14.3.1.2 Cartographic Analysis

*William Larkin, Map of the County of Galway, 1819 (**Figure 14.1**)*

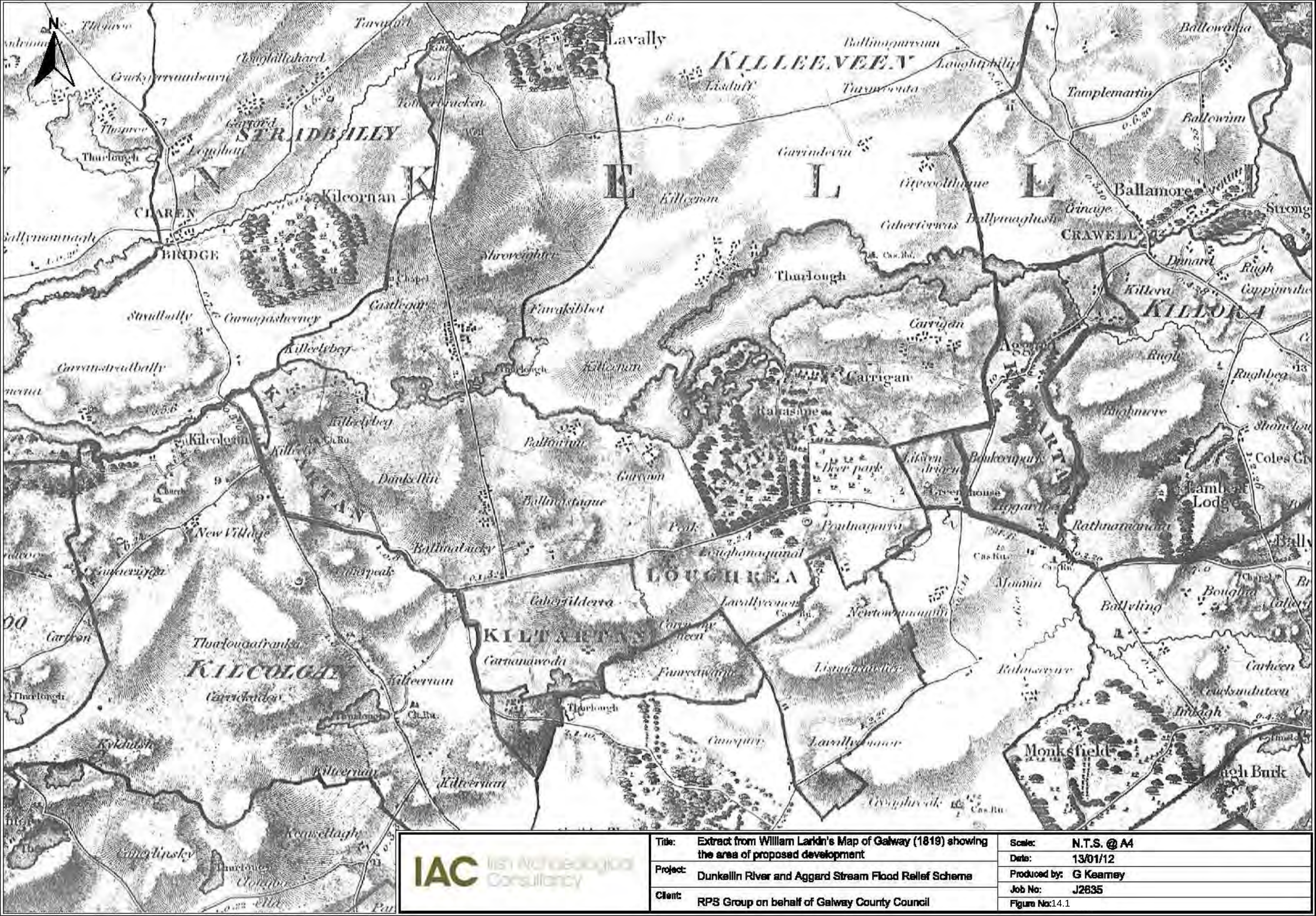
The Dunkellin River is shown running west from '*Crawell*' in a wide meandering path. A large house and demesne, annotated as '*Ballamore*' are illustrated to the east of '*Crawell*' along a tree-lined avenue. The majority of the linear settlement is located to the north of the river. The river temporarily diverges at '*Crawell*' to form a small island which is crossed by a road. This road divides south of the town, one arm passing south-east through '*Dunard*' and the other running south-west through '*Aggard*' townland. A small stream runs north through Aggard townland before discharging into the River Dunkellin. A small structure is shown within the location of a mill site however it is not annotated as such. This stream is formed by the amalgamation of two streams which merge to the south of the road in Aggard. The western stream runs south–north and partially forms the parish boundary between Killora and Kiltartan. This stream forms the northern half of the current Aggard Stream and passes in proximity to a large house (Aggard House RMP GA104-013, RPS 301). The stream crosses a road between '*Rathnamannin*' and '*Aggard Beg'*. A small cluster settlement is located here and the ruins of a castle (RMP GA104-197) are annotated to the south-west of the stream. An asterisk is marked on the stream within the vicinity of the ringfort and souterrain (RMP GA104-052, 001). Two houses are shown to the south of the road and east of the stream in the townland of Ballynamannin. Continuing south a castle (RMP GA104-041) is shown at '*Ballyling*' and the stream runs along the western perimeter of Monksfield demesne (RMP GA104-213). Castle ruins are shown at Cloghroak (RMP GA104-118) and a small cluster settlement is shown in '*Ballaglat's*'.

The Dunkellin River, at this time, is largely incorporated into two 'thurloughs', the largest of which is now known as Rahasane Turlough. This turlough runs from the point where the Aggard Stream discharges into the river west to a small settlement annotated as '*Gurraun*'. An island is shown in the turlough to the north of Rahasane Demesne. A small settlement is shown at 'Ballinrinn' (now Rinn) and a larger settlement is shown to the north of the river at 'Castlegar'. A road runs north–south crossing the river at Dunkellin, passing through this latter settlement and a small turlough is annotated to the east of this. A structure is illustrated at the location of Dunkellin castle (RMP GA103-120002) however this is not annotated as such. The river widens to the west of Dunkellin to form a pool before heading west within a more constricted course. A scattered settlement is shown at Killeely Beg and Killeely. A small stream, running south–north to discharge into the Dunkellin River, forms the parish boundary between Kilcolgan and Kiltartan and the townland boundary between Kilcolgan and Killeely. A road crosses the river at Kilcolgan however the majority of settlement is located further to the west near the church and castle. A building is shown at the location of mill site (RMP GA103-179) on the north bank of the river. To the north Kilcornan House is shown surrounded by a large landscaped demesne.

*First Edition Ordnance Survey Map, 1840, scale 1:10560 (**Figure 14.2 – 14.5**)*

This mapping is the first accurate representation of the landscape in question. In general a large portion of the land appears to have been enclosed and drained for agricultural use although the banks of the Dunkellin River are largely annotated as 'liable to flood'. The wide channel of the river diverges at Craughwell and a weir is marked on each channel (AAP 1 and 2). Two bridges are shown crossing the channel, the southern of these consisting of the late medieval six-arch limestone road bridge (NIAH 30336010). Craughwell town has grown slightly and a police barracks, post office and Roman Catholic church are annotated. Ballymore House and Demesne (RPS 247 and NIAH 30336004–5) is shown to the immediate east of the town bound to the south by the river. An unnamed demesne is highlighted to the west of Craughwell and north of the river in the townlands of Crinnage or Ballywulash. Five small structures are located along the lane bordering the northern bank of the river to the immediate west of Craughwell. The layout of the main roads remains unchanged from the previous map.

Three structures are shown *c*. 100m south of the Dunkellin River adjacent to the Aggard Stream which represent a mill (annotated in later mapping). The stream diverges creating a narrow island to the immediate west of these structures. Further south along the stream a small building is shown on the east bank to the immediate south of Aggard Bridge (RPS 302). Aggard House and Demesne (RMP GA104-013, RPS 301, NIAH 30410402) is illustrated to the west of the stream. Stables and a designed garden are shown to the south of the main house. Two turloughs are annotated along this section of the stream, Killora Turlough and Aggard Turlough. The stream meanders through marshy terrain and is crossed by a bridge at Mannin. The ringforts and enclosures are all illustrated and named individually,



Title:	Extract from William Larkin's Map of Galway (1819) showing the area of proposed development	**Scale:**	N.T.S. @ A4
		Date:	13/01/12
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme	**Produced by:**	G Kearney
		Job No:	J2635
Client:	RPS Group on behalf of Galway County Council	**Figure No:**	14.1

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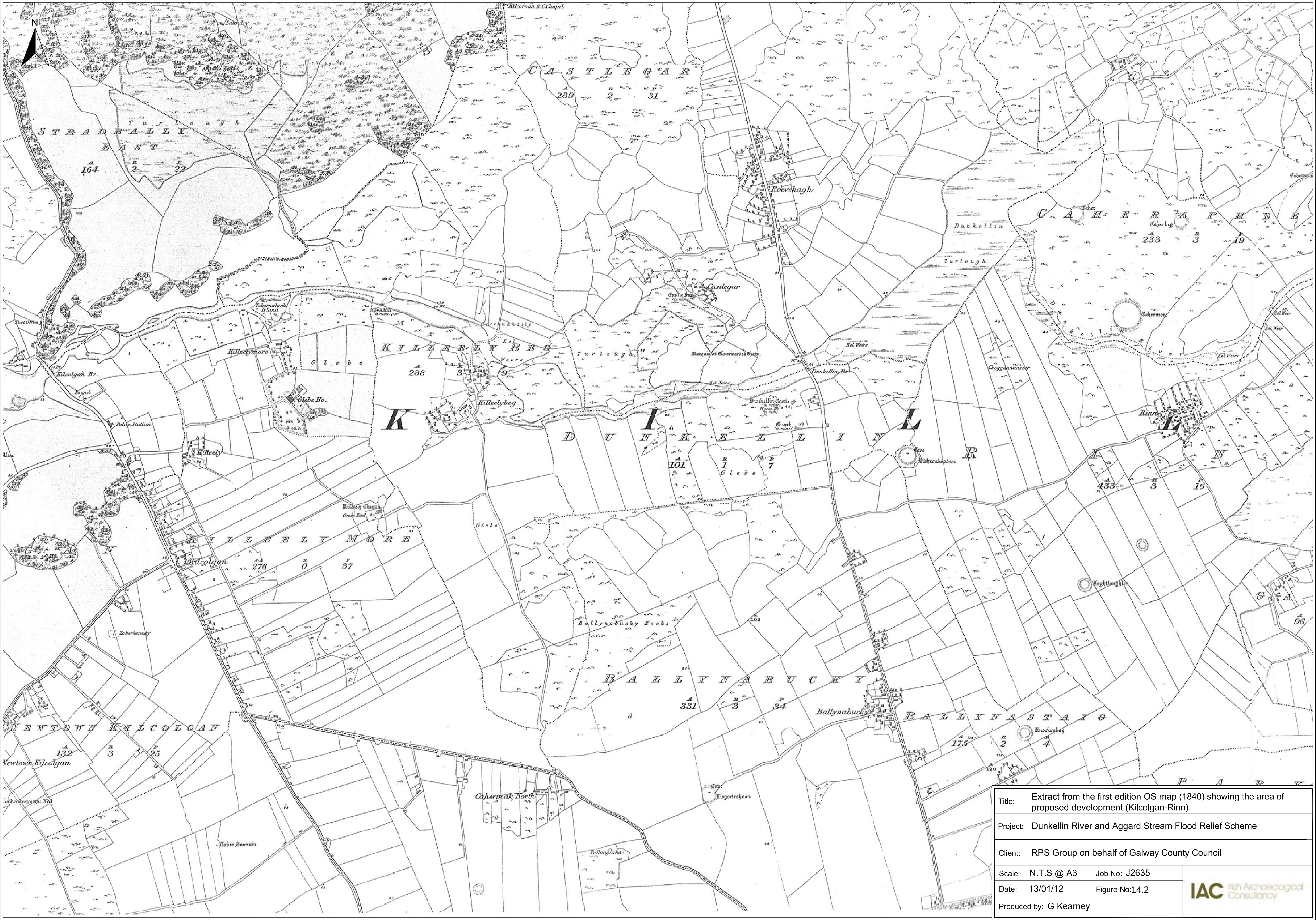

Title:	Extract from the first edition OS map (1840) showing the area of proposed development (Kilcolgan-Rinn)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale:	N.T.S @ A3
Job No:	J2635
Date:	13/01/12
Figure No:	14.2
Produced by:	G Kearney

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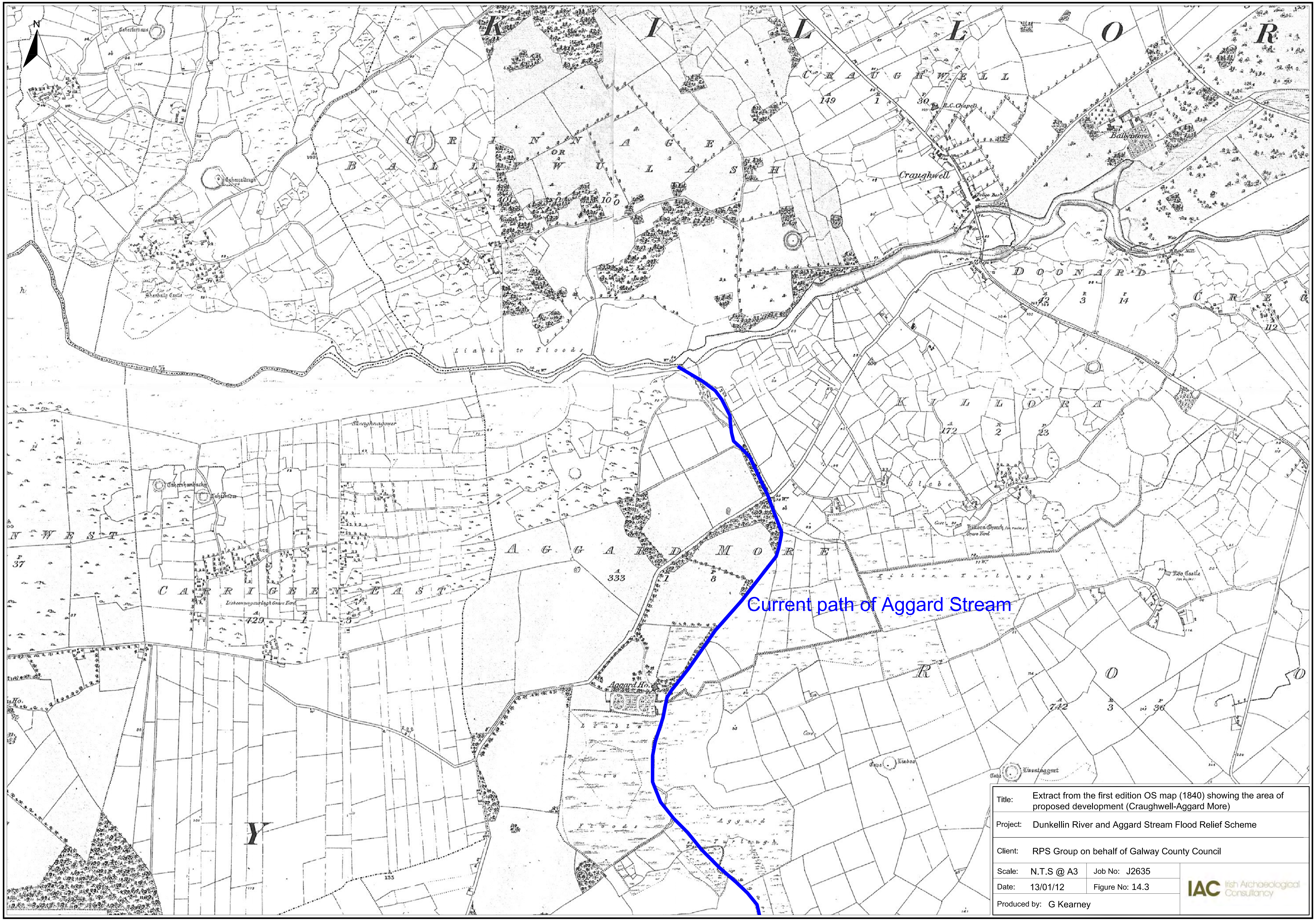

Title:	Extract from the first edition OS map (1840) showing the area of proposed development (Craughwell-Aggard More)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale:	N.T.S @ A3 — Job No: J2635
Date:	13/01/12 — Figure No: 14.3
Produced by:	G Kearney

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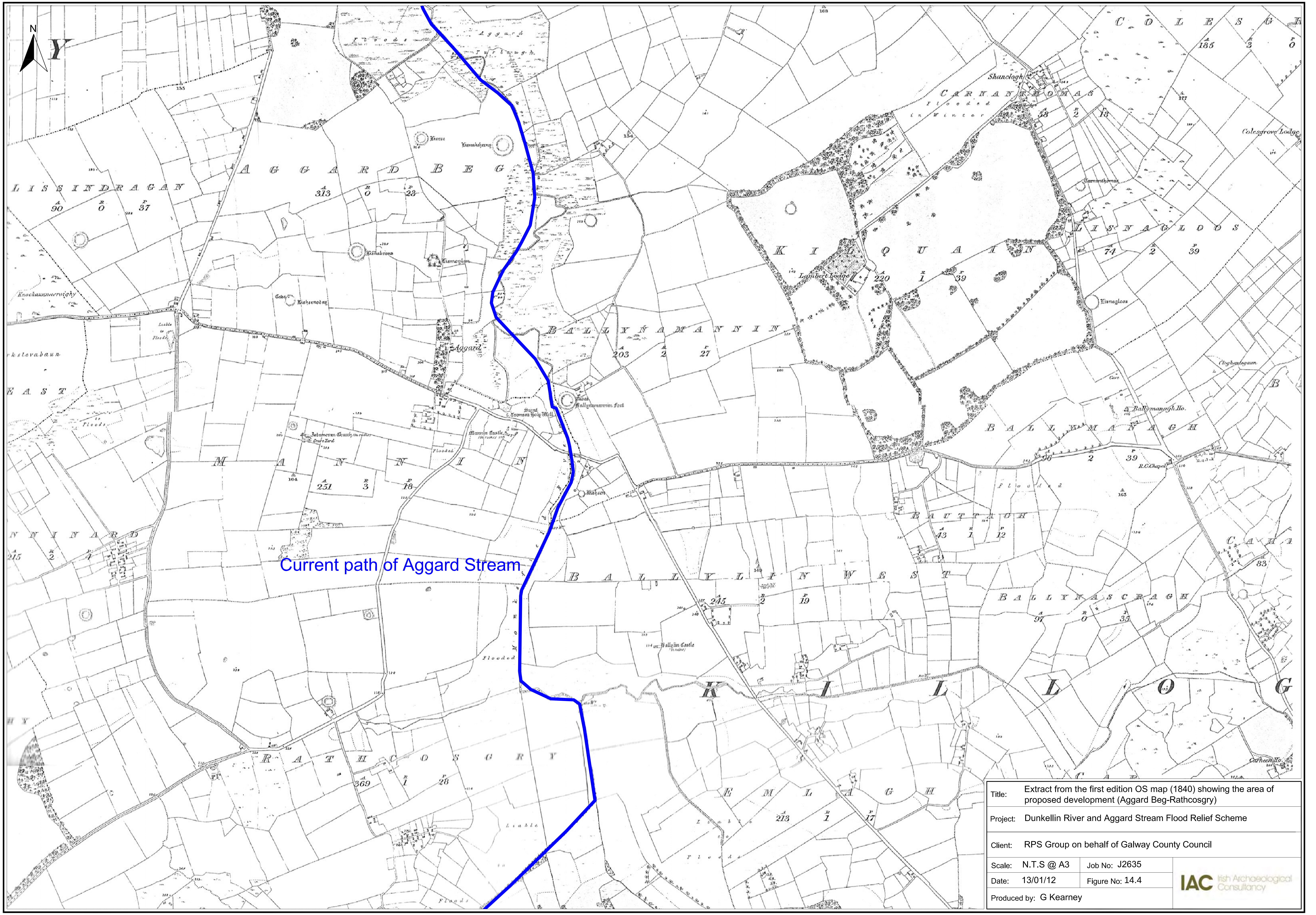
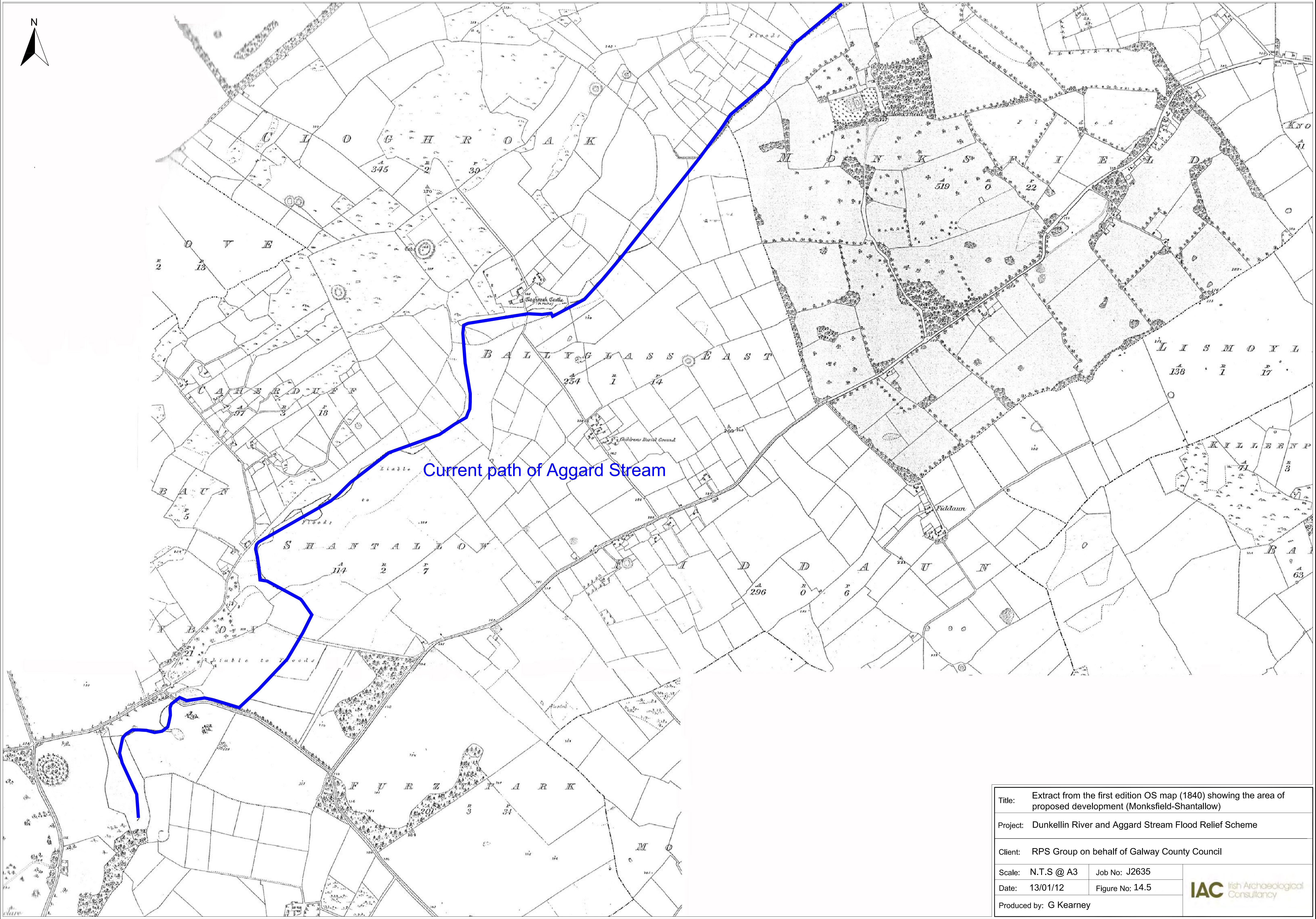


Title:	Extract from the first edition OS map (1840) showing the area of proposed development (Aggard Beg-Rathcosgry)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale: N.T.S @ A3	Job No: J2635
Date: 13/01/12	Figure No: 14.4
Produced by: G Kearney	IAC Irish Archaeological Consultancy



Title:	Extract from the first edition OS map (1840) showing the area of proposed development (Monksfield-Shantallow)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale: N.T.S @ A3	Job No: J2635
Date: 13/01/12	Figure No: 14.5
Produced by: G Kearney	IAC Irish Archaeological Consultancy

notably the large trivallate ringfort at Ballynamannin is named as a fort with caves (RMP GA104-052). St. Cronan's holy well (RMP GA104-198) and Mannin Castle (RMP GA104-197) are annotated to the west of the stream. South of the bridge at Mannin the stream is annotated as Monksfield Stream. Two structures are shown to the south of the wall and the ring barrow (RMP GA104-006) is marked as lisheen. A small circle to the west of the lisheen represents a lime kiln (AAP 3). Further south the stream is fed by a number of smaller watercourses, one of which runs along the northwestern perimeter of Monksfield Demesne. The current line of the stream appears to run along a series of field boundaries passing in proximity to Cloghroak castle (RMP GA104-118). The surrounding fields are annotated as liable to flood and at several locations along the line of the watercourse small pools of water are illustrated. At the southern limit of the stream two pools of water are shown in Ballyboy townland to the north of the road and in Lacka. Two ringforts (RMP GA114-150 and GA114-109) are illustrated within proximity to the stream in Lacka townland.

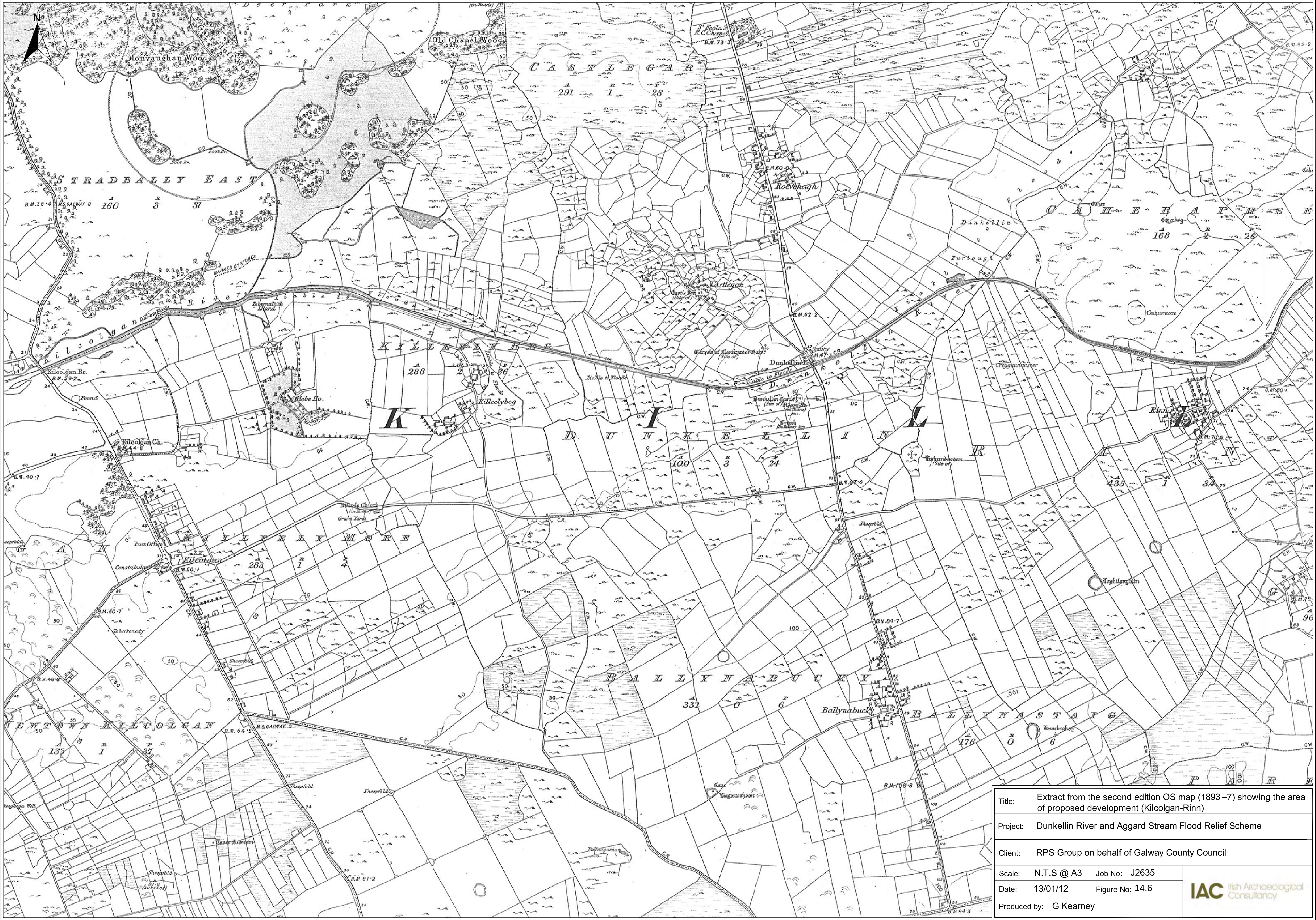
Heading west from Aggard More the Dunkellin River remains within a relatively narrow channel within Rahasane Turlough. The surrounding lands are marked liable to flood. West of the Rahasane Turlough the settlement at Rinn has grown *c*. 100m south of the river. Three eel weirs (AAP 4 and 5) are annotated across the river to the north-east of Rinn village. The river continues to the south of three cashels, Cahermore (RMP GA103-055), Caherbeg (RMP GA103-054) and Caher (RMP GA103-053) before turning into Dukellin Turlough. A further eel weir (AAP 6) is illustrated to the east of Dunkellin Bridge (NIAH 30410332). Dunkellin Bridge facilitates a north–south running road from Roevehagh and Ballynabucky villages. The bridge is shown with cutwaters on both façades however the river appears to be wider than its span. To the south-west of the bridge Dunkellin Castle, Pigeon house and church (RMP GA103-120002–4) are illustrated within marshy ground. A cluster of four structures is shown to the east of this complex fronting onto the road. The 'Marquis of Clonricardes Chair' (RMP GA103-102001) is annotated in a field *c*. 75m north of the river. A set of eel weirs (AAP 7) are annotated *c*. 300m west of Dunkellin Bridge and a further turlough is illustrated to the west of these again.

