

20. Summary of Mitigation Measures/Environmental Commitments

20.1 Introduction

Mitigation measures are those measures proposed in order to avoid, reduce or remedy the adverse environmental effects of the proposed road development. Mitigation measures have been incorporated into the design of the proposed road development where possible and will be applied during both the construction and operational stages where they are deemed to be necessary.

The following chapter provides a summary of these mitigation measures for the proposed road development as a whole, presented for each environmental topic. The relevant Chapters should be referred to for further detail of the mitigation measures.

20.2 Community Impacts

20.2.1 Construction

The implementation of the following measures, where feasible and practical, will significantly reduce the negative impacts associated with the construction phase:

- The LP3424 will not be used as a haul route because of the presence of St Beacon's church.
- Temporary diversions will be provided around bridge sites.
- The number and duration of temporary road closures will be limited.
- Reasonable and safe facilities will be provided for pedestrians and cyclists, as appropriate.
- The contractor for the works will be obliged to take precautions to control noise and prevent the spread of mud and dust onto public roads, etc. (See Section 20.3 and Section 20.4 – Noise and Vibration, and Air Quality respectively).
- Any damage to existing roads specified for access and their verges caused by construction traffic will be repaired.
- Where the temporary disruption of services is unavoidable, the duration of the disruption will be limited and advance notice will be given to affected parties.

- To minimise any hindrance to local businesses during the construction phase particularly regarding access, local businesses will be consulted and advance warning given of any necessary route diversions. Any such diversions will be clearly signed.
- To minimise disruption to rail services, the construction of the proposed railway bridges will be done by agreement and in consultation with Iarnród Éireann.
- To minimise disruption to the use of river Barrow for navigation, the construction of the proposed bridge will be done by agreement and in consultation with Waterways Ireland.

20.2.2 Operation

Specific mitigation measures proposed for the operational stages of the road development are presented in Tables 7.12a, b and c of Chapter 7.0. Further, more general, mitigation measures are listed in Table 7.13 of Chapter 7.0 Community Impacts.

20.3 Noise and Vibration

20.3.1 Description of Operational Noise Mitigation Measures

The proposed mitigation measures are detailed in Table 20.1, to the rear of this Chapter. The extent of each barrier is illustrated in Volume 2 – Book 1, EIS Drawings, as detailed in Chapter 8.0.

20.3.2 Construction Noise Mitigation Measures

The NRA guidelines recommend maximum permissible construction noise levels at the facades of dwellings for weekday daytime and evening periods as well as Saturday, Sunday and Bank Holiday daytime. Given the scale and nature of the road development under consideration, it was considered prudent to also set limits for periods outside those covered in the NRA document.

The limits that were adopted are as follows:

	07:00-19:00 (Day)		19:00-22:00 (Evening)	
	$L_{Aeq(1hr)}$	L_{Amax}	$L_{Aeq(1hr)}$	L_{Amax}
Monday to Friday	70	80	60	65
	08:00-16:30 (Day)			
	$L_{Aeq(1hr)}$	L_{Amax}		
Saturday	65	75		
Sunday & Bank Hols	60	65		

The contract documents will clearly specify that the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of BS 5228: Part 1. These measures will ensure that:

- No plant used on site will be permitted to cause an ongoing public nuisance due to noise
- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors will be attenuated models fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use. All ancillary pneumatic tools will be fitted with suitable silencers.
- Machinery used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- Any plant, such as generators or pumps, that is required to operate before 07:00hrs or after 19:00hrs will be surrounded by an acoustic enclosure or portable screen.
- During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in Table 8.5 of Chapter 8.0 Noise and Vibration, using methods outlined in BS 5228 "Noise and Vibration Control on Construction and open sites".

Additional measures are outlined for emergency works, as follows:

- Normal working times will be 07:00 to 19:00hrs Mon-Fri and 08.00-16.30 Saturdays. Works other than the pumping out of excavations, security and emergency works will not be undertaken outside these working hours without the written permission of the Contracting Authority. This permission, if granted, can be withdrawn at any time should the working regulations be breached.
- Works other than the pumping out of excavations, security and emergency works will not be undertaken at night and on Sundays without the written permission of the Contracting Authority. Night is defined as 19:00 to 07:00hrs.
- When overtime and shift work is permitted, the hauling of spoil and delivery of materials outside normal working hours is prohibited and the noise limits outlined in Section 8.7.1 will apply.

20.3.3 Operational Vibration Mitigation Measures

Mitigation measures are not required in respect of vibration in the operational phase. However, the following commitments are made:

- In-line with the NRA Guidelines, vibration from construction activities will be limited to the values set out in Table 8.8 of Chapter 8.0 Noise and Vibration. Where appropriate, at agreed locations, prior to construction activities, baseline vibration surveys will be carried out.
- Measures will be taken to minimise vibration due to plant and machinery on the site and no machine, which uses the dropping of heavy weights for the purpose of demolition, will be permitted. Where appropriate, at agreed locations, prior to construction activities, baseline vibration surveys will be carried out.

20.3.4 Construction Vibration Mitigation Measures

The contractor will be required to ensure that the specific peak particle velocity for the specified frequency band in the contact documents is not exceeded. Vibration monitoring of blasting operations will take place as necessary, typically at the property nearest the site where the blasting is taking place. The contract documents will specify that the Contractor will be obliged to

take specific abatement measures complying with the recommendations of BS 5228: Part 1 and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001, during blasting operations.

The particular methods used to minimise complaints in relation to blasting are set out below.

- A publicity campaign undertaken before any blasting starts, explaining what is being done and why.
- The firing of blasts at similar times to reduce the 'startle' effect.
- On going circulars informing people of the progress of the works.
- The implementation of an on site documented complaints procedure.
- The use of independent monitoring by external bodies for verification of results.
- Trial blasts in less sensitive areas to assist in blast designs and identify potential zones of influence.

In the vicinity of the blasting site, all buildings and structures liable to damage will be surveyed and adequate insurance cover, for both people and property, will be provided.

20.4 Air Quality

20.4.1 Construction

The following construction mitigation measures will be implemented within the construction site:

- Avoid unnecessary vehicle movements and manoeuvring, and limit speeds so as to minimize the generation of airbourne dust.
- During dry periods, dust emissions from heavily trafficked locations (on and off site) will be controlled by spraying surfaces with water.
- Hard surface roads will be swept to remove mud and aggregate materials from their surface while any un-surfaced roads will be restricted to essential site traffic only. Furthermore, any road that has the potential to give rise to fugitive dust will be regularly watered, as appropriate, during dry and/or windy conditions.
- All vehicles exiting the site will make use of a wheel wash facility, preferably automatic, prior to entering onto public roads, to ensure mud and other wastes are not tracked onto public roads. Public roads outside the site will be regularly inspected for cleanliness, and cleaned as necessary. The wheel-washing facilities will be located away from sensitive receptors.
- Re-suspension in the air of spillages material from trucks entering or leaving the site will be prevented by limiting the speed of vehicles within the site and by use of a mechanical road sweeper.
- Topsoil and other dusty material will be transported to and from the site in covered trucks. Where the likelihood of emitting dust is high and during dry weather conditions, the area of removal from the site will be sprayed by a mobile tanker on a regular basis to control dust emissions.
- Exhaust emissions from vehicles operating within the construction site, including trucks, excavators, diesel generators or other plant equipment, will be controlled by the contractor by ensuring that emissions from vehicles are minimised by routine servicing of vehicles and plant, rather than just following breakdowns; the positioning of exhausts at a height to ensure adequate local dispersal of emissions, the avoidance of engines running unnecessarily and the use of low emission fuels.
- Material handling systems and site stockpiling of materials will be designed and laid out to minimise exposure to wind. Water misting or sprays will be used as required if particularly dusty activities are necessary during dry or windy periods.
- Where drilling or pavement cutting, grinding or similar types of stone finishing operations are taking place, measures to control emissions will be used to prevent a nuisance within the locality, for example the erection of wind breaks or barriers. This may be a significant local source of fine particulate emissions, in particular particles less than 10µm (PM10).
- If cement is stored in a silo on site, a filter will be fitted to the silo. Alternatively, ready-mix concrete will be supplied by truck.
- It is proposed to carry out dust deposition monitoring during the dust generation phases of construction of the road development at the sensitive receptors closest to the construction site. Levels of dust deposition will be monitored using a Bergerhoff Gauge, or similar apparatus.

Dust deposition levels will be recorded monthly and compared to the German standard T.A. Luft (see Chapter 9) dust deposition limit value of 350mg/m² per day.

A complaints procedure will be implemented by the contractor and a Project Liaison Officer will be appointed to the site.

20.4.2 Operation

There are no air quality standards exceeded, therefore no mitigation measures are formally required.

20.5 Landscape and Visual

20.5.1 Introduction

Consideration was given to avoidance of impact wherever possible during the route selection and design process for the proposed road development. While all of the route options have potential for landscape and visual impact the recommended option was considered to have the least overall potential for significant adverse landscape and visual impact.

As such, in this respect the alignment has already been selected to minimise impact on residential property, topographical features, trees and woodland wherever possible. However, as with any development some degree of impact is inevitable and wherever possible measures have been proposed to mitigate the negative nature of these impacts and the various specific measures are listed in detail on a section-by-section basis.

