

Habitats Regulations Assessment

**Report of Information to Inform an
Appropriate Assessment:**

**718736-3000-R-019 Lough Foyle and Lough
Neagh & Lough Beg Ramsar Sites**

A5 Western Transport Corridor

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1 Introduction

1.1 Background

1.1.1 Within Northern Ireland, the A5 Western Transport Corridor (A5 WTC) runs from Londonderry to the border just south of Aughnacloy. The A5 WTC project involves providing a new off line dual carriageway between New Buildings and Aughnacloy with single carriageway bypasses of New Buildings and Aughnacloy tying the scheme into the existing A5 at the northern and southern ends. At the southern end, the scheme ties in just north of the border at County Monaghan. The existing A5 passes through New Buildings, Strabane, Sion Mills, Newtownstewart, Omagh and Aughnacloy.

1.1.2 For the purposes of this report, where the report refers to phased delivery the proposed construction programme is:

- Construction Phase 1: Newbuildings to North of Strabane (Junction 1 to Junction 3) together with south of Omagh to Ballygawley (Junction 13 to Junction 15); and
- Construction Phase 2: North of Strabane to South of Omagh (Junction 3 to Junction 13).

In line with the Public Inquiry Inspector's recommendation, the section of the proposed scheme between Ballygawley (Junction 15) and the border at Aughnacloy (Construction Phase 3) is not being taken forward until details of the link with the N2 at the border with the Irish Republic have been clearly identified. However, this section is included in the assessment in this report as it must take account of the full extents of an overall project.

1.1.3 The currently proposed scheme substantially reflects a proposed A5WTC scheme which was promoted in 2010 and for which an Environmental Statement (A5WTC ES 2010) was prepared and published. The environmental studies undertaken and reported in the A5WTC ES 2010 recognised and assessed likely impacts relative to European Designated Sites in the form of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs). Four SACs and 4 SPAs were identified. They also identified and assessed impacts relative to two Ramsar Sites.

1.1.4 The SACS and SPAs which form part of the collectively named Natura 2000 sites and the two Ramsar Sites, were also subject to consideration in the context of the EC Habitats Directive and EC Birds Directive, as transposed by the Conservation (Natural Habitats, etc) Regulations (Northern Ireland) 1995 as amended by the Conservation (Natural Habitats, etc.) (Amendment) Regulations (Northern Ireland) 2012 in Northern Ireland and the European Communities (Natural Habitats) Regulations 1997 (as amended) in the Republic of Ireland. The sites were screened to determine if the proposed scheme, with its proposed mitigation measures, would be likely to have a significant effect on any of the sites considered. It was concluded they would not be likely to have a significant effect in the context of the Habitats or Birds Directives, a conclusion which was agreed with by Northern Ireland Environment Agency (NIEA), the statutory consultee relative to the designated sites in Northern Ireland and National Parks and Wildlife Service (NPWS) the organisation charged with the implementation of the Habitats and Birds Directives in the ROI.

- 1.1.5 Notwithstanding these confirmations, a challenge to the consent for the proposed scheme that the River Foyle and Tributaries SAC should have been subject to an Appropriate Assessment was upheld. The finding was informed by concerns raised by Loughs Agency in responses to the A5WTC ES 2010 and presented in verbal submissions to the public inquiries held in 2011 concerning the protection of Atlantic salmon, and clarifications through case law relative to the interpretation of likelihood in the context of screening for likely significant effects as referred to in the Habitats Directive and the Regulations.
- 1.1.6 The currently proposed scheme will be the subject of further studies and assessments which will be reported in a project specific Environmental Statement along with relevant information gathered and reported in the A5WTC ES 2010. Appropriate assessments are also to be undertaken for Natura 2000 sites and Ramsar sites where it has been concluded the proposed scheme is either likely to have a significant effect on the sites in the context of the Habitats Directive, or that sufficient uncertainty remains following screening, such that likely significant effects cannot be ruled out.
- 1.1.7 This new document provides information to inform appropriate assessments for the following Ramsar Sites which have been identified during screening as ones where it has been concluded the currently proposed scheme will be likely to have a significant effect by virtue of its use by birds¹ and in the case of Lough Foyle Ramsar Site, fish species, identified as primary and/or qualifying species in the citations for the two Ramsar Sites.
- Lough Foyle Ramsar Site; and
 - Lough Neagh & Lough Beg Ramsar Site
- 1.1.8 The information will be submitted to NIEA and NPWS as statutory consultees for the designated sites in Northern Ireland and the Republic of Ireland. The Royal Society for the Protection of Birds, Northern Ireland (RSPB NI) will also be invited to provide responses relating to the information and preliminary findings contained in the report. The information is also to be made publicly available for comment. The information and information received in response to the consultations will then be considered by RS and the Minister along with further information derived during the finalisation of the proposed scheme as appropriate assessments are completed in advance of a decision to proceed or not in accordance with the requirements of the Directive and Regulations. Should the responses or any modifications associated with finalisation of the proposed scheme require further evaluation the resulting information will be subject to further consultation as appropriate prior to the completion of the appropriate assessments.
- 1.1.9 The gathering and presentation of the information has been informed by the guidance provided in Managing Natura 2000 Sites, the provisions of Article 6 of the 'Habitats'

¹ Some of the whooper swan and geese which use the SPAs, and are therefore qualifying features of the sites are known to use the Foyle floodplain for foraging.

Directive 92/43/EEC (EC, 2000 & 2001) and Section 4, Part 1 of Volume 11 of the DMRB (HD44/09).

1.2 Natura 2000 sites

- 1.2.1 Natura 2000 sites consist of Special Areas of Conservation (SACs) designated under European Directive 92/43/EEC on the Conservation of Natural Habitats and Wild Flora and Fauna (the 'Habitats Directive') and Special Protection Areas (SPAs) designated under Directive 2009/147/EC, (the codified version of 79/409/EEC as amended) on the conservation of wild birds (the 'Birds Directive'.)
- 1.2.2 Ramsar sites are designated under the Convention on Wetlands of International Importance, agreed in Ramsar, Iran, in 1971. Originally intended to protect sites of importance, especially as waterfowl habitat, the Convention has broadened its scope over the years to cover all aspects of wetland conservation and wise use, recognising wetlands as ecosystems that are extremely important for biodiversity conservation in general and for the well-being of human communities. Ramsar sites are not referred to under the Directives or their transposition into UK and ROI Regulations. However, Planning Policy Statement 2 (PPS2) in Northern Ireland applies the same level of consideration and protection to them as to Natura 2000 sites.

1.3 Legislative background

- 1.3.1 Article 6(3) of the Habitats Directive, as abstracted below, places an obligation on competent authorities of member states charged with determining consent for projects and plans which are not directly connected with or necessary to the management of a Natura 2000 site to undertake an appropriate assessment if such projects or plans are likely to have a significant effect on the site.

Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans and projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives. In light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public

- 1.3.2 The obligation, and those of the Habitats Directive more widely, have been transposed into Northern Ireland legislation by way of the Conservation (Natural Habitats, &c) (Northern Ireland) Regulations 1995 as amended (The NI Regulations) and into Republic of Ireland legislation by way of the European Communities (Natural Habitats) Regulations 1997 (as amended) (The ROI Regulations).
- 1.3.3 The two Ramsar Sites under consideration have been subject to a screening exercise for the currently proposed scheme based on the guidance provided in HD 44/09 and using the suggested screening matrix template provided in Annex 4 of the guidance to record the findings of the process. In both instances it has been concluded:

- the proposed scheme is a project which is not connected with or necessary to the management of the Ramsar Sites;
- the likelihood of the proposed scheme having a significant effect on the sites cannot be excluded on the basis of objective information; and
- that appropriate assessments should accordingly be undertaken.

1.3.4 Copies of the screening matrices are provided in Appendix 1.

1.3.5 Paragraph 4 as referred to in Article 6(3) makes provision for further consideration where an appropriate assessment cannot conclude a plan or project will not adversely affect the integrity of a designated site. This will be a matter for further consideration subject to the findings of the appropriate assessments for the Ramsar Sites.

1.3.6 The definition for integrity adopted in this report is that provided in Environment & Heritage Service (2002) Habitat Regulations - Guidance Notes For Competent Authorities which defines integrity in the context of a designated site as:-

The coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified.

2 Assessment methodology

2.1 Scope of the information to inform the appropriate assessments.

2.1.1 The scope for the studies and assessments which form the focus of the information provided in this report has been established in light of the findings of the screenings for the designated sites. Likely impacts identified relate to:

- loss of feeding habitat (functional habitat)² at Dunalong/Thorn Hill and Grange Foyle outside of the Ramsar Sites and which is used by wintering birds associated with the Ramsar Sites;
- disturbance of wintering birds associated with the Ramsar Sites during their use of feeding habitat outside of the Ramsar Sites at Dunalong/Thorn Hill and Grange Foyle;
- disturbance or harm to Atlantic salmon and sea lamprey as species identified as a species qualifying under the Ramsar Site Selection Criteria and the wider catchments supporting populations of these species;
- loss of habitat supporting Atlantic salmon and sea lamprey within the wider catchments supporting populations of these species.

Loss of feeding habitat used by wintering birds associated with the two Ramsar Sites

2.1.2 The assessment has involved quantification of the extent of available feeding habitat within the Dunalong /Thorn Hill and Grange Foyle areas and comparison with the total extent of such habitat available in the two areas.