A sprawling village is shown at Killeely Beg with a trackway dotted crossing the river to Castlegar townland. No bridge is illustrated. A number of weirs are shown either side of this crossing. A corn mill in ruins (AAP 8) is illustrated *c*. 300m north-west of Killeely Beg village on the south bank of the river, to the immediate east of the townland boundary with Killeely More. A glebe house (RMP GA103-133) and lands comprising nine fields are highlighted in the south bank of the river in Killeely More to the south of a farmyard containing thatch cottage (NIAH 30410335). To the north of this a small island, named 'Tobernalack Island', is illustrated in the river. The wide channel of the river incorporates three further islands to the east of Kilcolgan Bridge (RPS 295, NIAH 30410330).

*Second Edition Ordnance Survey Map, 1893–7, scale 1:10560 (**Figure 14.6 – 14.9**)*

The Dunkellin River has been straightened and narrowed west from Craughwell to Kilcolgan. A new canal channel has been cut through the southern half of the Rahasane Turlough. Reclamation of river banks and parts of the Dunkellin Turlough has been undertaken and the islands to the immediate east of Kilcolgan Bridge have been incorporated into the north and southern banks respectively. The town of Craughwell has not expanded, although the Waterford and Limerick Railway Line is shown running north–south *c*. 200m west of the town. The northern channel of the river at Craughwell has been partially drained and the water diverted to the southern channel. A children's burial ground is annotated for the first time in Craughwell (RMP GA096-069). A bridge crossing the river and two road bridges were constructed on the banks of the river - Grenage Bridge (NIAH 30336008) and Aggard Bridge (NIAH 30336009) were constructed in *c*. 1860. A line of the railway runs roughly parallel to the Aggard Stream as it continues south and it crosses the stream at three locations in Ballynamannin and Ballyglass East. It is currently proposed to replace one of these culverts (AG 8) located on the in Ballyglass East. The railway line truncated the western banks of the trivallate ringfort in Ballynamannin (RMP GA104-052).

The Aggard Stream has also been narrowed and straightened and several drains have been excavated to join with it. The corn mill in Aggard More is annotated for the first time as such in addition to a mill race, two sluices and a weir. The corn mill (AAP 8) at Killeely Beg is no longer shown however a boundary wall delineates the site. There is no annotation for the six eel weirs shown on the first edition OS mapping (AAP 1, 2 and 4–7) along the path of the river between Craughwell and Killeely More. The lime kiln (AAP 3) is no longer shown. Some additional stables have been constructed along the banks of the Aggard Stream to the south of Aggard House.



Title:	Extract from the second edition OS map (1893–7) showing the area of proposed development (Kilcolgan-Rinn)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale: N.T.S @ A3	Job No: J2635
Date: 13/01/12	Figure No: 14.6
Produced by: G Kearney	

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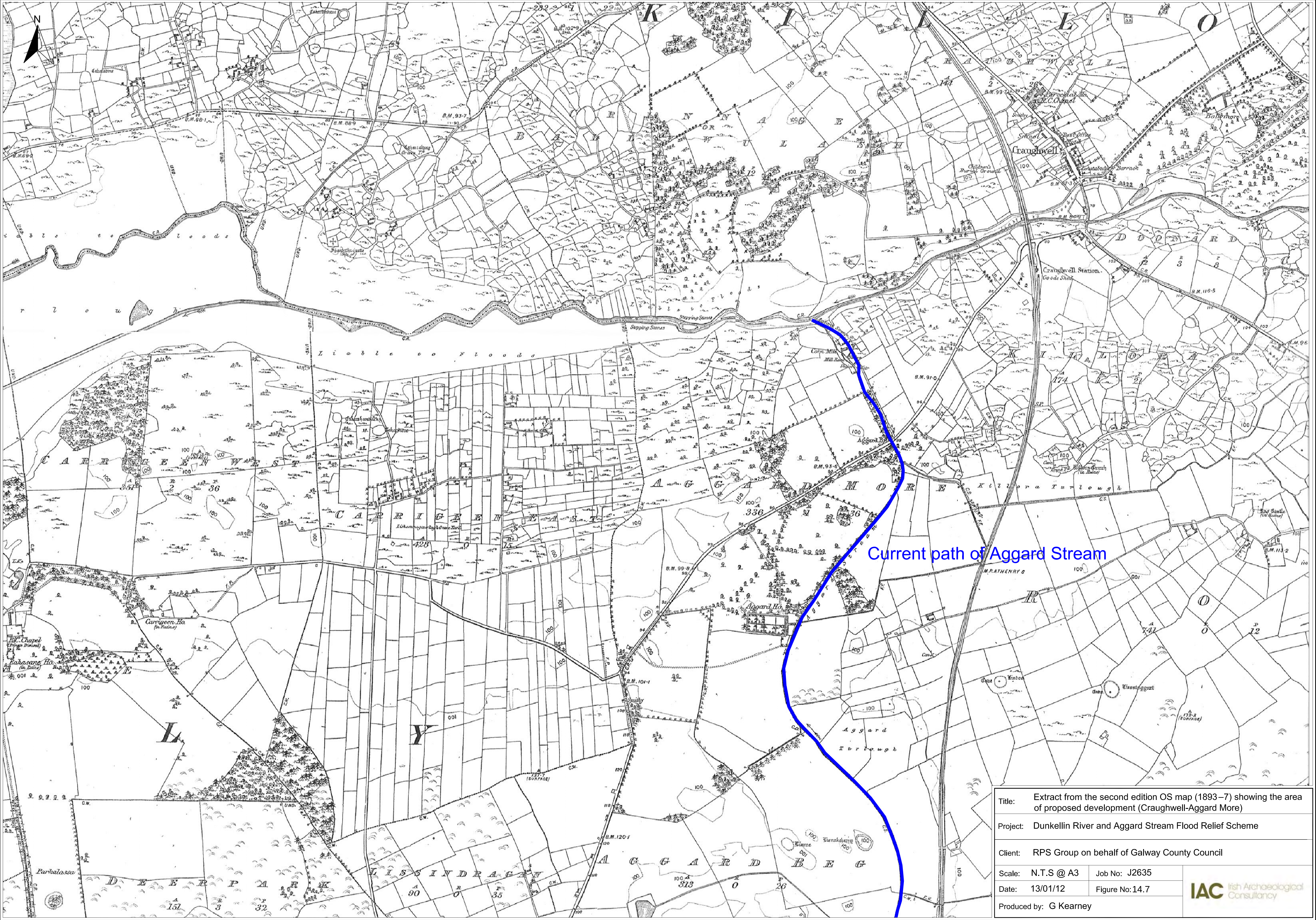

Title:	Extract from the second edition OS map (1893–7) showing the area of proposed development (Craughwell-Aggard More)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale:	N.T.S @ A3 — Job No: J2635
Date:	13/01/12 — Figure No: 14.7
Produced by:	G Kearney

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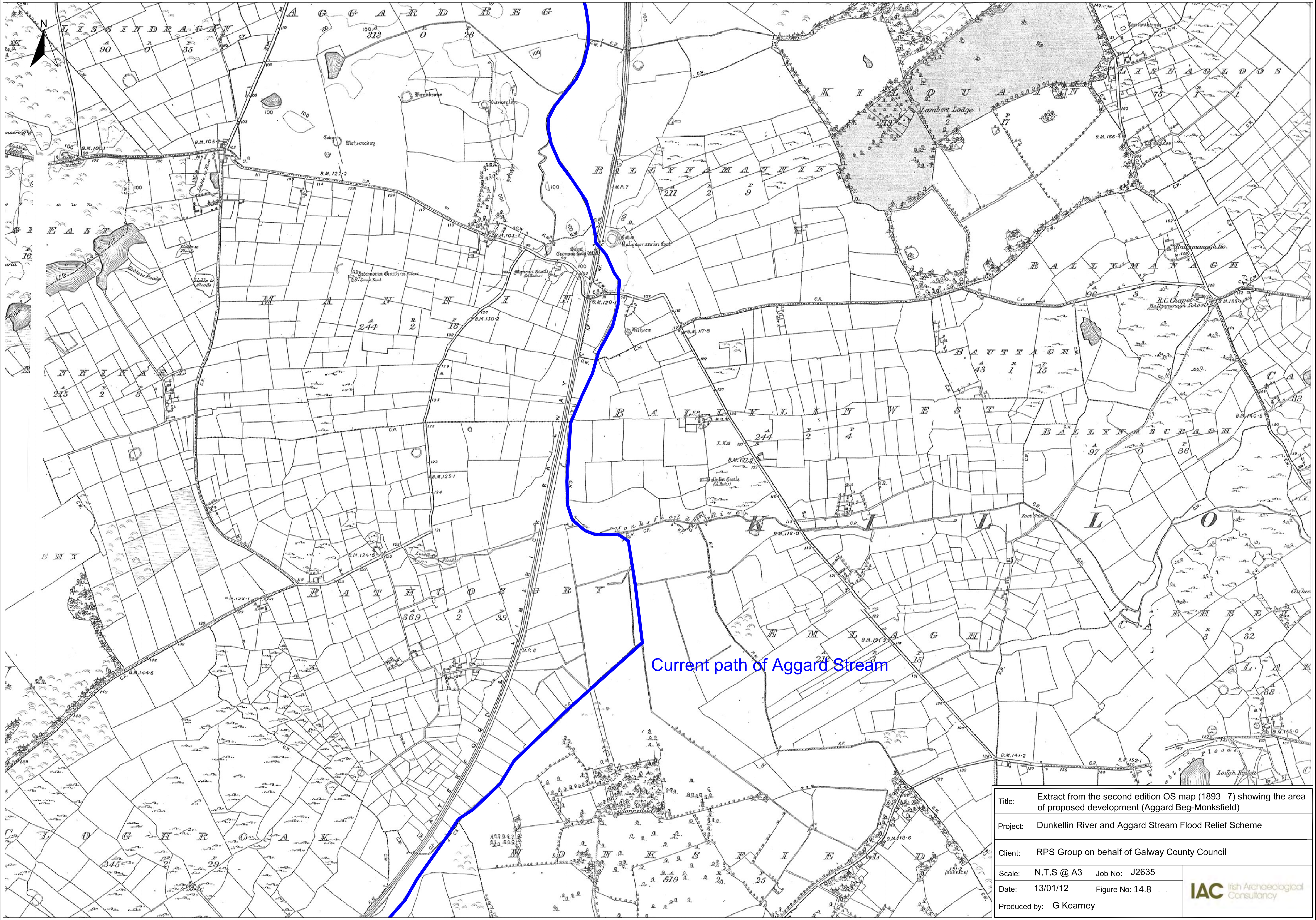
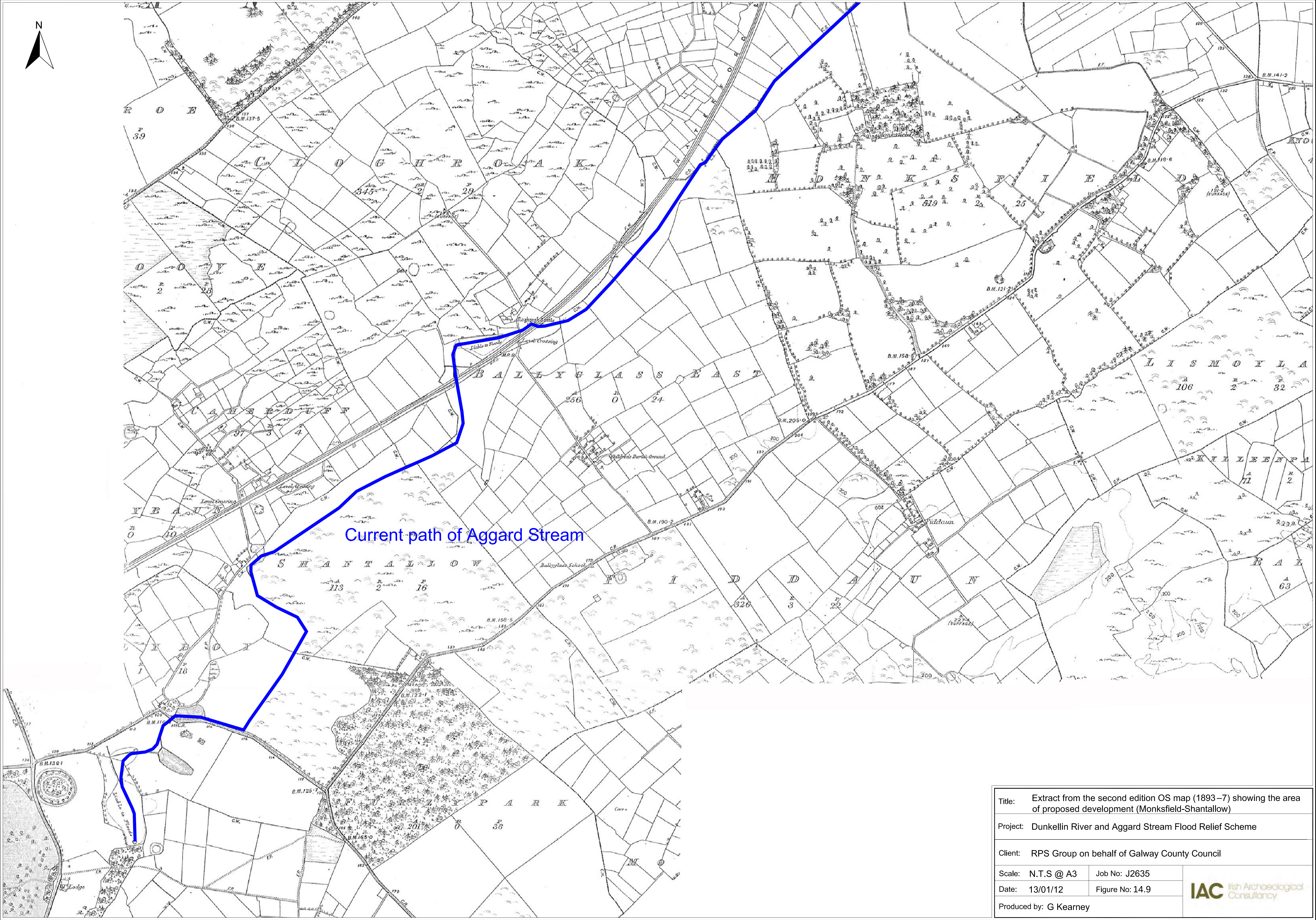


Title:	Extract from the second edition OS map (1893–7) showing the area of proposed development (Aggard Beg-Monksfield)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale:	N.T.S @ A3 — Job No: J2635
Date:	13/01/12 — Figure No: 14.8
Produced by:	G Kearney

IAC Irish Archaeological Consultancy



Title:	Extract from the second edition OS map (1893–7) showing the area of proposed development (Monksfield-Shantallow)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale: N.T.S @ A3	Job No: J2635
Date: 13/01/12	Figure No: 14.9
Produced by: G Kearney	IAC Irish Archaeological Consultancy

Third Edition Ordnance Survey Map, 1915–1920, scale 1:10560

There are no major changes to the course of the river shown on this mapping. The surrounding landscape has been further enclosed and drained. Two of the railway bridges at Craughwell have been named as Grenage and Aggard bridges for the first time. The corn mill continues to be named in Aggard More. A bridge is shown crossing the river at Killeely Beg for the first time.

Fourth Edition Ordnance Survey Map, 1933, scale 1:10560

There are no major changes to the course of the river shown on this mapping. A bridge is shown crossing the river at Rinn for the first time. The demesne lands surrounding Aggard House have been notably reduced.

14.3.1.3 County Development Plan

The County Galway (2009–2015) and Craughwell Local Area Plan (2009–2015) identify and acknowledge the statutory protection afforded to the RMPs within the vicinity of the proposed development area under the National Monuments Act. Approximately 70 individual or groups of sites of archaeological significance are recorded within 500m of the proposed Flood Relief Scheme. These are detailed in **Appendix D.1.**

14.3.1.4 Aerial Photographic Analysis

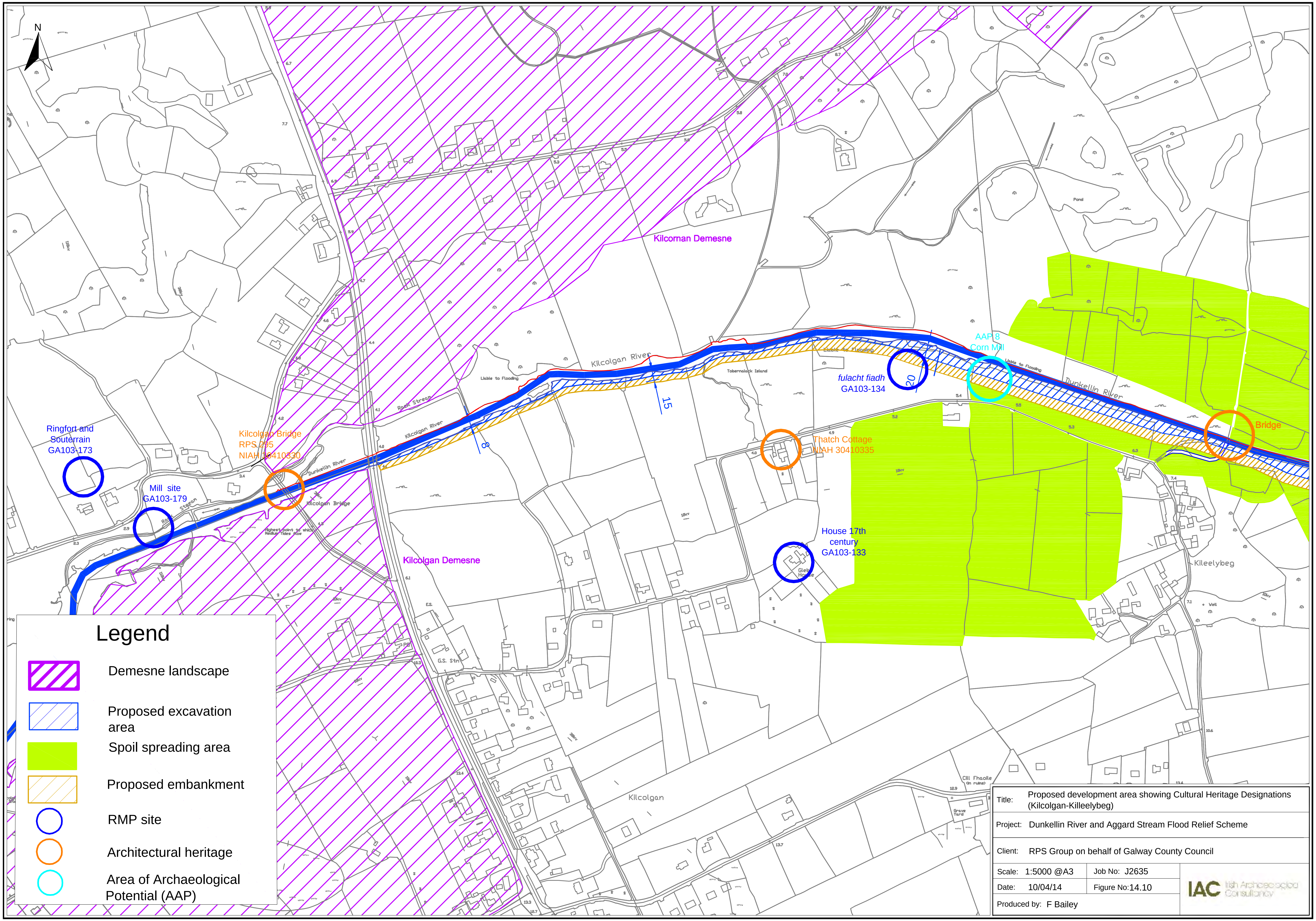
Inspection of the aerial photographic coverage of the proposed development area held by the Ordnance Survey (1995, 2000, 2005) and Google Earth (2008) revealed no previously unrecorded sites of archaeological potential within the area of proposed development.

14.3.1.5 Field Inspection

The field inspection sought to assess the scheme development area, its previous and current land use, the topography and whether any areas or sites of archaeological potential were present. During the course of the field investigation the proposed development area and its surrounding environs were inspected for known or previously unknown archaeological sites (**Figures 14.10 – 14.18**). The field inspection was undertaken on Monday 12th and Tuesday 13th December 2011 in overcast wet conditions. Due to the adverse weather conditions on the day large tracts of the river banks were flooded and as such were not available for inspection.

Dunkellin River

The course of the river at Craughwell has been largely canalised. The northern channel was heavily overgrown and has been subject to disturbance due to recent construction and dredging (**Image 14.1**). A masonry stone wall lines the southern bank of the north channel which appears to be 19th century in date. The southern channel, although straightened appears less disturbed (**Image 14.2**). There was no sign of the weirs noted in the first edition OS map (AAP 1 and 2).



Title: Proposed development area showing Cultural Heritage Designations (Kilcolgan-Killeelybeg)

Project: Dunkellin River and Aggard Stream Flood Relief Scheme

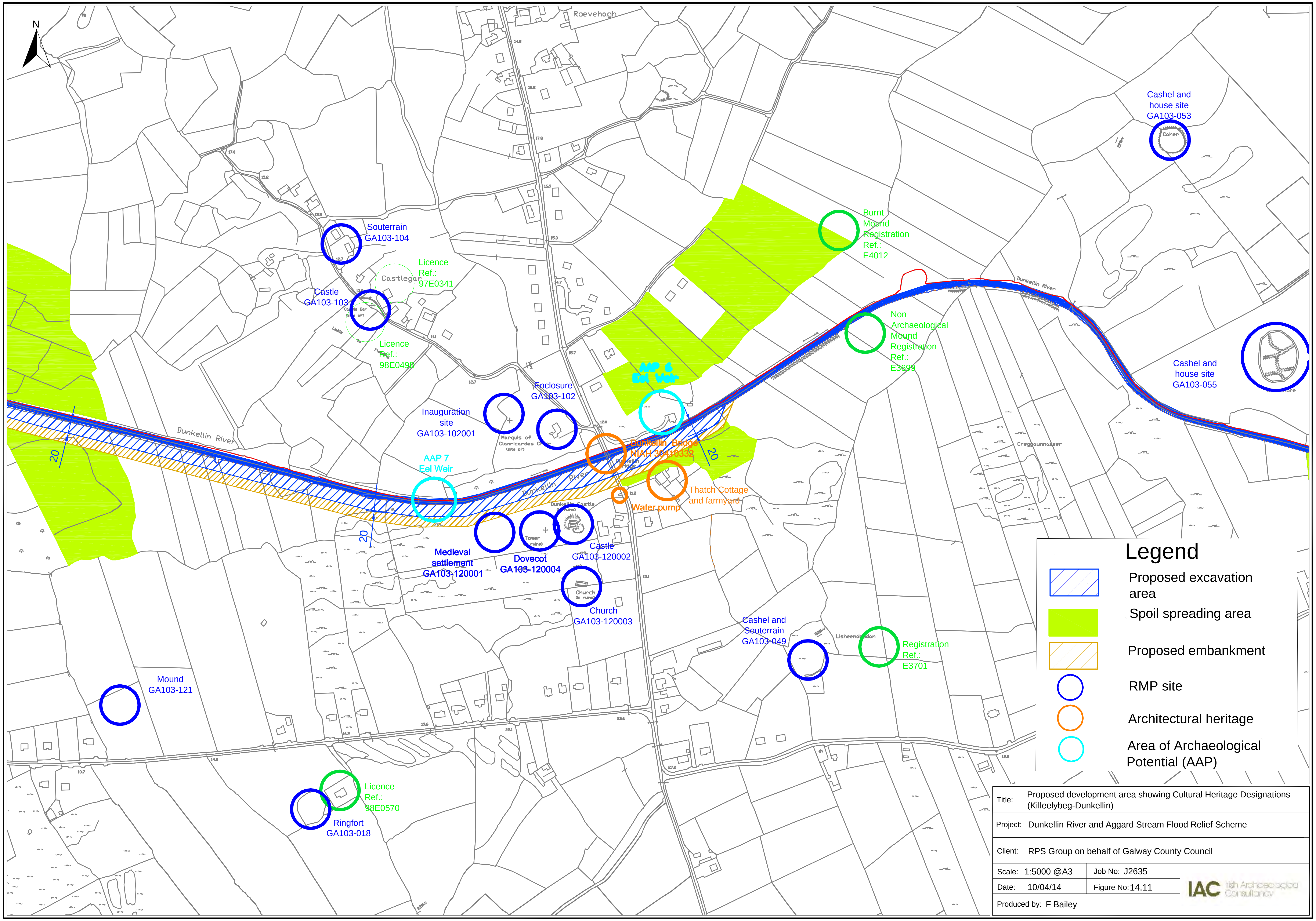
Client: RPS Group on behalf of Galway County Council

