Appendices:
Chapter 7 – Air Quality

July 2013

Experts in air quality
management & assessment

Document Control

Client	Mouchel Fairhurst Joint Venture	**Principal Contact**	Rachel McEvan

Job Number	J1465

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Document Status and Review Schedule

Report No.	Date	Status	Reviewed by
1465/1/F1	22 July 2013	Final Report	Prof. Duncan Laxen

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Glossary

AADT Annual Average Daily Traffic

ADMS-Roads Atmospheric Dispersion Modelling System

AQMA Air Quality Management Area

Defra Department for Environment, Food and Rural Affairs

DMRB Design Manual for Roads and Bridges

Exceedence A period of time when the concentration of a pollutant is greater than the appropriate air quality objective. This applies to specified locations with relevant exposure

HDV Heavy Duty Vehicles (> 3.5 tonnes)

LDV Light Duty Vehicles (<3.5 tonnes)

µg/m^3 Microgrammes per cubic metre

NO Nitric oxide

NO_2 Nitrogen dioxide

NOx Nitrogen oxides (taken to be NO_2 + NO)

Objectives A nationally defined set of health-based concentrations for nine pollutants, seven of which are incorporated in Regulations, setting out the extent to which the standards should be achieved by a defined date. There are also vegetation-based objectives for sulphur dioxide and nitrogen oxides

PM_{10} Small airborne particles, more specifically particulate matter less than 10 micrometres in aerodynamic diameter

$PM_{2.5}$ Small airborne particles less than 2.5 micrometres in aerodynamic diameter

Standards A nationally defined set of concentrations for nine pollutants below which health effects do not occur or are minimal

A7.1 Modelling Methodology

Local Air Quality

Approach to Future Year Predictions

A7.1.1 Interim Advice Note (IAN) 170/12, which supplements the DMRB Vol 11, Seciton 3, Part 1, provides advice on the assessment of future year NOx and NO_2 concentrations taking into account the uncertainty over reductions in future year emissions. The IAN sets out a method based on simple calculations and use of a set of estimated reduction factors. A modified, more detailed, approach has been adopted within this assessment. This involves presenting worst-case future-year concentrations by fixing traffic emissions (per vehicle) at current (2012) levels until 2016 ('without emission reductions'), as a sensitivity test.

Background Concentrations

A7.1.2 The background concentrations across the study area have been defined using the national pollution maps published by Defra (2012). These cover the whole country on a 1x1 km grid and are published for each year from 2010 until 2030. The maps include the influence of emissions from a range of different sources; one of which is road traffic. As noted in Chapter 7, there are some concerns that Defra may have over-predicted the rate at which road traffic emissions of nitrogen oxides will fall in the future. The maps currently in use were verified against measurements made during 2010 at a large number of automatic monitoring stations and so there can be reasonable confidence that the maps are representative of conditions during 2010. Similarly, there is reasonable confidence that the reductions which Defra predicts from other sectors (e.g. rail) will be achieved.

A7.1.3 In order to calculate background nitrogen dioxide and nitrogen oxides concentrations in 2012 (the 'existing' baseline year), it is assumed that there was no reduction in the road traffic component of backgrounds between 2010[1] and 2012. This has been done using the source-specific background nitrogen oxides maps provided by Defra (2012). For each grid square, the road traffic component has been held constant at 2010 levels, while 2012 values have been taken for the other components. Nitrogen dioxide concentrations have then been calculated using the background nitrogen dioxide calculator which Defra (2012) published to accompany the maps. The result is a set of 'adjusted 2012 background' concentrations.

[1] This approach assumes that has been no reduction in emissions per vehicle but also that traffic volumes have remained constant. This is not the same as the assumption made for dispersion modelling, in which emissions per vehicle are held constant while traffic volumes are assumed to change year on year. Overall, this discrepancy is unlikely to influence the overall conclusions of the assessment.

A7.1.4 As an additional step, the background maps for nitrogen dioxide have been calibrated against local measurements made by the local authority (See Table A7.1.1). This has been carried out by comparing 2011 background mapped concentrations with concentrations measured in 2011 at three background monitoring locations: 34 Kirkgate, Irvine; 12 Garnock Street, Dalry; and Hunterston Road (2011 was used, as 2012 data were not available when this was carried out). The calculated calibration factor has been applied to the adjusted background concentrations to provide the final local background concentrations for all the assessment years.

Table A7.1.1: Background Concentrations vs Background Monitoring Concentrations in 2011 (μg/m^3)

Site	2011 measured NO_2	2011 mapped background NO_2	Ratio
34 Kirkgate Irvine	14.0	12.0	1.17
12 Garnock St, Dalry	11.0	7.9	1.40
Hunterston Road	6.0	4.3	1.38
Overall	-	-	**1.32**

A7.1.5 In addition to the above, two separate sets of 2016 background nitrogen dioxide concentrations have been used for the 2016 assessment. The 2016 background 'without emissions reduction' has been calculated using the same approach as described for the 2012 data: the road traffic component of background nitrogen oxides has been held constant at 2010 values, while 2016 data are taken for the other components. Nitrogen dioxide has then been calculated using Defra's background nitrogen dioxide calculator. This has been adjusted by a factor of 1.32 for the background calibration as described in paragraph A7.1.4. The 2016 background 'with emissions reduction' assumes that Defra's revised predicted reductions occur from 2012 onward. This dataset has been derived first by calculating the ratio of the unadjusted mapped value for 2012 to the unadjusted mapped value for 2016. This ratio has then been applied to the adjusted calibrated 2012 value (as derived earlier).