Disturbance of wintering birds associated with the two Ramsar Sites during their use of feeding habitat at Dunalong/Thorn Hill and Grange Foyle

Data Sources

2.1.3 The following data sources have been relied on:

- data provided in the A5WTC ES 2010, including surveys undertaken at Dunalong/Thorn Hill and Grange Foyle between October 2009 and April 2010;
- data derived from site surveys undertaken at Dunalong/Thorn Hill and Grange Foyle between October 2013 and April 2014 in 2012 and 2013 by the Mouchel assessment team;

² Habitat outside of a designated site which is used / relied on by species associated with the designated site

- data for use of the area by whooper swan for 2010-2013 provided by the Irish Whooper Swan Study Group.

Impact assessment

- 2.1.4 There are no generally accepted thresholds for the loss of functional habitat or the numbers of birds which may be disturbed and displaced in the short-term or long-term from areas of functional habitat. Determination of whether either or both is likely to have a significant effect on the area of functional habitat and the species which use / are reliant on the area with consequent effects on the integrity of a designated site is necessarily context specific.
- 2.1.5 In the case of the two Ramsar sites considered in this report, habitat loss has been quantified and represented as a percentage of the habitat which surveys have indicated are used and the overall extent of potential functional habitat within the area in the vicinity of the proposed scheme.
- 2.1.6 Potential for disturbance of the whooper swan and greylag geese which annually utilise the area has been considered relative to sources of disturbance during construction and operation and identification and consultation with NIEA and RSPB(NI) regarding mitigation measures with a particular focus on construction activities which are likely to involve higher and tonally distinct noise levels and characteristics.

Disturbance or harm to Atlantic salmon and sea lamprey associated with the two Ramsar Sites

Data Sources

- 2.1.7 The following data sources have been relied on:
- data provided in the A5WTC ES 2010;
 - data derived from site surveys undertaken in 2012 and 2013 by the Mouchel assessment team at specific locations where the provision of bridges, culverts, watercourse diversions and drainage outfalls will involve construction on watercourses within the wider Foyle Catchment to establish the presence, potential presence or absence of salmonid holding (resting), spawning or nursery habitat in the specific locations;
 - data derived from surveys undertaken by Loughs Agency along sections of watercourses where the proposed of bridges, culverts, watercourse diversions and drainage outfalls are located to establish the presence, potential presence or absence of salmonid holding, spawning or nursery habitat in the relevant sections; and
 - Discussion with Loughs Agency regarding the potential presence of sea lamprey.
- 2.1.8 Data is also being collected by Loughs Agency by way of ongoing site surveys to establish if there are indications of Atlantic salmon presence or potential presence along the relevant sections of watercourse. Where either or both of the two sets of data relating to location-

specific and section-related salmonid interest have indicated salmonid presence or potential they have been classified as sections of salmonid watercourse. For the purposes of this initial assessment, and in keeping with a precautionary approach, it has been assumed that all watercourses with salmonid potential are utilised by Atlantic salmon, and that all watercourses are used by sea lamprey.

2.1.9 The location-specific site surveys were undertaken in August and September 2012, July to September 2013 and January 2014. The surveys were conducted in accordance with guidance issued by the Department of Agriculture for Northern Ireland (Fisheries Division) and agreed with Loughs Agency. The relevant watercourses were surveyed 250m upstream and downstream from each bridge, culvert, watercourse diversion or outfall. The following data was collected:

- Flow velocity – this was taken where possible using an in-stream flow meter with impeller to provide a count or measured by timing a floating object over a known distance, velocity has then been calculated using the count, depth and width measurements – the flow velocity is critical to keep eggs/fry in a spawning/ nursery area well oxygenated,
- In-stream vegetation – presence and extent was estimated looking downstream to the left and right – in-stream vegetation can provide adequate cover in the nursery habitat as shelter from predators,
- The extent of mature scrubby bank cover where present – mature scrubby vegetation can provide cover for nursery areas as well as stability and cover in holding areas,
- The extent of overhanging bank cover where present – overhanging tree and scrub cover can enhance the food supply available for fry in nursery areas by way of insects dropping off branches into the water,
- Water depth – the depth of the water is important for all three habitat classifications. Adequate depth in spawning areas ensures that redds³ are covered by water at all times. Shallow water in the nursery area makes the fry less vulnerable to predation not only from larger fish but also rippling of the water surface makes them less easily seen by birds. Deeper water allows adult fish to rest where the minimum energy is required to stay on station,
- Water width – this measurement has been used in combination with depth to calculate flow velocity,
- Substrate type – this has been measured as a percentage of bedrock, boulder, cobble, gravel, fines, sand, silt and mud – a stable substrate in holding areas allows adult fish secure resting areas on a staged ascent/ descent of the river. A stony substrate

³ A redd is a spawning nest dug in gravels of the stream bed by fish, especially salmon

provides good shelter from predators and creates more territory space allowing it to accommodate more fry in the nursery area. This stable environment also will invariably have more invertebrates living on the stones as a source of food for the fry. The presence and size of gravel is critical for the creation of a redd in salmonid spawning areas whilst the presence of large quantities of finer silt material with gravel can cause compaction of the gravel making redd construction more difficult and reduce oxygen supply to the eggs,

- Gravel depth – the depth of gravel and, thereby, the potential depth of a redd exerts a strong influence on spawning in relation to the size and type of fish able to lay eggs in an area.

2.1.10 Photographs of the site, with upstream and downstream views were taken where possible. Additional comments on the watercourse characteristics were also recorded where relevant.

Impact assessment

2.1.11 The data collected from the location-specific surveys has been reviewed and each location has been classified relative to its salmonid potential in accordance with the Annex 1 Habitat Classification detailed in the Fisheries Division guidance. Each location has been categorised relative to holding spawning or nursery habitat into one of four grades, grade 1 being optimal habitat and grade 4 indicating an absence of habitat or habitat which is failing. Only locations with classifications of 4 relative to all three holding, spawning or nursery habitat types have been excluded as not being of salmonid interest subject to evaluation against the findings of the Loughs Agency's section-based survey data. All watercourses are assumed to have potential sea lamprey presence.

2.1.12 Information relating to the nature of the construction activities which will be required to install the proposed bridges, culverts, watercourse diversions and drainage outfalls has been confirmed with the contractor advisors to Roads Service. Consideration has also been given to sections of watercourses which will be located within 50m of the proposed working areas and, hence, where the risk of migration of sediments over ground, particularly during rainfall, could have an impact on water quality and /or marginal and aquatic habitats. The assessment has involved consideration of the risk taking into account proposed mitigation measures which have been agreed with the contractor advisors and which will be incorporated into a Construction Environment Management Plan (CEMP) and Silt Management Plan (SMP) which contractors will be required to adopt during construction.

2.1.13 Loughs Agency has indicated a threshold comprising a maximum increase of 10mg/l in concentrations of in-stream sediment, measured as Total Suspended Solids (TSS), above background levels should be adhered to during construction for watercourses identified as having Atlantic salmon interest.

2.1.14 The assessments relative to impacts associated with the future use of the proposed scheme have been focused on discharge of sediments from drainage outfalls which could result in the smothering of salmonid habitat, harm to fish as they pass through the relevant section of watercourse and fragmentation associated with obstruction of passage along watercourses.

2.1.15 In relation to discharge of sediments and other road related pollutants from the proposed road drainage networks, analysis and calculations have been undertaken to establish if design parameters agreed with NIEA and Loughs Agency, will be likely to be achieved and if water quality relative to sediments and other pollutants, such as metals and hydrocarbons, associated with road related run-off will prove acceptable in the context of the ecological status of the watercourses using the Highways Agency Water Risk Assessment Tool (HAWRAT). The HAWRAT is an assessment tool which is recommended in Volume 11 of the DMRB and which has been agreed with the statutory bodies responsible for water quality throughout the UK. NIEA has agreed it as the appropriate means of assessing the discharge concentrations for the proposed scheme. The outcome from the application of the HAWRAT is that a discharge will either pass or fail in light of the predicted concentrations of sediments and other pollutants and the sensitivity for the receiving watercourse. Where the evaluation has indicated an outfall will fail, appropriate combinations of mitigation measures have been identified and the evaluation has been re-run until the outfall achieves a pass.

2.1.16 The design parameters required by NIEA and Loughs Agency are:

- a threshold of 50mg/l TSS concentrations in discharges at all outfalls; and
- a threshold of 25mg/l TSS in-stream concentrations downstream of all outfalls in keeping with the Water Framework Directive (WFD) recommended in-stream concentrations relative to the passage of fish.

2.1.17 Evaluation of the 50mg/l discharge threshold at outfalls has involved adoption of the standard TSS value of 116mg/l for untreated road runoff from the Highways Agency 'cold and wet' climatic region (which includes Northern Ireland)⁴ and identification of appropriate combinations of mitigation measures for inclusion in the drainage design to achieve a minimum 57% sediment treatment required to achieve the threshold. The untreated TSS value has been taken from Phase 2 of the Improved Determination of Runoff from Highways Project (Crabtree et al, 2007).