20.5.2 Construction Phase

- During the construction stage, contracts will be framed to ensure good working practices so as to minimise any negative impacts arising from construction and to ensure that site machinery operates within the scheme construction area.
- Storage areas will be located so as to avoid impacting further on existing residential properties, trees, hedgerows, drainage patterns etc. All such areas will be fully reinstated prior to or at the end of the construction contract.
- Works will have continuous monitoring so as to ensure adequate protection of areas outside of the construction works.
- On completion of sections of the proposed road development, side slopes including cuttings and embankments, verges and other soft areas will be prepared for soiling,

and either seeded or planted as set out in the Outline Landscape Proposals.

20.5.3 Operational Phase

20.5.3.1 Landscape Strategy

The proposed road development crosses a primarily rural and agricultural landscape with a dispersed nature of residential development. As such an approach, which aims to protect the rural and residential amenity and enhance the rural edge of the roadside landscape, is proposed.

The objectives for the landscape works to the proposed scheme are:

- To develop a landscape strategy, the character of which relates to the patterns, scale and diversity of the existing character of the study area;
- To develop a landscape structure which assists to physically and visually integrate the proposed road development, its embankments and associated features into the local surroundings;
- To minimise visual intrusion and reduce the negative nature of any visual obstruction;
- To protect, reinstate or enhance elements of the existing landscape, directly or indirectly affected by proposal;
- To assist in the creation of pleasant safe driving conditions, and
- To maximise attractive views from the proposed road development, where there is no conflict with screening visual impact from properties.
- Landscape mitigation will entail general landscape measures, which may be applied over the road development as a whole together with other more specific landscape proposals at certain locations, which are discussed in a section-by-section basis.

20.5.3.2 General Landscape Mitigation Measures

Introduction

General measures, which will be applied throughout the Scheme where feasible, include:

- In order to soften the impact of the road development on the landscape, certain areas adjacent to strong mature tree-lines or tree-lined hedgerows, are proposed for planting in order to break up linearity, for habitat

protection and enhancement and for local landscape integration and screening. This is particularly significant in the strongly tree-lined hedgerow landscape of south Kilkenny below King's River.

- General measures will be applied over the entire road development, depending on the nature of the particular road section, ensuring that field boundaries are re-connected with hedgerows. This approach will be locally modified to incorporate other landscape treatments, which may negate the requirement for the hedgerow, e.g. extensive woodland planting or where it is considered to have appropriately located open sections of carriageway.
- Open sections will allow for views to the wider landscape only where they do not impinge on residential or other amenity.
- Proposals will ensure planting is distributed along the entire scheme and the associated county road re-alignments and will vary from typically rural tree-lined hedgerow reinstatement to the establishment of extensive areas of new woodland as screening and integration for the development.
- Treatments will take into consideration the assessment and recommendations of the Terrestrial Ecology (Chapter 11) and Aquatic Ecology and Hydrology (Chapter 12) in this EIS.
- Treatments will ensure that in the general scenario, species, which are locally indigenous and native, are used in the proposed plantings. However, proposals in terms of their nature and approach will consider the locally impacted environment, in terms of species, e.g. beech planting at old demesnes, and a more ornamental approach where garden plantings are disturbed.

Areas in Cut and on Fill

- A grass or meadow sward will generally be established over the entire slope except in areas of cutting through stable rock, which will be left exposed for natural colonisation as a local landscape feature.
- Planting at sensitive locations particularly close to residential and recreational amenities will be used to reduce the visual intrusion and mitigate against visual obstruction caused by the raising of the scheme on to embankments, especially at junctions.

- Shrub planting will be used at the edge of the plantings to increase density and diversity and to improve the biodiversity structure of the plantings. It is not proposed to plant either cut or fill slopes in their entirety, but to encourage a more naturalistic and locally sympathetic grouping of plantings in a natural grass sward.
- Embankments in proximity to residential and other property will be strongly planted so as to reduce visual intrusion of the elevated road and traffic.

Areas at Grade

- Proposed planting will ameliorate the negative impacts of vehicles, and the visual expanse of the proposed road development.
- Boundary delineation will be augmented by means of hedgerow plantings irregularly interspersed with tree plantings where such proposals will assist with ecological connectivity and with integration in the surrounding landscape fabric.

Other Areas

Landscape areas within junctions and small areas of severed fields, lots or other property acquired for the construction of the proposed scheme will be varyingly treated including planted in copse like fashion with native or semi-native woodland species, which will enhance the local landscape fabric. Specific details of these specific measures are included in the detail descriptions set out below.

- Certain areas along the length of the road development have been set aside for drainage requirements / pollution control / attenuation. Where such works are of a linear nature, disturbed sections of hedgerow will be replanted to match the existing. Where such works acquire larger plots these will be varyingly treated as 'wetland habitat areas' with appropriate planting and landscaping.
- In specific locations barriers will be provided to reduce the impact of noise. Such barriers will also have the effect of providing visual screening from properties and will wherever possible be integrated within the proposed landscaping. Chapter 8 of this EIS outlines the assessment of noise and the requirements for mitigation. The noise mitigation measures are provided as fencing, bunding or a combination of the two. The noise mitigation measures are shown on Figures 4.52 to 4.98, the mainline plans and profiles.

Lighting Mitigation

Fully horizontal cut-off light fittings will be used which in combination with the extensive landscaping proposed, will ensure that in general light spill effect will be maintained within the road corridor.

20.5.3.3 Specific Landscape Mitigation Measures

Where specific measures relate to screening for mitigation of visual impact, landscape works will generally entail dense planting as noted. Otherwise where specific measures relate to mitigation of landscape impact, landscape works will generally comprise a diversity of approach. Therefore, while some planting will be included, treatments will also include for open areas, meadows and other diverse landscape treatments.

Waterford to Powerstown

- Specific landscape proposals are set out in detail in Table 10.5, 10.6 and 10.7 of Chapter 10.
- Where such specific measures are located outside of the lands required for the construction of the road, these will be planted at the earliest opportunity so as to provide for the quickest possible establishment of such planting and to increase mitigation potential.
- Requirements for additional land for planting must take account of possible demands for fencing, drainage etc.

Planting Specification

- The proposed planting will generally be established with forestry planting techniques, i.e.. 'bare root transplants', 'whips' and 'feathered trees' which adapt readily to disturbed ground conditions.
- A proportion of 'Standard' and taller size trees will be used to supplement these plantings especially in the vicinity of residential areas.
- All planting mixes will take cognisance of, and include native and local species as identified in the Terrestrial Ecology (Chapter 11) and Aquatic Ecology and Hydrology (Chapter 12) sections of this EIS.
- Tree species utilised will be selected from a list of primarily native, naturalised and indigenous species (except where the proposal is contiguous with existing plantations containing other species such as

conifers or beech etc.), which will include alder, common ash, aspen, downy and silver birch, bird and wild cherry, mountain ash, pedunculate and sessile oaks, Scots pine, and willow species.

- Planting sizes will be from 750mm, to 4.0m high and planted at average 2.0m centres.
- Shrub planting species utilised will be selected from a list of primarily native and indigenous species, which will include, blackthorn, crab apple, elder, hawthorn, hazel, holly, guelder rose, spindle, willows and other plants found naturalised in the affected localities.
- Hedge planting will be primarily of blackthorn, elder, hawthorn with hazel and other species planted at 750 - 900mm heights at 500mm centres and interspersed with taller random planted tree species such as common ash and oak.
- Grass seeding areas to be topsoiled and seeded either with a low maintenance grass sward or a naturalising meadow style mix.

20.6 Terrestrial Ecology**20.6.1 Designated Areas****General**

The following general mitigation measures are proposed in relation to terrestrial ecology:

- Habitats that are damaged and disturbed will be left to regenerate naturally or will be rehabilitated and landscaped, as appropriate, once construction is complete.
- No dumping of soils will be allowed during the construction phase in the following areas:
 - Hugginstown Fen cSAC
 - King's River cSAC
 - Pococke River cSAC
 - Little Arrigle tributary cSAC
 - River Nore cSAC
 - Madlin River cSAC
 - River Barrow cSAC
 - Danganbeg Wetland
- The proposed crossing of the Pococke River, the first order tributary of the Little Arrigle, the King's River, the Madlin River, the River Nore and the River Barrow, have been

selected to avoid direct impacts on the river habitats of these cSACs where feasible (See Table 11.5 of Chapter 11.0 Landscape and Visual and Section 20.7.2 of Chapter 20.)

- Bridge design will fulfil the requirements outlined in mitigation measures for watercourse crossings (See Section 20.7). The bridge design will minimise the impacts during construction and operation.
- Compensatory planting will be required to facilitate habitat re-creation within the cSAC lands. Compensatory planting is proposed in these areas to facilitate the restoration of impacted habitats within the cSAC lands. All lands proposed for compensatory planting at the cSAC watercourse crossings will be permanently acquired. This will allow more control of the restorations of these areas.
- The soils excavated from within all cSAC will be reused for restoration of areas that were temporarily disturbed. Any importation of additional soil, if required, will be free of contaminants.