A7.1.6 The maps do not provide predicted concentrations after 2030. Therefore the 2030 concentrations have been assumed to represent the 2031 concentrations. The 2031 background 'with emissions reduction' assumes that Defra's revised predicted reductions occur from 2012 onward. This dataset has been derived first by calculating the ratio of the unadjusted mapped value for 2012 to the unadjusted mapped value for 2030. This ratio has then been applied to the adjusted calibrated 2012 value (see above).

A7.1.7 For PM_{10} and $PM_{2.5}$, there is no strong evidence that Defra's predictions are unrealistic and so the year-specific mapped concentrations have been used in this assessment, with no adjustments.

Model Inputs

A7.1.8 Predictions of nitrogen dioxide, PM_{10} and $PM_{2.5}$ concentrations from vehicle exhaust have been carried out using the ADMS-Roads dispersion model (v3.1) for each assessment scenario. The model requires the user to provide various input data, including emissions from each section of road, and the road characteristic (including road width and street canyon height, where applicable). Vehicle exhaust emissions have been calculated using the AIRE model and were provided by SIAS. For nitrogen dioxide 2016 concentrations have been predicted once using year-specific (2016) emission factors and once using emission factors for 2012[2] which is the year for baseline predictions have been carried out.

A7.1.9 Concentrations of PM_{10} and $PM_{2.5}$ from brake and tyre wear and surface abrasion have been separately calculated using the ADMS-Roads dispersion model (v3.1) for each of the scenarios. Emissions have been calculated using the EFT(v3.1.5), which provides source specific emission factors for exhaust, brake wear, tyre wear, and surface abrasion for PM.

A7.1.10 The model has been run using the most recent full year of meteorological data (2011) from the monitoring station located at Preswick, which is considered suitable for this area.

A7.1.11 For the purposes of modelling, it has been assumed that the front façade of the properties on New Street, North Street and Main Street are within a street canyon formed by the buildings themselves. These roads have a number of canyon-like features which will reduce dispersion of traffic emissions which can lead to concentrations of pollutants being higher here than they would be in areas with greater dispersion. These roads have been modelled as canyons within ADMS.

A7.1.12 A default diurnal flow profile for the traffic flows has been used. Other model input parameters included a surface roughness length of 0.2 m and a minimum Monin-Obukhov length of 10 m.

A7.1.13 Within 50 m of any receptor, road widths and canyon heights have been assigned in detail specifically for each section of road. More than 50 m from any receptor, the approximate location of the road centre line for each link has been included and the road assigned a nominal width.

A7.1.14 Sections of the new road will be raised or 'cut-in' to the surrounding area. Elevated sections will experience greater dispersion, therefore modelling the sections as elevated within ADMS-roads will lead to the impacts being smaller. As a worst-case approach the raised sections have been modelled at ground level within the model. ADMS-roads is not able to model 'cut-in' sections. Therefore these have also been assumed to be at ground level within the modelling.

A7.1.15 A review of the link lengths around junctions, where slower traffic speeds are expected, has been carried out. Where lengths are short (<50 m) the average speed can be assumed to represent the slower speeds associated with the proximity to the junction. Only 9 links adjacent to junctions were

[2] i.e. combining current-year emission factors with future-year traffic data.

over 50 m and the speeds on these links were evaluated and considered suitably representative. Therefore there has been no adjustment to the emission rates calculated by SIAS.

A7.1.16 Figure 7.1 shows the road network included within the model and defines the study area.

Model Verification

A7.1.17 In order to ensure that ADMS-Roads accurately predicts local concentrations, it is necessary to verify the model against local measurements. The verification methodology is described below.

Background Concentrations

A7.1.18 Background concentrations of nitrogen dioxide for the verification sites have been taken from the national maps of background concentrations available from the Defra LAQM Support website (Defra, 2012) and adjusted using the method described in paragraph A7.1.3 and A7.1.4. The background concentrations for each of the diffusion tube locations are presented in Table A7.1.2.

Table A7.1.2: Background Concentrations used in the Verification for 2011 (μg/m^3)

Location	NO_2
Highfield Hamlet Dalry	9.8
67 New St Dalry	10.3
45 New St Dalry	10.3
2 Townhead St Dalry	10.3

Nitrogen Dioxide

A7.1.19 Most nitrogen dioxide (NO_2) is produced in the atmosphere by reaction of nitric oxide (NO) with ozone It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides (NOx = NO + NO_2) The model has been run to predict the annual mean NOx concentrations during 2011 at the four kerbside diffusion tube monitoring sites within the study area (three in Dalry and one in Highfields hamlet). Concentrations have been modelled at the height of the monitors.

A7.1.20 The model output of road-NOx (i.e. the component of total NOx coming from road traffic) has been compared with the 'measured' road-NOx. Measured road-NOx was calculated from the measured NO_2 concentrations and the predicted background NO_2 concentration using the NOx from NO_2 calculator available on the Defra LAQM Support website (Defra, 2012).