2.1.18 The calculations relating to the 25mg/l downstream concentrations have involved use of the local standard annual average rainfall value in combination with the impermeable area of each drainage network to establish an annual volume of water draining through each network to outfall. The standard TSS value of 116mg/l for untreated road runoff adopted for evaluation of the 50mg/l discharge threshold has been applied. The sediment loading has been compared to the receiving annual water flow volume and TSS data for the receiving watercourse. Data for TSS was gained from a combination of Loughs Agency and NIEA Monitoring Stations and surveys undertaken by Mouchel prior to the publication of the A5WTC ES 2010. Where the calculation has indicated a concentration will exceed the in-stream threshold, appropriate combinations of mitigation measures have been identified and the calculation has been re-run until the outfall achieves a pass.

⁴ As per the WRC report 'Improved Determination of Pollutants in Highway Runoff Phase 2. Wrc Report UC7309.

- 2.1.19 The identification of the specific mitigation measures proposed for each drainage outfall has involved the adoption of the most onerous combination of measures in light of the outcome of all three evaluations.
- 2.1.20 Where more than one outfall discharges into the same reach of a watercourse the combined impacts will be more significant. In these circumstances the outfalls were subject to an aggregate assessment in HAWRAT.
- 2.1.21 To aggregate the outfalls the drained areas were simply added together. The location on the watercourse used for the cumulative assessment was positioned downstream of the last outfall in the reach. For this purpose a reach is defined as a length of watercourse between two confluences, as the available dilution and stream velocity will naturally change at confluences and influence the assessment.
- 2.1.22 Watercourse reaches can vary greatly in length. Therefore, for the assessment of the impacts of soluble pollutants, only outfalls within 1km of each other along the length of a watercourse were aggregated for cumulative assessment. When assessing the combined impact of sediment bound pollutants, outfalls within 100m of one another were assessed. Beyond 100m, the road runoff sediment is likely to be sufficiently diluted with natural sediments so as not to have an adverse impact.

2.2 Determination of adverse impact relative to integrity

- 2.2.1 Once the potential impacts have been identified, they are considered in relation to the potential to have a negative effect on the integrity of the Ramsar Sites. The assessment determines whether there is likely to be:
- a reduction in the coherence of the ecological structure or function of the site, taking into account the whole area of the site, and supporting habitats which are integral to the structure and function of the site, and
 - whether any such reduction would reduce the ability of the site to sustain the qualifying species for which it was classified.
- 2.2.2 The DMRB guidance (HD 44/09) provides a suitable checklist to identify interactions and potential effects on the integrity of the site. Discussion with NIEA indicates that there are no separate conservation objectives available for the Ramsar Sites, therefore the objectives assessed are those from the Lough Foyle and Lough Neagh & Lough Beg SPAs, with additional consideration given to conservation of Atlantic salmon taken from the River Foyle & Tributaries, River Finn and Owenkillev SAC conservation objectives. Completed checklists are provided in Appendix 9.

3 Description of the proposed scheme

3.1 Whooper swan and greylag geese

Alignment and relationship to the functional habitat associated with the Ramsar Sites

- 3.1.1 The proposed scheme comprises an 85km dual carriageway running between the existing A5 north of New Buildings and the existing A5 south of Aughnacloy. Its location and relationship to the two Ramsar Sites is shown in Figure 1 in Appendix 2.
- 3.1.2 The proposed dual carriageway initially runs east of the River Foyle between Magheramason and the River Mourne at Strabane. As it runs south it crosses two tributaries of the Foyle, the Burn Dennet and the Glenmornan River and a number of small watercourses and drainage channels which feed into the main river channel and the two principal tributaries. It is at its closest to the designated site at Magheramason (some 50m).
- 3.1.3 The section of the proposed scheme corridor which is of relevance to the qualifying bird populations of the Ramsar Sites is that between Magheramason and the Burn Dennet. Here, the proposed dual carriageway will generally be located between 1.2 and 2km east of the River Foyle. It is an area of mixed arable and agricultural grassland some 40% of which is within the River Foyle floodplain. Parts of the area are used annually by whooper swan and greylag geese associated with the Lough Foyle Ramsar Sites for feeding and by whooper swan from Lough Neagh & Lough Beg Ramsar Site during migration.
- 3.1.4 Over this section, the proposed scheme follows a north-south alignment which broadly reflects that of the existing A5. Between Magheramason and Bready it will be located some 200-250m west of the existing road and will be on embankment as it crosses Meenagh Road and approaches a proposed bridge over the existing A5, Victoria Road north of its existing junction with Cloghboy Road. South of the new bridge, the alignment will initially encroach onto the lower western-facing slopes of Sollus Hill in deep cutting. As the dual carriageway continues south it will be some 200m east of the existing road. It will emerge from the cutting and follow an alignment roughly parallel with the A5, crossing beneath Donagheady Road. and following a gentle curve to the south-west, passing between Willow Farm and housing on the A5, Victoria Road. It will cross Willow Road in shallow cutting and rise on high embankment to enable it to be bridged over the A5, Victoria Road. The dual carriageway will descend from the bridge to cross Ash Avenue on low embankment before rising again onto high embankment and crossing Drumenny Road via a new bridge before approaching and crossing the Burn Dennet via a new open span bridge.
- 3.1.5 Construction of this section, other than at Sollus Hill, will involve the use of large excavators, dump trucks for transporting excavated materials to areas of fill within the working areas, bulldozers, graders, compaction plant including various rollers and soil stabilisation plant. It is not anticipated there will be a need for blasting, the break out of rock at Sollus Hill being implemented by way of rock breakers.
- 3.1.6 The dual carriageway then follows an alignment along the western margin of Strabane crossing the Mourne River and running close to the eastern boundary of the River Finn as far as a proposed roundabout (J7) located adjacent to the bank of the river. The dual

carriageway then follows a south-easterly alignment away from the River Finn. It is located on the eastern-facing slopes of the Mourne Valley at a distance varying between 500m and 1.5km from the western margins of the river. It crosses a small tributary of the Mourne River as it approaches and passes west of Victoria Bridge some 700m west of the tributary's confluence with the main river.

- 3.1.7 Approximately mid-way between Victoria Bridge and Newtonstewart the dual carriageway crosses the River Derg, some 700m west of the confluence of the River Derg, the Mourne River and the River Strule. As the dual carriageway runs south across the wide Derg Valley it crosses over a south to north flowing tributary of the River Derg west of Wood Hills and then ascends the hills west of Newtownstewart. It passes west of Newtownstewart some 500m west of the settlement limits. At this point the dual carriageway will be approximately 900m west of the River Strule where it flows to the east of the town and 1.8km west of the Owenkillew River where it extends east from the Owenkillew's confluence with the River Strule.
- 3.1.8 Continuing south of Newtonstewart, the dual carriageway will curve to the south-west and descend the eastern facing slopes of the Strule Valley to follow an alignment on the lower valley slopes. It will be 200-300m distant from the River Strule and separated from the margins of the river channel by the existing A5.
- 3.1.9 As the dual carriageway emerges from the valley the river will become markedly more distant from the dual carriageway where the river channel is located in a significant easterly-orientated meander. The dual carriageway continues on its south-westerly alignment passing west of Mountjoy and east of Tully Bog to a crossing of the Fairy Water some 400m north-west of its confluence with the River Strule. Throughout this section of the alignment the dual carriageway is located some 1km – 2km from the River Strule and will cross a number of small tributaries of the main river and drainage channels which feed into the tributaries.
- 3.1.10 Once the dual carriageway has crossed the Fairy Water and its wide floodplain, it will follow a wide arc west of Omagh to a new junction (J13) south of the town. It will cross a number of small watercourses which run in an easterly direction through the urban area to the River Strule as it flows through the town. North-west of J13 it will cross the Drumragh River as it meanders west and then south to north to its confluence with the River Strule close to the town centre.
- 3.1.11 South of J13 the dual carriageway generally follows a north to south alignment crossing tributaries of the Camowen River between Doogary Bog and Moylagh, a tributary of the Routing Burn at Moylagh, the Routing Burn north of Newtownsaville and the head of a tributary of the Routing Burn south of Newtownsaville.
- 3.1.12 The proposed scheme will then continue south, descending through the Brougher Ridge and into the Blackwater River Catchment. There will be no relationship between these sections of the proposed scheme and watercourses within the Foyle Catchment.

3.2 Bridges

- 3.2.1 Open span bridges are proposed where the dual carriageway crosses the seven principal rivers within the Foyle Catchment, namely the Burn Dennet, Glenmornan River, River Mourne, River Derg, Fairy Water, Drumragh River and the Routing Burn.