Scale: 1:5000 @A3 | Job No: J2635

Date: 10/04/14 | Figure No: 14.10

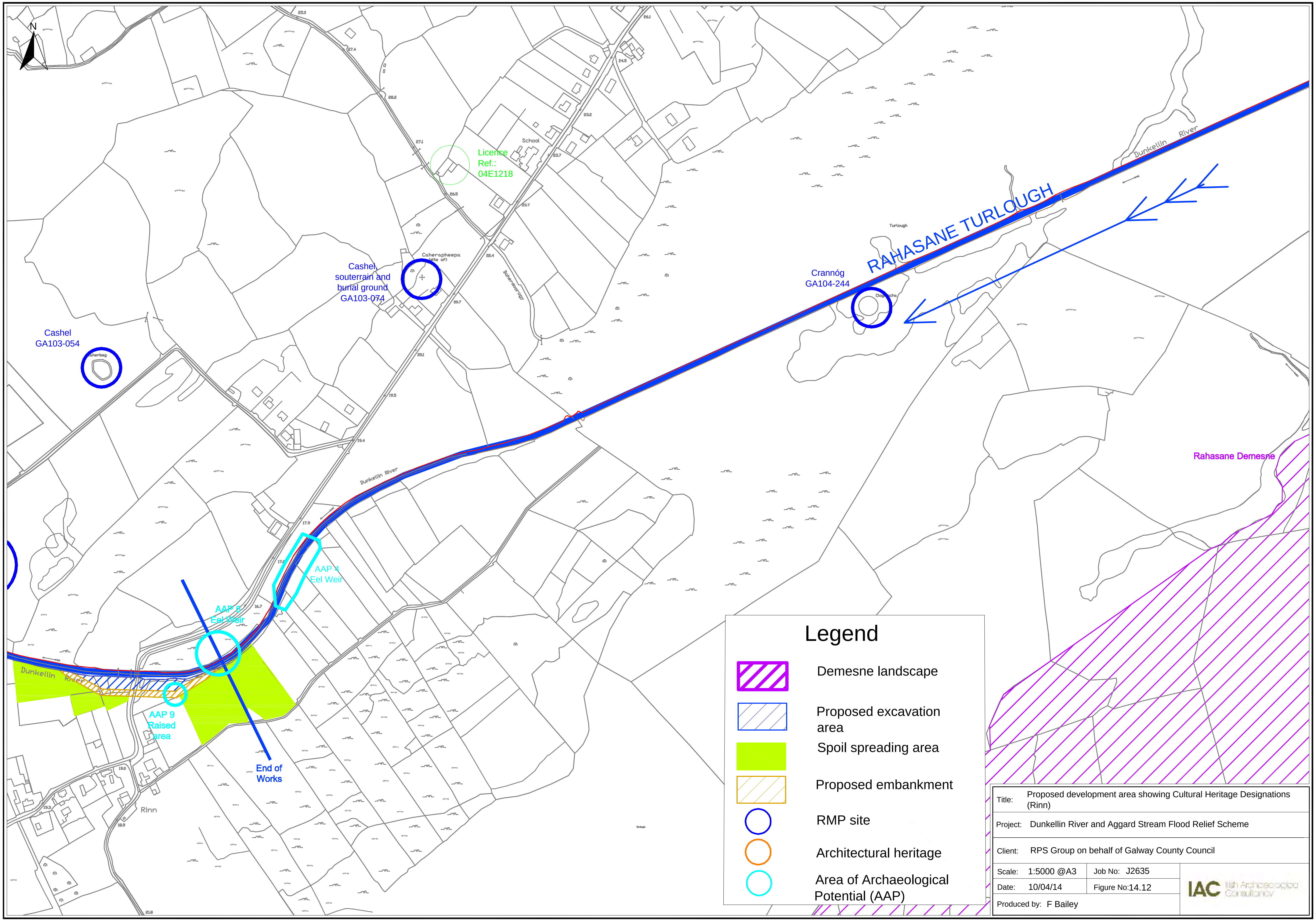
Produced by: F Bailey

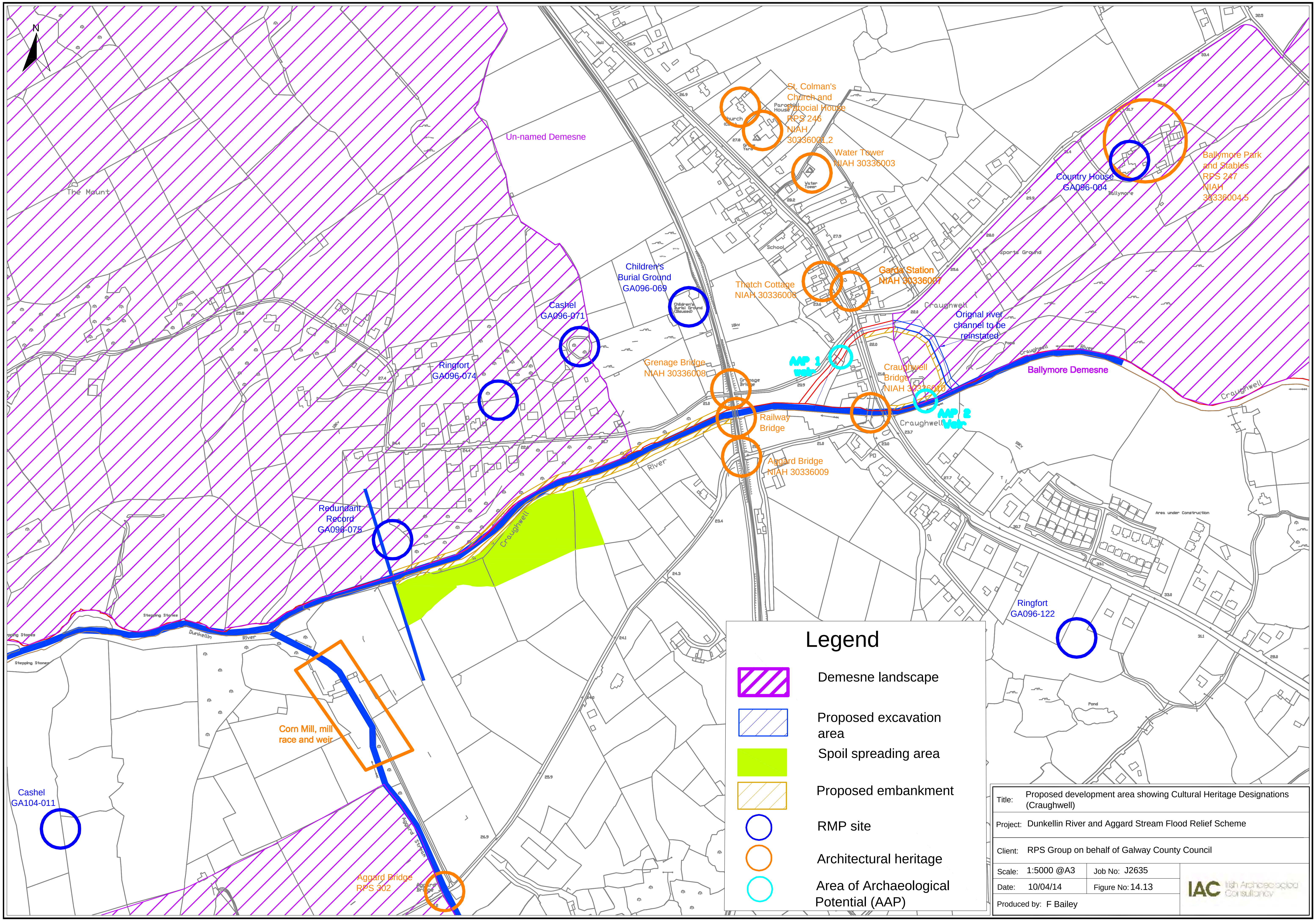
IAC Irish Archaeological Consultancy



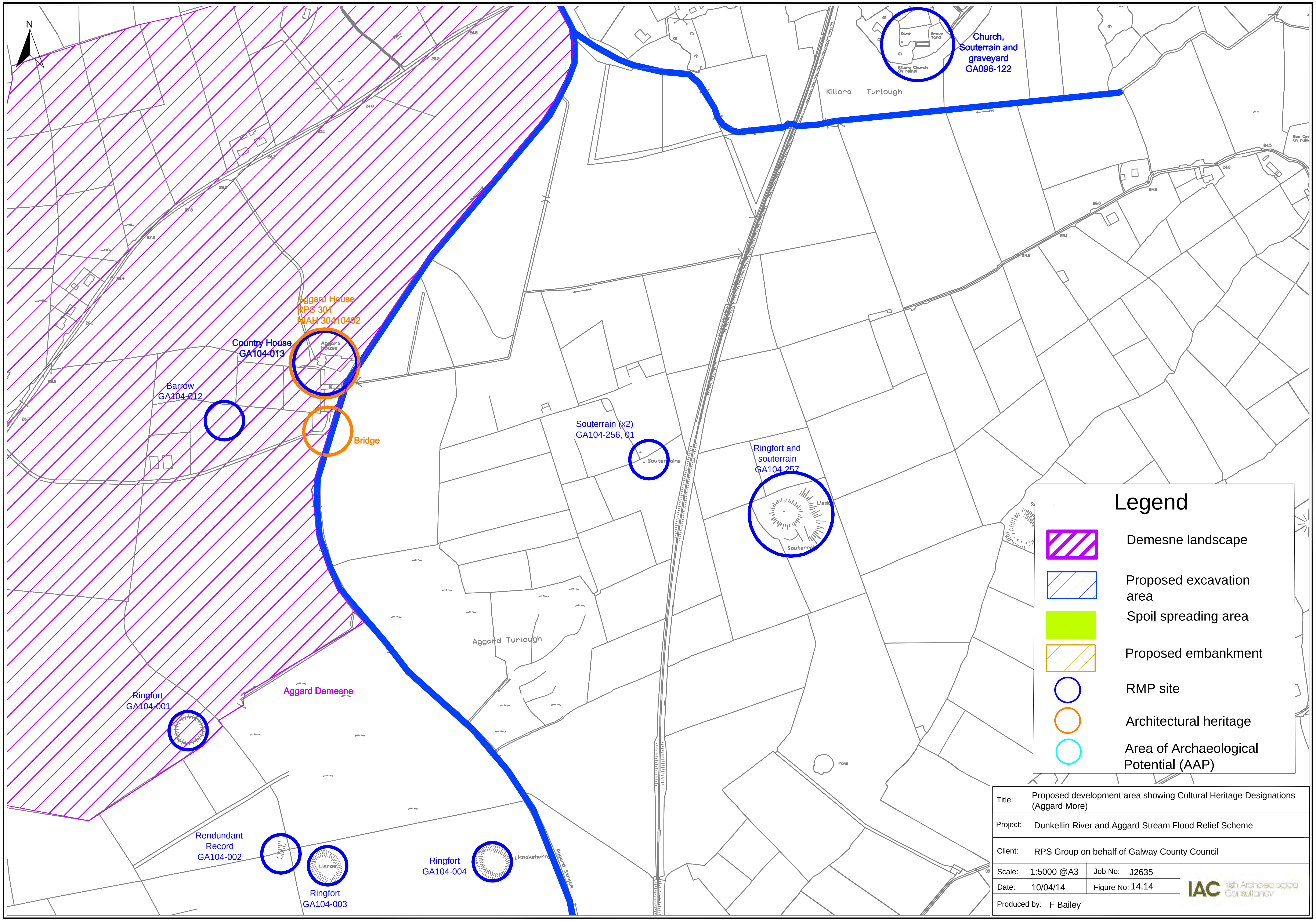
Title:	Proposed development area showing Cultural Heritage Designations (Killeelybeg-Dunkellin)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale: 1:5000 @A3	Job No: J2635
Date: 10/04/14	Figure No: 14.11
Produced by: F Bailey	

IAC Irish Archaeological Consultancy


N
Licence Ref.: 04E1218
School
Cashel souterrain and burial ground GA103-074
Cashel GA103-054
RAHASANE TURLOUGH
Crannóg GA104-244
Dunkellin River
Rahasane Demesne
AAP 4 Eel Weir
AAP 8 Eel Weir
AAP 9 Raised area
End of Works
Rinn
Legend
Demesne landscape
Proposed excavation area
Spoil spreading area
Proposed embankment
RMP site
Architectural heritage
Area of Archaeological Potential (AAP)
Title: Proposed development area showing Cultural Heritage Designations (Rinn)
Project: Dunkellin River and Aggard Stream Flood Relief Scheme
Client: RPS Group on behalf of Galway County Council
Scale: 1:5000 @A3
Job No: J2635
Date: 10/04/14
Figure No: 14.12
Produced by: F Bailey
IAC Irish Archaeological Consultancy

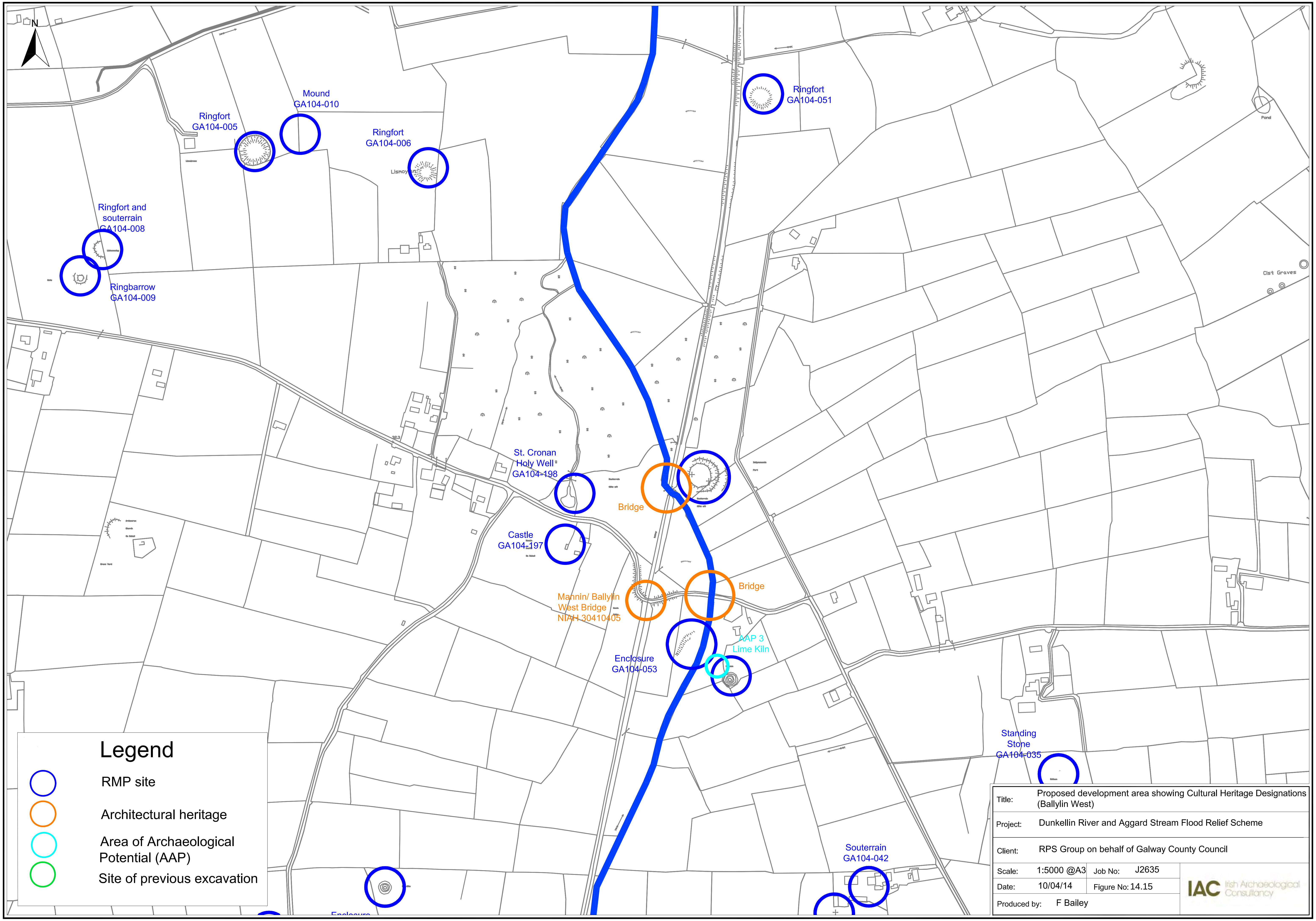


Title:	Proposed development area showing Cultural Heritage Designations (Craughwell)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale: 1:5000 @A3	Job No: J2635
Date: 10/04/14	Figure No: 14.13
Produced by: F Bailey	



Title:	Proposed development area showing Cultural Heritage Designations (Aggard More)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale:	1:5000 @A3 — Job No: J2635
Date:	10/04/14 — Figure No: 14.14
Produced by:	F Bailey

IAC Irish Archaeological Consultancy



Title:	Proposed development area showing Cultural Heritage Designations (Ballylin West)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale:	1:5000 @A3 — Job No: J2635
Date:	10/04/14 — Figure No: 14.15
Produced by:	F Bailey

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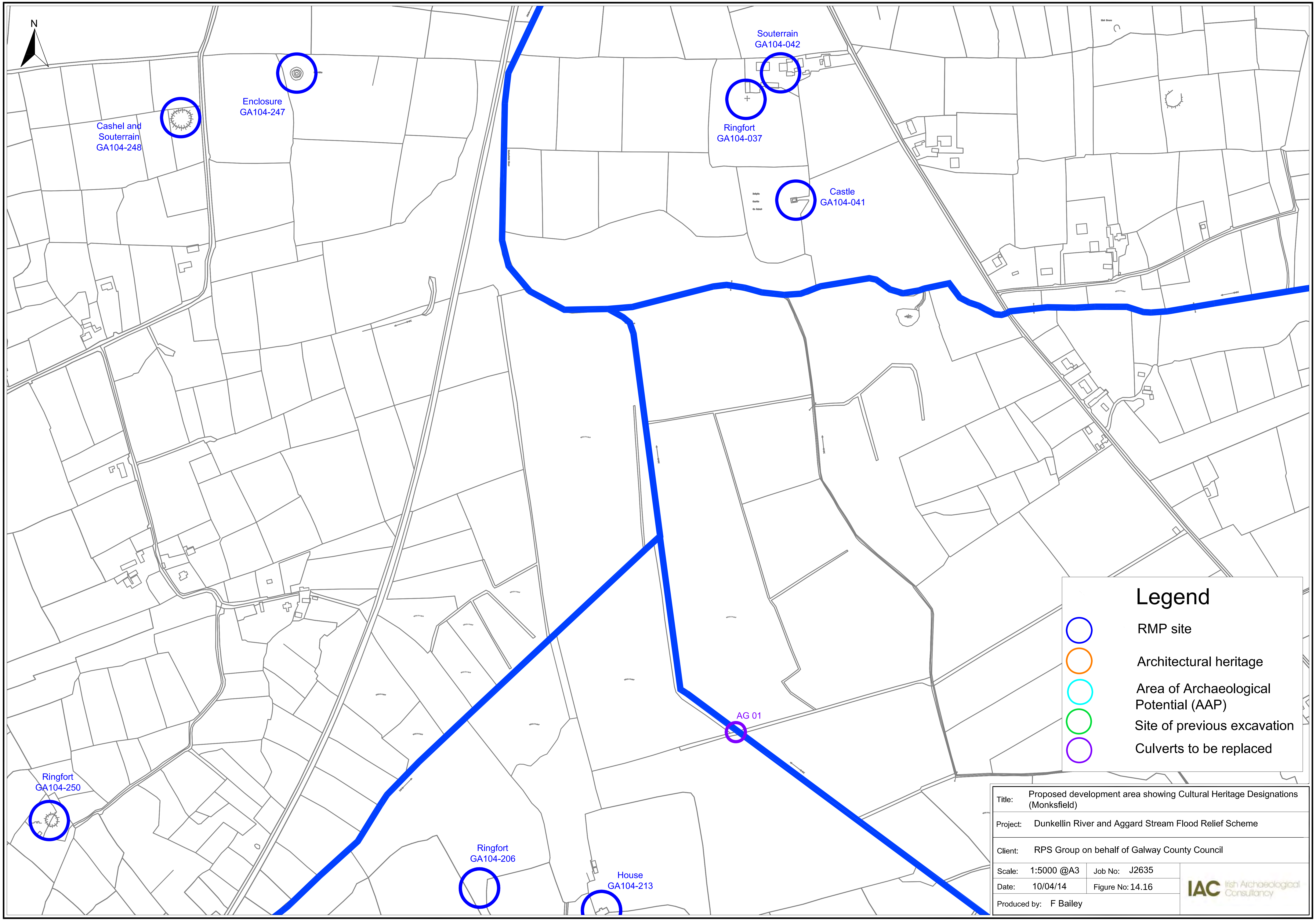
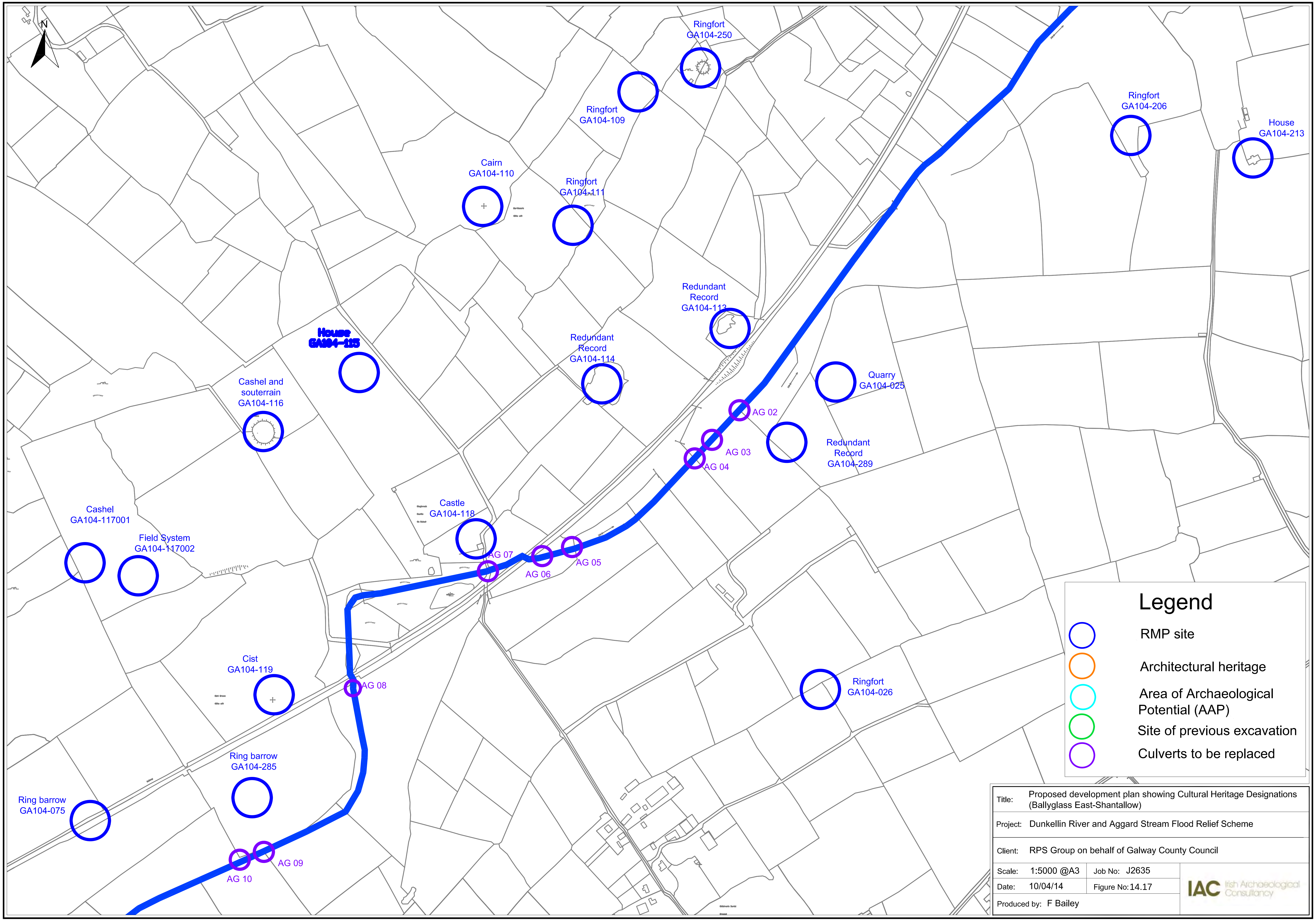
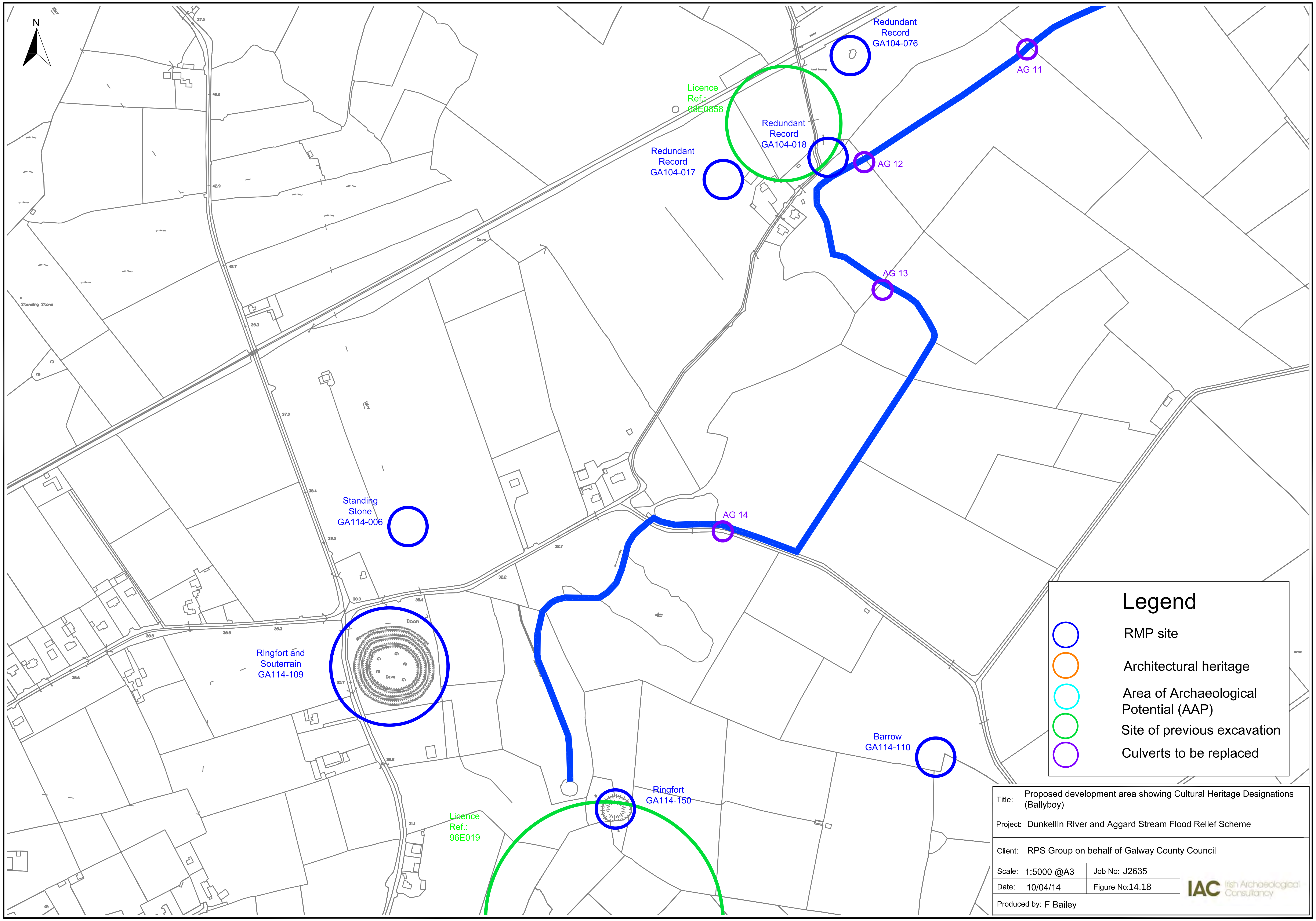


Title:	Proposed development area showing Cultural Heritage Designations (Monksfield)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale:	1:5000 @A3
Job No:	J2635
Date:	10/04/14
Figure No:	14.16
Produced by:	F Bailey

IAC Irish Archaeological Consultancy



Title:	Proposed development plan showing Cultural Heritage Designations (Ballyglass East-Shantallow)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale:	1:5000 @A3 — Job No: J2635
Date:	10/04/14 — Figure No: 14.17
Produced by:	F Bailey



Title:	Proposed development area showing Cultural Heritage Designations (Ballyboy)
Project:	Dunkellin River and Aggard Stream Flood Relief Scheme
Client:	RPS Group on behalf of Galway County Council
Scale: 1:5000 @A3	Job No: J2635
Date: 10/04/14	Figure No:14.18
Produced by: F Bailey	

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Image 14.1 Northern channel of river at Craughwell

Image 14.2 Southern channel of river at Craughwell

To the west of the railway line the river bank is largely overgrown and recent development in the form of a housing development and new road has caused disturbance along the southern banks (**Image 14.3** and **14.4**). The ground falls by *c.* 2–3m on the southern bank but appears to be lower on the northern bank. Nothing of archaeological significance was identified in this area.