A7.1.21 A primary adjustment factor was determined as the slope of the best fit line between the 'measured' road contribution and the model derived road contribution, forced through zero (Figure A7.1.1). This factor was then applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations. The total nitrogen dioxide concentrations

were then determined by combining the adjusted modelled road-NOx concentrations with the predicted background NO_2 concentration within the NOx from NO_2 calculator. A secondary adjustment factor was finally calculated as the slope of the best fit line applied to the adjusted data and forced through zero (Figure A7.1.2).

A7.1.22 The following primary and secondary adjustment factors have been applied to all modelled nitrogen dioxide data:

- Primary adjustment factor : 1.835
- Secondary adjustment factor: 1.002

A7.1.23 The results imply that the model was under-predicting the road-NOx contribution. This is a common experience with this and most other models. The final NO_2 adjustment is minor.

A7.1.24 Figure A7.1.3 compares final adjusted modelled total NO_2 at each of the monitoring sites, to measured total NO_2, and shows a 1:1 relationship.

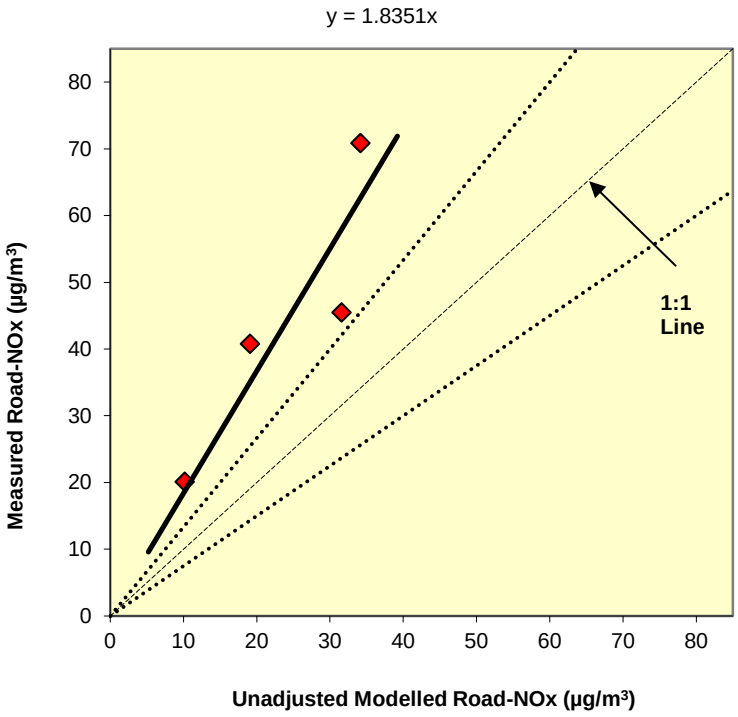

Figure A7.1.1: Comparison of Measured Road NOx to Unadjusted Modelled Road NOx Concentrations. The dashed lines show ± 25%.

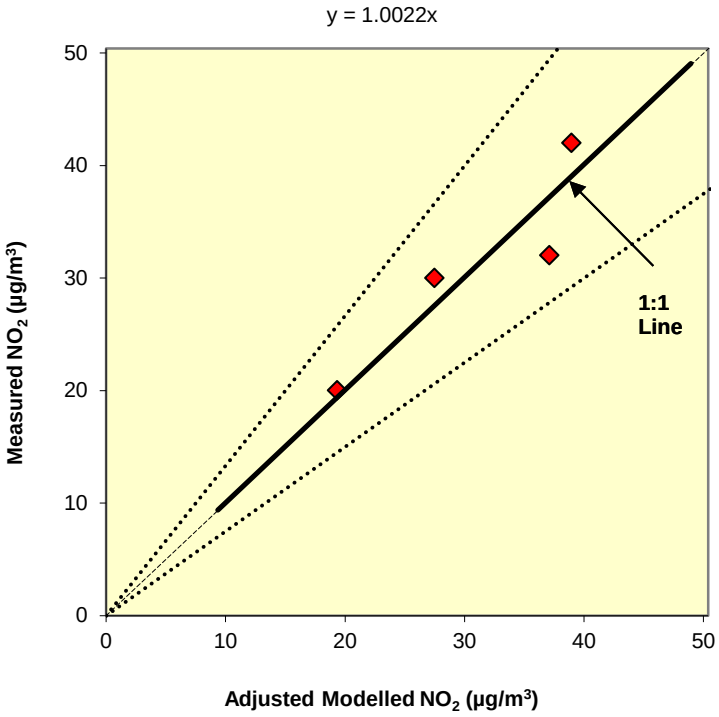

Figure A7.1.2: Comparison of Measured Total NO_2 to Primary Adjusted Modelled Total NO_2 Concentrations. The dashed lines show ± 25%.