River Nore

The following mitigation measures are proposed at the River Nore crossing:

- Compensatory planting of willow for an area of 0.34ha will take place on the south side of the proposed bridge on the western bank along the marsh area (former mill-race channel). This planting will comprise of willow (sourced as cuttings from the species of willow within the area of riparian woodland which will be lost due to construction of bridge piers). This will reconnect with another area of riparian woodland to the south of the proposed crossing. This compensatory planting will recreate an area of riparian woodland greater than the area lost and will also act as screening of the bridge from the south.
- The area of wet grassland (0.78ha) on the floodplain of the western bank between the river and the proposed compensatory planting will be permanently acquired to allow natural regeneration.
- The existing mill-race channel that courses through the riparian woodland will be retained, by installing culverts within the western abutments, ensuring the hydrological regime of the wetland area will not be altered.
- The area of woodland to be retained will be fenced off at the outset prior to construction.

- Any works on the construction of piers will be accessed from the northern side of the proposed crossing.
- Planting will be carried out with trees grown from locally sourced seeds. Soils removed from the impacted wet grassland areas will be utilised for habitat re-creation, as it provides a seed base and a suitable matrix for recolonisation.

River Barrow

The following mitigation measures are proposed at the River Barrow crossing:

- A strip of hazel will be planted on the northern embankment of the proposed road development on both sides of the River Barrow, with willow and alder at the base of the embankment (a minimum 5 metres in width) on the eastern side of the river. This strip would act as a flight line for bats allowing access to the river and guiding them under the bridge in order to feed on the southern side of the roadway.
- The southern tip of Cloghrick Wood pNHA (which is within the boundary of the River Barrow and River Nore System cSAC) will be impacted by the proposed route, resulting in the loss of approximately 0.12ha of woodland. As the alignment impacts on the southern tip of the wood, compensatory planting of 0.25ha will take place (See Chapter 10 Landscape and Visual, for further details regarding planting). This will be carried out adjacent to the wood and utilize soils salvaged from the impacted area of woodland. Planting will be carried out with oak grown from locally sourced acorns and the area of compensations will be greater than the area lost.

King's River

- At the King's River, compensatory planting of 0.26ha will take place on the south side of the proposed bridge adjacent to the existing woodland to replace tree species lost. As much as possible of the habitat at the base of the slope underneath the bridge will be retained. Compensatory planting will be carried out on the embankments of the road within and adjacent to the cSAC boundary.

Other River cSAC Crossings

The following mitigation measures will be addressed at the other River cSAC crossings:

- Compensatory planting will be carried out on the embankments of the road within and adjacent to the cSAC boundary of the

Pococke River, the first order tributary of the Little Arrigle River and the Madlin River. This will act as screening and provide new habitat adjacent to the watercourses. NPWS will be consulted to seek approval in relation to the bridge design for the crossing of these cSACs.

- Any attenuation areas proposed within designated areas will conform to the highest level of design specifications to replicate a semi-natural water body. The existing field boundaries in close proximity to the proposed attenuation areas will be retained. The design of attenuation ponds will be agreed in consultation with the NPWS.

Hugginstown Fen

- Mammal passes are proposed at the northern and southern ends of the section of the road development adjacent to Hugginstown Fen.

20.6.2 Non-Designated Areas

The following mitigation measures are proposed in relation to non-designated areas:

- Site clearance of vegetation will be outside the period, 1st March to the 31st of August inclusive, where feasible, to avoid disturbance to nesting birds.
- The working area around ecological sites, hedgerows and treelines will be kept to a minimum to reduce the area or length of these sites or habitats that will be lost. The working area will be defined at the outset by the erection of fencing to define the limits of site works. Any trees, treelines or hedgerows that are to be retained within the site works will be fenced off at the outset, at the outer canopy line of trees/hedgerows. Ground levels will not be altered in any way (within the canopy line of trees/hedgerows that are to be retained) and there will be no storage of materials, machinery or spoil within the outer canopy line.
- Where other ecological sites, hedgerows, treelines and mature trees cannot be avoided, direct mitigation is not feasible. To compensate for the loss of this habitat resource, new areas of semi-natural habitat will be created within the land taken for the road development using native seed sources and the species composition will reflect that of the habitats being lost. Hedgerows and treelines will be planted along new road margins, where appropriate, to reconnect severed hedgerows and treelines. This will create new networks of ecological corridors

and interlink other areas of semi-natural habitat.

- Areas of severed land will be used for habitat creation (as shown on the Scheme Layout Figures 4.1 to 4.50). There will be compensatory planting of broadleaved trees and new areas of wetland and riparian habitat will be created at the river crossings. Fencing will be erected to protect newly planted areas as appropriate. The details of tree planting, species mixes and habitat creation will be established at the detailed design stage in conjunction with a qualified ecologist. The area of habitat lost will equate to that being created.
- Hedgerows, treelines and small streams within the land-take that bound screening areas, drainage outfalls or access tracks will be retained. Access tracks will be positioned outside the crown spread of hedgerows and construction of tracks adjacent to small streams will retain a strip of riparian habitat to minimise impacts.
- Field boundaries that are within the fenceline but not impacted by the road alignment will be retained. Any such lands that are proposed as site compounds, will retain existing field boundaries. Where access is required between plots, minimise the length of boundary to be removed. Table 11.8 of Chapter 11.0 Terrestrial Ecology, lists the treelines and hedgerows in close proximity to the fenceline, which will be retained.
- Design of balancing ponds/attenuations areas will allow for existing hedgerow and treeline and associated streams to be left intact. (See Section 20.7).

20.6.3 Specific Remedial or Reductive Measures

Habitat Recreation

The following specific habitat recreation mitigation measures are proposed:

- To compensate for the loss of other semi-natural habitats such as wet grassland and dry neutral grassland (See Table 11.3 of Chapter 11.0 Terrestrial Ecology), there will be compensatory habitat recreation in appropriate locations. The salvage of soils from specific habitats for subsequent re-use in habitat recreation enables the retention of the appropriate seed-bank and micro-fauna. These soils could be reused in the creation of reed-bed attenuation areas.

- Compensatory planting and habitat recreation of Danganbeg wetland (Appendix 11.2) is proposed through acquisition of additional land adjacent to the wetland site, to replace the area lost (see Chapter 11.0 Terrestrial Ecology). The inclusion of a mammal pass will maintain a link with the scrub at the north-western end of the site.
- Road construction will ensure that the upwelling springs on the western side of the wetland will continue to discharge in a diffuse pattern into the Danganbeg wetland site. Details of specific mitigation measures are outlined in Section 20.8. Provided the mitigation measures proposed by the hydrologists on the area of habitat predominantly wet grassland, which is of high local value, will be implemented and monitoring undertaken quarterly.
- Clear spanning bridges or open-bottomed culverts (which are over-sized to allow the retention of river banks) will be constructed over the two first order tributaries of the River Blackwater (C1 and C2), the Derrylacky River (E 1) the Monefelim River (FW2), a first order tributary of the Monefelim River (FW3), the Gowran River (E12), and a first order tributary of the River Barrow (FW15), in addition to the designated watercourses, as listed in Section 11.5.2. Landscaping in the vicinity of these areas will compensate for existing trees lost and aim to reconnect severed ecological corridors.

Mammal Passage

Provision has been made for the passage of mammals across the scheme at specific locations. Table 11.6 provides a list of indicative locations for mammal passes along the proposed route, which have been included in the road development. In addition to the dedicated mammal passage facilities listed in Table 11.6, provision for the passage of mammals will be incorporated into all watercourse crossings of high ecological value (C sites) or greater.

20.6.4 Terrestrial Fauna – Mitigation Measures

The following mitigation measures are proposed in relation to terrestrial fauna:

- **Otter** - Mammal passage facilities will be incorporated into all crossings of watercourses (of high ecological value or greater) to facilitate the unimpeded movement of otter, with appropriate fencing to guide animals, and planting to provide the necessary vegetation cover. Provision of

mammal passage facilities for all watercourses of moderate ecological value will be determined at detailed design stage. There will be further investigation by appropriate specialists to identify potential holt locations in the vicinity of the crossing points during the detailed design stage.

- **Badgers** - Badger underpasses (diameter 450mm) have been incorporated and badger-proof fencing will be erected along the proposed route where appropriate. The current survey identified badger activity in a number of locations along the proposed route (Section 11.3.5 and 11.4.5) and provision for the passage of badgers will be required at these locations (Table 11.6 of Chapter 11.0 Terrestrial Ecology). A more detailed investigation to identify the full extent of sett locations, territories and path networks will be carried out at the detailed design stage. Exclusion of badgers from setts located within the fencing line will take place according to NPWS requirements during the months of July to September only.
- **Deer** - Further investigation of deer activity will be undertaken at the detailed design stage, in consultation with the NPWS. Deer fencing on the margins of the plantations/woodlands along the proposed route will be installed as required, if deemed necessary at that stage.

The following mitigation measures are proposed in relation to Bats:

- Buildings that are known to contain bat roosts will not be demolished or otherwise disturbed during the breeding season, between the months of June to August inclusive, or during hibernation in the months of November to March. Structures and trees that are to be demolished or cut down will be surveyed between April and September (weather dependent) prior to demolition, to establish the presence of bats. Trees found to either contain or likely to contain a roost will be felled during the months September to October.
- Where bats are confirmed to be using a building/structure, and its demolition is unavoidable, bats must be excluded prior to demolition under licence from the NPWS.