Image 14.3 Southern bank of the river, west of Craughwell, facing north-west

Image 14.4 Southern bank of the river, south of recent development, facing north-west

The fields to the east of Rinn Bridge were largely flooded at the time of inspection, however the field to the immediate east comprised of well drained pasture (**Image 14.5**). A rise in the ground bisected by the southern boundary of the field may represent an archaeological anomaly (AAP 9), although the first edition OS map does show this area as rough marshy ground during the 19th century. Rinn Bridge is a modern concrete construct and there was no visible evidence of any remains associated with the eel weirs AAP 4 and AAP 5. The river banks to the immediate west of Rinn Bridge were heavily overgrown and as such nothing of archaeological significance was noted in this area (**Image 14.6**).

Image 14.5 Field to the immediate east of Rinn Bridge showing AAP 9, facing east

Image 14.6 River bank to the west of Rinn Bridge, facing west

Large tracts of land in the townland of Dunkellin, north and south of the channel, were flooded at the time of the inspection. These lands are located within the area annotated on the first edition OS map as Dunkellin Turlough (**Image 14.7**). Several low embankments are visible to the immediate east of the bridge however these most likely represent previous attempts at flood defences (**Image 14.8**). A modern house has been built on the site of the eel weirs (AAP 6) as shown on the northern bank of the river in the first edition OS map.

Image 14.7 Flooded lands to the east of Dunkellin Bridge, facing east

Image 14.8 Embankments to the east of Dunkellin Bridge, facing north-east

To the south-west of Dunkellin Bridge and west of the road a cluster of RMP sites including Dunkellin Castle, a dovecot, medieval settlement and a church (RMP GA103-120001–4) are located to the immediate south of the proposed embankment. The remains of the castle comprise of a large earthen mound containing disturbed stone from the fabric of the structure (**Image 14.9**). The mound stands c. 2m above the surrounding level and two façades of the original castle wall are visible, albeit in poor condition. The castle fabric has been robbed out and an ESB pole has been set into the centre of the site causing further disturbance. There are no above ground structural remains of the dovecot (RMP GA103-120004) or medieval settlement site (RMP GA103-120001) visible on the southern bank of the river (**Image 14.10**). The proposed spoil spreading area partially covers the site of the settlement and lies to the immediate north of the castle and dovecot sites. The site of Dunkellin church (RMP GA103-120003) lies further to the south and is completely overgrown.

Image 14.9 Dunkellin Castle (RMP GA103-120002), facing north

Image 14.10 Site of dovecot and medieval settlement (RMP GA103-120001,4), facing west

An overgrown earthen embankment is located along the southern bank of the river to the north-west of the RMP sites however the northern half of this field was flooded at the time of inspection. West of this settlement cluster at Dunkellin the riverbank becomes increasingly overgrown and covered in scrub. The banks of the river are overgrown and it was difficult to identify evidence for archaeological remains (**Image 14.11**). A low stone wall comprises a townland boundary between Dunkellin and Castlegar (**Image 14.12**). At a number of locations along the southern river bank in Castlegar and Killeely Beg low embankments comprising of loose stone have been constructed.

Image 14.11 Overgrown riverbank in Dunkellin townland, facing west

Image 14.12 Townland boundary between Dunkellin and Castlegar, facing south

To the east of Killeely Beg Bridge the river bed deepens and the southern bank is slightly raised from the surrounding lands. The fields are flooding in the east, within an area marked as turlough on the OS mapping (**Image 14.13**). Nothing of archaeological significance was noted within the area available for inspection. At Killeely Beg a modern salmon counter has been constructed which has caused significant disturbance along the bed of the river and the southern bank. The southern river bank to the west of Killeely Beg Bridge was flooded and as such was not available for inspection (**Image 14.14**).

Image 14.13 Southern bank in Killeely Beg townland, facing east

Image 14.14 Lands to the west of Killeely Beg Bridge, facing south-west

The site of the corn mill (AAP 8) is located to the north of the wall on the southern bank of the river in Killeely Beg townland (**Image 14.15**). No upstanding structural remains were noted during the inspection. A recorded *fulacht fiadh* is also located within this area, although no upstanding remains were identified during the field inspection (GA103-134). A north–south running laneway runs from the road in the south to the river bank immediately west of the mill site (**Image 14.16**). It is bound to the west and east by drystone walls and was flooded at the time of the inspection. This access lane forms the townland boundary between Killeely More and Killeely Beg.

Image 14.15 Site of corn mill (AAP 8) in Killeely More, facing north-east

Image 14.16 Access laneway to river and corn mill site, townland boundary, facing north

Moving west along the riverbank in Killeely More townland the ground becomes increasingly waterlogged and scrub like (**Image 14.17**). An irregular enclosed area illustrated on the mapping on the south bank appeared to be a heavily overgrown raised area (**Image 14.17**). No structural remains or evidence for archaeological remains were noted here. The river bank was dissected by a number of small drains and watercourses, the most westerly of which in Kilcolgan townland represents a townland boundary. The banks to the immediate east of the N18 were heavily waterlogged and access was limited (**Image 14.18**). Nothing of archaeological significance was noted within the lands available for inspection.

Image 14.17 Waterlogged terrain in Killeely More and raised area in background, facing NNE

Image 14.18 Flooded fields on the southern banks of the river immediately east of the N18

Aggard Stream

The lands surrounding the Aggard Stream were inspected to determine any impact on the known archaeological landscape and any potential sites of archaeological significance. At the confluence with the Dunkellin River the banks of the stream were heavily overgrown. The remains of a mill complex, illustrated in the OS mapping is located c. 75m south of this confluence. This will be discussed below as built heritage. The banks of the stream to the north of the Aggard Bridge have been narrowed and constricted to accommodate the mill complex (**Image 14.19**). To the south of the bridge the stream continues in much the same form through fields of pasture. The banks of the stream are planted with mature trees and hedgerow. Nothing of archaeological significance was noted in the surrounding fields.

Image 14.19 Aggard Stream to the north of the Aggard Bridge, facing north

Image 14.20 Aggard Stream to the south of the Aggard House, facing south

The Aggard Stream passes through the demesne lands for the Aggard House (see below) which have been designed and levelled in the 18th and 19th centuries. An avenue of trees was been planted to the north-east of the house although it is much more open to the south of the property (**Image 14.20**). Nothing of archaeological significance was noted within the area of proposed flood relief works.

The fields bordering the stream in this area comprise of pastureland which are drained by numerous small watercourses. A substantial number of ringforts and cashels are located within 500m of the stream testifying to the quality of the land for settlement.

A large trivallate earthen ringfort is located to the immediate east of the stream in the townland of Ballynamannin (RMP GA104-052) at the point where the railway line crosses the stream. The western side of the ringfort was truncated by the railway works in the 19th century (**Image 14.21** and **14.22**). A drystone field wall has been built over the southern tip of the ringfort. The entrance to the souterrain was clearly visible on the surface of the central raised area.

Image 14.21 Western half of the trivallate ringfort (RMP GA104-052) truncated by the railway and castle (RMP GA104-197) in the background, facing west.

Image 14.22 Ringfort (RMP GA104-052-052) viewed from the bank of the Aggard Stream, facing east

Further to the south an enclosure (RMP GA104-053) and ring barrow (RMP GA104-006) are located on the banks of the stream in Mannin and Ballynamannin townlands respectively (**Image 14.23** and **14.24**). Both sites were partially overgrown. Evidence for lime kiln (AAP 3) comprised of an overgrown rise in the ground to the immediate north-west of the ring barrow site.

Image 14.23 Enclosure (RMP GA104-053) on west bank of Aggard Stream, facing north-west

Image 14.24 Ring barrow and children's Burial Ground (RMP GA104-006), facing south-east

Heading south through the landscape the stream appears to have been canalised and narrowed. Much of this area was under flood water at the time of inspection. A number of redundant records (RMP GA104-113, 114, 289) are located within proximity to the stream however these have been removed from the record as they were later deemed non-archaeological. The remains of Cloghroak castle (RMP GA104-118) are located on a high point in the landscape overlooking the Aggard Stream. This section of the stream has been recently disturbed with works associated with the reopening of the railway. A new access road traverses the rail line and runs between the stream and the railway. There was no above ground trace of the ring barrow (RMP GA104-285) or cist (RMP GA104-119) also located within Cloghroak townland.

Works were recently undertaken in Ballybaun townland associated within the renovated railway which investigated the site of the now redundant record (RMP GA104-018). Nothing of archaeological significance was identified at this point. The Aggard Stream appears as a surface water drain in this area and much of it has been recently cleaned out with low spoil heaps evident on the banks (**Image 14.25**).

Continuing south the fields surrounding the stream in the townlands of Ballyboy and Lackan were heavily flooded at the time of inspection and therefore access was restricted (**Image 14.26**). Nothing of archaeological significance was noted in addition to the recorded monuments in the area.

Image 14.25 Section of Aggard Stream in Shantallow townland, facing NNW

Image 14.26 Flood lands in Lackan townland along the course of the Aggard Stream, facing south

14.3.1.6 Conclusions

There are a large amount of recorded archaeological sites within the receiving environment of both the Dunkellin River (Craughwell to Kilcolgan) and the Aggard Stream (Aggardmore to Lackan). A total of 26 sites are recorded within 500m of the Dunkellin River. The closest of these sites to the proposed works consist of the site of a medieval village (GA103-120001), a dovecot (GA103-120004), the site of a castle (GA103-120002) and a recorded *fulacht fiadh* (GA103-134) which are located to the immediate south of the proposed works within the townland of Dunkellin and Killeely Beg. There are a total of 51 recorded sites located within 500m of the Aggard Stream. However, it is proposed to replace a total of 14 culverts along this stream and as such the closest recorded site consists of a castle (GA104-118), which is located to the immediate north of culvert AG 8.

A review of the topographical files held by the National Museum revealed that a number of artefacts have been identified in and within the vicinity of the receiving environment of the scheme. Whilst the majority of these have been found in association with recorded archaeological sites, one item, which is listed as a ‘salmon spear’, was found in the Dunkellin River at Kilcolgan (NMI 1943:251). No other detail regarding the material or date of the artefacts is given in the file.

A number of previous archaeological excavations have been carried out within the receiving environment of the Dunkellin River and Aggard Stream. All but one of these investigations failed to reveal any features of archaeological significance. In the townland of Roevehagh, the poorly preserved remains of a burnt mound were excavated c. 75m north of the Dunkellin River (E885). This site produced a late Bronze Age date.

A review of the aerial photographic coverage of the receiving environment failed to identify any previously unrecorded sites of archaeological potential. However, several potential sites were identified during the cartographic analysis of the area. The first edition Ordnance Survey map from the mid-19th century shows the Dunkellin River as considerably wider and more irregular in appearance. Later drainage works resulted in a much narrower channel, which also bypassed much of the Rahasane Turlough. A number of weirs are marked on the first edition OS map. These are not extant today but associated remains have the potential to survive beneath the current ground level in these areas. AAP 1 and 2 are located at Craughwell, with AAP 4 and 5 are located at Rinn and Caherapheepa with AAP 6 and 7 consisting of eel weirs located at Dunkellin and Roevehagh. The first edition OS map also shows the site of a mill (in ruins) at AAP 8, within the townland of Killeely Beg. This also appears to have possessed associated weirs, which stretched across the river at this location. The site of a lime kiln was also identified to the immediate east of the Aggard Stream, within the townland of Ballynamannin (AAP 3). This is shown on the first edition OS map.

A field inspection has been carried out as part of this assessment. Access to parts of the river was restricted in areas due to the presence of flood water. One addition area of archaeological potential was identified during the field inspection. This consists of a small area of raised ground that is located within a field of pasture to the immediate east of Rinn Bridge (AAP 9). It is possible that the area, which is sub-circular in plan, has the potential to represent the site of an enclosure or settlement platform. No other specific features of archaeological potential were identified during the field inspection.

Whilst individual sites of potential have been identified as part of this assessment, the receiving environment of the proposed flood relief works as a whole should be considered to possess high archaeological potential. Streams and rivers have attracted human activity from the early prehistoric periods through to the modern day. Remains such as *fulachta fiadh* are regularly identified within the environs of water courses. In addition, water logged environments have the potential to preserve artefacts such as leather and worked wood along with other environmental evidence, which do not usually survive within the terrestrial archaeological record. The Dunkellin River and Aggard Stream have already been impacted upon to a certain degree due to post medieval drainage, which included the straightening and canalisation of both water courses.

14.3.2 Results and Analysis – Architecture

14.3.2.1 Built Heritage Background

Built heritage refers to all built features in the environment including buildings and other structures such as harbours, bridges, and wells. These sites have been identified through consultation with the County Development Plan (2009–2015), National Inventory of Architectural Heritage (NIAH), aerial photographs and through cartographic analysis and field inspection.

The built heritage within this area is typified by the vernacular cottage and associated outbuildings, much of which are shown on the first edition OS map. Vernacular architecture is defined in James Steven Curl's Encyclopedia of Architectural Terms as 'a term used to describe the local regional traditional building forms and types using indigenous materials, and without grand architectural pretensions', i.e. the homes and workplaces of the ordinary people built by local people using local materials. This is in contrast to formal architecture, such as the grand estate houses of the gentry, churches and public buildings, which were often designed by architects or engineers. The majority of vernacular buildings are domestic dwellings. Examples of other structures that may fall into this category include shops, outbuildings, mills, lime kilns, farmsteads, forges, gates and gate piers.

Typically the single storied thatched cottage would be considered to represent the real vernacular style in Ireland. Following *c*. AD1700, settlement clusters were likely to have consisted primarily of single-storey thatched cottages with associated farm buildings. Two examples of early thatched cottages are recorded in the NIAH survey within 500m of the proposed scheme in Killeely More townland (NIAH 30410335) and Craughwell town (NIAH 30336006) *c.* 160m south and 180m north of the river respectively.

The 18th century, a relatively peaceful period, saw the large-scale development of demesnes and country houses in Ireland. The houses generally form part of the larger demesne landscape. Demesnes were dominant features of the rural landscape throughout the 18th and 19th centuries. A number of demesne lands are highlighted on the first edition OS map within proximity to the proposed flood relief works associated with the following large houses Kilcolgan Castle, Kilcornan House, Aggard House, Ballymore House, Rahasane House, Monksfield House and Cregaclare House. Unnamed demesne lands are also highlighted to the west of Craughwell in Crinnage or Ballywulash townland.

From the mid to late 19th century, the Anglo-Irish landowning classes began to slowly loose their grip on the thousands of acres of Irish landscape that formed a large part of their estates. The large country house and demesne were often only a small part of the visible wealth possessed by such families and their demise was brought about by a number of factors including The Famine; the loss of a younger generation to the first world war and the fight for independence by the Republicans. The lower classes resented the amount of land that was owned by the Anglo-Irish gentry and in 1922 the Land Commission was established. The purpose of the Commission was to purchase these estates (often for a greatly reduced price) so they could be re-distributed amongst the lower classes. As a result of this, many families became little more than upper class farmers and as a result many left Ireland to return to England. The large houses and demesnes were often left to decay with the houses often demolished for building materials and the demesnes subsumed back into the landscape.

Kilcolgan village, located within the western limit of the constraints area, is illustrated on the first edition OS map as a narrow linear settlement. A post office and corn mill (RMP GA103-179) are located to the north of Kilcolgan Bridge (RPS 295, NIAH 30410330) and Dunkellin River. Kilcolgan Castle (RMP GA103-128001) is located *c*. 650m west of the village. The village of Killeely Beg is shown in the first edition in much the same size and layout as today however it doesn’t appear as if many of the structures predate the 20th century. The bridge at Killeely Beg appears to be a later addition following the restructuring of the Dunkellin River in the mid-later 19th century.

Six weirs are shown on the first edition OS mapping (AAP 1, 2 and 4–7) along the path of the river between Craughwell and Killeely More. These are not shown on the later OS mapping although some structural elements may remain *in situ*.

A corn mill, located on the Aggard Stream *c*. 75m south of the Dunkellin River, is shown on the first edition OS mapping. It is annotated for the first time with all of its associated features, mill race, weir and sluices, on the second edition OS map. A corn mill (in ruins) was also marked in the townland of Killeely Beg on the south bank of the Dunkellin River on the first edition OS map. There are no upstanding structural remains so the site has been designated as AAP 8 for the purpose of this report.

Further south along the stream the Aggard Bridge is a recorded structure (RPS 302). Built in *c*. 1820 it comprises of a double-arched road bridge with large buttress cut-waters.

Craughwell village is a linear village crossing the Dunkellin River which flourished in the 19th century due to its location on the rail line. Several structures remaining on the main street in Craughwell date to the early and mid 19th century. St. Colman's Catholic Church (NIAH 30336002, RPS 246), dating from the 1840s, was built as a place of worship following Catholic Emancipation in 1829 during the Great Famine. The survey states that the church forms an integral part of the streetscape of Craughwell. The current Garda Station (NIAH 30336007) comprises of a detached three-bay two-storey former RIC police barracks which was built in *c*. 1830. The LAP for Craughwell town (2009–2015) highlights seven structures of local interest (SLI) located along the main street including Cheevers Pub located *c.* 75m north of the river channel. One of the most significant structures at Craughwell is the former road bridge over the Dunkellin River, which is now bypassed by a modern structure. The bridge (NIAH 30336010) is thought to date to at least the late 16th century and has been subject to widening on a number of occasions.

The Waterford and Limerick Railway was constructed to the west of Craughwell in the late 19th century joining Limerick with Sligo in the north. The railway crosses both the Dunkellin River and the Aggard Stream and the respective bridges have been identified as built heritage. These stone masonry bridges appear to be in good condition. Craughwell Station had a single platform, single storey stone built station building and small goods shed. The station closed to passengers when Limerick to Claremorris passenger trains ceased in 1976, but remained open for excursion traffic until the mid 1980s. Passenger services between Limerick and Galway via Athenry were restored in March 2010, and a new single platform station and car park was opened adjacent to the original site.

14.3.2.2 Cartographic Analysis

See **Section 14.3.1.3** for details.

14.3.2.3 County Development Plan

The County Galway (2009–2015) and Craughwell Local Area Plan (2009–2015) identify Protected Structure designations within the local area and county. Protected Structures are recorded on a schedule attached to the development plan and marked on associated mapping. A review of both plans revealed that there are five Protected Structures located within 500m to the proposed flood relief works, including Kilcolgan Bridge (RPS 295), Aggard House (RPS 301), Aggard Bridge (RPS 302), St. Colman's Catholic Church (RPS 246) and Ballymore Park (RPS 247). Three of these are also recorded as RMP sites, Aggard House (RMP GA104-013), St. Colman's Catholic Church (RMP GA096-070) and Ballymore Park (RMP GA096-004). Aggard House (NIAH 30410402), St. Colman's Catholic Church (NIAH 30336002) and Ballymore Park (NIAH 30336004) are also recorded within the NIAH Survey for County Galway.

The Craughwell Local Area Plan states that the village has a number of buildings of local and regional significance but that it is vulnerable to excessive development due to its attractive setting and proximity to Galway city. The plan states that Galway County Council are seeking for the inclusion of the old masonry bridge to the RPS. A total of five structures of local interest (SLI) on Main Street are listed in the LAP including: 1) Thatch Cottage, 2) Cheever's Pub, 3) Parochial House, 4) Finely cut stone pillars, 5) Garda Barracks. The nearest of these are Cheever's Pub and the Garda Barracks which are located *c.* 50–75m north of the river channel.

It is the policy of the Craughwell Council to acknowledge the origins, historical development and cultural heritage of Craughwell village and to ensure that new development respects and is responsive to the cultural heritage of the village (LAP 2009–2015).

14.3.2.4 National Inventory of Architectural Heritage

A review of both the architectural survey and garden survey was undertaken as part of this assessment. An area up to 500m that surrounds the proposed development area was examined in order to identify any buildings or areas of architectural significance. The results of this survey are summarised below.

Building Survey

A total of 14 structures are recorded in the NIAH survey within 500m of the proposed flood relief works including. Included in this 14 are a church, six bridges, two country houses, stables, two thatched cottages, a water tower and a garda station.

Craughwell Bridge (NIAH 30336010) comprises a six-arch limestone road bridge over Dunkellin River, built *c*. 1600 and widened to the west perhaps in the late 17th century and to the east in *c*. 1780 (www.buildingsofireland.ie). The bridge, located to the south of the main nucleus of Craughwell village, is now bypassed and in use as pedestrian bridge. The NIAH survey states:

"The survival of well-preserved wicker centering is significant. The varying nature of the elevations and arches adds visual and historic interest, and the various phases of the structure are indicative of the engineering of their periods. The good-quality stonework is a testament to the skills and engineering of local craftsmen. Its early date adds to its significance and gives it archaeological as well as architectural interest. The bridge is an important component of the village of Craughwell and was a key part of the national road infrastructure, having carried traffic between Dublin and Galway for four centuries."

Two further road bridges are recorded crossing the Dunkellin River. Dunkellin Bridge (NIAH 30410332) comprises of a seven-arch bridge built in *c*. 1820. Kicolgan Bridge (NIAH 30410330) is a six-arch humpback limestone bridge built in *c*. 1780. The NIAH survey states that the alterations to the bridge in the latter half of the 19th century were probably a response to changes in the flow of the river (www.buildingsofireland.ie). This bridge is located *c*. 120m west of the proposed scheme and has been bypassed by a new road bridge.

Three railway bridges are recorded in the NIAH within 500m to the proposed flood relief scheme. The bridge on the townland boundary between Mannin and Ballylin West (NIAH 30410405) is located *c*. 90m west of the Aggard Stream. Two rail bridges are located in proximity to Craughwell, Grenage Bridge (NIAH 30336008) and Aggard Bridge (NIAH 30336009), *c*. 20m north and *c*. 50m south of the Dunkellin River respectively.

Aggard House (NIAH 30410402) is located *c*. 40m west of Aggard Stream. This site is also recorded as a RPS (RPS 301) and a RMP (RMP GA104-013). Ballymore House (NIAH 30336004) comprises a detached five-bay two-storey country house built in *c*. 1750 located c. 400m north-east of the proposed scheme. The stables (NIAH 30336005) at Ballymore are also recorded in the survey.

Two thatch cottages are recorded in the survey in the townlands of Killeely More (NIAH 30410335) and Craughwell (NIAH 30336006) *c.* 160m south and 180m north of the river respectively.

St. Colman's Catholic Church (NIAH 30336002, RPS 246), dating from the 1840s, was built as a place of worship following Catholic Emancipation in 1829 during the Great Famine. The survey states that the church forms an integral part of the streetscape of Craughwell. The current Garda Station (NIAH 30336007) comprises of a detached three-bay two-storey former RIC police barracks which was built in *c*. 1830.

The final structure recorded within the NIAH survey within 500m of the proposed scheme is a modern mid 20th century water tower (NIAH 30336003) located within Craughwell town *c.* 270m north of the proposed scheme works.

Garden Survey

The gardens and demesne lands of three houses located within *c*. 500m of the proposed scheme were surveyed. The footprint of the gardens associated with Aggard House (NIAH GA-52-M-501185) is preserved, however many of the main features are unrecognisable. The Dunkellin River forms the southern boundary of the Kilcornan Demesne (NIAH GA-46-M-425204) which remains largely intact and visible on aerial photography.

The southern limit of the Aggard Stream flows through Cregaclare Demesne lands (NIAH GA-52-M-473124). Two small pools of water are located along the stream within the northern boundary of the demesne. The survey states that the peripheral landscape of this site is largely indistinguishable from surrounding farmland however the structural footprint is visible in aerial photography.

14.3.2.5 Field Inspection

Dunkellin River

The old Craughwell Bridge (NIAH 30336010) crosses the southern channel of the Dunkellin River (**Image 14.27**–**30**). The bridge has been pedestrianised and is a local landmark in the town. The bridge is in good condition and a review by the NIAH of its fabric has concluded that it is highly significant for the architectural and archaeological heritage of the area. All the architectural heritage features are marked on **Figures 14.10 – 14.18.**

Image 14.27: Old Craughwell Bridge (NIAH 30336010), facing NNE

Image 14.28: Old Craughwell Bridge (NIAH 30336010), facing NNW

Image 14.29 Preserved late medieval wicker centering

Image 14.30 Phases of construction evident at Craughwell Bridge

To the west of the town are three railway bridges, two of which cross roadway (Grenage Bridge NIAH NIAH 30336008 and Aggard Bridge NIAH 30336009) and a third that crosses the Dunkellin River. The bridge crossing the river (**Image 14.31**) was not included within the NIAH survey however it appears to be much the same design and date as the road bridges (**Image 14.32**) and as such possesses the same importance for the built heritage of the area.

Image 14.31 Railway bridge crossing the River Dunkellin at Craughwell, facing north-east

Image 14.32 Aggard Railway Bridge (NIAH 30336009), facing west

The bridge at Rinn is a modern concrete construction and possesses no built heritage value.

A thatch cottage, shown on the second edition OS map, is surrounded by a small farmyard to the east of Dunkellin Bridge (**Image 14.33**). This is located to the immediate south of the proposed spoil spreading area. Dunkellin Bridge (NIAH 30410332) comprises of a seven-arch bridge built in *c*. 1820 joining a north–south running roadway (**Image 14.34**). The NIAH survey notes that additional arches (central and three arches to the north) were built in *c*. 1870. A square-headed opening to north was rebuilt in mass concrete walling in the mid-section of the bridge.

Image 14.33 Vernacular farmyard, with thatch cottage in Dunkellin, facing south-east

Image 14.34 Dunkellin Bridge (NIAH 30410332), facing north-east

Killeely Beg Bridge dates to between 1840 to 1896. It is a single arched masonry bridge in moderate condition (**Image 14.35** and **14.36**). The bridge is not listed in the Record of Protected Structures but possesses local architectural significance.

Image 14.35 Killeely Beg Bridge, facing north-east

Image 14.36 Killeely Beg Bridge, facing north-west

A thatch cottage (NIAH 30410335), shown on the first edition OS map, is located in the townland of Killeely Beg (**Image 14.37**). A small farmyard with outbuildings surrounds the house which remains in use. This farmyard lies to the immediate south of the proposed spoil spreading area. The bridge connecting the N18 is a modern construction, replacing Kilcolgan Bridge (RPS 295, NIAH 30410330). Kilcolgan Bridge (**Image 14.38**) comprises of a six-arch humpback limestone bridge built in *c*. 1780. It continues to function as a road bridge.

Image 14.37 Vernacular thatched cottage (NIAH 30410335) in Killeely More, facing south-east

Image 14.38 Kilcolgan Bridge (RPS 295, NIAH 30410330), facing west

Aggard Stream

A corn mill, marked on the first and later editions of the OS map, is located c. 75m south of the Dunkellin River on the banks of the Aggard Stream. The main mill structure (**Image 14.39**) is associated with three other buildings (**Image 14.40**), a mill race (**Image 14.41**), a weir and sluices. The buildings are in a state of ruin and the yard is currently used as an access route for cattle to the adjacent field. The course of the Aggard Stream passes to the east of the main mill building with the route of the mill race passing parallel to the stream to the west. The small bridge crossing the stream from the track to the yard of the mill is of modern concrete block construction. The mill buildings have been constructed with a random rubble core, with the northern elevations displaying the remains of a roughly coursed and dressed façade, including roughly dressed quoin stones. An access laneway runs north from the road towards the mill complex, parallel to the stream (**Image 14.42**). It is bound by drystone walls in good condition and two gate pillars are located at the southern entrance.

Image 14.39 Corn mill in Aggard More, facing south-west

Image 14.40 Building attached to the western façade of the mill structure, facing south


Image 14.41 Overgrown route of the mill race, facing north


Image 14.42 Access lane to corn mill, bound by drystone walls, facing north

A small stone road bridge, known as Aggard Bridge (RPS 302), crosses the Aggard Stream c. 300m south of the mill complex (**Image 14.43**). This bridge is shown on the first edition OS map and remains in good condition.


Image 14.43 Aggard Bridge (RPS 302), facing south-east


Image 14.44 Aggard House (RPS 301, NIAH 30410402, RMP GA104-013), facing east

Aggard House (RPS 301, NIAH 30410402 and RMP GA104-013) and Demesne are located on the western bank of the Aggard Stream in the townland of Aggard More. The late 18th century house (**Image 14.44**) remains set in its original parkland setting with views of the house from the roadway. A long avenue leads to the house which has a courtyard and stables to the rear. The stable buildings and demesne wall line the stream bank and an avenue of mature trees runs north-east along bank (**Image 14.45** and **14.46**). A small stone arch bridge (**Image 14.47**) crosses the stream to the immediate south of the boundary wall shown in **Image 14.46** south of the main complex.