3.3 Culverts and piped watercourses

- 3.3.1 Wherever the proposed scheme crosses watercourses, other than the seven rivers described above, the proposals provide for the introduction of a culvert on the existing line of the watercourse or a culvert which forms part of a diverted section of watercourse. The latter approach is to be adopted where the angle of the crossing would require an overly long culvert or relative levels between the carriageways and existing channel of the watercourse require diversion to achieve appropriate clearances.
- 3.3.2 A total of 107 culverts are proposed within the Foyle catchment. These are scheduled in Appendix 3 and indicated in Figures 4-9 in Appendix 2). Selection of the form of culvert to be provided relates to the volumes of flow, context relative to floodplains and status relative to salmonids. Box culverts are proposed where volumes and/or the flooding regime indicates a need. They are also provided where the sections of watercourse have been identified as ones with salmonid presence or potential identified in accordance with the data and surveys described in 2.1.7-2.1.10 and the criteria described in 2.1.12. Those where salmonid potential has informed the selection of box culvert are indicated in the schedule in Appendix 3.
- 3.3.3 The design for culverts provided in light of the salmonid potential of a watercourse allows for a 350mm embedding of the culvert base below existing ground level and import of boulders and clean gravels which have been screened to ensure no invasive species are imported. The boulders and gravels will be substantially filled to the embedded depth to recreate suitable habitat and allow the generation of a narrower channel during periods of lower flow. The channel will not be completely filled to allow for natural recruitment of river bed material and formation of a 'natural' channel.
- 3.3.4 Boulders will also be located upstream and downstream of the culverts to enhance the value of these locations as resting areas prior to and following the passage of fish through the structures. Placement of the boulders and gravels within the culverts and upstream and downstream of them will be undertaken in consultation with Loughs Agency personnel.
- 3.3.5 Construction of all culverts will involve either the introduction of a temporary diversion to maintain flows and passage along the watercourses where the culvert is on line or the completion of construction of the culverts on diverted sections or watercourse in advance of the abandonment of the existing section of watercourse which is being diverted.

3.4 Watercourse diversions

- 3.4.1 A total of 77 watercourse diversions are proposed along watercourses located within the Foyle catchment. They are scheduled in Appendix 4. Their location is indicated in Figures 4 - 9 in Appendix 2. The schedule in Appendix 4 also indicates those sections of watercourse

which have been identified as being of salmonid interest, with all watercourses assumed to be of sea lamprey interest.

- 3.4.2 The construction of all watercourse diversions will involve the completion of construction of the diversions in advance of the abandonment of the existing section of watercourse which is being diverted.

3.5 Drainage and outfalls

- 3.5.1 The drainage strategy for the proposed scheme provides for discharge of road related run-off to existing watercourses. It includes a range of Sustainable Drainage Systems (SuDS) features focused on the interception and reduction in concentrations of sediments and other potentially harmful substances which are either suspended or in soluble form within road related run-off prior to discharge. Measures include the use of swales, attenuation ponds and wetlands. Discharges will be subject to Rivers Agency Consent prior to commencement of construction.

- 3.5.2 The proposals have been based on the following design parameters:

- adoption of the 1 year, 5 minute duration, return period storm event with an additional 20% allowance for climate change;
- adoption of a target limit of 50mg/l for TSS at all discharges to watercourses in accordance with NIEA requirements;
- adoption of a 25mg/l TSS concentration in-stream threshold downstream of the outfalls, in accordance with the recommended threshold in the Water Framework Directive relative to the passage of fish. It has been assumed for the purposes of the proposed scheme that all watercourses receiving road related run-off are of value to fish.
- adoption of the Q90⁵ flow rate for receiving watercourses for the purposes of calculating TSS concentrations in receiving watercourses following treatment as agreed with LA.

- 3.5.3 A total of 78 drainage outfalls are proposed to watercourses within the River Foyle Catchment. These are scheduled in Appendix 5. Their location is indicated in Figures 4-9 in Appendix 2. The schedule also indicates the design/mitigation measures which are proposed at the various outfalls which have been included to facilitate achievement of the design parameters relative to TSS concentrations and HAWRAT parameters relative to pollutants.

- 3.5.4 Construction of the proposed outfalls will involve localised removal of bankside and marginal vegetation and installation of headwalls, wingwalls and aprons as indicated in the typical outfall detail provided in Figure 10.

⁵ The Q90 flow rate is the rate which is exceeded 90% of the time in a watercourse, and is calculated using computer modelling of the watercourse's catchment.

3.6 Lighting

3.6.1 The dual carriageway will not be lit other than at the proposed junctions. Lighting will accordingly be located in the vicinity of several watercourses identified as having salmonid interest within the SACs or of tributaries and small watercourses associated with the wider River Foyle Catchment.

3.7 Temporary structures

3.7.1 Temporary structures are proposed for crossing the Burn Dennet, Glenmornan, River Derg and the Fairy Water. These structures will be required for the duration of the construction of the appropriate phase (approximately 3 years).

3.7.2 During construction smaller existing watercourses will need to be crossed until the mainline of the proposed scheme is structurally complete, at which point the temporary crossing can be removed. Following discussion with Loughs Agency it has been agreed these watercourses will be crossed using single bore pipes placed in stream with suitable cover placed over the pipe.

3.7.3 Where a smaller watercourse is to be provided with a pipe culvert in the final design, this culvert will be constructed and used as the crossing during construction of the remainder of the phase.

4 The Two Ramsar Sites

4.1 Introduction

- 4.1.1 The location, extent and relationship of the two Ramsar Sites to the proposed scheme is indicated in Figure 1 in Appendix 2. Details relating to the habitats and species identified as the primary reason for selection as a Ramsar Site and qualifying species are described in Table 4.1. A comment on the vulnerability of the site is included. The information has been obtained from the Ramsar Site Information Forms obtained from the Ramsar Site Information Service website (www.ramsar.wetlands.org). The Ramsar Site Information Forms are enclosed in Appendix 8.

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Table 4.1 Site Descriptions

Site Name	Designation & Code	Ramsar Criteria	Vulnerability
		Details Rationale for Criteria	
Lough Foyle	Ramsar 3UK133	1, 2, 3, 5, 6 ⁶	Introduction of invasive species of plant e.g. <i>Spartina spp.</i>
		<p>Ramsar criterion 1</p> <p>This is a particularly good representative example of a wetland complex including intertidal sand and mudflats with extensive seagrass beds, saltmarsh, estuaries and associated brackish ditches.</p> <p>This is a particularly good representative example of a wetland, which plays a substantial hydrological, biological and ecological system role in the natural functioning of a major river basin which is located in a trans-border position.</p>	
		<p>Ramsar criterion 2</p> <p>The site supports an appreciable assemblage of rare, vulnerable or endangered species or sub-species of plant and animal. A range of notable fish species have been recorded for the Lough Foyle estuary and the lower reaches of some of its tributary rivers. These include allis shad <i>Alosa alosa</i>, twaite shad <i>A. fallax fallax</i>, smelt <i>Osmerus eperlanus</i> and sea lamprey <i>Petromyzon marinus</i>, all of which are Irish Red Data Book species. In addition, important populations of Atlantic salmon <i>Salmo salar</i> migrate through the system to and from their spawning grounds.</p>	
		<p>Ramsar criterion 3</p> <p>The site supports a diverse assemblage of wintering waterfowl which are indicative of wetland values, productivity and diversity. These include internationally important populations of whooper swan <i>Cygnus cygnus</i>, light-bellied brent goose <i>Branta bernicla hrota</i> and bar-tailed godwit <i>Limosa lapponica</i>. Additional wildfowl species which are nationally important in an all-Ireland context are red-throated diver <i>Gavia stellata</i>, great crested grebe <i>Podiceps cristatus</i>, mute swan <i>Cygnus olor</i>, Bewick's Swan <i>C.</i></p>	

⁶ Ramsar Selection Criteria are explained in Appendix 8

Site Name	Designation & Code	Ramsar Criteria	Vulnerability
		Details Rationale for Criteria	
		<p><i>columbianus</i>, greylag goose <i>Anser anser</i>, shelduck <i>Tadorna tadorna</i>, teal <i>Anas crecca</i>, mallard <i>Anas platyrhynchos</i>, wigeon <i>A. penelope</i>, eider <i>Somateria mollissima</i>, and red-breasted merganser <i>Mergus serrator</i>. Nationally important wader species are oystercatcher <i>Haematopus ostralegus</i>. golden plover <i>Pluvialis apricaria</i>, grey plover <i>P. squatarola</i>, lapwing <i>Vanellus vanellus</i>, knot <i>Calidris canutus</i>, dunlin <i>C. aplina</i>, curlew <i>Numenius arquata</i>, redshank <i>Tringa totanus</i> and greenshank <i>T. nebilaria</i>.</p>	
		<p>Ramsar criterion 5 The site supports about 29000 migrating birds. Species and numbers are listed in Section 20 of the Ramsar Information Sheet in Appendix 8.</p>	
		<p>Ramsar criterion 6 Qualifying Species/populations (as identified at designation): <i>Species with peak counts in spring/autumn:</i> Whooper swan, <i>Cygnus cygnus</i>, Iceland/UK/Ireland Light-bellied brent goose, <i>Branta bernicla hrota</i>, East Canada/Ireland <i>Species with peak counts in winter:</i> Bar-tailed godwit, <i>Limosa lapponica lapponica</i>, W Palearctic</p> <p>Contemporary data and information on waterbird trends at this site and their regional (sub-national) and national contexts can be found in the Wetland Bird Survey report, which is updated annually. See www.bto.org/survey/webs/webs-alerts-index.htm. See Sections 19/20 of the Ramsar Information Sheet in Appendix 3 for details of noteworthy species Details of bird species occurring at levels of National importance are given in Section 20 of the Ramsar Information Sheet in Appendix 8.</p>	