Mitigation measures to offset disturbance and loss of roosts and potential roosting areas are detailed below:

- Any work on buildings or structures identified as having the greatest potential for bat use should preferably be undertaken in October

as bat numbers are then known to be fewer in buildings. This would reduce impact to bats present on site.

- Any demolition of structures where bat signs were observed should be done carefully with the expectation that bats may be found. The roof of such structures should be carefully removed by hand to protect any animals, which may be beneath slates. Half the roof should be removed then the work should cease for 24 hours to allow any bats to leave before removing the final half. If discovered, bats should be retained in a box until dusk and released on site.
- A bat survey will be carried out at the detailed design stage for of trees along the line of the proposed route that are potential bat roosts.
- Where the removal of mature trees cannot be avoided, and there is evidence of bat usage, bat boxes will be erected in appropriate locations in the area at least one month in advance of any felling or disturbance.
- There will only be road lighting at major junctions. Lighting at junctions will be kept to the necessary minimum to reduce the impacts on bats.
- The impacts of lighting on bats could be reduced by incorporating the following;
 - the reduction of height of lamp standard;
 - the use of Cowled lights to limit the light spread to the area required for illumination;
 - Mercury vapour type lamps are preferable, as they are shown to attract eight times the number of insects than their sodium alternatives. If sodium lamps have to be used then high pressure types will be installed as they are shown to attract far greater insect numbers than low pressure alternatives, which would help to counter the loss of bat prey due to the removal of trees, shrubs etc.

The following mitigation measures are proposed in relation to other fauna:

- For most other species of fauna that are not legally protected in Ireland at present, no special mitigation measures are proposed other than to retain as much semi-natural habitat as possible.

20.6.5 Site Specific Mitigation Measures

While the general remedial or reductive measures discussed above apply to all the sites impacted in this section, the site specific remedial or reductive measures are outlined in Table 11.5 of Chapter 11.0 Terrestrial Ecology.

20.7 Aquatic Ecology and Hydrology

20.7.1 General Mitigation Measures

Aquatic Ecology

The following seasonal constraints and remedial measures in relation to aquatic ecology;

- All works will be conducted in consultation with the SRFB and NPWS.
- For watercourses that contain salmonids, no works will be permitted during the annual closed season as defined in section 131 of the Fisheries (Consolidation) Act (1959). The SRFB have outlined the closed season for this region as the period October to June inclusive. However, it will be noted that section 173 of the Act recognises that local circumstance may require protection beyond this period – up to the development of ova and development of the juvenile fish. There may also be a requirement for the protection of seaward passage of smolts. These matters will be agreed in consultation with the SRFB.
- Further restrictions may also apply in the case of watercourses containing significant populations of other species including lamprey, coarse fish, freshwater pearl mussel and freshwater crayfish.
- If breeding birds are present in the riparian or bankside vegetation, where feasible, no works will be conducted during the months of March to August inclusive (Wildlife Amendment Act 2000).
- If necessary, to address the above seasonal constraints, advanced site clearance contracts will be put in place. This will ensure no disturbance will take place at sensitive sites during the restricted periods.
- No dumping of soils will be allowed during the construction phase in the following areas:
 - Hugginstown Fen cSAC
 - King's River cSAC
 - Pockocke River cSAC

- Little Arrigle tributary cSAC
- River Nore cSAC
- Madlin River cSAC
- River Barrow cSAC
- Danganbeg Wetland

Hydrology

The following mitigation measures are proposed in relation to hydrology:

- Existing overland flows, which may be impeded by the road development, will be intercepted and conveyed across the road corridor by appropriate cross drainage provision or where necessary, collected and discharged to a suitable outfall.
- Where it is not possible to maintain existing drainage flow paths, it will be necessary to provide infiltration basins where the underlying ground conditions permit, or divert these surface water drainage flows into the road drainage system.
- Road drainage will be provided for the mainline and some sections of realigned side roads. This drainage will discharge to existing watercourses. At some remote locations, where positive drainage connections for side road drainage are not practicable, surface water flows will discharge 'over-the-edge'.
- Where a known flooding problem or risk to residential property currently exists, then mitigation in the form of discharge flow attenuation will be provided. The attenuated discharge to the receiving watercourse will be restricted to the equivalent greenfield run-off rate for the original contributing catchment.

20.7.2 Specific Ecological Mitigation Measures in Designated Areas

The following specific ecological mitigation measures are proposed in relation to designated areas:

- An access track will be required between the bank and the abutment at the Madlin River. This track will maintain sufficient setback between the track and the riverbank edge, and be constructed with hardcore surface.
- Clear span bridges or viaducts, which will avoid direct impact on the river channels, reduce the impact on riparian habitats and fulfil the requirements outlined in mitigation measures for watercourses, are required

(Table 12.5 of Chapter 12.0 Aquatic Ecology and Hydrology).

- Compensatory planting is proposed in the vicinity of these areas to facilitate the restoration of impacted habitats within the cSAC lands. All lands proposed for compensatory planting at the cSAC watercourse crossings will be permanently acquired.
- A sufficient set-back will be maintained for the extent of the bridge works to ensure the riparian habitat of significant ecological value is maintained. All these watercourses will be fenced off at the outset, prior to construction, to minimise disturbance.
- There will be no fording of these designated watercourses.
- Measures will be taken within the fenceline to divert construction site run-off waters into siltation ponds, to prevent direct discharge of this run-off into the rivers. Drainage outfalls will be constructed in advance of the main construction works, where possible, in order to facilitate the release of water that goes through settlement ponds during construction.
- Any balance ponds proposed within the designated conservation areas at the Madlin River and the first order tributary of the Little Arrigle River will not impact on the qualifying interest of the cSAC and will conform to the highest level of design specifications to replicate a semi-natural water body. The existing field boundaries in close proximity to the proposed balance ponds will be retained. The design of balance ponds will be carried out in consultation with the NPWS.
- The design of any drainage outfall in the cSAC, will be such that it does not impact on the integrity of the cSAC and will be dealt with at the detailed design stage. This may involve specialist ecological surveys and design, as appropriate. These works will be designed to promote recolonisation and avoid any downstream impacts, and will be agreed in consultation with the SRFB and NPWS.

20.7.3 Specific Ecological Mitigation Measures in Non-Designated Areas

The following specific ecological mitigation measures are proposed in relation to non-designated areas:

- All bridges and culverts will be designed in consultation with the SRFB and will permit

- the passage of fish under all but extreme flow conditions.
- Clear spanning bridges or open-bottomed culverts (which are sized to allow the retention of river banks) will be constructed over the two first order tributaries of the River Blackwater (C1 and C2), the Derrylucky River (E 1) the Monefelim River (FW2), a first order tributary of the Monefelim River (FW3), the Gowran River (E12), and a first order tributary of the River Barrow (FW15), in addition to the designated watercourses, as listed in Section 12.5.3. The bridge abutments will be set back a sufficient distance to encourage the riparian habitat of significant ecological value to re-establish.
 - Bank stabilisation, erosion protection and drainage outfalls, if required, for these non-designated watercourse crossings, will be designed in consultation with the SRFB and NPWS at the detailed design stage. All such works will be carried out, outside the closed season and depending on the proximity of lamprey spawning, there may be additional seasonal constraints. If ammocete nursery beds are present in the vicinity, salvage may be required. These works will be designed to promote recolonisation of a natural bankside vegetation and avoid any downstream impacts.
 - If pitching of the bed is essential, it will be laid at the natural grade and level. Raised aprons will be avoided if possible. If one has to be used, a fish-pass will be incorporated. If “hard abutments” are used, they will be of minimum length and will be designed to cater for the passage of mammals.
 - Where bridging is not an economic option and culverts are required, their length will be kept to a minimum by running them square on to the line of the road wherever possible. This may result in some stream realignment.
 - Use will be made where required of open-bottomed type culverts, leaving the stream-bed undisturbed and maintaining some natural bank on both sides to allow for the passage of mammals.
 - Where box culverts are adopted, the design will allow for the maintenance of a minimum depth of water in the culvert. On all watercourses where mammal passage has been identified as a requirement, provision for access will be provided by a mammal ledge, dedicated culvert or similar means.
 - The following general principles will be adopted for the detailed design of drainage culverts;
 - a) The culvert will be set below bed-level.
 - b) Culvert width will approximate to that of the natural channels, the use of multiple units of lesser width is not recommended.
 - c) Where possible, the culvert will be laid at a level and grade that allows the upstream invert to remain drowned (by back-watering) under low-flow conditions (e.g. 100mm for trout, 150mm for salmon).
 - d) If the gradient is too steep, the drowning effect will ideally be met by way of a fish pass at the downstream end of the culvert.
 - e) If a culvert has to be laid at a steep gradient, special provision must be made to allow fish to swim upstream without undue effort.
 - f) Pools will be formed at each end of the culvert to provide for transition from the shape of the slope to the shape of the bed. They will be built in masonry or concrete, and designed to provide take-off conditions for upstream migrants entering and leaving the culvert. The downstream pool will be designed to act as a stilling-chamber that will prevent erosion of the banks below and provide quiescent take-off conditions for fish.
 - g) Culvert length will be kept to a minimum, where possible, by running them square-on to the line of the road and by setting the end walls as far as practical into the embankment. This may require localized realignment of stream channels, which should be carried out in accordance with the requirements of the SRFB
 - h) Concrete will not be used for preventing erosion of stream-beds and banks where a more environmentally friendly option is available e.g. natural bank protection techniques such as willow-fagotting, stone armour, logs, conifer tops or composite protection using products such as coir-matting or geoweb with appropriate planting (reeds, willow, etc). Where concrete is used, it must be sufficiently back-watered at all times to accommodate fish movement.