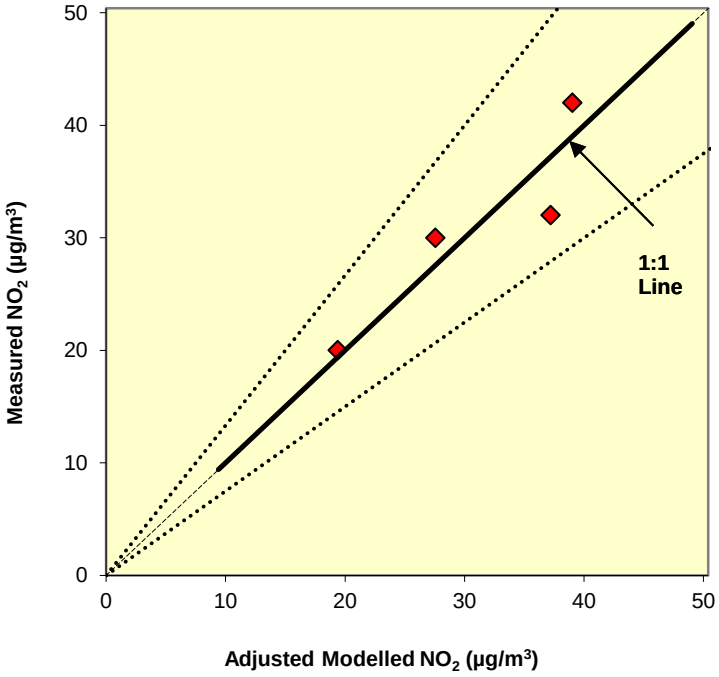

Figure A7.1.3: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations. The dashed lines show ± 25%.

PM_{10} and $PM_{2.5}$

A7.1.25 There are no nearby PM_{10} or $PM_{2.5}$ monitors. It has therefore not been possible to verify the model for PM_{10} or $PM_{2.5}$. The model outputs of road-PM_{10} and road-$PM_{2.5}$ have therefore been adjusted by applying the primary adjustment factor calculated for road NO_x.

Model Post-processing

Nitrogen oxides and nitrogen dioxide

A7.1.26 The model predicts road-NOx concentrations at each receptor location. These concentrations have then been adjusted using the primary adjustment factor, which, along with the background NO_2, is processed through the NOx from NO_2 calculator available on the Defra LAQM Support website (Defra, 2012). The traffic mix within the calculator was set to "All non-urban UK traffic" which is considered suitable for the study area. The calculator predicts the component of NO_2 based on the adjusted road-NOx and the background NO_2. This is then adjusted by the secondary adjustment factor to provide the final predicted concentrations.

PM_{10} and $PM_{2.5}$

A7.1.27 Predicted road-PM_{10} and –$PM_{2.5}$ concentrations are adjusted using the primary adjustment factor. These adjusted road concentrations are then added to the background concentrations and the predicted concentrations of brake and tyre ware and surface abrasion, to provide the final predicted concentrations.

A7.1.28 The number of exceedences of 50 µg/m^3 as a 24-hour mean PM_{10} concentration has been calculated from the adjusted-modelled total annual mean concentration following the relationship advised by (Defra, 2009):

$$A = -18.5 + 0.00145\ B^3 + 206/B$$

where A is the number of exceedences of 50 µg/m^3 as a 24-hour mean PM_{10} concentration and B is the annual mean PM_{10} concentration. The relationship is only applied to annual mean concentrations greater than 16.5 µg/m^3, below this concentration, the number of 24-hour exceedences is assumed to be zero.

Regional air quality and greenhouse gas

A7.1.29 Predicted emissions of oxides of nitrogen have been summed directly from AIRE for all the links within the study area to represent yearly emissions. Predicted emissions of PM_{10} include both the exhaust emissions from AIRE and brake and tyre wear and surface abrasion emissions from the EFT for all the links within the study area.

A7.2 Construction Dust Assessment Criteria

Assessment Procedure

A7.2.1 The criteria developed by IAQM divide the activities on construction sites into four types to reflect their different potential impacts. These are:

- demolition;
- earthworks;
- construction; and
- trackout.

A7.2.2 The assessment procedure is split into four steps summarised below:

STEP 1: Screen the Need for a Detailed Assessment

A7.2.3 An assessment is required where there are sensitive receptors within 350 m of the boundary of the site and/or within 100 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

A7.2.4 Where the need for a more detailed assessment is screened out, it can be concluded that the level of risk is *negligible*.

STEP 2: Assess the Risk of Dust Effects Arising

A7.2.5 The risk of dust effects is determined by:

- the scale and nature of the works, which determines the risk of dust arising; and
- the proximity of sensitive receptors.

A7.2.6 The risk categories assigned to the site are different for each of the four potential sources of dust (demolition, earthworks, construction and trackout).

Demolition

A7.2.7 The potential dust emission classes for demolition are as follows:

Large: Total building volume >50,000m^3, potentially dusty construction material (e.g. concrete), on site crushing and screening, demolition activities >20m above ground level;

Medium: Total building volume 20,000m^3 – 50,000m^3, potentially dusty construction material, demolition activities 10-20m above ground level; and

Small: Total building volume <20,000m^3, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10m above ground, demolition during wetter months.

A7.2.8 The potential dust emission class determined above should be used in the matrix in Table A7.2.1 to determine the **demolition risk category** with no mitigation applied based on the distance to the nearest receptors.

Table A7.2.1: Risk Category from Demolition Activities

Distance to Nearest Receptor (m)[a]		Dust Emission Class		
Dust Soiling and PM_{10}	**Ecological**	**Large**	**Medium**	**Small**
<20	**-**	High Risk Site	High Risk Site	Medium Risk Site
20 – 100	**<20**	High Risk Site	Medium Risk Site	Low Risk Site
100 – 200	**20 – 40**	Medium Risk Site	Low Risk Site	Low Risk Site
200 – 350	**40-100**	Medium Risk Site	Low Risk Site	Negligible

[a] These distances are from the dust emission source. Where this is not known then the distance should be from the site boundary. The risk is based on the distance to the nearest receptor.