Site Name	Designation & Code	Ramsar Criteria	Vulnerability
		Details Rationale for Criteria	
Lough Neagh & Lough Beg	Ramsar 3UK009	1, 2, 3, 4, 5, 6, 7 ⁷	Eutrophication and pollution by fertilisers.
		<p>Ramsar criterion 1</p> <p>A particularly good representative example of natural or near-natural wetlands, common to more than one iogeographic region. The site is the largest freshwater lake in the United Kingdom. Lough Neagh a relatively shallow body of water supporting beds of submerged aquatic vegetation fringed by associated species-rich damp grassland, reedbeds, islands, fens, marginal swampy woodland and pasture. Other interesting vegetation types include those associated with pockets of cut-over bog, basalt rock outcrops and boulders, and the mobile sandy shore.</p>	
		<p>Ramsar criterion 2</p> <p>Supports an appreciable assemblage of rare, vulnerable or endangered species or sub-species of plant or animal or an appreciable number of individuals of any one of these species. The site supports over 40 rare or local vascular plants which have been recorded for the site since 1970; the most notable are eight-stamened waterwort <i>Elatine hydropiper</i>, marsh pea <i>Lathyrus palustris</i>, Irish lady's tresses <i>Spiranthes romanzoffiana</i>, alder buckthorn <i>Frangula alnus</i>, narrow small-reed <i>Calamagrostis stricta</i> and holy grass <i>Hierochloe odorata</i>. The Lough and its margin are also home to a large number of rare or local invertebrates, including two aquatic and two terrestrial molluscs, a freshwater shrimp <i>Mysis relicta</i>, eight beetles, five hoverflies, seven moths and two butterflies. Of the rare beetles recorded two, <i>Stenus palposus</i> and <i>Dyschirius obscurus</i>, have their only known Irish location around the Lough. The Lough also supports twelve species of dragonfly.</p>	
		<p>Ramsar criterion 3</p> <p>This site is of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna. The site regularly supports substantial numbers of individuals from particular groups of waterfowl which are indicative of wetland values, productivity and diversity. In addition, this site is of</p>	

⁷ Ramsar Selection Criteria are explained in Appendix 8

Site Name	Designation & Code	Ramsar Criteria	Vulnerability
		Details Rationale for Criteria	
		special value for maintaining the genetic and ecological diversity of Northern Ireland because of the quality and peculiarities of its flora and fauna. A large number of plants and animal species are confined or almost confined to this area within Northern Ireland.	
		<p>Ramsar criterion 4</p> <p>This site is of special value as the habitat of plants or animals at a critical stage of their biological cycles. The site supports an important assemblage of breeding birds including the following species with which occur in nationally important numbers: great crested grebe <i>Podiceps cristatus</i>, gadwall <i>Anas strepera</i>, pochard <i>Aythya ferina</i>, tufted duck <i>Aythya fuligula</i>, snipe <i>Gallinago gallinago</i> and redshank <i>Tringa totanus</i>. Other important breeding wetland species include shelduck <i>Tadorna tadorna</i>, teal <i>Anas crecca</i>, shoveler <i>Anas clypeata</i>, lapwing <i>Vanellus vanellus</i> and curlew <i>Numenius arquata</i>.</p>	
		<p>Ramsar criterion 5</p> <p>Assemblages of international importance:</p> <p><i>Species with peak counts in winter:</i></p> <p>86639 waterfowl (5 year peak mean 1998/99-2002/2003)</p> <p>Species and numbers are listed in Section 20 of the Ramsar Information Sheet in Appendix 8.</p>	
		<p>Ramsar criterion 6</p> <p>Qualifying Species/populations (as identified at designation):</p> <p><i>Species with peak counts in spring/autumn:</i></p> <p>Tundra swan, <i>Cygnus columbianus bewickii</i>, NW Europe</p> <p><i>Species with peak counts in winter:</i></p> <p>Common goldeneye, <i>Bucephala clangula clangula</i>, NW & C Europe</p> <p>Common pochard, <i>Aythya ferina</i>, NE & NW Europe</p> <p>Greater scaup, <i>Aythya marila marila</i>, W Europe</p> <p>Tufted duck, <i>Aythya fuligula</i>, NW Europe</p> <p>Whooper swan, <i>Cygnus cygnus</i>, Iceland/UK/Ireland</p>	

Site Name	Designation & Code	Ramsar Criteria	Vulnerability
		Details Rationale for Criteria	
		<p>Species/populations identified subsequent to designation for possible future consideration under criterion 6.</p> <p><i>Species with peak counts in spring/autumn:</i> Great cormorant, <i>Phalacrocorax carbo carbo</i>, NW Europe Mute swan, <i>Cygnus olor</i>, Britain</p> <p>More contemporary data and information on waterbird trends at this site and their regional (sub-national) and national contexts can be found in the Wetland Bird Survey Alerts report, which is updated annually. See http://www.bto.org/survey/webs/webs-alerts-index.htm.</p>	
		<p>Ramsar criterion 7</p> <p>The site supports a population of pollan <i>Coregonus autumnalis</i>, one of the few locations in Ireland and one of the two known locations in the UK (the other is Lower Lough Erne). It is one of the most important species in Ireland in terms of faunal biodiversity since it occurs nowhere else in Europe, and the Irish populations are all well outside the typical range – the Arctic Ocean drainages of Siberia, Alaska and north-western Canada, where it is known as the Arctic cisco.</p>	

5 Potential impacts and mitigation

5.1 Loss of feeding habitat used by wintering birds associated with the Ramsar Sites

- 5.1.1 The area of the Foyle floodplain between Magheramason in the north and the Burn Dennett in the south has been identified by RSPB and the Irish Whooper Swan Study group as the area of functional habitat for which there is an interaction between the proposed scheme and the qualifying species of the Ramsar Sites.
- 5.1.2 There is approximately 1200 ha of potential foraging habitat within the area.
- 5.1.3 Figures 2 and 3 in Appendix 2 provide peak count numbers and locations of all recorded qualifying bird species for the surveys undertaken in 2009-2010 and 2013-2014 respectively. The numbers demonstrate that the area is used by two of these species, whooper swan and greylag goose. They also demonstrate that numbers for 2013-2014 have been significantly lower than the numbers recorded in 2009-2010 and that fewer parts of the area have been used. This is most likely due to the mild winter experienced in 2013-2014, which meant birds did not need the functional habitat of the Foyle floodplain as much as in 2009-2010. For the purposes of this assessment it has been assumed the higher numbers and more dispersed pattern recorded in 2009-2010 is more representative of the use of the area by birds associated with the functional habitat.
- 5.1.4 During 2009-2010 an area of approximately 330 ha was used by up to 430 whooper swan, and an area of approximately 150 ha was used by up to 350 greylag geese. During 2013-2014 an area of approximately 130 ha was used by up to 205 whooper swan, and an area of approximately 117 ha was used by up to 65 greylag geese.
- 5.1.5 The proposed scheme will involve the loss of approximately 40 ha of land within the area of potential functional habitat representing some 3% of the total area of potential habitat. None of the land take will affect parts of the area where use by either species has been recorded in the two surveys periods, in addition, there are alternative feeding sites located elsewhere along the river.
- 5.1.6 In light of the small percentage of potential loss and absence of loss in areas where use has been demonstrated, it has been concluded there will be no need for mitigation in the form of provision of compensatory habitat.

5.2 Disturbance of wintering birds associated with the Ramsar Sites during their use of feeding habitat at Dunalong/Thorn Hill and Grange Foyle

Construction disturbance

- 5.2.1 With regard to disturbance of the two species associated with construction of the proposed scheme, studies reported by Rees et al (2005) - Factors affecting the behavioural responses of whooper swans (*Cygnus c. cygnus*) to various human activities noted that pedestrian presence disturbed whooper swan when within 250-400m, and that construction vehicles disturbed whooper swan when within 250m, in contrast to tractors which caused disturbance when within 150m and other farm vehicles which caused disturbance when within 250m.

5.2.2 The proposed scheme will generally involve construction significantly more than 250m from those parts of the area of functional habitat where the presence of the species has been recorded during the surveys. Locations closest to parts of the area where presence has been recorded are:

- where the realignment of Donagheady Road will bring the works within 50m of an area of recorded use, although the works will be separated from the swans by the existing A5 with its current levels of traffic; and
- where proposed introduction of new link road between Ash Road and Drumenny Road will involve work within 100m of a part of the area where a maximum of 9 swans were recorded in 2009-2010.

5.2.3 There are two locations where construction will involve noise levels above those associated with the general activities associated with movement and activity of plant and vehicles; where the deep cutting at Bready will involve breaking out of rock at Sollus Hill and where piling will be required for the bridge abutments at the Burn Dennet. The Bready cutting is some 400m from the closest recorded whooper swan and over 1km from the closest recorded greylag geese. The Burn Dennet crossing is some 500m from the closest recorded whooper swan and over 2.5km from the closest recorded greylag geese.

5.2.4 Following discussion with the geotechnical advisors and contractor advisors for the project it has been confirmed that blasting is not likely to be required. Should further information come to light as the proposed scheme design is finalised which demonstrates a need for blasting, there will be a limitation placed on the timing of the activity to exclude the period between October and March when the birds are present.

5.2.5 There will also be a requirement under the contract that should it be the intention to undertake breaking out of rock at Bready and piling at the Burn Dennet within the period when the birds are present, trial breaking out and piling must be undertaken with monitoring by an appropriately qualified ecologist. The trials will involve short periods of breaking out and piling at prescribed intervals to establish if the activity results in disturbance which could prove detrimental should the more prolonged periods of the activities which will be required to complete the cutting and bridge abutments be progressed. Should the trials indicate this will be likely to be the case, the activities will be suspended until the birds have left the area.