- **Mammal Passage** - Provision has been made for the passage of mammals across the scheme at specific locations. Table 11.6 (see Chapter 11) provides a list of indicative locations for mammal passes along the proposed route, which have been included in the road development. In addition to the dedicated mammal passage facilities listed in Table 11.6, provision for the passage of mammals will be incorporated into all watercourse crossings of high ecological value (C sites) or greater.
- **Pollution Prevention** - Storm run-off from the proposed road to watercourses of fisheries value will be fed through pollution control measures that will be designed with adequate storage capacity and in a manner to facilitate maintenance and cleaning. Sediment traps will also be provided.
- **Design of balance ponds (flood attenuation areas)** - The design of a balance pond will aim to replicate a natural wetland habitat. Attention will therefore be given at the detailed design stage in relation to size and shape, water depth, supply and quality and general landscaping. The design of balance ponds will be agreed in consultation with the NPWS. Any balance ponds proposed within designated areas will conform to the highest level of design specifications to replicate a semi-natural water body. The existing field boundaries in close proximity to the proposed balance ponds will be retained.

The following mitigation measures are proposed in relation to watercourse diversions and in-stream works;

- Diversions of watercourses will be designed to replicate a natural watercourse system, incorporating meanders, riparian vegetation and other features of a natural watercourse.
- New channels will be sinuous and meandering rather than uniformly straight. The constant erosion and deposition within a sinuous channel results in the formation of riffle, glide and pool conditions. The degree of sinuosity within the channel depends on the space available and will be designed according to the prevailing conditions. Incorporating stone deflectors, v-notch weirs and other appropriate features can develop riffle, glide and pool conditions, within straight channel cuttings.
- Temporary stream diversions will be made on geotextile surfaces with a surface layer of coarse aggregate to hold it in place. The outline approach for permanent watercourse diversions will be agreed in consultation with the SRFB and the NPWS, in addition to the detailed design and construction methodology.

20.7.4 Construction Phase Mitigation Measures

The following general mitigation measures are proposed in relation to the construction phase:

- Bunds, siltation ponds, hydrocarbon and grit interceptors will be put in place, as appropriate, to control pollution and run-off.
- Oil storage tank(s) and the associated filling area and distribution pipe work should be at least 10 m distant from surface water courses (rivers, streams, field drains) and 50m from wells or boreholes. Storage tanks should have secondary containment (110% capacity) provided by means of an above ground bund to capture any oil leakage irrespective of whether it arises from leakage of the tank itself or from associated equipment such as filling and off-take points, sighting gauges etc., all of which should be located within the bund. Bund specification should conform to the current best practice for oil storage.
- Adequate protection measures will be put in place to ensure that all hydrocarbons and other chemicals used during the construction phase are appropriately handled, stored (no storage of hydrocarbons or any toxic chemicals will occur within 50m of a watercourse) and disposed of in accordance with recognised standards. Re-fuelling of plant will not occur within 50m of any watercourse.
- Concrete (including waste and wash-down water) will be contained and managed appropriately to prevent pollution of all watercourses. Pouring of concrete for aprons, sills, and other works will be carried out in the dry and allowed cure for 48 hours before re-flooding. Pumped or tremied concrete will be monitored carefully to ensure no accidental discharge. Mixer washings and excess concrete will not be discharged to water.
- The contractors' site compounds will be equipped with temporary toilet facilities, and the contractor will be responsible for their servicing and maintenance. Foul drainage from the offices and other construction facilities will be contained and disposed of in an appropriate manner to prevent pollution of

all watercourses. There will be no discharge from these facilities to the local environment.

- During the construction phase periodic monitoring of water quality in the vicinity of works will be carried out to ensure that there are no unauthorised discharges and to ensure the effectiveness of procedures designed to prevent pollution.
- The contract documents will specify the necessity for the contractor to take all reasonable precautions to prevent silt laden water from discharging directly to watercourses.
- Siltation of water bodies will be minimised by the appropriate use of settlement ponds, silt traps and bunds and by avoiding operating within water bodies where feasible. Where pumping of water is to be carried out, filters will be used at intake points and discharge will be through a sediment trap.
- All watercourses that occur in areas of land to be used for accommodation works or storage depots will be fenced off at a distance of at least 10m to avoid any direct impacts.
- Bankside vegetation will be left intact where feasible by erecting fencing prior to the commencement of any site works. Where possible the fence will be set at a minimum distance of 2m from the bank of the watercourse or at the edge of the woody canopy (whichever is greater).
- If temporary or permanent diversion of the watercourse is required, this will be carried out prior to the removal of bankside.
- Typical measures for control at river bank-sides include installation of cofferdams so that the river flows around the outside leaving the interior, that is, the works area, dry. As an alternative, the channel will be diverted around the works area leaving the latter dry. Such works will preferentially be done during the dry period of the year when flows are low and the risk of suspended solids release is minimal.
- A number of the smaller streams may be slightly realigned to pass under the road through culverts. In most cases the culvert will be made in pre-cast sections that can be lowered into the existing channel with minimal disturbance. However, in some cases it may be necessary to construct the culvert beside the existing channel and then connect the upstream end to the channel, while in other cases it might be more appropriate to divert the existing channel slightly 'off-line' and construct the culvert in the dry channel bed.
- In-stream works will not be carried out in watercourses frequented by salmon or trout during the Annual Close Season, duration of the season varies regionally, but the SRFB have been consulted on the timing and have indicated that October to June inclusive is the closed season in this region. Further restrictions may also apply in the case of watercourses containing significant populations of other species including lamprey, coarse fish, freshwater pearl mussel and freshwater crayfish.
- In-stream containment and dewatering operations may facilitate operation within closed periods. All dewatering flow will be passed through settlement ponds or tanks to remove sediments and will be preceded by a fish salvage operation carried out by, or on behalf of the SRFB.
- Where suitable spawning gravels occur within a watercourse at the site of a proposed crossing, these gravels will be removed and stored for reinstatement on completion of the works, in accordance with the requirements of the SRFB.
- Watercourse diversions will be carried out in the dry and in isolation from the existing watercourse. The compensatory diversion channel will be designed in detail and to the satisfaction of the statutory bodies. This will involve the grading of the riverbanks to an acceptable slope, the construction of a sinuous channel and the incorporation of suitable substrates.
- Where natural bankside vegetation is to be removed, machinery will operate from the bank and pull the vegetation back from the edge of the watercourse. If temporary or permanent diversion of the watercourse is required, this will be carried out prior to the removal of bankside vegetation. Where permanent diversion is taking place, existing vegetation will be removed in sods for replanting on the new river banks.
- Replanting or rehabilitation of banksides will be undertaken following sensitive grading of the banks to replicate a natural topography (slopes will not be greater than 1:2). Planting will be conducted using native species and will follow a natural zonation that is appropriate to the river profile. Temporary deer proof fencing will be erected to protect newly planted areas if required.

- Transplanting of bankside vegetation will be conducted in the dormant season, but where restrictions are in place due to the presence of salmonids, transplanting will be carried out during the period August to November.
- Once the construction is completed and establishment of vegetation has commenced, the connection to the existing watercourse can be made. This will only occur within the approved operational window for in-stream works. The salvage of fish from the section of watercourse to be abandoned will be undertaken by or on behalf of the SRFB. These watercourses will be surveyed for the presence of protected species and salvaged under licence from the NPWS.
- Operation of machinery in-stream will be kept to an absolute minimum. All construction machinery operating in-stream will be mechanically sound to avoid leaks of oils, hydraulic fluid, etc. Machinery will be steam-cleaned and checked prior to commencement of in-stream works.
- Forging of watercourses to gain access to the opposite bank will only be considered where no alternative option exists and under approval of the SRFB. Where required, access will be restricted to one crossing point and traffic limited. In-stream and bankside preparation and rehabilitation will be required.
- Specific measures in addition to those outlined in this section apply to the proposed drainage works on (i) the first order tributary of the Smartcastle stream, (ii) Lyrath stream and (iii) a field drain at Rathgarvan, and these are dealt with in Appendix 12.2.

20.7.5 Operation Phase Mitigation Measures

The following general mitigation measures are proposed in relation to the operational phase:

- At drainage outfalls where it has been identified that there would be a potentially increased risk of flooding in the receiving water, attenuation measures have been included in the design to reduce the discharge to approximately that of the natural catchment, i.e. the greenfield run-off rate.
- All surface water run-off from the new road to watercourses of fisheries value will be directed through pollution control measures. The pollution control measures will be designed with adequate storage capacity

and in a manner to facilitate maintenance and cleaning.