Image 14.45 Aggard Demesne along the stream, facing SSW

Image 14.46 Aggard Demesne along the stream, facing NNE

Image 14.47 Stone road bridge in Aggard Demesne, facing SSW

Image 14.48 Stone rail bridge in Ballynamannin townland, facing NNW

Two stone bridges cross the stream in Ballynamannin townland, a rail bridge (**Image 14.48**) and a road bridge (**Image 14.49**). The road bridge is shown on the first edition OS map and appears in good condition. The rail bridge was constructed in the late 19th century as part of the rail network.

Image 14.49 Stone road bridge in Ballynamannin townland, facing NNW

Image 14.50 Culverts AG2–4, facing south-west

It is proposed to replace 14 culverts along the lower section of stream (AG 1–14). All but one of these culverts comprise of modern concrete pipes (**Image 14.50**) with one exception. The culvert at AG 09 runs under an access laneway and is comprised of stone slabs and is of random rubble construction. A crossing point is illustrated at this location on the 25” OS maps however it appears to be narrower than the current structure. It was not possible to view AG08 or AG14 due to flooding.

14.3.2.6 Conclusions

The review of the Galway County Development Plan has revealed that there are five protected structures located within the receiving environment of the scheme. Two of these structures are bridges and consist of Kilcolgan Bridge (RPS 295), which crosses the Dunkellin River to the immediate west of the proposed works and Aggard Bridge (RPS 302), which crosses the Aggard Stream *c.* 550m south of the Dunkellin River. Aggard House and Ballymore Park are large country houses, located within the receiving environment, which are listed in the plan. In addition, the Catholic Church in Craughwell is also listed as a protected structure. All of these structures, with the exception of Aggard Bridge, are also listed within the NIAH survey for County Galway. It should also be noted that the Local Area Plan for Craughwell states that the old masonry bridge (also listed in the NIAH) is proposed for inclusion in the RPS by Galway County Council.

There are a total of 14 structures listed within the NIAH located within the receiving environment of the proposed scheme. Of these, four are listed as protected structures. The remaining consist of five bridges, the stable complex associated with Aggard House, two vernacular cottages, a garda station and a water tower. Six of these structures are located at Craughwell and consist of two railway bridges, to the immediate north and south of the Dunkellin River, a thatched cottage, the garda barracks, a water tower and the old Craughwell Bridge. The bridge crosses the Dunkellin River and is a significant structure. Whilst it has been subject to alteration on a number of occasions, the core of the structure has the potential to date to the late 16th century. This bridge is proposed for inclusion in the record of protected structures.

Further to the west Dunkellin Bridge is also included in the NIAH. This bridge also crosses the Dunkellin River within the townland of Dunkellin. This is also a large structure and is characterised by a number of flood eyes, as well as the main span over the river. Further again to the west in the townland of Killeelymore, the NIAH lists a vernacular cottage located c. 160m south of the Dunkellin River. All of the structures listed within the NIAH have been designated as being regionally important.

During the desktop assessment and field inspection a number of structures were identified that possess architectural merit. These are not subject to any statutory protection and consist of a ruinous mill complex within the townland of Aggard More, a railway bridge across the Dunkellin River at Craughwell, a small bridge across the river at Killeely Beg, a water pump at Dunkellin as well as a vernacular cottage and three small bridges along the path of the Aggard Stream. Of the 14 culverts that will be replaced as part of the scheme along the Aggard Stream, all are formed by concrete pipes and are of modern construction, with the exception of AG09, which is potentially slightly earlier, as it is formed by a stone built box culvert

14.3.3 Results and Analysis – Cultural Heritage

The scheme will be undertaken within the townlands of Kilcolgan, Killeely More, Killeely Beg, Castlegar, Dunkellin, Roevehagh, Rinn, Aggard More, Crinnage or Ballywulash, Craughwell, Ballymore, Doonard, Killora, Cloghroak, Ballyglass East, Shantallow, Ballyboy and Lackan. These townlands are located within the parishes of Kilcolgan, Killeely, Killora, Killogilleen and Adrahan, within the Barony of Dunkellin, County Galway.

14.3.3.1 Place name Analysis

Townland and topographic names are an invaluable source of information on topography, land ownership and land use within the landscape. They also provide information on history; archaeological monuments and folklore of an area. A place name may refer to a long forgotten site, and may indicate the possibility that the remains of certain sites may still survive below the ground surface. The Ordnance Survey surveyors wrote down townland names in the 1830’s and 1840’s, when the entire country was mapped for the first time. Some of the townland names in the study area are of Irish origin and through time have been anglicised. The main reference used for the place name analysis is *Irish Local Names*

Explained by P.W Joyce (1870). A description and possible explanation of each townland name in the environs of the proposed route are provided in **Table 14.1** and **Table 14.2.**

The Craughwell Local Area Plan gives two possible translations for the meaning of Craughwell:

"….cited as Garlic Wood – a deviation of '*Creamh-choill*' (Joyce, P.W., (2008)). Elsewhere it is thought that Craughwell derives from *Creachmhaoil* which is possibly a deviation from *Creach Mhaoileann*, the ridge of the cattlekeepers/ cattle-plunderers or plunder hill (Spellissy, S., (1999))."

Table 14.1 Townlands Traversed by the Scheme Along the Dunkellin River

Name	Derivation	Possible Meaning
Kilcolgan	*Cill Chólgáin*	Church of St. Colgan
Killeely More and Beg	*Cill Fhaoile*	Church of St. Faoile
Dunkellin	*Dún Caillín*	Caillin's Fort
Rinn	*Rin*	a point
Aggard More	Haggard	Farm/ farmyard
Craughwell	*Creamh-choill*	wild garlic wood
Ballymore	*Baile Mór*	Great town

Table 14.2 Townlands Traversed by the Scheme Along the Aggard Stream

Name	Derivation	Possible Meaning
Aggard More and Beg	Haggard	Farm/ farmyard
Roo	*Rua*	Red
Ballynamannin	*Beal Atha na Mainín*	Mouth of the Mannins' ford
Ballylin West	*Baile Ui Fhloin*	O Flynn's Town
Emlagh	*Imleach*	land bordering on a lake; and hence a marshy or swampy place
Monksfield	*Fearan na Manach*	land of the monks
Ballynascragh	*Baile na Scrath*	town of the swards
Rathcosgry	*Rath Cosgraigh*	Casgry's land/ fort
Mannin	Derived from a person's name	Derived from a person's name
Cloghroak	*Cloch Róca*	Rock's stone or stone building
Ballyglass East	Baile Glas	Green town
Caherduff	Cathair dubh	Black fort
Shantallow	Sean talamh	Old ground
Ballybaun	*Baile Bán*	White town
Ballyboy	*Baile Buí*	Yellow town
Lackan	Lacka	Hill side
Cregaclare Demesne	*Creig a chláir*	Rocky plain
Rathbaun	*Rath bán*	White fort

14.3.3.2 Townlands

The townland is an Irish land unit of considerable longevity as many of the units are likely to represent much earlier land divisions. However, the term townland was not used to denote a unit of land until the Civil Survey of 1654. It bears no relation to the modern word 'town' but like the Irish word *baile* refers to a place. It is possible that the word is derived from the Old English *tun land* and meant 'the land forming an estate or manor' (Culleton 1999, 174).

Gaelic land ownership required a clear definition of the territories held by each sept and a need for strong, permanent fences around their territories. It is possible that boundaries following ridge tops, streams or bog are more likely to be older in date than those composed of straight lines (*ibid.* 179).

The vast majority of townlands are referred to in the 17th century, when land documentation records begin. Many of the townlands are mapped within the Down Survey of the 1650s, so called as all measurements were carefully ‘laid downe’ on paper at a scale of forty perches to one inch. Therefore most are in the context of pre-17th century landscape organisation (McErlean 1983, 315).

In the 19th century, some demesnes, deer parks or large farms were given townland status during the Ordnance Survey and some imprecise townland boundaries in areas such as bogs or lakes, were given more precise definition (*ibid.*). Larger tracks of land were divided into a number of townlands, and named Upper, Middle or Lower, as well as Beg and More (small and large) and north, east, south and west (Culleton 1999, 179). By the time the first Ordnance Survey had been completed a total of 62,000 townlands were recorded in Ireland.

The Dunkellin River and the Aggard Stream for the most part, form townland and parish boundaries. It is common for townland boundaries to follow topographical features such as rivers and streams. However, there are parts of several boundaries also included within the areas proposed for excavation, adjacent to the southern bank of the Dunkellin River. These include the boundaries between Kilcolgan and Killeely More (TB 1); Killeely More and Killeely Beg (TB 2); Killeely Beg and Castlegar (TB 3); Castlegar and Dunkellin (TB 4); Dunkellin and Roevehagh (TB 5); Roevehagh and Rinn (TB 6). Four of the culvert replacements on the Aggard Stream will also take place on townland boundaries. AG 14 is located between Ballyboy and Lackan; AG 10 between Cloghroak and Shantallow; AG 09 between Cloghroak, Shantallow and Ballyglass East and AG 05 between Cloghroak and Ballyglass East.

14.3.3.3 Cultural Heritage Sites

The term ‘cultural heritage’ can be used as an over-arching term that can be applied to both archaeology and architectural. However, it also refers to more ephemeral aspects of the environment, which are often recorded in folk law or tradition or possibly date to a more recent period. No individual sites have been identified that could be defined as purely Cultural Heritage.

14.3.3.4 Conclusions

A review of the townlands names within the receiving environment of the proposed scheme has revealed some common topographical terms, which were used to describe portions of the landscape. These gradually became anglicised and lost their original form, although it still is possible to investigate their original structure. The majority of the townland names within the vicinity are derived from topographical features, former function (Haggard/ Aggard), field types (Cregaclare, Lackan) and landscape type (Rinn, Ballglass, Ballyboy, Ballybaun). Some of the townland names refer to ownership (Caillin’s Fort/ Dunkellin, Casgry’s land/ fort/ Rathcosgry, Monksfield, Ballynamannin) Two of the townland names possess a religious association (*Cill Chólgáin* and *Cill Fhaoile*).

A total of six townland boundaries (TB 1–6) are located within the area of proposed flood relief works along the Dunkellin River. These are comprised of streams and field walls. Four of the culvert replacements will be located in between townlands, where the Aggard Stream functions as a boundary.

14.4 POTENTIAL IMPACTS

14.4.1 Archaeology

14.4.1.1 Dunkellin River

Excavation of Riverbank and Construction of Embankment

- It is possible that the proposed excavation of the river bank and construction of embankment, as part of the scheme, may result in a significant negative impact on remains that may be associated with the recorded medieval settlement at Dunkellin (GA103-120001).
- It is possible that the proposed excavation of the river bank and construction of embankment, as part of the scheme, may result in a significant negative impact on remains that may be associated with the recorded *fulacht fiadh* at Killeely Beg (GA103-134).

- It is possible that the proposed excavation of the river bank and construction of embankment, as part of the scheme, may result in a significant negative impact on any surviving remains associated with weirs (AAP 1, 2, 3, 5, 6, 7), which are marked along the Dunkellin River on the first edition OS map.

- It is possible that the proposed excavation of the river bank and construction of embankment, as part of the scheme, may result in a significant negative impact on any surviving remains associated with the site of a corn mill (AAP 8), which are marked at Killeely Beg on the first edition OS map.

- It is possible that the proposed excavation of the river bank and construction of embankment, as part of the scheme, may result in a significant negative impact on archaeological remains that may be associated with an area of raised ground (AAP 9), located within the townland of Rinn.

- It is proposed to excavate the river bed at Craughwell Bridge, Craughwell Railway Bridge, Rinn Bridge and Killeely Beg Bridge. It is possible that the excavation will have a significant or profound negative impact on archaeological deposits or artefacts that may remain within the river bed at these locations.

- The river bank of the Dunkellin River has been heavily impacted on by post medieval drainage and canalisation. However, the portion of the southern bank within Killeely More remains relatively intact and possesses a similar topography as marked on the first edition OS map (c. 750m length). Therefore, the excavation of the southern bank may result in a significant negative impact on archaeological deposits or artefacts that have the potential to survive within the river bank and river bed.

- It is possible that the proposed excavation of the river bank, widening of the river channel and excavation of the new channel at Craughwell, as part of the scheme, may result in a significant or profound impact on previously unrecorded archaeological remains that have the potential to survive in this area.

Spreading of Spoil

- Whilst it is intended to re-use excavated river channel material within the proposed embankments, in order to minimise the transportation of spoil off site, some spoil may be spread (as extended spoil heaps) within fields located to the north and south of the Dunkellin River. Prior to the spreading of material, topsoil in these areas will be stripped. It is possible that the stripping of areas and subsequent spreading of soil may have a significant negative impact on previously unidentified features of archaeological significance that may exist within this area.

14.4.1.2 Aggard Stream

Replacement of 14 No. Culverts

It is possible that ground disturbances associated with the replacement of the 14 culverts along the Aggard Stream may have a significant negative impact on previously unrecorded archaeological deposits or artefacts, which have the potential to survive within undisturbed ground. It should be noted that the Aggard Stream has been subject to canalisation since the post medieval period and has also been cleaned out numerous times.

Channel Maintenance

It is proposed to carry out channel maintenance along the path of the Aggard Stream. As a result, excavation of the stream bed may be required and may have a significant negative impact on previously unrecorded archaeological deposits or artefacts, which have the potential to survive within the stream bed and immediate environs. It should be noted that the Aggard Stream has been subject to canalisation since the post medieval period and has also been cleaned out numerous times.

14.4.2 Architecture

14.4.2.1 Dunkellin River

Excavation of Riverbank and construction of Embankment

Craughwell Bridge

As part of the scheme, it is proposed to excavate the river bed at the location of Craughwell Bridge as well as provide mass concrete underpinning beneath each pier, including the three flood eyes and three main spans. This will result in a significant negative impact on the bridge, which is recorded within the NIAH survey as possessing regional significance and is a proposed protected structure.

Dunkellin Bridge

As part of the scheme, it is proposed to insert two large flood eyes at Dunkellin Bridge. Whilst the main river span of the bridge will be left intact, the proposed works will impact on four existing flood eyes, resulting in a significant negative impact. The bridge is recorded within the NIAH survey as possessing regional significance.

Killeely Bridge

As part of the scheme, it is proposed to remove the existing Killeely Bridge and replace it with a modern structure. The bridge is previously unrecorded and possesses local significance. Its removal will result in a significant negative impact.

Craughwell Railway Bridge

As part of the scheme, it is proposed to excavate the riverbed at Craughwell Railway Bridge as well as provide concrete underpinning. The bridge is previously unrecorded and possesses local significance. The proposed works will result in a moderate negative impact.

Rinn Bridge

As part of the scheme, it is proposed to provide additional flood eyes to the existing Rinn Bridge. This structure is of modern construction, with no architectural merit. As such its removal will not result in a negative impact upon the architectural resource.

Spreading of Spoil

Whilst it is intended to re-use excavated river channel material within the proposed embankments, in order to minimise the transportation of spoil off site, some spoil may be spread (as extended spoil heaps) within fields located to the south of the Dunkellin River. It is not envisaged that the spreading of topsoil will have a negative impact on the architectural resource.

14.4.2.2 Aggard Stream

Replacement of 14 No. Culverts

All but one of the 14 culverts are formed by modern concrete pipes. As such, the replacement of these features will not negatively impact on the architectural resource. One of the features (AG 09) is formed by a post medieval stone box culvert. The replacement of this feature will result in a slight negative impact on the architectural resource.

Channel Maintenance

It is proposed to carry out channel maintenance along the path of the Aggard Stream. As a result, it is possible that features associated with the former mill, Aggard Bridge and the smaller bridges located along the length of the Aggard Stream may be subject to a significant negative impact. This would be caused by disturbance associated with the channel maintenance.

14.4.3 Cultural Heritage

14.4.3.1 Dunkellin River

Excavation of Riverbank and construction of Embankment

The excavation of the southern bank of the Dunkellin River will result in the removal of small sections of townland boundaries 1-6. This will result in a slight negative impact.

14.4.3.2 Aggard Stream

It is not anticipated that works associated with the Aggard Stream will impact negatively on the cultural heritage resource.

14.4.3.3 Do Nothing Impact

If the proposed development were not to proceed, future flooding may impact negatively on the Recorded Archaeological Monuments located on the banks of the river along with structures of architectural merit, such as Craughwell Bridge and Dunkellin Bridge. Repeated flooding would subject archaeological features and architectural structures to erosion.

14.4.3.4 Worst Case Impact

Under a worst case scenario, the proposed development would disturb previously unrecorded and unidentified deposits, artefacts and structures, without proper excavation and recording being undertaken.

14.5 MITIGATION MEASURES

14.5.1 Archaeology

14.5.1.1 Dunkellin River

Excavation of Riverbank and construction of Embankment

- It is recommended that archaeological testing be carried out to the north of GA103-12001 at Dunkellin and GA103-134 at Killeely Beg within the footprint of the river channel excavation area and embankment location. This should be carried out by an archaeologist licenced to the Department of Arts, Heritage and Gaeltacht (DAHG). Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

- It is recommended that archaeological monitoring be undertaken at the sites of AAP 1, 2, 4, 5, 6, 7 during the excavation of the southern river bank. This should be carried out by a suitably qualified archaeologist. Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

- It is recommended that archaeological monitoring be undertaken at the site of AAP 8, during the excavation of the southern river bank. This should be carried out by a suitably qualified archaeologist. Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

- It is recommended that archaeological monitoring be undertaken at the site of AAP 9, during the excavation of the southern river bank. This should be carried out by a suitably qualified archaeologist. Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

- It is recommended that a full underwater archaeological survey is carried out at Craughwell Bridge, Craughwell Railway Bridge, Rinn Bridge and Killeely Beg Bridge. This should be carried out by an archaeologist licenced to the Department of Arts, Heritage and Gaeltacht (DoAHG). Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

- It is recommended that a full underwater archaeological survey is carried out along the 750m southern bank of the Dunkellin River within Killeely More. This should be carried out by an archaeologist licenced to the Department of Arts, Heritage and Gaeltacht (DoAHG). Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

- It is recommended that all excavation works in Craughwell are subject to monitoring by a suitably qualified archaeologist. This should be carried out by a suitably qualified archaeologist. Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

Spreading of Spoil

It is recommended that any topsoil that requires to be stripped in order to spread spoil is subject to archaeological monitoring. This should be carried out by a suitably qualified archaeologist. Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

14.5.1.2 Aggard Stream

Replacement of 14 No. Culverts

Should the replacement of the 14 culverts require the disturbance of virgin ground, it is recommended that archaeological monitoring be carried out. This should be carried out by a suitably qualified archaeologist. Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

Channel Maintenance

It is recommended that all channel works located between the Dunkellin River and Aggard Bridge be subject to archaeological monitoring, with direct impacts on the mill site avoided. Should the proposed maintenance require the disturbance of virgin ground, it is recommended that works be monitored by a suitably qualified archaeologist. Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

14.5.2 Architecture

14.5.2.1 Dunkellin River

Excavation of Riverbank and Construction of Embankment

Craughwell Bridge

It is recommended that negative impacts on Craughwell Bridge are avoided. However, if this cannot be achieved, it is recommended that a full conservation assessment be carried out on the bridge at Craughwell prior to the development going ahead. This should be carried out by a historic buildings expert or conservation architect. In addition both elevations of the bridge should also be subject to a measured and photographic survey in order to fully record the structure. Full consultation with the architectural expert should be carried out during the detailed design stage of the proposed bridge alterations.

Dunkellin Bridge

It is recommended that negative impacts on Dunkellin Bridge are avoided. However, if this cannot be achieved, it is recommended that a full conservation assessment be carried out on the bridge at Dunkellin prior to the development going ahead. This should be carried out by a historic buildings expert or conservation architect. In addition both elevations of the bridge should also be subject to a measured and photographic survey in order to fully record the structure. Full consultation with the architectural expert should be carried out during the detailed design stage of the proposed bridge alterations.

Killeely Bridge

It is recommended that a full conservation assessment be carried out on the bridge at Killeely prior to the development going ahead. This should be carried out by a historic buildings expert or conservation architect. In addition both elevations of the bridge should also be subject to a measured and photographic survey in order to fully record the structure.

Craughwell Railway Bridge

It is recommended that a full conservation assessment be carried out on the bridge at Craughwell Railway Bridge prior to the development going ahead. This should be carried out by a historic buildings expert or conservation architect. In addition both elevations of the bridge should also be subject to a measured and photographic survey in order to fully record the structure. Full consultation with the architectural expert should be carried out during the detailed design stage of the proposed bridge alterations.

Rinn Bridge

No mitigations measures are required for the proposal to add flood eyes to Rinn Bridge. This is a modern structure of no architectural merit.

Spreading of Spoil

No mitigation measures are required with regards to the architectural resource and spreading of topsoil.

14.5.2.2 Aggard Stream

Replacement of 14 No. Culverts

No further mitigation is required with regards to the replacement of the 14 culverts and the architectural resource. The record of AG 09 within this report is considered to be a suitable level of record for the feature.

Channel Maintenance

It is recommended that negative impacts on the mill, Aggard Bridge and the various stone bridges along the path of the Aggard Stream are avoided and these structures are left intact.

14.5.3 Cultural Heritage

14.5.3.1 Dunkellin River

Excavation of Riverbank and construction of Embankment

It is recommended that the excavation of the six townland boundary sections, during the excavation of the riverbed, is subject to archaeological monitoring. This should be carried out by a suitably qualified archaeologist. Full resolution should be made available for the resolution of any archaeological features or deposits that may be discovered, should that be deemed the most appropriate manner to proceed.

14.5.3.2 Aggard Stream

No mitigation measures are required with regards to the cultural heritage resource and Aggard Stream maintenance.

14.5.2 Monitoring

The mitigation measures recommended above would also function as a monitoring system to allow the further assessment of the scale of the predicted impacts and the effectiveness of the recommended mitigation measures.

14.6 RESIDUAL IMPACTS

14.6.1 Archaeology

If the above mitigation measures are carried out, then there will be no residual negative impact on the archaeological resource.

14.6.2 Architecture

Despite the recommended conservation assessment, measured and photographic survey, the scheme will have a residual negative impact on Craughwell Bridge and Dunkellin Bridge. This will be due to the change in appearance of both the structures in order to alleviate flooding.

14.6.3 Cultural Heritage

If the above mitigation measures are carried out, then there will be no residual negative impact on the cultural heritage resource.

Please note that all recommendations are subject to approval by the National Monument Service of the Heritage and Planning Division, Department of Arts, Heritage and the Gaeltacht.

14.7 CONCLUSION

The proposed development will involve the excavation of the southern bank of the Dunkellin River, along with the construction of an embankment and spreading spoil. It is possible that the proposed excavation of the river bank and construction of embankment, as part of the scheme, may result in a significant negative impact on remains that may be associated with the recorded medieval settlement at Dunkellin (GA103-120001) and a recorded *fulacht fiadh* located at Killeely Beg (GA103-134). It is recommended that archaeological testing be carried out to the north of both sites within the footprint of the river channel excavation area and embankment location. This should be carried out by an archaeologist licenced to the Department of Arts, Heritage and Gaeltacht (DAHG). Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

It is possible that the proposed excavation of the river bank and construction of embankment, as part of the scheme, may result in a significant negative impact on any surviving remains associated with weirs (AAP 1, 2, 4, 5, 6, 7), which are marked along the Dunkellin River on the first edition OS map; the site of a corn mill (AAP 8), which is marked at Killeely Beg on the first edition OS map and on an area of raised ground (AAP 9), located within the townland of Rinn. It is therefore recommended that archaeological monitoring be undertaken at the sites of AAP 1-9, during the excavation of the southern river bank. This should be carried out by a suitably qualified archaeologist. Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

It is proposed to excavate the river bed at Craughwell Bridge, Craughwell Railway Bridge, Rinn Bridge and Killeely Beg Bridge. It is possible that the excavation will have a significant or profound negative impact on archaeological deposits or artefacts that may remain within the river bed at these locations. It is recommended that a full underwater archaeological survey is carried out at these locations. This should be carried out by an archaeologist licenced to the Department of Arts, Heritage and Gaeltacht (DoAHG). Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

The river bank of the Dunkellin River has been heavily impacted on by post medieval drainage and canalisation. However, the portion of the southern bank within Killeely More remains relatively intact and possesses a similar topography as marked on the first edition OS map (c. 750m length). Therefore, the excavation of the southern bank may result in a significant negative impact on archaeological deposits or artefacts that have the potential to survive within the river bank and river bed. It is recommended that a full underwater archaeological survey is carried out along the 750m southern bank of the Dunkellin River within Killeely More. This should be carried out by an archaeologist licenced to the Department of Arts, Heritage and Gaeltacht (DoAHG). Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

It is possible that the proposed excavation of the river bank, widening of the river channel and excavation of the new channel at Craughwell, as part of the scheme, may result in a significant or profound impact on previously unrecorded archaeological remains that have the potential to survive in this area. It is recommended that all excavation works in Craughwell are subject to monitoring by a suitably qualified archaeologist. This should be carried out by a suitably qualified archaeologist. Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

Whilst it is intended to re-use excavated river channel material within the proposed embankments, in order to minimise the transportation of spoil off site, some spoil may be spread (as extended spoil heaps) within fields located to the north and south of the Dunkellin River. Prior to the spreading of material, topsoil in these areas will be stripped. It is possible that the stripping of areas and subsequent spreading of soil may have a significant negative impact on previously unidentified features of archaeological significance that may exist within this area. It is recommended any topsoil that requires stripping in order to spread spoil is subject to archaeological monitoring. This should be carried out by a suitably qualified archaeologist. Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

As part of the proposed Aggard Stream works, it is proposed to replace 14 culverts. It is possible that ground disturbances associated with the replacement these culverts may have a significant negative impact on previously unrecorded archaeological deposits or artefacts, which have the potential to survive within undisturbed ground. It should be noted that the Aggard Stream has been subject to canalisation since the post medieval period and has also been cleaned out numerous times. Should the replacement of the 14 culverts require the disturbance of virgin ground, it is recommended that archaeological monitoring be carried out. This should be carried out by a suitably qualified archaeologist. Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

It is also proposed to carry out channel maintenance along the path of the Aggard Stream. As a result, excavation of the stream bed may be required and may have a significant negative impact on previously unrecorded archaeological deposits or artefacts, which have the potential to survive within the stream bed and immediate environs. It should be noted that the Aggard Stream has been subject to canalisation since the post medieval period and has also been cleaned out numerous times. It is recommended that all channel works located between the Dunkellin River and Aggard Bridge be subject to archaeological monitoring, with direct impacts on the mill site avoided. Should the proposed maintenance require the disturbance of virgin ground, it is recommended that works be monitored by a suitably qualified archaeologist. Full provision should be made available for the resolution of any archaeological features or deposits that may be identified, should that be deemed the most appropriate manner to proceed.

As part of the scheme, it is proposed to excavate the river bed at the location of Craughwell Bridge as well as provide mass concrete underpinning beneath each pier, including the three flood eyes and three main spans. This will result in a significant negative impact on the bridge, which is recorded within the NIAH survey as possessing regional significance and is a proposed protected structure. It is recommended that negative impacts on Craughwell Bridge are avoided. However, if this cannot be achieved, it is recommended that a full conservation assessment be carried out on the bridge at Craughwell prior to the development going ahead. This should be carried out by a historic buildings expert or conservation architect. In addition both elevations of the bridge should also be subject to a measured and photographic survey in order to fully record the structure. Full consultation with the architectural expert should be carried out during the detailed design stage of the proposed bridge alterations.

As part of the scheme, it is proposed to insert two large flood eyes at Dunkellin Bridge. Whilst the main river span of the bridge will be left intact, the proposed works will impact on four existing flood eyes, resulting in a significant negative impact. The bridge is recorded within the NIAH survey as possessing regional significance. It is recommended that negative impacts on Dunkellin Bridge are avoided. However, if this cannot be achieved, it is recommended that a full conservation assessment be carried out on the bridge at Dunkellin prior to the development going ahead. This should be carried out by a historic buildings expert or conservation architect. In addition both elevations of the bridge should also be subject to a measured and photographic survey in order to fully record the structure. Full consultation with the architectural expert should be carried out during the detailed design stage of the proposed bridge alterations.

As part of the scheme, it is proposed to remove the existing Killeely Bridge and replace it with a modern structure. The bridge is previously unrecorded and possesses local significance. Its removal will result in a significant negative impact. It is recommended that a full conservation assessment be carried out on the bridge at Killeely prior to the development going ahead. This should be carried out by a historic buildings expert or conservation architect. In addition both elevations of the bridge should also be subject to a measured and photographic survey in order to fully record the structure.