Operational disturbance

5.2.6 The operation of the proposed scheme also has potential to cause disturbance to bird species, with the noise generated from increased traffic volume and speeds potentially causing the displacement of whooper swan through increased disturbance. However, behavioural impacts such as disturbance from feeding grounds as a result of construction or operation phases are always context-dependant, with responses to disturbance depending upon the trade-offs experienced by individual birds (Gill, 2007). For example, the decision to stay or to leave an area in response to disturbance will be influenced by the quality of the area, availability and relative quality of alternative areas, and relative predation risk on current and alternative sites among others (Gill, 2007). Habituation, that is 'the relatively

persistent waning of a response as a result of repeated stimulation which is not followed by any kind of reinforcement' (Hinde, 1970), has been demonstrated in the short-term in some studies on disturbance to whooper swan, however an increased tolerance did not appear to be maintained over longer periods with the behavioural patterns on a day to day basis providing additional support to this (Rees et al., 2005).

- 5.2.7 The Rees et al (2005) study was in relation to disturbance 'events' rather than exposure to constant stimuli. Whooper swan have been shown to quickly habituate to continuous traffic movements, for example at the Toome Bypass.
- 5.2.8 To determine the potential for disturbance of greylag geese it is important to understand the distances over which they will be disturbed. Keller (1989) identified greylag geese avoid roads in agricultural land in Scotland, with avoidance behaviour recorded for distances of 100m from roads. The closest recorded greylag geese in any of the studies undertaken was over 500m, thus operational disturbance is unlikely to occur.

5.3 Atlantic salmon and sea lamprey

- 5.3.1 The introduction of the proposed scheme into the existing mosaic of terrestrial and aquatic habitats within the River Foyle Catchment has the potential to affect Atlantic salmon and sea lamprey as a reason for selection of the Lough Foyle Ramsar Site where they are present within the Foyle catchment.
- 5.3.2 Potential impacts associated with the construction and future presence of the proposed scheme and its associated traffic which have been identified comprise:
- disturbance or harm associated with construction related noise, vibration and lighting within the Foyle catchment;
 - disturbance or harm associated with the construction of bridges, culverts, watercourse diversions and drainage outfalls and other locations where working areas including site compounds will be within 50m of watercourses within the Foyle catchment;
 - loss of habitat relied on by the species within the Foyle catchment;
 - fragmentation as a result of obstruction or prevention of passage for the species along watercourses within the Foyle catchment once the proposed scheme is open to use;
 - harm to the population of the species associated with the Ramsar Site as a result of increased concentrations of TSS and other harmful substances in watercourses associated with discharges from drainage outfalls for the proposed scheme; and
 - disturbance during use as a result of road related lighting in the Foyle catchment.

Construction related noise, vibration and lighting

Noise and vibration

- 5.3.3 Atlantic salmon are capable of detecting the pressure and particle motion components of sound; levels of anthropogenic noise and vibration may exceed the hearing threshold of Atlantic salmon (Hawkins and Johnstone, 1978). This is due to their physiological makeup and the particle composition of water and soil, which facilitate propagation further than in air (Popper, 2008). The resulting potential impacts can be hearing impairment (Nedwell et al., 2005) or death, either directly from the noise generation or indirectly as a result of hearing impairment. Lamprey lack any specialist hearing structures, making them less vulnerable to noise and vibration. There is potential however that lamprey may be able to hear infrasound. The hearing of lamprey is complicated by the fact that they do not have otolith organs and no known work has been undertaken on the response of lamprey to sound in relation to their statoliths or labyrinth organs. Work has been undertaken on cephalopods however, which also have statolith organs for the detection of linear accelerations including gravity (Packard et al., 1990). This investigation confirmed that cephalopods could detect the kinetic component of low frequency sounds and it is believed that the statoliths are the sensory organs involved (Packard et al., 1990). It was stated within this article that '*gross acceleration of the whole animal, as occurs in an underwater sound field, is an ideal stimulus for the statolith organ*'. On this basis it is considered likely that lamprey will be sensitive to infrasound. Construction activities associated with the proposed scheme likely to pose such a risk are blasting or piling particularly within watercourses.
- 5.3.4 The proposals do not require blasting or piling within watercourses. The establishment of abutment foundations at the proposed bridges will, however, involve piling close to the top of the bankside slopes at watercourses. In light of this, discussions have been held with Loughs Agency and appropriate mitigation measures have been identified and agreed.
- 5.3.5 In the case of the River Mourne crossing the contractors will be required to utilise Continuous Flight Auger piles. These are rotary bored piles which do not produce significant vibration. In the case of the foundations for the abutment walls at other bridges, the use of driven piles installed by a vibrating hammer will be permitted.
- 5.3.6 Mitigation to be incorporated in the construction procedure will include either a soft -start methodology, or a suitable deterrent device where this is not an option. The soft-start methodology will involve a gradual increase in force and intensity of piling, and hence, noise and vibration, over a 30 minute period to allow Atlantic salmon and lamprey to move outside of the area of influence. The soft-start methodology would be required each time the machinery is started following a 30 minute rest period. Where the soft-start methodology is not feasible or possible a suitable deterrent device (such as a Sound Projector Array) which generates underwater sound and strobe lighting to discourage fish from the area of influence will be used. The equipment would need to be run for a set period of time, approximately 15 minutes prior to the commencement of any piling activities and set to run for the duration of any significant breaks (greater than 30 minutes). Once the piling is in full operation, associated noise and vibration from the machinery will keep fish outside of the area of influence and thus equipment can be switched off. This process will need to be repeated at

the start of each day, as overnight working is not proposed for construction works in close proximity to watercourses.

Lighting

- 5.3.7 Artificial lighting at night has the potential to disrupt and disorientate fish, increase exposure to predation, alter light-sensitive endocrine systems and disrupt crepuscular and nocturnal mating, signalling and dispersal (Rich and Longcore, 2006). With regards to Atlantic salmon and sea lamprey, the main impacts resulting from artificial lighting are disruption to migration behaviour (Thorpe et al., 1988; Nemeth and Anderson, 1992 and Moser and Maser, 2009) and increased mortality rates due to increased efficiency of predators (Tabor et al., 2004; Kemp and Williams, 2009).
- 5.3.8 Night working in the vicinity of watercourses will not generally be allowed. However, circumstances may arise which require emergency works outside of daylight hours, in these cases lighting will be positioned/cowled to minimise light spill onto the watercourse and the duration will be kept to a minimum. These approaches will be contractual commitments placed on contractors by Road Service.

Disturbance or harm associated with construction

Release of sediment or other construction related pollutants into watercourses

- 5.3.9 Construction related to earthworks and structures can involve in the release of sediments and other construction related pollutants into watercourses. In the context of the proposed scheme this could result in loss of spawning and nursery habitat used by Atlantic salmon and sea lamprey and direct harm to the species as a result of concentrations of sediments and other pollutants in the water.
- 5.3.10 The risk of release of sediments or other construction related pollutants into watercourses will be limited to the Lough Foyle Ramsar Site, due to the presence of designation criteria species within the Foyle catchment.
- 5.3.11 In the case of the Lough Foyle Ramsar Site the risk will occur where:
- localised in-stream works and works on the bankside of watercourses will be required for the construction of temporary and permanent bridges, culverts, watercourse diversions and headwalls for drainage outfalls;
 - construction of earthworks to establish the vertical alignment for the proposed scheme is located within 50m of the watercourses;
 - construction of filter drains, ditches, swales, grassed channels and wet and dry ponds is required to attenuate and carry road related run-off to drainage outfalls;
 - site compounds and materials storage areas are located close to watercourses.

- 5.3.12 The installation of rip-rap to protect bridge abutments will require the placing of rock-filled gabion mattresses on the profiled and consolidated banks at the base of bridge abutments. Measures and requirements detailed in Annex 2.4 of the draft CEMP in Appendix 6 of this report will be adhered to to minimise potential sediment release into watercourses to negligible levels. Contractors will also be required to ensure imported rock does not contain invasive species of plant.
- 5.3.13 The temporary bridges over the Burn Dennet, Glenmornan, River Derg and Fairy Water will be clear span temporary bridge structures that will be installed at a level which allows for flood water to pass underneath, and does not block movement of animals along the watercourse corridor.
- 5.3.14 The installation of culverts and watercourse diversions will result in disturbance to watercourse channels and banksides and could result in consequent release of sediments into the watercourses. The proposed method of construction whereby culverts on diverted sections of watercourse will be completed prior to abandonment of the relevant section of existing channel, and temporary sections of diverted watercourse will be provided along watercourses where culverts are to be constructed on-line, will substantially limit potential release of sediments into watercourses.
- 5.3.15 As illustrated in Figure 10 headwalls will generally be of concrete construction. The area which will be subject to disturbance and the volumes of soils which will require to be excavated will be small. Excavated soils will be temporarily set aside a minimum of 3m from the top of the bankside and any not required for reinstatement of the bankside will be removed from site once reinstatement of the bankside profile is completed. The activity is one which will be of short duration.
- 5.3.16 The risk will be greater where outfalls are required on smaller tributaries and headwaters with relatively low volumes of flow. In these locations the works will be programmed for implementation at times of lowest flow between May and September.
- 5.3.17 Spillage of fuels and oils associated with machinery required for earthworks and installation of the structures could result in release of hydrocarbons in all of the above locations. The presence of cement in storage prior to use and release of such contaminants into watercourses as structures are built could result in mortality or harm where the watercourses are used by Atlantic salmon or sea lamprey.
- 5.3.18 The Water Framework Directive identifies a requirement for suspended solids levels to be kept below 25mg/l for fish species to thrive. However, Loughs Agency have raised concerns that the risks associated with sediments relative to Atlantic salmon will be greater during construction rather than during use of the proposed scheme upon completion of construction. The Agency's concern particularly relates to the proximity of work activities where sediments will be generated and potentially released into parts of the watercourses where there is Atlantic salmon spawning and nursery habitat and has stipulated a requirement for a maximum increase of 10mg/l of TSS during construction above background levels in such locations.