Earthworks and Construction

A7.2.9 The potential dust emission classes for earthworks are as follows:

Large: Total site area >10,000m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry to due small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8m in height, total material moved >100,000tonne;

Medium: Total site area 2,500m^2 – 10,000m^2, moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4m – 8m in height, total material moved 20,000tonne – 100,000tonne; and

Small: Total site area <2,500m^2, soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4m in height, total material moved <10,000tonne, earthworks during wetter months.

A7.2.10 The potential dust emission classes for construction are as follows:

Large: Total building volume >100,000m^3, piling, on site concrete batching; sandblasting

Medium: Total building volume 25,000m^3 – 100,000m^3, potentially dusty construction material (e.g. concrete), piling, on site concrete batching; and

Small: Total building volume <25,000m^3, construction material with low potential for dust release (e.g. metal cladding or timber).

A7.2.11 These potential dust emission classes should then be used in the matrix in Table A7.2.2 to determine the **earthworks risk category and the construction risk category** with no mitigation applied.

Table A7.2.2: Risk Category from Earthworks and Construction Activities

Distance to Nearest Receptor (m)[a]		Dust Emission Class		
Dust Soiling and PM_{10}	**Ecological**	**Large**	**Medium**	**Small**
<20	**-**	High Risk Site	High Risk Site	Medium Risk Site
20 – 50	**-**	High Risk Site	Medium Risk Site	Low Risk Site
50 – 100	**<20**	Medium Risk Site	Medium Risk Site	Low Risk Site
100 – 200	**20 – 40**	Medium Risk Site	Low Risk Site	Negligible
200 – 350	**40-100**	Low Risk Site	Low Risk Site	Negligible

[a] These distances are from the dust emission source. Where this is not known then the distance should be from the site boundary. The risk is based on the distance to the nearest receptor.

Trackout

A7.2.12 The potential dust emission classes for trackout are as follows:

Large: >100 HDV (>3.5t) trips in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100m;

Medium: 25-100 HDV (>3.5t) trips in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50m – 100m; and

Small / Medium: <25 HDV (>3.5t) trips in any one day, surface material with low potential for dust release, unpaved road length <50m.

A7.2.13 These potential dust emission classes should be used in Table A7.2.3 to determine the **risk category for trackout** with no mitigation applied.

Table A7.2.3: Risk Category from Trackout

Distance to Nearest Receptor (m)[a]		Dust Emission Class		
Dust Soiling and PM_{10}	**Ecological**	***Large***	**Medium**	**Small**
<20	**-**	High Risk Site	Medium Risk Site	Medium Risk Site
20 – 50	**<20m**	Medium Risk Site	Medium Risk Site	Low Risk Site
50-100	**20-100**	Low Risk Site	Low Risk Site	Negligible

[a] For trackout the distance is from the roads used by construction traffic.

A7.2.14 There is an extra dimension to the assessment of trackout, as the distance over which it might occur depends on the site. As general guidance, significant trackout may occur up to 500 m from *large* sites, 200 m from *medium* sites and 50 m from *small* sites, as measured from the site exit. These distances assume no site-specific mitigation.

A7.2.15 The 'distance to receptor' in Table A7.2.3 relates to the distance from the road where mud may be deposited. Therefore in determining the risk from trackout, both distances need to be taken into account.

STEP 3: Identify the Need for Site-specific Mitigation

A7.2.16 Having determined the risk categories for each of the four activities it is possible to determine the site-specific measures to be adopted. These measures will be related to whether the site is a *low*, *medium* or *high* risk site.

STEP 4: Define Effects and their Significance

A7.2.17 The significance is determined using professional judgement, taking account of the factors that define the sensitivity of the surrounding area and the overall pattern of potential risks set out within the risk effects summary table. The sensitivity of the area is defined as *very high*, *high*, *medium* and *low* based on the criteria in Table A7.2.4

Table A7.2.4: Examples of Factors Defining Sensitivity of an Area

Sensitivity of area	Examples	
	Human receptors	Ecological receptors[a]
Very high	• Very densely populated area. • More than 100 dwellings within 20m. • Local PM_{10} concentrations exceed the objective. • Contaminated buildings present. • Very sensitive receptors (e.g. oncology units). • Works continuing in one area of the site for more than one year.	European Designated site.
High	• Densely populated area. • 10-100 dwellings within 20m of site. • Local PM_{10} concentrations close to the objective (e.g. annual mean 36-40 µg/m^3). • Commercially sensitive horticultural land within 20m.	Nationally Designated site.
Medium	• Suburban or edge of town area. • Less than 10 receptors within 20m. • Local PM_{10} concentrations below the objective (e.g. annual mean 30-36 µg/m^3).	Locally designated site.
Low	• Rural area; industrial area • No receptors within 20m • Local PM_{10} concentrations well below the objectives (less than 75%) • Wooded area between site and receptors	No designations.

[a] Only if there are habitats that might be sensitive to dust

A7.2.18 The sensitivity of the area surrounding the construction / demolition site is combined with the risk of the site giving rise to dust effects to define the significance of the effects for each of the four activities (demolition, earthworks, construction and trackout) using Table A7.2.5 for the baseline without mitigation and Table A7.2.6 when mitigation is applied.

Table A7.2.5: Significance of Effects for Each Activity Without Mitigation.