As part of the scheme, it is proposed to excavate the riverbed at Craughwell Railway Bridge as well as provide concrete underpinning. The bridge is previously unrecorded and possesses local significance. The proposed works will result in a moderate negative impact. It is recommended that a full conservation assessment be carried out on the bridge at Craughwell Railway Bridge prior to the development going ahead. This should be carried out by a historic buildings expert or conservation architect. In addition both elevations of the bridge should also be subject to a measured and photographic survey in order to fully record the structure. Full consultation with the architectural expert should be carried out during the detailed design stage of the proposed works.

As part of the scheme, it is proposed to remove the existing Rinn Bridge. This structure is of modern construction, with no architectural merit. As such its removal will not result in a negative impact upon the cultural heritage resource. No mitigations measures are required for the removal of Rinn Bridge.

Whilst it is intended to re-use excavated river channel material within the proposed embankments, in order to minimise the transportation of spoil off site, some spoil may be spread (as extended spoil heaps) within fields located to the south of the Dunkellin River. It is not envisaged that the spreading of topsoil will have a negative impact on the architectural resource. As such no mitigation is required.

As part of the proposed scheme, 14 culverts will be replaced along the path of the Aggard Stream. All but one of the 14 culverts are formed by modern concrete pipes. As such, the replacement of these features will not negatively impact on the architectural resource. One of the features (AG 09) is formed by a post medieval stone box culvert. The replacement of this feature will result in a slight negative impact on the architectural resource. No further mitigation is required with regards to the replacement of the culverts. The record of AG 09 within this report is considered to be a suitable level of record for the feature.

It is proposed to carry out channel maintenance along the path of the Aggard Stream. As a result, it is possible that features associated with the former mill, Aggard Bridge and the smaller bridges located along the length of the Aggard Stream may be subject to a significant negative impact. This would be caused by disturbance associated with the channel maintenance. It is recommended that negative impacts on the mill, Aggard Bridge and the various stone bridges along the path of the Aggard Stream are avoided and these structures are left intact.

The excavation of the southern bank of the Dunkellin River will result in the removal of small sections of townland boundaries 1-6. This will result in a slight negative impact. It is recommended that the excavation of the six townland boundary sections, during the excavation of the riverbed, is subject to archaeological monitoring. This should be carried out by a suitably qualified archaeologist. Full resolution should be made available for the resolution of any archaeological features or deposits that may be discovered, should that be deemed the most appropriate manner to proceed.

It is not anticipated that works associated with the Aggard Stream will impact negatively on the cultural heritage resource. As such, no mitigation measures will be required.

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15 LANDSCAPE AND VISUAL ASSESSMENT

15.1 INTRODUCTION

The purpose of this chapter is to make an assessment of the landscape and visual impacts associated with the proposed Dunkellin River and Aggard Stream Flood Relief Scheme (the scheme). The assessment begins with a description of the existing landscape setting and visual resources to establish baseline conditions. The proposal is then applied to the baseline and the impacts of the scheme upon the existing landscape setting and visual resources are then predicted.

This chapter outlines the methodologies used to assess the potential landscape and visual impacts and describes the potential impact including the residual impact and provides details on mitigation measures.

15.2 METHODOLOGY

The landscape and visual assessment methods are derived from the *Guidelines for Landscape and Visual Impact Assessment, 3rd Ed.* (The Landscape Institute and Institute of Environmental Management & Assessment, 2002). In addition to this the following publications were considered as part of this assessment:

- Landscape and Landscape Assessment- Consultation Draft of Guidelines for Planning Authorities, (DOEHLG, 2000),

- 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).

The landscape has been appraised to allow it to be described and classified into landscape character areas that in turn enable the categorisation of landscape quality. The capacity of a landscape to accept change of the type proposed is then assessed. The key landscape components are landform, vegetation and historical and cultural components. Landform relates to topography, drainage characteristics and geology. Historical and cultural components include historic landscapes, protected structures, conservation areas and historic designed landscapes. Vegetation plays an important role in how the landscape and visual resources of an area are viewed and is an integral component of a landscape character.

Assessment was undertaken through analysis of up to date digital copies of OSI Discovery Series raster and OSI vector maps and aerial photography, in conjunction with drawings of the scheme. Site visits were undertaken to assess the existing environment and the landscape and visual impacts associated with the proposed flood relief scheme.

Existing visual resources were established along with sensitive receptors, i.e. residential properties, scenic viewpoints and visitor amenity areas. The proposed flood relief scheme was then applied to this landscape and visual baseline and potential impacts predicted.

A review of the Galway County Development Plan 2009 – 2015 and other relevant statutory documents was undertaken to establish if there are any relevant landscape related designations that may influence the assessment within the study area.

15.2.1 Significance of Landscape Impact

The level of significance of impact on landscape character is a product of landscape sensitivity and the magnitude of change in landscape resource. The magnitude of change is further described through scale, degree and duration of the impact as outlined in **Table 15.1** to **Table 15.4**. The result is a culmination of the significance of the impact as set out in **Table 15.5**.

Table 15.1 Landscape Sensitivity Categories

Landscape Sensitivity	Acceptability To Development
Low Sensitivity	All development kinds
Moderate Sensitivity	Many development kinds
High Sensitivity	Few development kinds
Special Sensitivity	Acceptable only in accordance with designation recommendations
Unique Sensitivity	Negligible alteration

(Source: DoEHLG's *Landscape and Landscape Assessment (2000))*

Table 15.2 Scales of Impacts

Scale Of Change	Description Of Scale
Negative	A change that reduces the quality of environment.
Neutral	A change, which does not affect the quality of the environment.
Positive	A change, which improves the quality of the environment.

(Source: EPA's *Guidelines on the Information to be contained in Environmental Impact Statements (March 2002))*

Table 15.3 Degree of Landscape Impacts

Degree Of Impact	Description Of Impact
Imperceptible	An impact capable of measurement, but without noticeable consequences
Slight Impact	An impact which causes noticeable changes in the character of the environment, without affecting its sensitivities
Moderate Impact	An impact that alters the character of the environment in a manner that is consistent with existing and emerging trends
Significant Impact	An impact which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment
Profound Impact	An impact which obliterates sensitive characteristics

(Source: EPA's *Guidelines on the Information to be contained in Environmental Impact Statements (March 2002))*

Table 15.4 Duration of Impact

Degree Of Duration Of Impact	Description Of Duration Of Impact
Temporary Impact	Impact lasting for 1 year or less
Short-Term Impact	Impact lasting one to seven years
Medium-Term Impact	Impact lasting seven to fifteen years
Long-Term Impact	Impact lasting fifteen to sixty years
Permanent Impact	Impact lasting over sixty years

(Source: EPA's *Guidelines on the Information to be contained in Environmental Impact Statements (March 2002))*

Table 15.5 Significance of Landscape Impact

Magnitude of landscape resource change	**Landscape Sensitivity**		
	Low	**Medium**	**High**
No change	No change	No change	No change
Low	Slight	Slight / moderate	Moderate
Medium	Slight / moderate	Moderate	Moderate / Substantial
High	Moderate	Moderate / Substantial	Substantial

15.2.2 Significance of Visual Impact

The significance of visual impact can only be defined on a project by project basis responding to the type of development proposed and its location. The principal criteria for determining significance are the existing visual amenity, resource, sensitivity and resulting magnitude of change. The significance of visual impact can then be determined.

The following text describes the key criteria and terminology used in the visual assessment.

Visual Amenity: Visual amenity is the value of a particular area or view in terms of what is seen by the viewer. This value may be influenced by the physical condition of the landscape viewed and the contribution the characteristics of the view make to the local environment.

Visual Resources: Visual resources are the overall key elements/features/characteristics that combine to make a view.

Viewer Sensitivity: Viewer sensitivity is a combination of the sensitivity of the human receptor (i.e. resident; commuter; tourist; walker; recreationist; or worker) and the quality of view experienced by the viewer and is defined using the following categories and criteria:

- **High sensitivity: -** users of an outdoor recreation feature which focuses on the landscape; valued views enjoyed by the community; tourist visitors to scenic viewpoint; occupiers of residential properties with a high level of visual amenity;

- **Medium sensitivity: -** users of outdoor sport or recreation which does not offer or focus attention on landscape; occupiers of residential properties with a medium level of visual amenity;

- **Low sensitivity: -** regular commuters, people at place of work; occupiers of residential properties with a low level of visual amenity.

Magnitude of Visual Resource Change: the magnitude of change in visual resource or amenity results from the scale of change in the view with respect to the loss or addition of features in the view and changes in the view composition, including proportion of the view occupied by the proposed development. Distance and duration of view must be considered. Other infrastructure features in the landscape and the backdrop to the development will all influence resource change. The following categories and criteria have been used:

- **High: -** Total loss or alteration to key elements/ features/ characteristics of the existing landscape or view and/or introduction of elements considered totally uncharacteristic when set within the attributes of the receiving landscape or view;

- **Medium: -** Partial loss or alteration to key elements/ features/ characteristics of the existing landscape or view and/or introduction of elements that may be prominent but not necessarily substantially uncharacteristic when set within the attributes of the receiving landscape/view;

- **Low: -** Minor loss or alteration to key elements/ features/ characteristics of the existing landscape or view and/or introduction of elements that may not be uncharacteristic when set within the attributes of the receiving landscape/view;

- **No change: -** Very minor loss or alteration to key elements/ features/ characteristics of the existing landscape or view and/or introduction of elements that are not uncharacteristic when set within the attributes of the receiving landscape/view.

Significance of Visual Impact: Significance of visual impact can only be defined on a project by project basis responding to the type of development proposed and its location. The principal criteria for determining significance are magnitude of visual resource change and viewer sensitivity.

Table 15.6 illustrates significance of visual impact as a correlation between viewer sensitivity and magnitude of visual resource change.

Table 15.6 Significance of Visual Impact

Magnitude of visual resource change	**Viewer Sensitivity**		
	Low	**Medium**	**High**
No change	No change	No change	No change
Low	Slight	Slight / moderate	Moderate
Medium	Slight / moderate	Moderate	Moderate / Substantial
High	Moderate	Moderate / Substantial	Substantial

15.3 EXISTING ENVIRONMENT

The Galway County Development Plan 2009-2015 incorporates the findings of the Landscape Character Assessment Report carried out in 2003 which assessed each area of the County under the following classifications:

- Character;
- Values; and
- Sensitivity.

15.3.1 Landscape Character

Landscape Character is a combination of landform, land cover and visual units, which are attractive in the landscape. According to the County Development Plan 2009-2015, the study area encompasses two Landscape Character Areas:

- **Area No. 4 "Southeast Galway (Clarinbridge to Gort)":** The landscape is undulating scrubby grassland, bound by field hedgerows without mature trees. The landscape is scenic without being remarkable and there are long distance views of the Slieve Aughty Mountains to the east. **Image 15.1** shows a typical example of this landscape within the study area.

- **Area No. 13 "East Galway Bay (Oranmore to Kinvara Bay and inland to N18 Road)":** The coastline is intimate and sinuous with many sheltered inlets. The coast is scenic and relatively undeveloped. The landscape adjacent to the coast comprises pastureland in large fields bordered by mature hedgerows. The existing vegetation screens the coastline from roads and properties inland of the N18 road. **Image 15.2** shows a typical example of this landscape within the study area.

Image 15.1 Typical Example of Landscape Classed as Area No. 4 Within the Study Area

Image 15.2 Typical Example of Landscape Classed as Area No. 13 Within the Study Area
(Source: Dr. Martin O’Grady, Inland Fisheries Ireland (I.F.I.))

Refer to **Figure 15.1** for the landscape character map of County Galway.

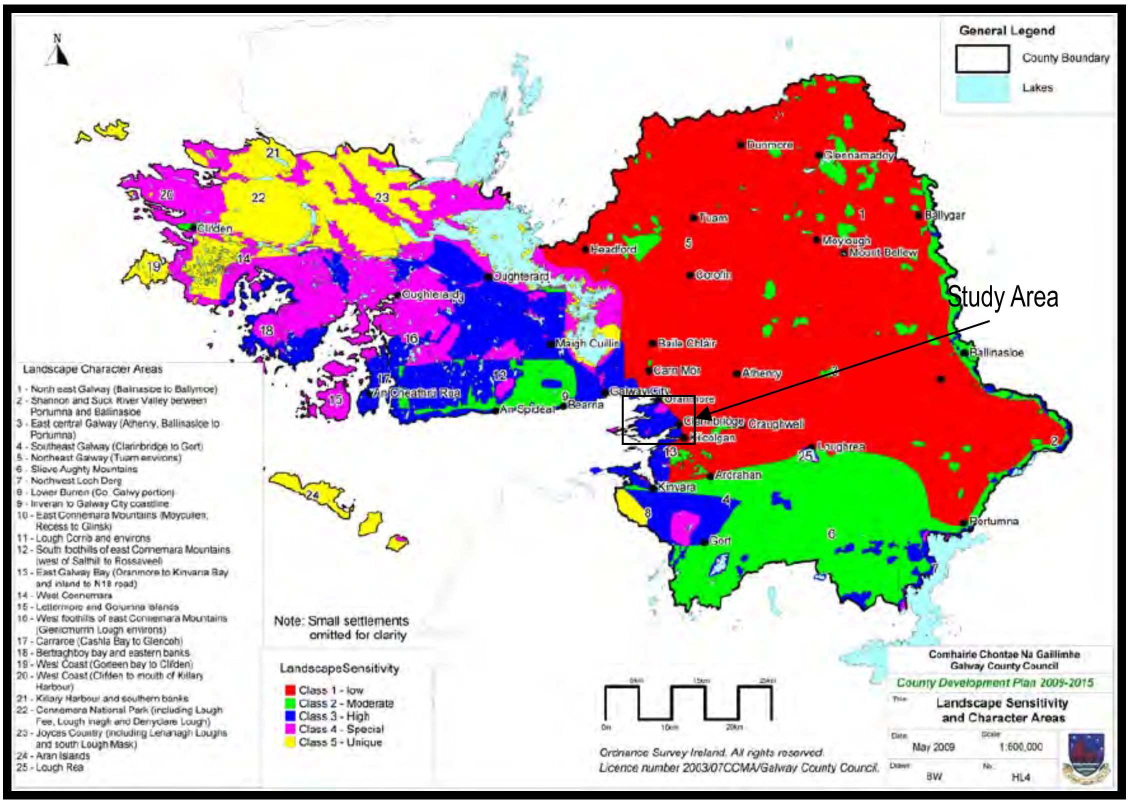

Figure 15.1 Landscape Sensitivity and Character Areas of County Galway
(Source: Galway County Development Plan 2009-2015)

15.3.2 Landscape Values

Landscape Values are the local communities' perceptions of the landscape they inhabit. These perceptions arise from features such as archaeology, visual beauty, mythology, religious sites, ecology, social history, traditional settlement patterns and community values.

The landscape value rating of the Dunkellin River, from Craughwell to Kilcolgan is designated as low. The landscape value rating of the Dunkellin River from Kilcolgan to its discharge point into Dunbulcaun Bay is high.

Refer to **Figure 15.2** for the landscape values map of County Galway.

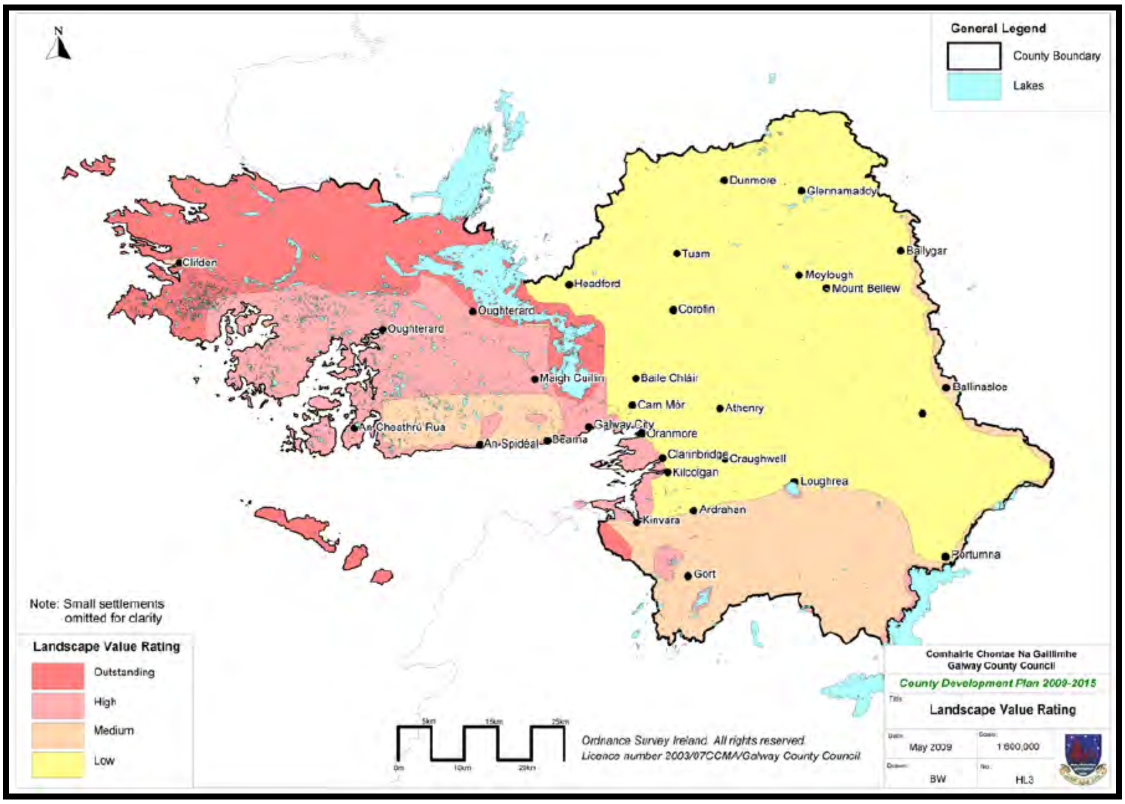

Figure 15.2 Landscape Value Rating of Galway County

(Source: Galway County Development Plan 2009-2015)

15.3.3 Landscape Sensitivity

Landscape Sensitivity is a measure of the ability of the landscape to accommodate change or intervention without suffering unacceptable effects to its character and values. Sensitivity ratings are derived from a combination of landscape values and landscape character. Five landscape sensitivity classes have been established and Galway County Development Plan 2009-2015 has further described these classes as detailed in **Table 15.7**.

Table 15.7 Classes of Landscape Sensitivity and Associated Prescriptions for Development

Landscape Sensitivity Class	Prescriptions for Proposed Developments (Galway County Development Plan 2009-2015)
Class 1 – Low sensitivity	All developments consistent with settlement policies

Class 2 – Moderate sensitivity	Various developments, which are of appropriate scale and design and are in compliance with settlement policies.
Class 3 – High sensitivity	Few developments, including those with substantiated cases for such a specific location and which are in compliance with settlement policies.
Class 4 – Special	Restricted to essential residential needs of local households and family farm business.
Class 5 – Unique	Negligible alteration will be allowed only in exceptional circumstances

The study area also encompasses a number of different Landscape Sensitivity ratings.

- The area around the Aggard Stream is designated as Class 1 – Low sensitivity,
- The village of Craughwell is designated as Class 1 – Low sensitivity,
- The area around the Dunkellin River, between the villages of Craughwell and Kilcolgan is a mix of two class designations; Class 1 – Low sensitivity and Class 2 – Moderate sensitivity,
- The village of Kilcolgan is situated on the boundary of two class designations; Class 1 – Low sensitivity and Class 3 – High sensitivity.

These sub-sections of the study area are further assessed in **Section 15.4.**

Refer to **Figure 15.1** for the landscape sensitivity map of County Galway.

15.3.4 Visual Environment

The Landscape Character Assessment 2003 also identified areas of protected “Focal Points/Views” which identify areas of scenic amenity value and interest. There are no protected “Focal Points/Views” located within the study area.

Architectural and local landscape sensitivities within the study area at a local level are further discussed in **Chapter 14.**

15.4 POTENTIAL IMPACTS

The potential impacts on the landscape and visual environment are further broken down into construction and operational stages of the scheme.

15.4.1 Construction Stage

The EPA Guidelines for Information to be included in an EIS identifies *Flood Relief Works* as Project Type 12A and lists the potential site preparation stage impacts as:

- temporary accommodation of materials and personnel;
- Acquisition and management of lands prior to development;
- Site preparation works;
- Time of year, duration and phasing;

- Equipment maintenance and storage;
- Water course diversion (temporary);
- Dredging and excavation; and
- Spoil handling, storage and final deposition.

15.4.1.1 Landscape Impacts

An assessment of the significance of the impact of the scheme on the landscape character, value and sensitivity of the study area during construction has been completed and summarised here.

Landscape Character and Value

- **Area No. 4 "Southeast Galway (Clarinbridge to Gort)"**

The proposed site preparation stage of the proposed flood relief scheme is located directly within the Southeast Galway (Clarinbridge to Gort) as set out in Galway County Development Plan 2009-2015. This landscape unit has also been afforded a low landscape value. The proposed activities will be of low prominence during site preparation and construction stages due to the ground level nature of these activities. The topography of the study area is set within an undulating scrubby grassland that can easily absorbs the low level of activity required at the site preparation and construction stages. The site preparation and construction stage of the proposal will be temporary in nature and duration.

When landscape character and value impacts are assessed during the site preparation and construction phase there will be slight negative impacts due to the limited influence of this staged activities and low landscape resource change that will result.

- **Area No. 13 "East Galway Bay (Oranmore to Kinvara Bay and inland to N18 Road)"**

No construction works will take place beyond the N18 bridge at Kilcologan. As a result the high landscape value attributed the coast line will not be impacted by this stage of the scheme. This landscape value also identifies pastureland in large fields bordered by mature hedgerows. The proposed activities will be of low prominence during site preparation and construction stages due to the ground level nature of these activities. The site preparation and construction stage of the proposal will be temporary in nature and duration.

When landscape character and value impacts are assessed during the site preparation and construction phase there will be no negative impacts due to the limited influence of this staged activities and low landscape resource change that will result.

Landscape Sensitivity

The study area has been divided into five varying landscape sensitivity classes (based on **Section 15.3.3**) and **Table 15.8** sets out any potential impacts on this aspect of the existing landscape as a result of the construction stage.

Table 15.8 Potential Impact of the Construction Phase on the Landscape Sensitivity of the Study Area

Sensitivity Rating	Potential Impact	Reason
- The Aggard Stream Class 1 – Low sensitivity,	Low impact	Low sensitivity coupled with limited influence of this temporary staged activities and low landscape resource change that will result.

Sensitivity Rating	Potential Impact	Reason
- Craughwell Village Class 1 – Low sensitivity	Low impact	Low sensitivity coupled with limited influence of this temporary staged activities and low landscape resource change that will result
- The Dunkellin River, between the villages of Craughwell and Kilcolgan (with the exception of Rahasane Turlough) Class 1 – Low sensitivity	Low impact	Low sensitivity coupled with limited influence of this temporary staged activities and low landscape resource change that will result
- Rahasane Turlough Class 2 – Moderate sensitivity,	No impact	No construction work will take place within Rahasane Turlough
- East of the village of Kilcolgan Class 1 – Low sensitivity	Low impact	Low sensitivity coupled with limited influence of this temporary staged activities and low landscape resource change that will result
West of the village of Kilcolgan Class 3 – High sensitivity.	No impact	No construction work will take place west of Kilcolgan.

15.4.1.2 Visual Impacts

The landscape value rating of the Dunkellin River, from Craughwell to Kilcolgan is designated as low. The landscape value rating of the Dunkellin River from Kilcolgan to its discharge point into Dunbulcaun Bay is high.

The assessment of the existing visual environment and the impact of the scheme and its various component parts during the site preparation and construction stage has established that the likely sources of impact will be at ground level with occasional vehicles accessing the site for preparation works and therefore barely visible from the wider low lying and undulating landscape. Such surface changes and individual vehicles will be readily absorbed into the wider panoramic view. The site preparation and construction of the scheme will be temporary in nature and duration.

When viewed from within the wider landscape the overall visual impacts during the site preparation and construction stage will be slight due to the limited viewer exposure and low visual resource change.

15.4.2 Operational Stage

The EPA Guidelines for Information to be included in EIS identifies *Flood Relief Works* as Project Type 12A and lists the potential operational stage impacts as;

- Operational range of water levels and associated controls;
- Maintenance/Management cycles;
- Safety and contingency plans; and
- Operational control.

15.4.2.1 Landscape Impacts

The careful design of the scheme will result in low levels of change in landscape resource (character, value and sensitivity). The landscape in which the scheme is located is a mix of low lying, flat and undulating scrubby grassland. The majority of this landscape is low in landscape sensitivity and value.

The scheme covers a linear length of approximately 17 km in total (Aggard Stream and Dunkellin River). Some of these measures are sporadic in nature, e.g. bridge works, culvert replacement etc., a fact that helps to reduce the scale of the proposal and its potential landscape impact.

There are two elements of the operation of this scheme which have the potential to impact on the landscape resource.

- **Removal and Spreading of Excavated Material:** The proposal to deepen and widen the channel of the Dunkellin River and general maintenance associate with the Aggard Stream will result in excavation of material which it is proposed will be landspread on adjacent lands. This could have a potential negative impact on the existing landscape resources of the study area.

  However the significance of this impact is reduced greatly owing to the fact that land spreading will occur over a distance of 5 km when compared to 17 km of the study area. In addition the river channel works have been confined to one bank to reduce the overall impact to the adjacent landscape. Therefore the influence is significantly reduced by the lack of prominent features and it will be lost in the wider landscape. This ensures assimilation of the material in to the landscape without significant visual impact. Such areas are all located in areas of low landscape resource.

  Areas which have been afforded a medium to high landscape resource rating will not have landspreading of material within the vicinity.

- **Change in Water Levels:** The purpose of the scheme is to contain flood waters from inundating surrounding lands and roads during a flood event. In order to complete this there is a requirement for the Dunkellin River Channel and associated Rahasane Turlough to accommodate such events. Hydrological modelling has been completed for the scheme and predicts that in the case of a flood event similar to that which occurred in November 2009 there will be no change in the plan area of Rahasane Turlough. As a result there is no potential permanent impact resulting from the operation of the scheme on the moderately sensitive Rahasane Turlough landscape in this regard.

  Proposed replacement and alteration to existing bridges situated along the Dunkellin is included in the proposed measures. The value and link these structures have to the landscape environment is further addressed in **Chapter 14.**

In summary:

- This landscape character area has an overall low value and sensitivity to change;
- The predicted magnitude of change in the landscape resource is low, and
- The predicted significance of landscape impact is low.

15.4.2.2 Visual Impact

Broadly speaking the visual environment for the scheme is limited due to the low lying and slightly undulating nature of the surrounding landscape. Due to the localised length of river and drain channels involved in the scheme combined with the level and low lying nature of the study area and surrounding landscape the scheme will blend visually with the existing landscape elements and there will be no significant visual impacts from longer distance locations.

An assessment of the visual environment within the study area has been completed. It is presented below and has been divided into units corresponding to the landscape sensitivity ratings of the study area.

The Aggard Stream

Image 15.3 View of the Aggard Stream and Typical Views of the Surrounding Landscape

Viewer sensitivity: The view is available from adjacent one-off housing and agricultural lands. The viewer sensitivity is low.

Existing visual resource: The view of the area is largely from a localised standpoint and from agricultural access points to lands adjacent to the Aggard Stream as the surrounding landscape is low lying.

Predicted view: It is proposed to replace culverts along the Aggard Stream. Once these are in place they will be intermittently visible depending on water levels as is the case now.

Magnitude of change: The magnitude of change in visual resource is low.

Significance of Visual Impact: The predicted significance of visual impact is low.

Craughwell Village

Image 15.4 View of Craughwell Village During Flooding in 2009

Viewer sensitivity: The view is available from the R446 and dwellings and business within the village. The viewer sensitivity is low.

Existing visual resource: The existing view from the R446, businesses and dwellings within the village is limited due to the built up nature of the environment and presence of mature vegetation.

Predicted view: It is proposed to complete river deepening and underpinning of bridges. This work will not be visible once complete. It is also proposed to land spread on lands located to the west of the village. Local dwellings may note a change in existing views but this change will be slight.

Magnitude of change: The magnitude of change in visual resource is low.