5.3.19 Mitigation measures have accordingly been discussed with Loughs Agency which are focused on the achievement of both thresholds in accordance with the status of the watercourses as ones used for fish passage and ones where salmonid nursery and spawning habitat is present. The measures have been formalised in Section 2 of the draft SMP provided in Appendix 7 and will be a mandatory requirement of the contract-specific SMPs which contractors will be required to prepare agree with RS and Loughs Agency prior to the commencement of works.

Loss of supporting habitat

5.3.20 Where bridges, culverts, watercourse diversions and headwalls for drainage outfalls are proposed there will be a permanent loss of habitats which are relied on by Atlantic salmon and sea lamprey. These include marginal habitats with overhanging vegetation and reduced flows which are important for fish migration as they provide areas of cover under which to rest. They also provide protection from predators and direct sunlight.

Open span bridges

5.3.21 The proposed open span bridges will involve the permanent loss of the bankside vegetation beneath the open span structures. The loss will include grassy banks, scrub and overhanging trees. In the context of each of the watercourses crossed, the length and scale of the watercourses and extent of salmonid habitat associated with each watercourse, the loss will be negligible. To ensure that in stream vegetation habitat loss is minimised pre-planted coir rolls of suitable native emergent and marginal vegetation will be inserted into the rip-rap during construction. In addition, suitable bankside planting will be undertaken where possible. Where open span bridges are installed at major watercourse crossings, there may be an impact from the shade cast by the bridge on in-stream habitats. This shade could reduce the ability of the habitats to thrive, and could result in a minor reduction in primary production within the watercourse.

Culverts

5.3.22 The proposed culverts will involve the permanent loss of supporting habitats where the culverts are aligned beneath the proposed dual carriageway and its supporting earthworks. The surveys undertaken during 2012 and 2013 by Mouchel and Loughs Agency have established that a total of 85 culverts will be constructed, with 64 culverts located on watercourses classified as being of salmonid potential. In line with the precautionary approach adopted during the preparation of this initial information, those to be constructed on salmonid watercourses are currently assumed to be of importance to Atlantic salmon and will comprise box culverts as described in Table A3.1. The remainder will be pipe culverts which do not form a barrier to sea lamprey movement.

5.3.23 The proposed culverts vary in length from 25m to 110m. Most do not exceed 60m. The total length of culvert, and hence the length over which bankside, marginal and in-stream habitat will be permanently lost is some 3400m. 14 salmonid watercourses have more than one culvert proposed, with 12 of these requiring 2 culverts and 2 requiring 3 culverts.

- 5.3.24 In the context of in excess of 300 kilometres of watercourse where salmonid presence / potential has been established, the permanent loss of some 6800m of marginal and bankside habitat⁸ constitutes a small and non-significant impact. This is also the case in relation to the presence of the number of culverts located along individual sections of watercourse.
- 5.3.25 Notwithstanding the low level of impact, proposed mitigation provides for the introduction of bankside planting reflecting that which will be lost within the vested land upstream and downstream of each culvert which will in some instances enhancing the tree, scrub and grassland habitats as sources of food and shade at resting places.
- 5.3.26 Initial loss of in-stream habitat, primarily comprising gravels and boulders, will be largely mitigated as a result of the proposals relating to the embedding of culvert bases, introduction of gravels and boulders, provision for natural sedimentation and location of boulders upstream and downstream of the structures.

Watercourse diversions

- 5.3.27 The 55 proposed watercourse diversions of watercourses with salmonid interest will involve the permanent loss of supporting habitats along some 10km of existing sections of watercourse which will be abandoned. The lost habitat will, however, be re-established as part of the construction of the new sections.
- 5.3.28 This will involve the replication of bed and channel characteristics of the watercourses and planting of marginal and bankside habitat which will reinstate the ecological characteristics of the original watercourse along the diversions on which they are located. It will also be a specific requirement of the contracts that construction of the new sections must be completed prior to the closure and abandonment of the diverted section. The de-watering of the abandoned sections will be carried out under supervision of an ecological clerk of works to ensure fish which may be present, including salmon and lamprey, are safely removed.

Habitat Fragmentation

- 5.3.29 The introduction of bridges and culverts along watercourses associated with the Lough Foyle Ramsar Site could potentially obstruct or discourage passage of the fish as they seek to return to spawning areas and migrate to sea. The following design and mitigation measures which include advice detailed in River Crossings and Migratory Fish: Design Guidance' (Scottish Executive 2000) have accordingly been incorporated into the proposals:
- provision of oversized box culverts along watercourses identified as being of importance to salmonids;

⁸ Taking the precautionary approach that both banks have suitable habitat for the length lost, i.e. 3400m x 2

- diversion of watercourses to facilitate the introduction of a shorter culvert, with lower flow velocity downstream and better light penetration, at or close to right angles to the proposed scheme carriageways where the angle of crossing would otherwise be overly long or steep;
- avoidance of steps in the vertical profile through culverts and along associated diverted watercourses;
- avoidance of bends in culverts which could initiate the deposition of debris and obstruct passage;
- adoption of vertical profiles through the culverts relative to length in accordance with Table 5.1 of the guidance;
- provision of resting areas upstream and downstream of the culverts.

5.3.30 The proposals recognise that during periods of low flow many of the smaller watercourses which feed into the main rivers and principal tributaries and in the upper parts of the catchment have little depth of water. The design proposals described in 3.3.3 and 3.3.4 which require embedding of culvert bases, introduction of gravels and boulders, provision for natural sedimentation and location of boulders upstream and downstream of the structures, make specific provision for these locations but will also be required wherever box culverts are proposed in light of salmonid presence / potential.

Road related lighting

5.3.31 All new lighting will involve the use of full spill cut-off luminaires which will contain the extent of spill within the dual carriageway footprint. Luminaires on the existing Mourne River bridge and associated with the existing A38 approach and bridge linking the existing A5 and Lifford will also be replaced with full spill cut-off units such that the extent of spill associated with the existing bridge will be reduced. This combination of proposals will result in a slight improvement relative to light and the passage of salmon in this location.

6 Summary

- 6.1.1 The Lough Foyle Ramsar Site and Lough Neagh & Lough Beg Ramsar Site have been identified as sites with a relationship to the proposed A5WTC which requires that they should be considered in the context of the EC Birds Directive, as transposed by the Conservation (Natural Habitats, &c) Regulations (Northern Ireland) 1995 as amended by the Conservation (Natural Habitats, etc.) (Amendment) Regulations (Northern Ireland) 2012 in Northern Ireland and the European Communities (Natural Habitats) Regulations 1997 (as amended) in the Republic of Ireland
- 6.1.2 Both Ramsar Sites have been subject to a process of screening based on the guidance provided in HD 44/09 of Volume 11 of the Design Manual for Roads and Bridges. In both instances it has been concluded:
- the proposed scheme is a project which is not connected with or necessary to the management of the Ramsar Sites;
 - the likelihood of the proposed scheme having a significant effect on the sites cannot be excluded on the basis of objective information; and
 - that appropriate assessments required under Article 6(3) of the Habitats Directive should accordingly be undertaken.
- 6.1.3 This document provides information to inform appropriate assessments for the two Ramsar Sites. The information is being made available to statutory consultees and for wider public consultation. The information in this report and information received in response to the consultations will be considered by Roads Service and the Minister along with further information derived during the finalisation of the proposed scheme as appropriate assessments are completed in advance of a decision to proceed or not in accordance with the requirements of the Directive and Regulations.
- 6.1.4 Should the responses or any modifications associated with finalisation of the proposed scheme require further evaluation, the resulting information will be subject to further consultation prior to the completion of the appropriate assessments.
- 6.1.5 The information provided in this report indicates that with proposed mitigation relative to timing of construction activities, and specifically relative to the formation of the cutting at Bready and the bridge abutments at the Burn Dennet, the proposed scheme will not have an impact on the functional habitat in the vicinity of the proposed scheme or the whooper swan and greylag geese using the area which will have a consequent adverse impact on the integrity of the Ramsar Sites i.e. it is unlikely that population size will be affected by the proposed works. In addition, with the proposed mitigation in relation to construction near and within watercourses, and in relation to construction and operational run-off, noise and lighting, the proposed scheme will not have an adverse impact on the functional habitat of Atlantic salmon or sea lamprey which would have a consequent adverse impact on the integrity of the Ramsar Sites. A final view, however, cannot be concluded until further

evaluation is undertaken in light of responses to the consultations or any modifications referred to above are completed.