Sensitivity of surrounding area	Risk of site giving rise to dust effects		
	High	Medium	Low
Very High	Substantial adverse	Moderate adverse	Moderate adverse
High	Moderate adverse	Moderate adverse	Slight adverse
Medium	Moderate adverse	Slight adverse	Negligible
Low	Slight Adverse	Negligible	Negligible

Table A7.2.6: Significance of Effects for Each Activity With Mitigation.

Sensitivity of surrounding area	Risk of site giving rise to dust effects		
	High	Medium	Low
Very High	Slight adverse	Slight adverse	Negligible
High	Slight adverse	Negligible	Negligible
Medium	Negligible	Negligible	Negligible
Low	Negligible	Negligible	Negligible

A7.2.19 The final step is to determine the overall significance of the effects arising from the construction phase of a proposed development. This is based on professional judgement but takes into account of the significance of the effects for each of the four activities.

A7.3 Professional Experience

Prof. Duncan Laxen, BSc (Hons) MSc PhD MIEnvSc FIAQM

Prof Laxen is the Managing Director of Air Quality Consultants, a company which he founded in 1993. He has over forty years' experience in environmental sciences and has been a member of Defra's Air Quality Expert Group and the Department of Health's Committee on the Medical Effects of Air Pollution. He has been involved in major studies of air quality, including nitrogen dioxide, lead, dust, acid rain, PM_{10}, $PM_{2.5}$ and ozone and was responsible for setting up UK's urban air quality monitoring network. Prof Laxen has been responsible for appraisals of all local authorities' air quality Review & Assessment reports and for providing guidance and support to local authorities carrying out their local air quality management duties. He has carried out air quality assessments for power stations; road schemes; ports; airports; railways; mineral and landfill sites; and residential/commercial developments. He has also been involved in numerous investigations into industrial emissions; ambient air quality; indoor air quality; nuisance dust and transport emissions. Prof Laxen has prepared specialist reviews on air quality topics and contributed to the development of air quality management in the UK. He has been an expert witness at numerous Public Inquiries and published over 70 scientific papers and given numerous presentations at conferences.

Dr Ben Marner, BSc (Hons) PhD CSci MIEnvSc MIAQM

Dr Marner is a Technical Director with AQC, and has thirteen years' relevant experience in the field of air quality. He has been responsible for air quality and greenhouse gas assessments of road schemes, rail schemes, airports, power stations, waste incinerators, commercial developments and residential developments in the UK and abroad. He has been an expert witness at several public inquiries, where he has presented evidence on health-related air quality impacts, the impacts of air quality on sensitive ecosystems, and greenhouse gas impacts. He has extensive experience of using detailed dispersion models, as well as contributing to the development of modelling best practices. Dr Marner has arranged and overseen air quality monitoring surveys, as well as contributing to Defra guidance on harmonising monitoring methods. He has been responsible for air quality review and assessments on behalf of numerous local authorities. He has also developed methods to predict nitrogen deposition fluxes on behalf of the Environment Agency, provided support and advice to the UK Government's air quality review and assessment helpdesk, Transport Scotland, Transport for London, and numerous local authorities.

Kieran Laxen, MEng(Hons) AMIEnvSc MIAQM

Mr Laxen is a Senior Consultant with AQC with over four years' experience in the field of air quality management and assessment. Previously having two years' experience in scientific research on internal combustion engines he now works in the field of air quality assessment and is involved in a

range of development projects, most of which have involved use of ADMS modelling methodologies for biomass boilers and roads. He has pioneered the use of OpenAir software within the Company, which is used to analyse air quality monitoring data. He is responsible for routine calibration of air quality monitoring stations, together with data ratification.

Full CVs are available at www.aqconsultants.co.uk

A7.4 Operational Impact Descriptors and Assessment of Significance

Local Air Quality

A7.4.1 There is no official guidance in the UK on how to describe the nature of air quality impacts nor to assess their significance. The approach developed by the Institute of Air Quality Management[3] (Institute of Air Quality Management, 2009), and incorporated in Environmental Protection UK's guidance document on planning and air quality (Environmental Protection UK, 2010), has therefore been used. This involves three distinct stages: the application of descriptors for magnitude of change; the description of the impact at each sensitive receptor; and then the assessment of overall significance of the scheme.

Impact Descriptors

A7.4.2 The definition of ***impact magnitude*** is solely related to the degree of change in pollutant concentrations, expressed in microgrammes per cubic metre, but originally determined as a percentage of the air quality objective. ***Impact description*** takes account of the impact magnitude and of the absolute concentrations and how they relate to the air quality objectives or other relevant standards. The descriptors for the magnitude of change due to the scheme are set out Table A7.4.1 while Table A7.4.2 sets out the impact descriptors. These tables have been designed to assist with describing air quality impacts at each specific receptor. They apply to the pollutants relevant to this scheme and the objectives against which they are being assessed.

[3] The IAQM is the professional body for air quality practitioners in the UK.