- The proposed drainage systems will ensure that the release of particulate matter (mainly grit, dust and grass clippings where grass is planted) to watercourses will be minimal
- Accidental spill containment will be included in the pollution control measures.
- The outfall for each drainage discharge pipe will be specifically designed to ensure that scouring of either the bottom or the banks of the receiving watercourse will be minimal.

20.7.6 Site-specific Mitigation Measures

While the general remedial or reductive measures for watercourses outlined above apply to the watercourses in this section, the more specific, remedial or reductive measures are outlined in Table 12.5 of Chapter 12.0 Aquatic Ecology and Hydrology.

In addition, the realignment of the second order tributary at Knocktopher junction (E5) is a short-term impact as this stretch of river will be re-established as a watercourse with natural features. The current condition along this stretch is of low ecological value due to siltation and the absence of a variable flow regime. The realignment will improve the flow regime of this stretch of watercourse by incorporating the measures outlined above for stream diversions.

20.8 Soils, Geology and Hydrogeology

20.8.1 General Construction Phase Mitigation Measures

The following general mitigation measures are proposed in relation to the construction phase:

Soft Ground Areas

Any excavated material from soft ground areas will need to be disposed of landscape areas or off-site to a suitably licensed receptor.

In poorly drained/waterlogged areas, where possible, use will be made of pre-earthworks drainage, which will improve the engineering characteristics and stability of soft areas.

Rock Excavation

Where blasting is undertaken, it is likely that significant noise, dust and vibration will occur in the immediate vicinity of the works. The mitigation measure given in Chapter 8 – Noise and Vibration will be applicable here.

Side Slopes

It is to be expected that the main ground investigation will deliver information that will allow side slopes to be locally steepened up while areas requiring a shallower side slope may be identified.

Embankments higher than 9m to 10m will include basal strengthening in the form of geo-grid reinforcement or a rock fill starter layer to help to prevent failure occurring within the fill in the embankment.

Where cut slopes will be excavated below the groundwater table, suitable drainage measures will be implemented to ensure that outwash of the embankment face does not occur. Such drainage measures may involve a permanent lowering of the water table or the installation of granular counterfort drains within the slope.

Where the presence of geological fault lines is suspected close to cut sections at Ch.4+500 and Ch.28+500 further information on the exact ground conditions at these locations will be gathered as part of the Detailed Ground Investigation.

Piling

The type of piling method selected will dictate the likely impact that the installation process will have on the environment.

Care will be taken where piling works are undertaken in the vicinity of watercourses or aquifers to ensure that there is no contamination of the water by the materials and equipment used in the construction. In particular, where open bored piling is carried out in the vicinity of watercourses care will be taken to avoid concrete spills into the watercourse and the use of bentonite will be avoided.

Disposal of Excavated Material Unsuitable for Re-use

In order to maximise the re-usability potential of the excavated materials they will be handled and trafficked to a minimum and stockpiled in such a way as to minimise the effects of weathering. The time between excavation and re-use during wet weather periods will be kept to a minimum.

Where practical, lowering the moisture content of the excavated material towards its optimum will potentially increase the percentage of reusable overburden. However, site conditions do not always permit the drying out of excavated material. Indeed, persistent rainfall on exposed stockpiles of material for reuse can have the reverse effect

In order Spillages from Construction Plant

All fuel will be stored/stocked within containment bunds within the site to prevent release into the ground. Where it is necessary to refuel plant on site, this will be done in a carefully managed manner. Emergency procedures will be put in place by the Contractor so that the effects of accidental spillages can be minimised.

20.8.2 Specific Hydrogeology Mitigation Measures**General**

It is possible that with further information gathered as part of the main ground investigation, the level of impact to some of the affected wells could be reduced. Mitigation measures for the existing scenario are outlined below:

- Where aquifers may be impacted upon, care must be exercised in the design of drainage systems to ensure that these aquifers are not compromised, either by providing “closed” drainage systems in these areas or through the use of lined swales. This will prevent any runoff borne contaminants directly entering the groundwater system via infiltration.
- Silt traps and oil interceptors/pollution control facilities for all drainage discharge will be included in the road design.
- Recirculation of groundwater from excavation dewatering back into the same groundwater catchment, via an interceptor, will also minimise the potential effect of reduced spring and surface water flows.
- Further monitoring of groundwater levels prior to and during the construction phase of the project will be undertaken to ensure that the groundwater table at the areas of cutting predicted during the design process agree with the conditions on site.

The following measures will be undertaken sequentially where the water table is lowered to such an extent that output from an adjacent well is reduced to less than the current requirements of the owner.

- If not already carried out, a pumping test will be conducted to determine the sustainable yield of the well.
- Consideration will be given to the need/benefit of drilling deeper in the existing well in order to increase the yield if deemed necessary.

- Soft ground areas may require removal and replacement or in-situ ground improvement. Ground improvement may involve additives such as cement or lime.
 - If the well is deepened, the likely sustainable yield will be assessed either by airlifting at the end of drilling or by carrying out a pumping test.
 - If well deepening does not satisfy the yield and quality objectives then another suitable location will be drilled and sufficient groundwater found to either supplement or replace the impacted well or an alternative water source will be provided.
 - Where an existing well is to be removed a replacement well will be constructed.
 - An environmental management plan will be developed and reviewed during the construction phase with particular care required where the road flanks Hugginstown Fen and Danganbeg wetland. Transfer areas will have adequate protective measures to guard against potential accidental spills and leakages. All equipment and machinery will have regular checking for leakages and quality of performance.
 - To mitigate and effectively deal with accidental spillage during the operational phase of the project, an emergency clean-up team will be contracted for service by the relevant local authority.
 - The construction methodology in the vicinity of the holy well adjacent to mainline Ch. 29+400 will consider the detailed groundwater levels gathered at the next stage of design, to ensure the effects on the site are minimised.
- natural impact. This data will be assessed by a qualified wetland hydrologist;
- The realigned side road (Ch. 17+900 to 18+500) will have no significant sections of cutting and there will be no excessive stripping of soils in this area. Standard shallow road drainage (<0.4m depth) will be used;
 - Local subsoil materials will be used, where possible, in the construction of the fill embankments (at Ch. 18+450), in order to maintain the same recharge characteristics of the in-situ substrate.
 - The drainage system will include pollution controls and adequate hydraulic capacity to ensure containment. Closed drainage will be employed along the boundary of the cSAC, and all interceptors/settlement balance ponds be located outside of the cSAC designated area;
 - Drainage controls during the construction phase will ensure containment of all run off within the site to designated discharge points. All waters arising from the construction site will be discharged outside of the cSAC designated area;
 - Topsoil stripping for embankments will be minimised and where ground conditions are suitable, a geotextile will be used and placed directly on existing topsoil.
 - Ongoing monitoring of groundwater levels and chemistry will continue during the construction phase.
 - No mitigation measures are required for the reduction in fen catchment or for the reduction in groundwater recharge.

Mitigation Measures for Hugginstown Fen

In relation to the impacts identified at Hugginstown Fen, the following mitigation measures will be implemented:

- To ensure that no impact arises from the cuts proposed, baseline monitoring over 24 months will be undertaken prior to development; during construction at an increased frequency to identify any change imposed by the development (early indicators); and post construction for a minimum of 12 months. This monitoring will enable continued characterisation of fen hydrology and any patterns, trends of fluctuations in water level and chemistry arising from seasonal variations or non-

Mitigation Measures for Danganbeg Wetland

The following mitigation measures will be implemented in relation to Danganbeg Wetland:

- Periodic transverse and vertical hydraulic barriers made of impermeable or low permeability materials will be installed every 50 –100m along the mainline within the wetland catchment (Ch. 25,540 to 26,620) to force groundwater to pass through the foundation and emerge on the opposite side to natural ground conditions.
- During construction, groundwater intercepted will be pumped to soakaway structures downstream from the mainline to replenish dewatered waters.

The following engineering enhancements will be implemented at the detailed design stage along the length of Fill 2 to prevent a negative hydraulic impact on the wetland:

- Use of inert lightweight fill (e.g. polystyrene blocks) or a free draining granular fill to maintain permeability and throughflow of groundwater.
- Construction of embankment during dryer months to avoid excessive dewatering. Aside from the mainline, any sumps used will be filled and returned to or above pre-construction ground level conditions.
- Installation of low permeability vertical hydraulic barriers across the road at 50-100m intervals to force groundwater to cross the road into the wetland.
- Where possible, use locally excavated materials (alkaline based) from sites with no history of contamination. Synthesised geotextiles/polystyrene fill will be inert and unable to impart or absorb chemistry from passing groundwater. Other construction materials that have potential to change groundwater chemistry (e.g. cement, bentonite) will be reviewed with respect to throughflow of groundwater to the wetland. Mitigation measures such as using alternative materials or sleeving of items in sensitive areas will be considered.
- The realigned side road parallel to the mainline (at Ch. 26,600 to Ch. 27,200) and Cut 2 will be kept out of cutting where possible. Where cut is a necessity, it will be not greater than 1 m in depth and less than the mainline Cut 2.
- A closed drainage system will be installed between Ch. 25+540 to Ch. 26+620 to prevent any potential leakage of contaminants into groundwater that contributes to the wetland.
- An attenuation pond will be constructed parallel to the mainline between Ch. 25,750 and Ch. 26,400. This pond will be fully lined and divorced hydraulically from groundwater interaction. Pollution control measures will be employed to maintain outflow water quality to existing baseline standards.
- Topsoil stripping for embankments will be minimised and where ground conditions are suitable, a geotextile will be used directly on existing topsoil to minimise potential for suspended solids release.