DRAFT

References

- Alabaster, J.S. and Lloyd, R. (1982) Water quality criteria for freshwater fish. Butterworths, 297pp.
- BirdLife International (2010) IUCN Red list for birds. Downloaded from <http://www.birdlife.org> on 20/12/2010.
- BirdLife International (2010) Species factsheet: Anser anser. Downloaded from <http://www.birdlife.org> on 22/12/2010.
- Bruton, M. N. (1985) The effects of suspensoids on fish. *Hydrobiologia* 125 pp 221 – 241.
- Chapman, D. W. (1988) Critical review of variables used to define effects of fines in redds of large salmonids. *Transactions of the American Fisheries Society* 117 pp 1 – 21.
- Colhoun, K. (2001). The Irish Wetland Bird Survey 1998 – 99: results from the fifth winter of the Irish Wetland Bird Survey. BWI/NPW/WWT, Dublin.
- Crabtree, B., Dempsey, P., Moy, F., Brown, C., and Song, M. (2007b) Improved determination of pollutants in highway runoff phase 2 stage 3 report. WRc Report UC7309.
- Crisp, D. T. (1996) Environmental requirements of common riverine European salmonids fish species in fresh water with particular reference to physical and chemical aspects. *Hydrobiologia* 323, pp 201-221.
- Crowe, O., McElwaine, J.G., Worden, J., Watson, G.A., Walsh, A., & Boland, H. (2005). Whooper *Cygnus cygnus* and Bewick's *C. columbianus bewickii* Swans in Ireland: results of the International Swan Census, January 2005. *Irish Birds* 7 (2005).
- Department of Finance and Personnel (2006) A Sustainable Development Strategy for NI – first steps towards sustainability. The document can be found at: <http://www.ofmdfmi.gov.uk/sustain-develop.pdf>
- Design Manual for Roads and Bridges (2008a) Volume 11 Section 2, Part 1– HA 201/08 Environmental Impact Assessment.
- Design Manual for Roads and Bridges (2008b) Volume 11 Section 2, Part 5 – HA 205/08 Assessment and Management of Environmental Effects.
- Design Manual for Roads and Bridges (DMRB) Standard HD 44/09. Assessment of implications (of Highways and/or Roads projects) on European sites (including appropriate assessment). Volume 11, Section 4. Full text found at: <http://www.standardsforhighways.co.uk/dmrb/index.htm>
- Environment & Heritage Service (2002) Habitat Regulations - Guidance Notes For Competent Authorities

European Commission (2000) Managing Natura 2000 Sites, The provisions of Article 6 of the 'Habitats' Directive 92/43/CEE.

European Commission (2001) Assessment of plans and projects significantly affecting Natura 2000 sites; Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC.

European Council (1992) Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (OJ L 206, 22.7.1992, p. 7).

European Court of Justice (2004) Landelijke Vereniging tot Behoud van de Waddenzee and Nederlandse Vereniging tot Bescherming van Vogels v Staatssecretaris van Landbouw, Natuurbeheer en Visserij. Case C-127/02. European Court reports 2004 Page 00000

Forman, R.T.T & Alexander, L.E. (1998) Roads and their Major Ecological Effects. *Annu. Rev. Ecol. Syst.* 29 207-31.

Gill, J. A. (2007). Approaches to measuring the effects of human disturbance on birds. *Ibis* 149 (Suppl. 1) pp 9 – 14.

Hawkins, A. D. and Johnstone, A. D. F. (1978) The hearing of the Atlantic salmon *Salmo salar*. *Journal of Fish Biology* 13 (6) pp 655 – 749.

Hawkins, A. D. and Smith, G. W. (1986) Radio tracking observations of Atlantic salmon (*Salmo salar* L.) ascending the Aberdeenshire Dee. *Scottish Fisheries Research Report* 36 (24).

Hearn, R.D. & Mitchell, C.R. (2004). Greylag Goose *Anser anser* (Iceland population) in Britain and Ireland 1960/61 – 1999/2000. *Waterbird Review Series*, The Wildfowl and Wetlands Trust/Joint Nature Conservation Committee, Slimbridge.

Hellawell, J. M, Leatham, H. and Williams, G. I. (1974) The upstream migratory behaviour of salmonids in the River Frome, Dorset. *Journal of Fish Biology* 6, pp 729-744.

Hendry, K. and Cragg-Hine, D. (2003) Ecology of the Atlantic Salmon. *Conserving Natura 2000 Rivers Ecology Series No. 7*. English Nature, Peterborough.

HMSO (1995) The Conservation (Natural Habitats, &c.) Regulations (Northern Ireland) 1995.

Keller V.E. (1989) The effect of disturbance from roads on the distribution of feeding sites of geese (*Anser brachyrhynchus*, *A. anser*), wintering in north-east Scotland. *Ardea*. 79, 229-232.

Kemp, P. S. and Williams, J. G. (2009) Illumination influences the ability of migrating juvenile salmonids to pass a submerged experimental weir. *Ecology of Freshwater Fish* 18 pp 297 – 304.

Loughs Agency (2009) River and Tributaries Status Reports 2009. Accessed through www.loughs-agency.org on 15th December 2010

McElwaine, G. & Spouncer, C. (2006). A6 Road Improvements- Toome to Castledawson: Whooper Swan (*Cygnus cygnus*) Survey 2005/2006 and Impact Assessment.

Moser, M.L. and Mesa, M.G. (2009) Passage Considerations for Anadromous Lampreys. American Fisheries Society Symposium 72:000–000, 2009

Mouchel (2010) A5 Western Transport Corridor Environmental Statement Volumes 1 to 3. Document Ref 718736-3000-R-008

Mullarney, K., Svensson, L., Zetterström, D. and Grant, P. J. (1999) Bird Guide. HarperCollins Publishers, London.

Nedwell, J. R., Lovell, J. M. and Turnpenny, A. W. H. (2005) Experimental validation of a species-specific behavioural impact metric for underwater noise. Proceedings of the 50th Meeting of the Acoustical Society of America/NOISE-CON 2005, 17-21 October 2005, Minneapolis, Minnesota.

Nemeth, R. S. and Anderson, J. J. (1992) Response of Juvenile Coho and Chinook Salmon to Strobe and Mercury Vapour Lights. North American Journal of Fisheries Management 12 pp 684 – 692.

NI Biodiversity Group (2002) NI Biodiversity Strategy. Environment and Heritage Service, Belfast.

NI Biodiversity Action Plan (NIBAP) (2005) Full texts for all habitats referred to available at: http://www.ni-environment.gov.uk/biodiversity/hap_uk/hap_ni.htm

Office of the Attorney General (ROI) (1997) S.I. No. 94/1997 European Communities (Natural Habitats) Regulations 1997 (as amended).

Popper, A. N. (2008) Effects of Mid- and High-Frequency Sonars on Fish. Contract N66604-07M-6056, Naval Undersea Warfare Centre Division, Newport, Rhode Island.

Rees, E.C., Bruce, J.H. & White, G.T. (2005). Factors affecting the behavioural responses of whooper swans (*Cygnus c. cygnus*) to various human activities. Biological Conservation, 121 (pgs 369-382).

Reijnen, R. Foppen, R. ter Braak, C. and Thissen, J. 1995. The effects of car traffic on breeding bird populations in woodland. III. Reduction of density in relation to the proximity of main roads. Journal of Applied Ecology 32 pp187-202.

Reijnen R, Foppen R, Meeuwsen H. 1996; The effects of traffic on the density of breeding birds in Dutch agricultural grasslands. Biological Conservation 75 255-260.

Rich, C. And Longcore, T. (eds) (2006) Ecological Consequences of Artificial Night Lighting. Island Press, Washington DC, USA.

Robinson, J.A., Colhoun, K., McElwaine, J.G. & Rees, E.C. (2004). Whooper Swan *Cygnus cygnus* (Iceland population) in Britain and Ireland 1960/61 – 1999/2000. Waterbird Review Series, The Wildfowl and Wetlands Trust/Joint Nature Conservation Committee, Slimbridge.

Ryan, P. A. (1991) Environmental effects of sediment on New Zealand streams: A review. New Zealand Journal of Marine and Freshwater Research 25 pp 207 – 221.

Scottish Executive (2000) River Crossings and Migratory Fish: Design Guidance. Accessed through <http://www.scotland.gov.uk/consultations/transport/rcmf-00.asp> on 7th November 2008.

Skinner, A., Young, M. and Hastie, L. (2003) Ecology of the Freshwater Pearl Mussel. English Nature, Peterborough, UK.

Suttle, K. B., Power, M. E., Levine, J. M. and McNeely, C. (2004) How fine sediment in riverbeds impairs growth and survival of juvenile salmonids. Ecological Applications 14 (4) pp 969 – 974.

Tabor, R. A., Brown, G. S. and Luiting, V. T. (2004) The effect of light intensity on sockeye salmon fry migratory behaviour and predation by cottids in the Cedar River, Washington. North American Journal of Fisheries Management 24 pp 128 – 145.

Thorpe, J. E., Morgan, R. I. G., Pretswell, D. and Higgins, P. (1988) Movement rhythms in juvenile Atlantic salmon, *Salmo salar* L. Journal of Fish Biology 33 pp 931 – 940.