Table A7.4.1: Definition of Impact Magnitude for Changes in Ambient Pollutant Concentrations

Magnitude of Change	Annual Mean NO_2/ PM_{10} [a]	No. days with PM_{10} concentration greater than 50 µg/m^3 [b]	Annual Mean $PM_{2.5}$ [a]
Large	Increase/decrease ≥4 µg/m^3 / ≥1.8 µg/m^3	Increase/decrease >4 days	Increase/decrease ≥1.25 µg/m^3
Medium	Increase/decrease 2 - <4 µg/m^3 / 0.9 - <1.8 µg/m^3	Increase/decrease 3 or 4 days	Increase/decrease 0.625 - <1.25 µg/m^3
Small	Increase/decrease 0.4 - <2 µg/m^3 / 0.18 - <0.9 µg/m^3	Increase/decrease 1 or 2 days	Increase/decrease 0.125 - <0.625 µg/m^3
Imperceptible	Increase/decrease <0.4 µg/m^3 / <0.18 µg/m^3	Increase/decrease <1 day	Increase/decrease <0.125 µg/m^3

[a] The EPUK guidance presents rounded values to 1 decimal point, based on a percentage of the objective (10%, 5% 1%). The unrounded values are presented.

[b] Applicable to England, Wales and Northern Ireland only. In Scotland the annual mean objective is the most stringent criteria, therefore changes in the annual mean concentration are most important. An equivalent table for Scotland would involve part days and would not be very meaningful. The values are based on a percentage of 35 days (the England, Wales and Northern Ireland objective), rounded to most appropriate whole number of days.

Table A7.4.2: Air Quality Impact Descriptors for Changes to Annual Mean Nitrogen Dioxide, PM_{10} and $PM_{2.5}$ Concentrations and Changes to Number of Days with PM_{10} Concentration Greater than 50 µg/m^3 at a Receptor [a]

Absolute Concentration [b] in Relation to Objective/Limit Value	Change in Concentration/day [c]		
	Small	**Medium**	**Large**
Above Objective/Limit Value [d]	Slight	Moderate	Substantial
Just Below Objective/Limit Value [e]	Slight	Moderate	Moderate
Below Objective/Limit Value [f]	Negligible	Slight	Slight
Well Below Objective/Limit Value [g]	Negligible	Negligible	Slight

[a] Criteria have been adapted from the published criteria to remove overlaps at transitions.

[b] The 'Absolute Concentration' relates to the 'With-Scheme' air quality where there is an increase in concentrations and to the 'Without-Scheme' air quality where there is a decrease in concentrations.

[c] Where the Impact Magnitude is *Imperceptible*, then the Impact Description is *Negligible*.

[d] Where the Impact Magnitude is *Imperceptible*, then the Impact Description is *Negligible*.

[d] 'Above': >40 µg/m^3 annual mean NO_2; >18 µg/m^3 annual mean PM_{10}; >12 µg/m^3 annual mean $PM_{2.5}$; or >7 days with PM_{10} > 50 µg/m^3.

[e] 'Just below': >36 – ≤40 µg/m^3 of annual mean NO_2; 16.2 – ≤18 µg/m^3 of annual mean PM_{10}; >10.8 - ≤12 µg/m^3 annual mean $PM_{2.5}$; or >6 – ≤7 days with PM_{10} >50 µg/m^3.

[f] 'Below': >30 – ≤36 µg/m^3 of annual mean NO_2; >13.5 – ≤16.2 µg/m^3 of annual mean PM_{10}; >9 - ≤10.8 µg/m^3 annual mean $PM_{2.5}$; or >5 – ≤6 days with PM_{10} >50 µg/m^3.

[g] 'Well below': ≤30 µg/m^3 annual mean NO_2; ≤13.5 µg/m^3 annual mean PM_{10}; ≤9 µg/m^3 annual mean $PM_{2.5}$, or ≤5 days with PM_{10} >50 µg/m^3.

Assessment of Significance

A7.4.3 The IAQM (Institute of Air Quality Management, 2009) guidance is that the ***assessment of significance*** should be based on professional judgement, with the overall air quality impact of the scheme described as either, *insignificant*, *minor*, *moderate* or *major*. In drawing these conclusions, the factors set out in Table A7.4.3 should be taken into account. A summary of the professional experience of staff contributing to this assessment is provided in Appendix A7.3.

Table A7.4.3: Factors Taken into Account in Determining Air Quality Significance

Factors
Number of people affected by increases and/or decreases in concentrations and a judgement on the overall balance.
The magnitude of the changes and the descriptions of the impacts at the receptors using the criteria set out in Table A7.4.1 and Table A7.4.2.
Whether or not an exceedence of an objective or limit value is predicted to arise in the study area where none existed before or an exceedence area is substantially increased.
Whether or not the study area exceeds an objective or limit value and this exceedence is removed or the exceedence area is reduced.
Uncertainty, including the extent to which worst-case assumptions have been made
The extent to which an objective or limit value is exceeded, e.g. an annual mean NO_2 of 41 µg/m^3 should attract less significance than an annual mean of 51 µg/m^3

Regional Air Quality and Greenhouse Gas

A7.4.4 There is no official guidance in the UK on how to describe the nature of air quality or greenhouse gas impacts nor to assess their significance. For consistency, the same general approach adopted to determine the local air quality significance has been used to determine the significance of the regional air quality and greenhouse gas. The guidance, for local air quality, is that the assessment of significance should be based on professional judgement, with the overall impact of the Scheme described as *insignificant*, *minor*, *moderate* or *major*. A summary of the professional experience of the staff contributing to this assessment is provided in Appendix A7.3.