Significance of Visual Impact: The predicted significance of visual impact is low.

The Dunkellin River between the Villages of Craughwell and Kilcolgan

Image 15.5 View Available Between Dunkellin Bridge and Rinn Bridge

Image 15.6 View Available Below Dunkellin Bridge

Viewer sensitivity: The view is available from bridge crossings and agricultural lands. The viewer sensitivity is low.

Existing visual resource: The view of the area is largely from a localised standpoint, bridge crossings and from agricultural access points to lands adjacent to the Dunkellin River as the surrounding landscape is low lying.

Predicted view: It is proposed to complete river widening and land spreading of excavated material as well as bridge replacement and improvement works. These works will therefore be visible from various vantage points along its course.

Magnitude of change: The magnitude of change in visual resource is medium.

Significance of Visual Impact: The predicted significance of visual impact is moderate.

Rahasane Turlough

Image 15.7 View Available of Rahasane Turlough

Viewer sensitivity: The view is available from adjacent one-off housing and agricultural lands. The viewer sensitivity is moderate.

Existing visual resource: The view of the area is largely from a localised standpoint, bridge crossings and from agricultural access points to lands adjacent to the turlough as the surrounding landscape is low lying.

Predicted view: The predicted view will remain the same as the existing view as no works are proposed within the turlough.

Magnitude of change: The magnitude of change in visual resource is no change.

Significance of Visual Impact: The predicted significance of visual impact is no change.

East of the Village of Kilcolgan

Image 15.8 View Available East of Kilcolgan

Viewer sensitivity: The view is available from the N18 and agricultural lands. The viewer sensitivity is low.

Existing visual resource: The view of the area is largely from the N18 and from agricultural access points to lands adjacent to the Dunkellin River as the surrounding landscape is low lying.

Predicted view: It is proposed to complete river widening and landspreading of excavated material as well as bridge replacement and improvement works. These works will therefore be visible from various vantage points along its course.

Magnitude of change: The magnitude of change in visual resource is low.

Significance of Visual Impact: The predicted significance of visual impact is moderate.

West of the Village of Kilcolgan

Image 15.9 Aerial View Available West of Kilcolgan
(Source: Dr. Martin O'Grady, Inland Fisheries Ireland)

Viewer sensitivity: The view is available from adjacent one-off housing and agricultural lands. The viewer sensitivity is high.

Existing visual resource: The view of the area is largely from a one off housing, localised standpoints agricultural access points to lands and from the bay (boat users etc) as the surrounding landscape is low lying.

Predicted view: The predicted view will remain the same as the existing view as no works are proposed here.

Magnitude of change: The magnitude of change in visual resource is no change.

Significance of Visual Impact: The predicted significance of visual impact is no change.

15.5 MITIGATION MEASURES

The potential impacts on the existing landscape and visual environment, as a result of the scheme at both construction and operational phases has been assessed. The potential impacts to this aspect of the environment are minimal in this instance. The most likely impacts would result from the temporary construction works along the banks of the river and at bridge crossings and the deposition of excavated material on lands adjacent to the river.

In order to ensure that the landscape and visual environment are impacted to a minimum degree the following measures should be put in place to further ensure lack of impacts in this regard:

- Ensure the project programme and plan allow for physical and visual integration of the proposed flood relief scheme and associated features into the surrounding landscape;
- Where land spreading of excavated material is proposed replace topsoil in areas where topsoil will be stripped to spread spoil and replace topsoil. Return fit for purpose to landowners, e.g. in areas of improved agricultural grassland (GA1),
- Where it is possible retain existing bank side vegetation and earth banks to field boundaries as far as possible;

- Where not possible to retain existing vegetation consider reinstatement of same when construction phase is complete only where it will not interfere with the flood conveyency capacity of the newly constructed second stage channel; and

- During construction, site compounds and proposed access tracks should be kept clean and tidy at all times.

15.6 RESIDUAL IMPACTS

This section assesses the impact of the scheme on the landscape and visual environment after the mitigation described above has been completed.

After reinstatement and establishment of the vegetation cover along the river/drain banks and along roads and near bridges, the proposed scheme will blend with the existing landscape. Satisfactory reinstatement of disturbed landscapes will result in no residual landscape impacts.

There will be no significant loss of existing views. The scheme will not be a prominent feature in the landscape due its low-lying nature and design mitigation measures. No significant visual impacts are predicted. From time to time, visits by maintenance vehicles will occur but such activities will only cause low levels of magnitude of change in visual resource and will be temporary in nature.

This landscape and visual assessment has a direct interaction with the Terrestrial and Aquatic Ecology sections (**Chapter 10** and **Chapter 11**) of the EIS. The loss of habitats is described fully in those chapters and not elaborated in this landscape and visual impact assessment. In completing the landscape and visual impact assessment due consideration has been afforded to appropriate mitigation measures outlined within the Terrestrial Ecology and Aquatic Ecology sections of this EIS.

Table 15.9 summarises the potential impacts and proposed mitigation measures relative to the landscape and visual environment.

Table 15.9 Summary of Potential Impacts and Proposed Mitigation Measures Relative to the Landscape and Visual Environment

Potential Impact on Landscape and Visuals	Positive/ Negative/ Negligible	Major/ Moderate/ Minor	Area Affected	Duration	Mitigation Measures	Residual Impact
Construction Phase of the Flood Relief Scheme						
Proposed activities will be of low prominence during construction due to the ground level nature of these activities.	Negative	Minor	Area No. 4 “Southeast Galway (Clarinbridge to Gort)” Area No. 13 “East Galway Bay (Oranmore to Kinvara Bay and inland to N18 Road)”:	Temporary	There is limited influence of this stage’s activities and low landscape resource change that will result. Retain existing landscape features as far as is possible. Keep site preparation areas tidy.	None
Operational Phase of the Flood Relief Scheme						
Low levels of change in landscape resource.	Negligible	n/a	Area No. 4 “Southeast Galway (Clarinbridge to Gort)” Area No. 13 “East Galway Bay (Oranmore to Kinvara Bay and inland to N18 Road)”:	n/a	The landscape in which the scheme is located is low lying, a fact that helps to reduce the scale of the proposal and its potential landscape impact. Ensure the project programme and plan allow for physical and visual integration of the scheme and associated features into the surrounding landscape. Where land spreading of excavated material is proposed replace topsoil in areas where topsoil will be stripped to spread spoil and replace topsoil. Return fit for purpose. Where it is possible retain existing bank side vegetation and earth banks to field boundaries as far as possible.	None

Potential Impact on Landscape and Visuals	Positive/ Negative/ Negligible	Major/ Moderate/ Minor	Area Affected	Duration	Mitigation Measures	Residual Impact
Aggard Stream	Negative	Minor	Various visual receptors including road users, farmers and house owners.	Temporary	Ensure the project programme and plan allows for physical and visual integration of the scheme and associated features into the surrounding landscape. Where land spreading of excavated material is proposed replace topsoil in areas where topsoil will be stripped to spread spoil and replace topsoil. Return fit for purpose.	Minor
Craughwell Village	Negative	Minor				
The Dunkellin River between the Villages of Craughwell and Kilcolgan	Negative	Minor				
Rahasane Turlough	Negligible	-				
East of the Village of Kilcolgan	Negative	Minor				
West of the Village of Kilcolgan	Negligible	-				

15.7 CONCLUSION

The proposed Dunkellin River and Aggard Stream Flood Relief Scheme is located in a landscape that has been divided into two landscape character areas that of Area No. 4 “Southeast Galway (Clarinbridge to Gort)” and Area No. 13 “East Galway Bay (Oranmore to Kinvara Bay and inland to N18 Road)”. The value afforded Area 4 is low and Area 13 is high.

The landscape sensitivity varies from low around the Aggard Stream, Craughwell Village and for part of the Dunkellin Channel to high downstream of Kilcolgan Bridge. Part of the Dunkellin River Channel runs through a landscape of moderate sensitivity – this relates to Rahasane Turlough.

A review of the visual environment found that the main visual receptors in the study area included road users, farmers and occupiers of residential properties. No focal points/views” which identify areas of scenic amenity value and interest are located within the study area.

No proposed flood alleviation measures are proposed to take place with Rahasane Turlough (moderate landscape sensitivity) or downstream of the N18 bridge at Kilcolgan (high sensitivity).

An assessment of the construction stage impacts on landscape concluded that there will be slight negative impacts due to the limited influence of this staged activities and low landscape resource change that will result. Visually when viewed from within the wider landscape the overall visual impacts during the site preparation and construction stage will be slight due to the limited viewer exposure and low visual resource change. Mitigation measures including keeping the site compounds and access points clean and tidy will mitigate further any potential negative impacts in this regard.

During the operational stage, the scheme was identified as having the potential to impact on landscape. Firstly the removal and spreading of excavated material during channel widening was identified as having the potential to impact the existing landscape resource. In order to lessen or remove the potential impact resulting from channel widening and landspreading of the material on adjacent lands it is proposed to replace topsoil in areas where topsoil will be stripped to spread spoil and replace topsoil. Where it is possible existing bank side vegetation will be retained where it is not possible to retain existing vegetation reinstatement of same may be considered (where it does not interfere with the flood alleviation measures) when the construction stage is complete.

Architectural/local landscape sensitivities within the study area at a local level are further discussed in **Chapter 14.**

16 HUMAN BEINGS AND MATERIAL ASSETS

16.1 INTRODUCTION

Human beings and their associated material assets (physical resources in the environment, which may be either of human or natural origin) are an important element of the environment. Any potential impact on the status of human beings by the proposed Dunkellin River and Aggard Stream Flood Relief Scheme (the scheme) must therefore be comprehensively assessed. The principal concern is that human beings within the study area experience no significant unacceptable diminution in aspects of quality of life as a consequence of the scheme. Relevant components of this chapter of the EIS include land use, demography, employment, amenity/community aspects and services/utilities.

This chapter also describes the potential impacts on material assets as a result of the scheme. For the purposes of this assessment, material assets include:

- Economic Assets of Natural and Human Origin, and
- Cultural Assets of a Physical and Social Type.

16.2 METHODOLOGY

The EPA Advice Notes on Current Practice in the preparation of Environmental Impact Statements (2003) sets out a useful framework methodology, which has been consulted in the process of preparing this assessment. The Advice Notes suggest that the human environment be assessed under the following headings:

- **Economic Activity** – will the proposed flood relief scheme stimulate additional development and/or reduce economic activity, and if either, what type, how much and where?
- **Social Consideration** – will the proposed flood relief scheme change patterns and types of activity and land use?
- **Land Use** – will there be severance, loss of rights of way or amenities, conflicts, or other changes likely to ultimately alter the character and use of the surroundings?
- **Health and Safety** – will there be risks of death, disease, discomfort or nuisance?

Likewise the Advice Notes suggest that Material Assets should be assessed under the following headings:

- **Economic Assets of Natural and Human Origin, and**
- **Cultural Assets of a Physical and Social Type.**

These issues are addressed in this assessment and a baseline study of the existing human and material assets environment was undertaken in order to complete this. Desktop research comprised the method of obtaining this information. The following sources of information were consulted in the process of this assessment:

- 2006 Census of Ireland, Central Statistics Office, 2006,
- 2011 Census of Ireland, Central Statistics Office, 2011,
- Galway County Development Plan 2009-2015,and
- Local Area Plans where available.

Some of the issues discussed in this chapter including traffic, noise, air quality, visual amenity and water quality are addressed in greater detail in the relevant chapters of this EIS. This chapter should be read in conjunction with the layout plans for the scheme and project description section of this EIS (**Chapter 6**).

Where relevant, impacts on material assets such as the road network and designated conservation sites are more appropriately described in other chapters of this EIS. **Table 16.1** highlights other chapters that are relevant to human beings and material assets.

Table 16.1 EIS Chapters Relevant to Human Beings and Material Assets

Chapter No.	Title	Human Aspect or Assets
8	Hydrology & Drainage	Flooding and Shellfish Industry
9	Soils, Geology & Hydrogeology	Natural Resources
10 & 11	Terrestrial & Aquatic Ecology	Designated Conservation Sites
11	Aquatic Ecology	Water Quality and Amenity
12	Air Quality & Climate	Air Quality
13	Noise	Noise Environment
14	Archaeology, Architectural and Cultural Heritage	Cultural Assets
15	Landscape and Visual Assessment	Views
17	Traffic	Road Infrastructure and Use

16.3 EXISTING ENVIRONMENT

16.3.1 Economic Activity

Demography & Employment - In this section, the key demographic and employment characteristics of the resident population within the study area is examined. The most recent census of population was taken in April 2011 by the Central Statistics Office (CSO) the current census report contains results which are based on summaries returned by each of the 4,854 census enumerators. Refer to **Table 16.2** for details.

The population of Ireland increased by 8.1% between the years of 2006 and 2011, while for the corresponding period the population of County Galway also increased by 8.1%.

Table 16.2 sets out the population structure, employment trends and employment levels for the six main electoral divisions that cover the study area and the urban area of Craughwell from the 2006 and 2011 Census.

Table 16.2 Population Structure, Employment Trends and Employment Levels for the Six Main Electoral Divisions in the Study Area

		ED of Rahasane		ED of Killeely		ED of Clarinbridge		ED of Drumacoo		ED of Castletaylor		ED of Killogillean		Craughwell	
Year Of Census		2006	2011	2006	2011	2006	2011	2006	2011	2006	2011	2006	2011	2006	2011
Population		279	329	1257	1596	2666	3271	997	1239	486	547	640	818	1363	1640
Unemployment Levels (%)		4		23		45		26		8		14		31	
Main Employment Sector*	Female		Professional Workers		Professional Workers		Professional Workers		Professional Workers		Professional Workers		Professional Workers		Professional Workers
	Male		Farming, Fishing & Forestry		Building & Construction		Professional Workers		Manufacturing		Building & Construction		Farming, Fishing & Forestry		Professional Workers

(Source: CSO, 2006 & 2011)

As this information is taken from the 2006 census it is likely that the breakdown of these working sectors has changed to reflect recent economic changes. It is likely that unemployment levels have increased and that the level of those employed in the building and construction sector will have decreased. Fishing in the region, both freshwater and in Galway Bay (including aquaculture) is an important element of employment for the region and is directly associated with the visiting community and amenity value of the region.

The Galway County Development Plan 2009-2015 sets out economic development aims for the entire County and stresses the need for a balance between economic growth and sustainable development. The strategic aims of the development plan reflect this through the following strategic aims:

- *Implement an overall development strategy for the County aimed at achieving the balanced and sustainable development of County Galway in a strategic and plan led manner.*
- *Improve the quality of life for the people of Galway and maintain the County as a uniquely attractive place in which to live, work and visit.*
- *Create a receptive development environment in response to national and regional policy, such as the National Spatial Strategy, the National Development Plan 2007-2013 and the West Regional Planning Guidelines 2004-2016 (i.e. Counties Galway, Mayo, Roscommon and Galway City) (RPGs) and secure the development of the identified major infrastructural projects which will underpin sustainable development throughout the County and Region during the Plan period.*
- *To drive forward the balanced economic and social development of Galway by facilitating new strategic developments at appropriate locations and enhancing the quality of life for the citizens of Galway within an environment of outstanding quality.*
- *To move towards a more sustainable and integrated concept of development with regard to land use, transportation, water services, energy supply and waste management over the lifetime of the Plan.*

16.3.2 Social Consideration

Amenity & Communities - There are three principal elements to the community of the study area, namely:

- the residential community,
- the working community, and
- the visiting community.

For the purpose of this assessment the residential community consists of those living within the study area. The two main settlements within this region are the villages of Craughwell and Kilcolgan. Clarinbridge, which is located approximately 2 km north of Kilcolgan, has a population on 364 people and Kilcolgan has 230 people. There is a population density ranging from 90-175 people per hectare in and close to the urban centres of Craughwell and Kilcolgan to 60 people per hectare in the southern rural part of the study area. Residential settlement is for the most part in ribbon development following the local road network.

From **Table 16.2** it is clear that the working community consists for the most part of professional workers for the female population. This reflects the location of the study area close to Galway City for commuting. The male community has a more diverse work sector with a mix of professional (associated with the urban centres and Galway City), manufacturing, building and construction and farming, fishing and forestry.

In Kilcolgan and Clarinbridge, most are recorded as professional workers, however, many households would also have gained income from building and construction, farming and/ or fishing including aquaculture. Aquaculture in the vicinity of the Dunkellin and Clarin rivers within Dunbalcan Bay is predominately oysters (both native and pacific) and mussels with some licences for other shellfish such as clams. Many of the members of the shellfisheries licensed areas and co-operatives in the Dubalcan Bay operate other businesses (farming etc) as well as aquaculture licences. For some of the operators, this is a full time business and their sole source of income, it is a substantial part of the annual income of all the operators. **Figure 16.1** shows the Clarinbridge / Kilcolgan Designated Shellfish waters and licensed shellfish areas.

In terms of visiting community the predominant attraction is angling. The Dunkellin River (or as it is referred to in its lower reaches, the Kilcolgan River), is included in the Anglers Guide to Game Fishing in the Western Fisheries Region which was published by the then Western Regional Fisheries. It states that the Kilcolgan River is good for trout from Kilcolgan to Craughwell and sea trout and salmon are caught in the lower reaches of the river in Spring and Summer. The attraction of anglers to the area is an important resource within the study area. Similarly people visit the area for the Clarinbridge Oyster Festival further reinforcing the importance of aquaculture in Galway Bay.

The lower reaches of the Dunkellin River is also occasionally used for water pursuits (refer to **Image 16.2**). Other marine activities in the area which attract visitors include sailing, diving and windsurfing. In the wider region the heritage sites of Athenry Castle and Coole Park attract visitors to the area.

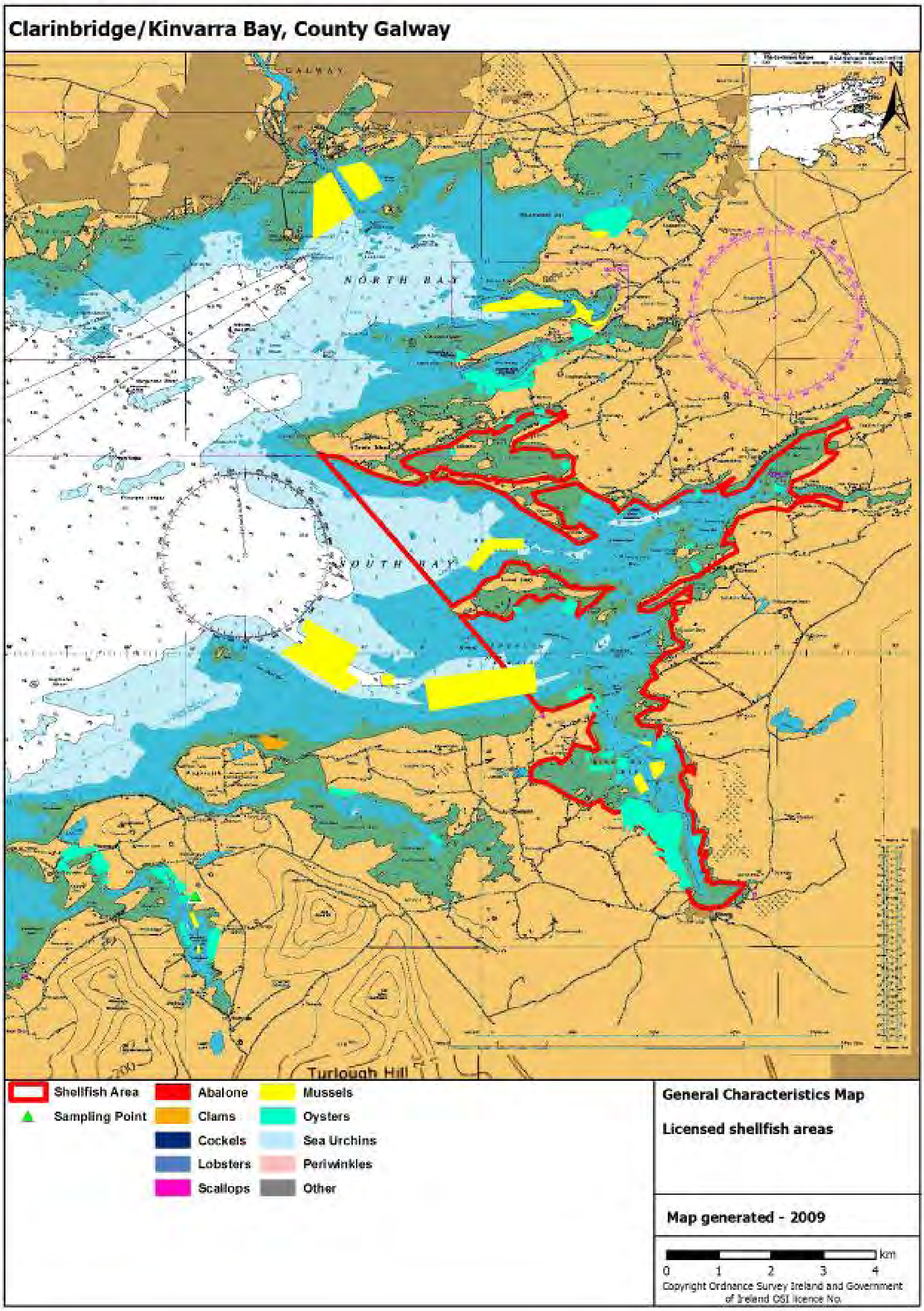

Figure 16.1 Clarinbridge / Kilcolgan Designated Shellfish Waters and Licensed Shellfish Areas (by product).

(Source: Extract from the Shellfish Pollution Reduction Programme, Characterisation Report Number V, Clarinbridge Kinvarra Bay Shellfish Area, County Galway, DoEHLG, 2009)

Image 16.1 Typical Land Use in the Study Area (Dunkellin River in Mid-Ground of Image)
(Source: Dr. Martin O'Grady, Inland Fisheries Ireland (I.F.I.))

Image 16.2 Example of How the Dunkellin River is Used as an Amenity

16.3.3 Landuse, Services and Utilities

The study area encompasses lands surrounding the course of the Aggard Stream from its source to its confluence with the Dunkellin River and the Dunkellin River from just upstream of Craughwell Village to its discharge to Galway Bay just west of Kilcolgan

Given the region's location relative to Galway City a major land use within the study area is residential. Beyond these urban settlements the main land use of the study area is agriculture. **Image 16.1** shows typical farm land and dwelling locations in the study area. Mineral extraction is present in the study area. There are three extractive industry related activities in the wider region – Goode Concrete in Adrahan, Canon Concrete in Oranmore and Tonroe Quarry.

Services and utilities are enterprises or facilities that serve the public by means of an integrated system of collection, transmission, distribution and/or processing through permanent physical connections between the utility and the public. Major utilities in the region of the study area include the transportation network, electricity supply, telecommunications and the water supply (public scheme).

Major utilities in the region of the proposed works include the following:

Transportation Network: Several crossings of the Dunkellin River and Aggard Stream occur within the study area including the N18 at Kilcolgan and the R446 at Craughwell (the N6 National Route which has been reclassified). The Western rail corridor also runs through the study area and crosses the Dunkellin River at the railway bridge in Craughwell. The railway line runs almost parallel to the Aggard Stream and crosses the stream at three locations; Ballynamannin townland, Rathcosgy townland and Ballyglass East.

Energy Infrastructure: A medium voltage three phase 10 kV ESB distribution line runs from Craughwell to Kilcolgan following the line of the Dunkellin River and crossing it at Rinn Bridge and Ballywulash townland near Craughwell village. The 10 kV ESB line also crosses the Aggard Stream at the Aggard Bridge where the R347 Adrahan Road crosses the channel. A 220 kV transmission line crosses the Dunkellin River at Caherapheepa between Dunkellin Bridge and Rinn Bridge and a 38 kV and 110 kV line cross the Kilcolgan River downstream of Kilcolgan bridge. The village of Craughwell is also supplied with natural gas by An Bord Gais. A distribution network line crosses the Dunkellin River at the N6 Bridge in the village of Craughwell.

Water Supply: There are some surface water bodies in the area that are designated as drinking water protected areas – Dooyertha River, Lough Rea, Craughwell River and Kilcolgan River and six group water schemes (groundwater) are located within the study area.

Wastewater Treatment: There are no Local Authority wastewater treatment plants located within the study area. All wastewater is currently treated via private wastewater treatment systems. There are four local authority licenced discharges all concentrated around and upstream of Craughwell Village.

16.3.4 Material Assets

Material assets can be defined as physical resources in the environment, which may be either of human or natural origin. These are further broken down in the EPA publication Advice Notes on Current Practice in the preparation of Environmental Impact Statements (2003) into the following:

Economic Assets of Natural and Human Origin: A number of economic assets namely the agricultural lands and associated soils are considered to be a non-renewable natural resource of high economic importance for the region. There are known mineral or aggregate deposits existing within the study area.

The main significant natural resource occurring within the study are the river channels themselves. These freshwater habitats are important fisheries habitats which have an economic value in terms of angling, tourism and amenity value. Downstream of the study area Clarinbridge and Kinvara Bay shellfish waters contain commercial aquaculture activity which forms a significant economic element of the region (Refer to **Figure 16.1**).

The water quality and morphology of the river channels and associated bays downstream have the potential to be influenced by the scheme works. Native and Pacific oysters and mussels are the most important shellfish species harvested within the designated shellfish area. Average production of native oysters for the period 2000 to 2003 was seven tonnes per annum. Production of Pacific oysters between 2001 and 2004 averaged approximately 175 tonnes per annum. Mussel production for the period from 2000 to 2004 averaged 155 tonnes per annum. A single licence fishery for sea urchins for the Japanese and Asian markets is also present in the Clarinbridge / Kilcolgan Shellfish Waters (**Figure 16.1**). There are no fin fisheries in the area. This particular oyster fishery is well known. The fishery has a significant export market second only to Irish Harvest located in Donegal. Due to the history of this activity the aquaculture in the region also have cultural significance, for example, the Clarinbridge Oyster festival.

Cultural Assets of a Physical and Social Type: There are a number of records of monuments and places (RMP's)[23]located in the region although none are designated as National Monuments or have Preservation Orders placed on them. There is no known geological heritage site identified within the study area. Some of the bridge structures located within the study area could be considered important material assets from a cultural and physical point of view. In terms of social assets there is no known existing link to the site in terms of language and dialect, folklore and tradition, religion and belief and literary and artistic association. Issues of cultural and architectural heritage within the study area are further discussed in detail in **Chapter 14.**

16.4 POTENTIAL IMPACTS

The human environment and its associated material assets in the region of the scheme have been set out in the previous section. This section further assesses the potential impacts on this element of the environment resulting from the construction and operational stages of the scheme.

[23] A statutory list of all known archaeological monuments provided for in the National Monuments Acts.

16.4.1 Construction Stage

The most obvious impact the scheme will have during construction will be the loss of agricultural land along approximately 4.5 km of the Dunkellin River Bank. This will have a localised negative and permanent impact on the existing land use, i.e. agriculture. Stripping of top soil for land spreading will also pose a negative impact. However this will be temporary in nature as the top soil will be reinstated after land spreading of excavated material has been completed.

There is also the possibility that the residential community in the immediate vicinity of the proposed widening, deepening and structural work will experience increase noise levels and traffic disruption (this may also affect the working community).

The potential for amenity uses of water namely angling may also be temporarily disrupted during construction.

There will be a requirement to employ contractors to complete the proposed works and this will have a significant positive impact on the local economy and working community.

16.4.2 Operational Stage

Once the scheme has been implemented there will be a significant positive impact to the local community. The scheme will provide the local community with a situation where existing flooding at peak flows is reduced and will have indefinite positive impacts for the economy of the region through mitigation of flooding within the study area.

A salinity modelling exercise was completed in order to ascertain if in times of a flood event, the receiving shellfish waters of Dunbulcaun Bay at Roevehagh would experience a drop in salinity levels which would have the potential to affect the functioning of the oyster farms present. Further to this an independent expert review and opinion was sought on the findings of this model.

The modelling demonstrated that, for a flood event similar to that experienced in November 2009, the salinity levels at the shellfish beds would experience minimal effects due to the alleviation scheme. This was further agreed with by the expert opinion. **Appendix E** details the modelling undertaken and the conclusion of same.