- Transport of suspended solids will be controlled by settlement/attenuation ponds prior to outfall to existing drains. These drains will bypass Danganbeg wetland.
- Drainage controls during the construction phase will ensure containment of all run off within the site to designated discharge points. All waters arising from the construction site will be discharged outside of the Danganbeg Wetland area;
- Ongoing monitoring of groundwater levels and chemistry will continue during the construction phase.

Dumping of Soils

As outlined in Chapter 11 and 12 of this EIS, no dumping of soils will be allowed during the construction phase in certain areas, including cSAC designated watercourse crossings and the following:

- Hugginstown Fen cSAC
- Danganbeg Wetland

The extent of each of these areas in the vicinity of the scheme is shown on Figures 13.2 to 13.3 of this EIS.

20.9 Climate

20.9.1 Construction

No Mitigation measures will be necessary.

20.9.2 Road Traffic

The EU has reached a voluntary agreement with car manufacturing associations to achieve an average CO₂ emissions for new passenger cars of 140 g CO₂/km by the year 2008/2009. through EU legislation. This measure will reduce CO₂ emissions from new cars by an average of 25% in the period 1995 to 2008/2009 whilst 15% of the necessary effort towards the overall climate change target of the EU will be met by this measure alone. Additional fuel efficiency measures include VRT and Motor Tax rebalancing to favour the purchases of more fuel-efficient vehicles, the National Car Test and Fuel Economy Labelling.

20.10 Material Assets – Agriculture

20.10.1 Mitigation of Operational Impacts

Mitigation of operational impacts takes place under the following headings:

Access Arrangements

This includes measures to allow access from one side of the new road so as to allow access between severed lands. It also includes replacement access points when existing entrances are removed. Table 15.3 presents a summary of the access arrangements provided.

General Mitigation Measures

These include general measures included in the construction of the road to prevent operational impacts of the road. These include:

- Boundary Fencing
- Drainage works to prevent flooding

Further measures to compensate farmers due to land acquisition, drainage works, reinstatement of boundaries and loss of facilities are part of the compensation under the compulsory purchase system.

20.10.2 Mitigation of Construction Impacts

Construction impacts will be minimised by the following measures:

- The provision of temporary access across the construction site until permanent access arrangements are in place;
- Minimising the duration of any road closures;
- Advanced notification of temporary severance;
- Dust minimisation plan; and
- Land acquired temporarily to facilitate construction will be reinstated and returned to the original ownership following the completion of works at that location, where possible and agreed.

20.11 Material Assets – Non-agricultural Properties

Where an access to a property is affected, the access will be reinstated to match the existing. Further measures to compensate affected parties due to land acquisition, drainage works, reinstatement of boundaries and loss of facilities are part of the compensation under the compulsory purchase system.

20.12 Archaeology and Cultural Heritage**20.12.1 General**

The design development of the proposed scheme has endeavoured to minimise the impact

on the archaeological and cultural heritage wherever possible (see Chapter 3). Where it has not been possible to avoid adverse impacts, mitigation measures have been proposed, as discussed below.

Mitigation measures, both at pre-construction and construction phases, will be undertaken in compliance with national policy guidance and statutory provisions for the protection of the archaeological and cultural heritage, including the following:

- National Monuments Acts 1930-2004.
- Code of Practice (2000) between the National Roads Authority and Department of Arts, Heritage, Gaeltacht & the Islands.
- Framework & Principles for the Protection of the Archaeological Heritage (1999). Department of Arts, Heritage, Gaeltacht & the Islands.
- Policy & Guidelines on Archaeological Excavation (1999). Department of Arts, Heritage, Gaeltacht & the Islands.
- Architectural Heritage Protection, Guidelines for Planning Authorities (Draft 2001). Department of Arts, Heritage, Gaeltacht & the Islands.

All archaeological works will be undertaken in accordance with directions issued by the Minister for Environment Heritage & Local Government under the supervision of the Project Archaeologist.

Proposed mitigation measures are presented as recommendations as they are subjected to the approval of Department of the Environment, Heritage and Local Government.

20.12.2 Recommendations and Mitigation Measures – Prior to Construction**20.12.2.1 Introduction**

It is recommended that the following measures be undertaken in advance of the construction phase. This is aimed at allowing a satisfactory time frame in which the mitigation measures can be conducted and the results assessed without causing delays to the construction programme.

The location of each site is shown on Figures 17.1 to 17.10 of Volume 2 Book 2

20.12.2.2 Non Intrusive Survey

The following non-intrusive recommendations and mitigation measures are recommended prior to construction:

Aerial Survey

Prior to further on-site archaeological work, it is recommended that an aerial survey of the proposed route and attendant areas be conducted to aid in interpreting the archaeological landscape. This involves low level (c. 1000ft), oblique aerial photography and comprises direct visual examination of the ground from the air by qualified archaeological staff and full photographic coverage.

Geophysical Survey

Additional geophysical survey work is recommended along selected sections of the route to aid in interpreting the archaeological landscape, in advance of a programme of intrusive archaeological investigation. This has been recommended in seven locations, at sites S16, S39, S40, S49, S51, S54 and S78. Geophysical survey is recommended for each of the 33 areas of archaeological potential where ground conditions permit. Geophysical survey presents an image of sub-surface features obtained in a non-intrusive manner. The results are provided in the form of geophysical interpretation and archaeological interpretation with supporting maps that detail and highlight potential features present below ground level. Anomalies recorded in these surveys can be taken into account, allowing for a more controlled approach during the intrusive stage of test trenching.

Topographical Survey

Topographical surveys present a comprehensive picture of visible and partially visible surface features, obtained in a non-intrusive manner. The results are provided in contour maps, three-dimensional surface maps and shaded relief maps which details and highlights potential sites that are present but are not always visible to the naked eye. Anomalies recorded in these surveys can be taken into account, allowing for a more controlled approach during the intrusive stage of investigation. This is recommended for Sites S25, S36, S37, S49, S51, S58, S61, S66 and S80.

Underwater Inspection & Survey

Underwater inspection is recommended for significant waterbodies that will have a major impact upon them by the proposed scheme. Underwater Inspection and Survey is recommended for sites SR4-10, SR11-21 and SR26. This is detailed in table 17.3. It may consist of a wading survey or a full dive survey or a visual inspection and/or a metal-detector survey of the underwater environment and the riverbank as appropriate at each impacted

waterbody. The results should be provided in the format of a report recommending an appropriate mitigation strategy, if required.

Photographic Recording

Photographic recording is recommended for all townland boundaries and sites SR3, S14, S17 and S71. This should consist of a photographic record for each site with a description of the site or composition of the townland boundary.

20.12.2.3 Intrusive Survey

If this scheme is approved by An Bord Pleanála it is the intention of Kilkenny County Council to apply to the Minister for Environment Heritage and Local Government for directions, under Sect. 14A (2) of the National Monuments Acts 1930 to 2004, for all archaeological works on this scheme. The following works are recommended:

Site Specific Test Trenching

Site specific archaeological investigative test trenching is recommended for sites of archaeological potential within the proposed scheme. Test trenching as part of a site specific archaeological assessment will aid in determining the nature, extent and significance of the archaeology present. The results of the test trench investigation will enable the appropriate mitigation strategy to be undertaken with the approval of the DoEHLG. Site specific test trenching is recommended for the following sixty one sites, S3, S4, S5, S6, S7, S8, S9, S11, S12, S13, S15, S16, S18, S19, S20, S21, S22, S23, S25, S26, S27, S32, S35, S36, S37, S39, S40 S44, S49, S50, S51, S52, S54, S56, S58, S59, S61, S64, S65, S66, S70, S72, S73, S74, S77, S78, S80, S81, S83, S84, S86, S88, S89, S90, S95, S96, S97, S98, S99, S100/C20 and S101/C21.

General Archaeological Test Trenching

It is recommended that archaeological test trenching along selected sections of the route be undertaken prior to the construction phase, in order to locate sites of archaeological significance in advance of construction. Test trenching is recommended for each of the 33 areas of archaeological potential. Mitigation strategies can then be adopted to deal with such findings in advance of construction, thereby helping to minimise delays during the construction phase. Such mitigation strategies can involve preservation by record of the archaeological deposits (archaeological excavation) or preservation *in situ*. Archaeological test trenching is recommended specifically in the identified Areas of

Archaeological Potential, and other areas as required.

Preservation In Situ

Strategies for the preservation *in situ* of archaeological remains should be considered on a case by case basis in consultation with the Statutory Authorities.