16.5 MITIGATION MEASURES

Any potential negative impact identified will be mitigated for through a range of measures which are assessed in detail in this EIS (refer to **Table 16.1**). **Table 16.3** summarises the potential impacts identified for human beings and material assets as a result of the scheme measures. Mitigation measures are included where required.

Table 16.3 Summary of Impact Assessment on Human Beings & Material Assets

Potential Impact on Human and Material Assets Environment	Positive/ Negative	Major/Moderate /Minor	Area Affected	Duration*	Mitigation Measures	Residual Impact
Construction Stage						
Transport machinery to site causing traffic inconvenience.	Negative.	Minor.	Local.	Temporary.	• Notify local road users of time that machinery will be transport to site. • Transport machinery during non- peak traffic hours.	None.
Road closures, diversions or traffic management changes.	Negative.	Minor.	Local.	Temporary.	• Consult with Galway County Council Roads Department. • Notify local road users through public notice in a County paper.	None.
Increased noise levels.	Negative.	Minor.	Adjacent to site.	Temporary.	• Ensure that activities are restricted to working hours where working near sensitive receptors.	None.
Alteration of existing land use.	Negative.	Moderate.	Local.	Permanent.	• Notify local landowners through interference notices. • Replace lands adjacent to the river widening areas fit for purpose post flood relief scheme works.	The land will be economically beneficial to the local community.
Loss of river bank structure and vegetation as a natural resource.	Negative.	Minor.	Local.	Permanent.	N/A	The land which will be used for flood channel creation will be permanently lost to the landowners. The landowners will be compensated.
Pollution of water as a natural resource.	Negative.	Major.	Regional.	Temporary.	• A range of measures to be put in place as per **Chapters 10** and **11**.	Slight alterations to water quality and flows resulting in potential impact on local amenity uses.

Potential Impact on Human and Material Assets Environment	Positive/ Negative	Major/Moderate /Minor	Area Affected	Duration*	Mitigation Measures	Residual Impact
Visual Impact for local residents.	Negative.	Moderate.	Local – Adjacent.	Permanent	• Retention of the existing vegetation and earth banks to field boundaries as far as possible. • Site preparation areas and compound areas will be kept tidy at all times.	Potential minor impact for local residents.
Health and Safety Risks at all stages of the proposed flood relief scheme implementation.	Negative.	Major.	Construction Workers.	Permanent.	• Follow Galway County Council Health and Safety Policies and Statements at all times during works.	None.
Generation of employment.	Positive.	Major.	Local economy and working community.	Temporary.	N/A	Positive impact on local economy.
Operational Stage						
Elimination of future flood of study area (including damage to commercial, residential properties, loss of land, transport disruption etc).	Positive.	Major.	Entire study area.	Permanent.	N/A	Elimination of future flood of study area

16.6 RESIDUAL IMPACTS

There may be minor temporary impacts for local road users and noise sensitive receptors during site implementation of the scheme measures. However implementation of suitable mitigation measure should ensure that these are minor in magnitude. The scheme will provide the local community with a situation where existing flooding at peak flows is reduced and will have indefinite positive impacts for the economy of the region through mitigation of flooding.

In extreme flood conditions, the increased freshwater delivery to the estuary may have an effect on the overall salinity. However, even in the 2009 flood event, the total change due to the scheme would be less than 1 PSU at the nearest shellfisheries beds. Shellfish areas and mussel aquaculture in the outer receving waters would not record any change in conditions. The Dunkellin River is only one of a number of freshwater sources to the area and therefore despite the works the overall changes are minimal. It is anticipated that in the event of an extreme flood the works would result in improved water quality of flood waters due to the channelization.

16.7 CONCLUSION

A review of the human environment in terms of economy, community land use and services and utilities was carried out to gain an understanding of this aspect of the environment. Material assets of natural resource and cultural were also assessed. The assessment found that the area is rural in nature with two main urban centres - Craughwell and Kilcolgan. The main land use in the region is residential and agricultural and while the main area of employment is Galway City and the urban centres, there are also important industries in the region relating to angling on the river and the shellfish industry in the receiving bay.

The proposed Dunkellin River and Aggard Stream Flood Relief Scheme will have significant positive impacts for the local human environment in terms of alleviation of significant flooding in the area as occurred in November 2009 and provision of employment during the construction phase.

It is anticipated that there may be some minor temporary disturbances to local road users and noise sensitive receptors during scheme implementation. However if proposed mitigation measures are put in place as recommended these impacts should remain minor or insignificant in nature. There will be a permanent loss of agricultural land owing to the proposed river widening and while this cannot be mitigated for directly, the benefits of flood alleviation for these lands in future outweighs the continued threat of flooded agricultural lands in the study area.

The mitigation put in place for the shellfish industry will minimise any possible impacts during construction. Under normal operating conditions there will be no discernable changes. In extreme flood events (such as the 2009 flood), the increased flow from the Dunkellin River as a result of the works would have a minor affect on salinity in the receiving waters, this effect has been modelled and would result in a change of less than 1 PSU. As the water quality of the flood water is likely to be improved as a result of the works, this minor change in itself is highly unlikely to cause any impact.

17 TRAFFIC

17.1 INTRODUCTION

The purpose of this chapter is to assess the impact of the proposed Dunkellin River and Aggard Stream Flood Relief Scheme (the scheme) on the receiving environment with respect to traffic conditions, transport routes and general traffic safety. The assessment identifies the existing road network in the vicinity of the proposed construction areas, potential impacts of the various stages of the proposal on the transport infrastructure and its users and proposes where required suitable mitigation measures.

The scope of this assessment is to assess existing conditions from a traffic perspective relative to the scheme. It is not intended to undertake detailed junction geometry surveys, detailed traffic forecasting or traffic flow modelling.

In assessing traffic as part of the scheme the following objectives will be considered:

- Ensure safety of workers and the public,
- Avoid damage to transport infrastructure, including roads and bridges, and
- Minimise pollution and spillage.

17.2 METHODOLOGY

A review of the existing transport infrastructure for the region was undertaken in order to establish a baseline environment for the traffic assessment. This was completed on two levels which considered:

- The public road network in the region, and
- The internal access routes within the existing study area where flood relief scheme measures will be implemented.

In the process of completing this assessment the following publications were consulted:

- *Guidelines on the Information to be contained in Environmental Impact Statements*, EPA, 2002,
- *Advice Notes on Current Practice in the preparation of Environmental Impact Statements, EPA, 2003, and*
- *The Galway County Development Plan 2009-2015.*

17.3 EXISTING ENVIRONMENT

The existing traffic related environment has been assessed at two levels for the purpose of this assessment. The regional and local transport network was assessed and the internal access roads in the proposed study area.

17.3.1 Existing Road Network

The Dunkellin River is located between the villages of Craughwell (upstream) and Kilcolgan (downstream). The Aggard Stream is located between the townland of Cregaclare (downstream) and Craughwell village (upstream). The study area is essentially bound to the west by the N18 and to the east by the R446 (formerly the N6).

The N18 National Route runs through Kilcolgan and is the primary route between Galway City and Limerick City. At Kilcolgan village there is a junction of the N18 with the N67 secondary route to Kinvarra. The N18 passes over the Dunkellin River at Kilcolgan bridge. The N67 does not cross the Dunkellin River.

The N6 National Route which has been reclassified as the R446, runs through Craughwell village. This is the primary route between Loughrea town and Galway City and was previously the primary route between Galway and Dublin prior to the opening of the M6 motorway in 2009. The R446 passes over the Dunkellin River at two locations in Craughwell; the main N6 Bridge and the old N6 Bridge. A network of local county roads also cross the Dunkellin River and **Images 17.1-17.12** depict the existing road network and all of the bridge crossings (from upstream to downstream) that are located on the Dunkellin River and Aggard Stream.

The R347 regional road links Craughwell village and Adrahan village (located south of Kilcolgan on N18). The R347 crosses the Aggard Stream at the Aggard Bridge located in the townland of Aggard More approximately 1 km southwest of Craughwell. A number of local county roads cross the Aggard Stream at the townlands of Ballynaminnin, Ballylin West, Monksfield and Ballyboy.

17.3.2 Existing Rail Network

The western rail corridor runs almost parallel to the Aggard Stream and crosses the stream at three locations; Ballynamannin townland, Rathcosgy townland and Ballyglass East and crosses the Dunkellin River at the railway bridge in Craughwell.

17.3.3 Proposed Flood Alleviation Measures and Traffic

As part of the scheme there will be a requirement for construction machinery to gain access to the river bank for river deepening, widening and structural work on bridge crossings, etc. Some of the locations in the study area will be easily accessed by way of existing roads and tracks. However work proposed on river widening and deepening will require the development of temporary access roads and tracks.

It is envisaged that there will be up to three work crews and six contracts crews, at maximum, working within the study area at any one time. The construction of the scheme will require four main compounds and the provision of four access points to the Dunkellin River as follows:

- Site compound at Killeely Beg Bridge,
- Site compound at Dunkellin Bridge,
- Site compound at Rinn Bridge,
- Provision of an access point into the Dunkellin River at Killeely Beg Bridge,
- Provision of access point into the Dunkellin River at the Dunkellin Bridge,
- Provision of an access point into the Dunkellin River at Rinn Bridge,
- Temporary access road to Killeely Beg Bridge to facilitate the movement of large precast bridge beams, and
- Site compound at Craughwell Village.

It is envisaged that the four main access points will consist of a temporary surface which will be provided along the river bank to allow vehicles to enter and travel to the proposed work sites. These track will be typically formed from stone excavated from the proposed works and will be constructed ahead of the excavation plant as work progresses.

Image 17.1 N18 at Kilcolgan

Image 17.2 Example of Local Roads Traversing the Dunkellin River

Image 17.3 Example of Local Roads Traversing the Dunkellin River

Image 17.4 R446 Bridge at Craughwell Village (formerly N6)

Image 17.5 Masonry Arch Pedestrian Bridge at Craughwell

Image 17.6 Railway Bridge in Craughwell

Image 17.7 Rinn Bridge

Image 17.8 Dunkellin Bridge

Image 17.9 N18 Kilcolgan Bridge

Image 17.10 Railway Crossing along the Aggard Stream in Ballyglass

Image 17.11 Railway Crossing along the Aggard Stream in Monksfield

Image 17.12 The Aggard Bridge

17.4 POTENTIAL IMPACTS

Potential impacts of the proposed flood relief scheme on the existing traffic and transport network of the study area are set out in this section under the following headings:

- Site preparation and measures implementation, and
- Site management.

17.4.1 Site Preparation and Measures Implementation

Works proposed on bridge crossings, proposed site compounds and access points to working areas all have the potential to impact on the existing traffic in the following ways:

- **R446 Bridge at Craughwell Village (formerly the N6)**: Underpinning works will require partial road closure during proposed works to the bridge resulting in single lane traffic. This has the potential to cause a temporary negative effect on the local traffic flow.
- **Masonry Arch Pedestrian Bridge at Craughwell:** Underpinning works will require partial closure during proposed works to the bridge resulting in no pedestrian access over bridge during works. This has the potential to cause a temporary negative effect on pedestrians in the village.
- **Railway Bridge in Craughwell:** Underpinning works will require partial road closure during proposed works to the bridge resulting in the potential to delays to rail services using this bridge. This has the potential to cause a temporary negative effect on the rail services using this line.
- **Rinn Bridge:** The provision of three additional flood eyes on this bridge will not require any road closure and so no traffic related impact will result from this proposed measure.
- **Dunkellin Bridge:** Replacement of existing flood eyes on the existing bridge will require road closure during construction. This has the potential to cause a temporary negative effect on road users who will be required to divert.
- **Killeely Beg Bridge:** Provision of a new bridge will require road closure during construction. This has the potential to cause a temporary negative effect on road users who will be required to divert.
- **Culvert Replacement along the Aggard Stream:** It is to proposed to replace culverts at road or rail crossings so there will be no traffic related impact will result from these proposed measures.
- The delivery of machines onto the site will not create a negative impact to the local county roads – these roads are capable of accommodating such machinery. In terms of disruption to local road users likewise it is not anticipated that the delivery of these machines will cause negative impacts. This will be ensured through the delivery of these pieces of machinery outside of peak traffic hours as set out in the mitigation section.
- **Site Compounds:** Four site compounds are proposed for the construction stage of this project at Killeely Beg Bridge, Dunkellin Bridge, Rinn Bridge and Craughwell Village. The site compound entrance/exit in these locations have the potential to lead to local traffic disruption and delays, however this will be a minor temporary impact owing to the level of traffic using these areas.

17.4.2 Site Management

Throughout the lifetime of the scheme, regular maintenance and management will be required in order to ensure the conveyency capacity of the second stage channel is maintained and to ensure that all environmental issues are mitigated and eliminated. Typically this will require regular visits by Galway County Council to the site to monitor vegetation growth, maintenance of drains, and stability of second stage channels.

At the very most maintenance of the second stage channel and drains may require the movement of a machine onto the site sporadically to cut or remove vegetation or to clean drains. It is not anticipated that this stage of the scheme will have any impact on the traffic and transport of the region.

17.5 MITIGATION MEASURES

Mitigation measures will be implemented during all stages of the scheme in order to ensure that the existing transport network and road users are not significantly negatively impacted upon by the proposal. In addition measures will be implemented to ensure that internal roads are fit for their purpose, environmentally sensitive, safe for construction workers and legally compliant.

With regard to the potential for disruption to rail travel, Irish Rail where contacted by the design engineers for the scheme and it has been agreed that rail services must run as normal during construction and so no negative impact will result from this.

17.5.1 Site Preparation

The site preparation phase of the scheme will require the use of existing regional and local county roads for transport of machinery onto and off compound areas as well as potential delivery of aggregate materials if required for river bank access tracks (should sufficient material not be available from excavated material). The delivery of this machinery to site will take place outside of peak traffic hours and will not be delivered in convoy. This will ensure that local road users are not inconvenienced or delayed by the movement of these machines onto or off the site.

Measures that should be adhered to when developing access tracks along the Dunkellin River and Aggard Stream banks include:

- all access tracks will be situated near aquatic zones, therefore care should be taken to control sediment run-off and visual impacts;
- under no circumstances are machines permitted to enter the river channel;
- locate refuelling, maintenance and storage areas at least 50 metres from the nearest aquatic zone;
- rehabilitate badly disturbed areas, landing bays, entrances, tracks etc.,
- construction of access tracks should only be carried out during the months when river bank works and in-river works are permitted during the period of May to September, subject to consultation with IFI, and
- repair roads if required.

Road closures or road diversions will need to be discussed in advance with Galway County Council's Roads Department and a public notice will need to be placed in the local newspapers to inform the public.

17.5.2 Management

It is not anticipated that this stage of the scheme will have any impact on the traffic and transport of the region. If machinery is required to be transported to or from the site for maintenance work it will be done so during non-peak traffic hours to ensure there is no disruption to local road users.

Table 17.1 summarises the potential impacts of the proposed flood relief scheme and footbridge on the transport and traffic network and mitigation measures are proposed where relevant.

17.6 RESIDUAL IMPACTS

If all proposed mitigation measures are implemented as recommended and if the relevant public road traffic management issues are fully discussed between the OPW and the Roads Department of Galway County Council it is not anticipated that there will be residual impacts resulting on the traffic and transport aspect of the environment from any stage of the proposed flood relief scheme measures implementation.

17.7 CONCLUSION

A review of the existing transport network, both public and internally in the proposed study area, was completed as part of this assessment. The potential for impact on traffic and transport was considered at all stages of the proposed measures implementation: site preparation, measures implementation, and maintenance. Some potential impacts including temporary inconvenience to road users when machinery is delivered or where road traffic restrictions, closures and diversions were identified.

It is noted that details of public road traffic management, closures and diversions at the time of flood relief measures implementation will need to be discussed further at the appropriate time with the Roads Department of Galway County Council.

It is concluded that if proposed mitigation measures are fully implemented and if the relevant public road traffic management issues are fully considered by Galway County Council at the appropriate times over the lifespan of the proposed flood relief scheme measures implementation, then traffic and transport will not be significantly impacted upon as a result of this scheme.

Table 17.1 Summary of Potential Impacts and Proposed Mitigation Measures Relative to Traffic and Transport

Potential Impact on Traffic & Transport Environment	Positive/ Negative	Major/ Moderate/ Minor	Area Affected	Duration	Mitigation Measures	Residual Impact
Construction Stage						
Transport machinery to site causing traffic inconvenience.	Negative.	Minor.	Local Road Users.	Temporary	Notify local road users of time that machinery will be transported to site. Transport machinery during non- peak traffic hours. Don't transport machinery in convoy.	None.
Delivery of material (aggregate) for river bank access track creation.	Negative.	Minor.	Local Road Users.	Temporary	Notify local road users of time that aggregate will be transport to site. Transport materials during non- peak traffic hours.	None.
Access to 4 no. site compounds causing traffic inconvenience	Negative.	Minor.	Local Road Users.	Temporary	Notify local road users of site compound access points and potential for delays.	Possible travel time delays.
Temporary road closures, diversions, or traffic controls to facilitate bridge underpinning, construction and alteration	Negative.	Moderate.	Local Road Users.	Temporary	Discussion and agreement with Galway County Council's Roads and Planning Department required. Road Closures to be placed as Public Notices in a prominent paper to inform the public.	None.

18 IMPACT INTERACTIONS AND CUMULATIVE IMPACTS

18.1 IMPACT INTERACTIONS

The potential impacts of the scheme have been discussed in detail with respect to all aspects of the environment. This section summarises these likely significant effects together with their consequent interaction. Schedule 2 (b) of the Planning and Development Regulations 2001-2013 requires consideration of the interactions between the various environmental factors:

- *"a description of the aspects of the environment likely to be significantly affected by the proposed development, including in particular;*
- *human beings, fauna, flora,*
- *soil, water, air, climatic factors and the landscape,*
- *material assets, including the architectural; archaeological, and cultural heritage, and*
- *the inter-relationship between the above factors".*

The environmental factors of the scheme have been assessed individually and mitigation measures recommended where required. It is also important to analyse any interactions that could result in impacts having a knock on effect on other elements of the environment.

Table 18.1 illustrates the interactive impacts that could result as identified in the EIS if no mitigation measures are put in place for any impacts identified. It demonstrates that impacts resulting from one aspect of the environment can have a direct effect on other elements of the environment. The table demonstrates that the interactions identified are mainly between aquatic ecology, soils, archaeology and the human environment.

However, as suitable mitigation measures will eliminate and or reduce the possibility of these effects during the life time of the scheme, the above interactions will be avoided or significantly reduced.

Table 18.1 Summary of Potential Interactions Resulting from the Proposed Dunkellin River and Aggard Stream Flood Relief Scheme

Potential Impact on	Interacting with
Terrestrial Ecology	• Aquatic Ecology and Water Quality • Hydrology and Drainage • Soils, Hydrogeology & Geology
Aquatic Ecology and Water Quality	• Terrestrial Ecology • Hydrology and Drainage • Soils, Hydrogeology & Geology • Human Beings and Material Assets
Avifauna	• Terrestrial Ecology
Hydrology and Drainage	• Terrestrial Ecology • Aquatic Ecology and Water Quality • Soils, Hydrogeology & Geology • Human Beings and Material Assets
Soils, Hydrogeology & Geology	• Terrestrial Ecology

Potential Impact on	Interacting with
	• Aquatic Ecology and Water Quality • Soils, Hydrogeology & Geology • Human Beings and Material Assets
Air Quality and Climate	• Terrestrial Ecology • Human Beings and Material Assets
Noise and Vibration	• Terrestrial Ecology • Human Beings and Material Assets
Archaeology, Architectural and Cultural Heritage	• Human Beings and Material Assets
Landscape and Visuals	• Human Beings and Material Assets • Archaeology, Architectural and Cultural Heritage
Telecommunications	• Human Beings and Material Assets
Human Beings and Material Assets	• Potential for impacts on human beings have interactions with all other elements of the environment
Traffic	• Human Beings and Material Assets

18.2 CUMULATIVE IMPACTS

A cumulative impact can be considered as an impact on the environment that results from incremental changes to environmental parameters when added to changes brought about by other past, present or reasonably foreseeable actions (European Commission, 1999). Cumulative impacts can result from individually minor but collectively significant actions taking place over the same period of time or/ and within the same geographical area. Cumulative impacts therefore can cover all aspects of the environment.

While a single activity may itself result in a minor impact, it may, when combined with other impacts (minor or insignificant) in the same geographical area, and occurring at the same time, result in a cumulative impact that is collectively significant. This impact is known as a synergistic cumulative impact.

It was assumed that current day-to-day activities within the area would continue into the future. On examination of current activities and land-uses and the continuation of these activities it was deemed that they would not contribute significantly to compound an impact so were not considered further in this cumulative impact assessment.

To address the cumulative impacts for the scheme, an understanding and knowledge of historical, existing, and reasonably foreseeable future activities are essential. The main significant development planned in the vicinity of the proposed scheme is the construction of the proposed N18 Oranmore to Gort Road Scheme.

This road scheme will cross the study area approximately 600 metres upstream of the existing Dunkellin Bridge Bridge and it is proposed will cross the Dunkellin River by construction a clear span bridge. Refer to **Figure 18.1** for the proposed location of this structure relative to the study area.

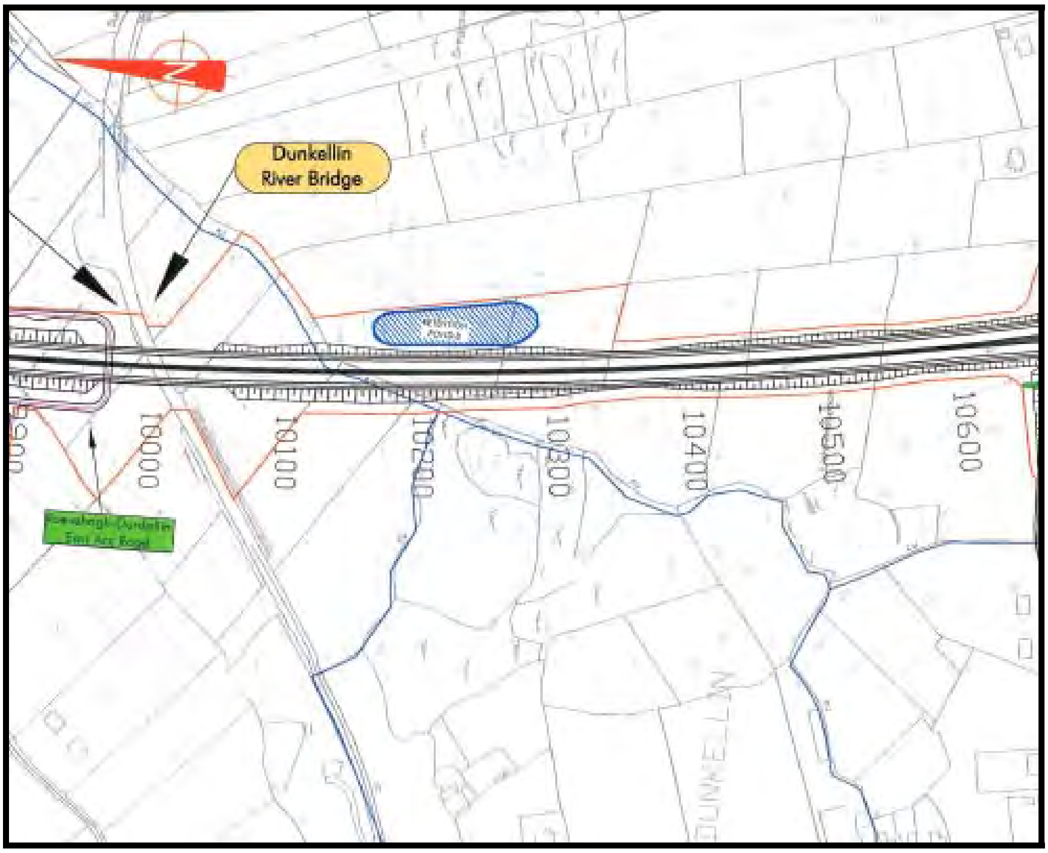

Figure 18.1 Location of Proposed N18 Road Scheme in the Study Area
(Source: N18 Oranmore to Gort Road Scheme, EIS Volume 3, Galway County Council)

Taking this into account the main consideration in this particular instance is the construction and operation of the N18 crossing the Dunkellin at this point.

Table 18.2 summaries the potentially significant cumulative impacts resulting from the progression of the scheme with the proposed N18 road scheme.

Table 18.2 Summary of the Findings of Significant Cumulative Impacts

Environmental Receptor	Significant Cumulative Impacts
Hydrology and Drainage	No significant cumulative impact is anticipated.
Soils, Hydrogeology & Geology	No significant cumulative impact is anticipated.
Terrestrial Ecology	No significant cumulative impact is anticipated.
Aquatic Ecology and Water Quality	No significant cumulative impacts provided pollution control measures are strictly adhered to during constriction of both schemes.
Air Quality and Climate	No significant cumulative impact is anticipated.
Noise and Vibration	No significant cumulative impact is anticipated.
Archaeology, Architectural and Cultural Heritage	No significant cumulative impact is anticipated.
Landscape and Visuals	No significant cumulative impact is anticipated.
Human Beings and Material Assets	No significant cumulative impact is anticipated.

Environmental Receptor	Significant Cumulative Impacts
Traffic	Potential increase in construction traffic in the region if both schemes progress at this location at one time.

Further detail on this project is set out in **Appendix A, Works Description, Section 3.6.2.**

19 SUMMARY OF SIGNIFICANT IMPACTS

Table 19.1 summarises those potentially significant impacts that have been identified as part of this EIS process for the proposed Dunkelin River and Aggard Stream Flood Relief Scheme.

Table 19.1 Potentially Significant Impacts

Potential Environmental Impact	Quality/Significance and Duration of Impact	Mitigation Proposed	Residual Impact (After Mitigation Measures have been implemented)
Proposed scheme (excavation of river bank bed and work to bridges) may result in a significant negative impact on archaeology and architectural heritage.	Significant Negative. Permanent.	• It is recommended that archaeological testing be carried out at specific detailed locations (refer to **Chapter 14**) by a suitably qualified archaeologist. • It is recommended that archaeological monitoring be undertaken at specific locations (refer to **Chapter 14**) by a suitably qualified archaeologist. • It is recommended that a full underwater archaeological survey is carried out at specific locations (refer to **Chapter 14**) by a suitably qualified archaeologist. • It is recommended that a full conservation assessment be carried out on bridges at prior to the development going ahead.	There will be no residual negative impact on the archaeological resource. A residual negative impact on Craughwell Bridge and Dunkellin Bridge will remain. This will be due to the change in appearance of both the structures in order to alleviate flooding.

20 CONCLUSIONS

An EIS has been completed for the proposed Dunkellin River and Aggard Stream Flood Relief Scheme in south County Galway.

The scheme includes for flood relief works to be completed along the main channel of the Dunkellin River from Craughwell to Kilcolgan (over 11km) and along the Aggard Stream which runs from the townland of Cregaclare (near Ardrahan) to its outfall at the confluence of the Dunkellin and Craughwell Rivers (over 7.5 km).

A combination of river widening, deepening, culvert upgrade and replacement, bridge improvement and replacement and general channel maintenance make up the proposed measures for this scheme.

The intention of the scheme is to provide optimum flood relief with minimal environmental impact whilst also controlling the overall capital investment required.

Having completed the EIS in line with all required legislation and relevant guidelines pertaining to the nature of the proposal the EIA process concludes the following:

- Potential impacts on both the natural and socio-economic environments have been identified.

- Where necessary suitable mitigation measures to reduce negative impacts have been recommended including a comprehensive river enhancement programme. These will ensure elimination and reduction of any significant environmental risks.

- The scheme has the potential to have an affect on aspects of the environment particularly during the construction stage. These include potential for pollutants to enter watercourses, disturbance to aquatic and terrestrial flora and fauna, disturbance to archaeological and cultural heritage along the river bank, the removal of bridges of cultural heritage value and temporary traffic disruptions for local road users. Detailed mitigation measures have been recommended in order to lessen and/or eliminate such impacts where possible.

- The mitigation put in place for the shellfish industry will minimise any possible impacts during construction. Under normal operating conditions there will be no discernible changes to the receiving shellfish waters. In extreme flood events (such as the 2009 flood), the increased flow from the Dunkellin River as a result of the works would have a minor affect on salinity in the receiving waters, this effect has been modelled as part of this EIS.

- Once construction has been completed the proposed scheme will aim to reduce the impact of extreme flood events similar to that which occurred in November 2009.