Preservation by Record (Archaeological Excavation)

Preservation by record, in the form of archaeological excavation and recording, is recommended for sites where initial investigation has yielded evidence of archaeologically significant material or structures, and where preservation *in situ* is not feasible.

NOTE:	Recommendations are subject to approval by the Department of the Environment, Heritage and Local Government.
--------------	--------------------------------------------------------------------------------------------------------------

20.12.3 Recommendations and Mitigation Measure During Construction

Introduction

Mitigation measures at construction phase will be undertaken in compliance with national policy guidance and statutory provisions for the protection of the archaeological and cultural heritage. This may include archaeological monitoring of the topsoil stripping if deemed appropriate following assessment of the pre-construction investigations.

Discovery of Archaeological Material

In the event of potential archaeological deposits being uncovered during the construction phase, initial assessment will determine the nature, extent and significance of the archaeology present. As a result of the assessment, decisions on the most appropriate mitigation strategy will be taken with the approval of the DoEHLG.

Section 23 of the National Monuments Acts 1930 (as amended) provide that finding of an archaeological object must be reported to the Director of the National Museum or the Garda Síochána within 96 hours of discovery.

NOTE:	Recommendations are subject to approval by the Department of the Environment, Heritage and Local Government.
--------------	--------------------------------------------------------------------------------------------------------------

20.13 Architectural Heritage

20.13.1 General

The design development of the proposed scheme has endeavoured to minimise the impact on the architectural and industrial heritage wherever possible (see Chapter 3). Where it has not been possible to avoid adverse impacts, mitigation measures have been proposed, as discussed below.

Mitigation measures, both at pre-construction and construction phases, will be undertaken in compliance with national policy guidance and statutory provisions for the protection of the architectural heritage, including the following:

- National Monuments Acts 1930-2004.
- Code of Practice (2000) between the National Roads Authority and Department of Arts, Heritage, Gaeltacht & the Islands.
- Framework & Principles for the Protection of the Archaeological Heritage (1999). Department of Arts, Heritage, Gaeltacht & the Islands.
- Policy & Guidelines on Archaeological Excavation (1999). Department of Arts, Heritage, Gaeltacht & the Islands.
- Architectural Heritage Protection, Guidelines for Planning Authorities (Draft 2001). Department of Arts, Heritage, Gaeltacht & the Islands.

All works in association with architectural heritage sites will be undertaken in accordance with directions issued by the Minister for Environment Heritage & Local Government and in consultation with the Project Archaeologist.

Proposed mitigation measures are presented as recommendations as they are subjected to the approval of Department of the Environment, Heritage and Local Government.

20.13.2 Recommendations and Mitigation Measures – Prior to Construction

It is recommended that the following measures be undertaken in advance of the construction phase. This is aimed at allowing a satisfactory time frame in which the mitigation measures can be conducted and the results assessed without causing delays to the construction programme.

If this scheme is approved by An Bord Pleanála it is the intention of Kilkenny County Council to apply to the Minister for Environment Heritage & Local Government for directions, under Sect. 14A (2) of the National Monuments Acts 1930 to

2004, for all archaeological works on this scheme. The following archaeological investigation works are recommended:

Archaeological Investigations

Archaeological investigative excavations, in the form of controlled test trenching is recommended for sites or their environs when a site of heritage potential lies close to or within the proposed route. The initial investigation will determine the nature, extent and significance of the heritage remains present. Some of the identified sites are without clearly defined indicators. Archaeological investigation will determine if full excavation and recording is required. Archaeological investigations are recommended for a number of sites, including SIA3, SAH30, SIA5, SAH53, SIA7, SAH65, SAH77, SAH85, SAH87, and SAH105.

Architectural Recording/Survey

Additional written and photographic survey and assessment is recommended for architectural structures that are impacted. This may incorporate measured hand drawn survey. Architectural recording/survey are recommended at Sites SAH2, SAH6, SAH14, SIA3, SAH16, SAH18, SAH20, SAH21 SAH22 SAH23, SAH24, SAH25, SAH26, SAH28, SAH30, SAH34, SAH36, SAH41, SIA4, SAH49, SAH50, SAH51, SIA8, SAH57, SAH67, SIA10, SAH73, SAH76, SAH83, SAH85, SAH88, SIA13, and SAH101.

Topographical Survey

Topographical surveys present a comprehensive picture of visible and partially visible surface features, obtained in a non-intrusive manner. The results are provided in contour maps, three-dimensional surface maps and shaded relief maps which details and highlights potential sites that are present but are not always visible to the naked eye. Anomalies recorded in these surveys can be taken into account, allowing for a more controlled approach during the intrusive stage of investigation. This is recommended for Sites SAH2, SIA3, SAH30, SIA5, and SIA7,

NOTE:	Recommendations are subject to approval by the Department of the Environment, Heritage and Local Government
--------------	-------------------------------------------------------------------------------------------------------------

20.13.3 Recommendations and Mitigation Measures During Construction

Mitigation measures at construction phase will be undertaken in compliance with national policy guidance and statutory provisions for the protection of the archaeological, architectural and cultural heritage. This may include

archaeological monitoring of the topsoil stripping if deemed appropriate following assessment of the pre-construction surveys.

Archaeological Monitoring

It is recommended that archaeological monitoring of all ground disturbances at site SAH17 be undertaken prior to the construction phase. This technique will be effective in the locating of possible associated features of architectural significance in advance of construction. SAH17 is a church site. There is always a high probability of finding grave material in association with such sites. This may be found outside as well as inside the boundary wall. For this reason an archaeologist must always be present when groundworks are being undertaken in the vicinity of a church site. This allows for the resolution of these features in advance of construction, thus minimising delays during the construction phase.

Property Boundaries & Re-instatement

The reinstatement of structure associated with a number of architectural sites is recommended. These mostly consist of elements of the boundary walls and/or gates and entrances. Where a property boundary is impacted by the scheme, where practical it is recommended that the boundary be replicated along the frontage facing onto the road. This is recommended for sites SAH6, SAH14, SAH18, SAH20, SAH21, SAH23, SAH25, SAH30, SAH34, SAH36, SAH51, SAH72, SAH76, SAH85 and SAH99.

Protection During Construction

It is recommended that sites SIA6 is fenced off and protected during the construction phase. No works are anticipated outside the land acquisition boundary. However, in the exceptional event of any construction activity taking place outside of the land acquisition boundary and in vicinity of the following sites SAH7, SIA2, SAH17, SAH19, SAH23, SAH25, SAH27, SAH29, SAH30, SAH30a, SAH34, SAH37, SAH40, SIA5, SAH50, SAH52, SAH58, SAH60, SAH69, SAH71, SAH74, SAH78, SAH86, SAH94, SAH95, SIA14, SAH97, SAH99, it is recommended that the sites are fenced off and protected during construction phase.

Discovery of Heritage Remains

In the event of potential heritage remains being uncovered during the construction phase, initial assessment will determine the nature, extent and significance of the remains present. As a result of the assessment, decisions on the most appropriate mitigation strategy will be taken with the approval of the DoEHLG.

NOTE:	Recommendations are subject to approval by the Department of the Environment, Heritage and Local Government
--------------	-------------------------------------------------------------------------------------------------------------

Preservation In Situ

Any proposal for preservation in situ will be carried out to the approval of the DoEHLG.

Mitigation of Indirect Impacts

Consideration has been given to sites that are particularly sensitive to indirect impacts. In these cases, the general noise and vibration and air quality mitigation measures indicated for the construction phase (refer to Chapters 8 and 9 respectively for details) are especially important. In addition, the visual setting of certain sites will be impacted by the scheme, which may also result in a indirect impact. This has been assessed in Chapter 10 of this EIS and the relevant mitigation measures have been addressed in that chapter.

The site-specific details for these issues are listed in Table 18.1 of Chapter 18.

Table 20.1 Location of Barrier Mitigation Measures throughout Scheme

Waterford to King's River			
Location	Chainage	Barrier Height	2025
			L_{den}
A29	9+660 – 9+780	2m bund	59dB
A30	9+660 – 9+920	3m bund/fence	60dB
A48	16+870 – 17+180	2.5m fence	65dB
A49	18+100 – 18+400	2.5m fence	64dB
A59	23+420 – 23+580	2m fence	59dB
King's River to Ballyquirke			
Location	Chainage	Barrier Height	2025
			L_{den}
B32	46+660 – 46+980	4m bund/fence	60dB
B34	47+740 – 48+020	2m fence	60dB
B35	47+900 – 48+100	2m fence	60dB
B39	48+720 – 49020	2m bund	60dB
Ballyquirke to Powerstown			
Location	Chainage	Barrier Height	2025
			L_{den}
C07	62+640 – 62+900	1m fence	59dB
C08	62+640 – 62+900	1m fence	60dB
C10	62+900 – 63+140	1m fence	60dB
C21	66+000 – 66+300	2m bund	59dB
C23	66+000 – 66+300	2m bund	60dB
C26	66+750 – 66+900	1.5m bund	59dB
C35	69+000 – 69+100	2m fence	60dB
C42	72+450 – 72+620	2.25m bund	60dB
C48	74+660 – 74+930	2.5m fence	60dB
C51	75+020 – 75+150	1m bund	60dB