A7.5 DMRB modelling

A7.5.1 For the STAG assessment, predictions have been carried out using the Design Manual for Roads and Bridges (DMRB) model v1.03c. The model requires the user to provide various input data, including the Annual Average Daily Traffic (AADT) flow, the proportion of heavy duty vehicles (HDVs), the distance of the road from the receptor, and the vehicle speed. The flow; percentage of HDVs; and speed have been provided by SIAS for each link. In line with the approach set out in STAG, the DMRB model has been run at a range of distances: 20 m, 70 m, 115 m and 175 m. It is also necessary to input background pollutant concentrations. Average background concentrations for the study area have been derived from the national maps, as discussed in Appendix A7.1. The background concentrations are presented in Table A7.5.1.

Table A7.5.1: Background Concentrations in the Study Area (μg/m^3)

Location	NO_x	NO_2	PM_{10}
2012[a]	12.4	9.3	10.2
2016 With Reduction [b]	10.6	8.1	9.9
2016 Without Reduction [c]	11.2	8.5	N/A
2031[d]	8.8	6.8	9.6

[a] This assumes vehicle emission factors in 2012 remain the same as 2010 (See Appendix A7.1).

[b] This assumes vehicle emission factors in 2016 remain the same as in 2012.

[c] This assumes vehicle emission factors reduce into the future at the current 'official' rates but does not include the reductions due to the introduction of Euro VI and Euro 6 vehicles.

[d] Background concentrations are only available up to 2030. Therefore 2030 concentrations have been assumed to represent 2031 concentrations. This assumes vehicle emission factors reduce into the future at the current 'official' rates.

Model Verification

A7.5.2 As with the ADMS-Roads model, the DMRB model has been verified, to ensure it predicts local concentrations as accurately as possible. The verification methodology is described below.

Nitrogen Dioxide

A7.5.3 Most nitrogen dioxide (NO_2) is produced in the atmosphere by reaction of nitric oxide (NO) with ozone It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides (NOx = NO + NO_2) The model has been run to predict the annual mean NOx concentrations during 2011 at the four kerbside diffusion tube monitoring sites within the study

area (three in Dalry and one in Highfields hamlet). Concentrations have been modelled at the distance from the road of the monitors.

A7.5.4 The model output of road-NOx (i.e. the component of total NOx coming from road traffic) has been compared with the 'measured' road-NOx. Measured road-NOx was calculated from the measured NO_2 concentrations and the predicted background NO_2 concentration using the NOx from NO_2 calculator available on the Defra LAQM Support website (Defra, 2012).

A7.5.5 A primary adjustment factor was determined as the slope of the best fit line between the 'measured' road contribution and the model derived road contribution, forced through zero (Figure A7.5.1). This factor was then applied to the modelled road-NOx concentration for each receptor to provide adjusted modelled road-NOx concentrations. The total nitrogen dioxide concentrations were then determined by combining the adjusted modelled road-NOx concentrations with the predicted background NO_2 concentration within the NOx from NO_2 calculator. A secondary adjustment factor was finally calculated as the slope of the best fit line applied to the adjusted data and forced through zero (Figure A7.5.2).

A7.5.6 The following primary and secondary adjustment factors have been applied to all modelled nitrogen dioxide data:

- Primary adjustment factor : 3.220
- Secondary adjustment factor: 0.993

A7.5.7 The results imply that the model was under-predicting the road-NOx contribution. This is a common experience with this and most other models. The final NO_2 adjustment is minor.

A7.5.8 Figure A7.5.3 compares final adjusted modelled total NO_2 at each of the monitoring sites, to measured total NO_2, and shows a 1:1 relationship.

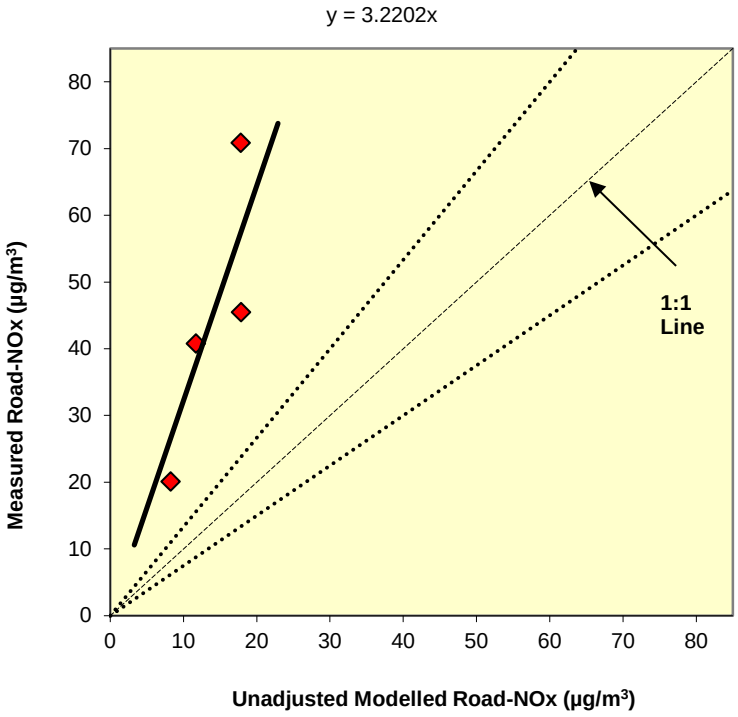

Figure A7.5.1: Comparison of Measured Road NOx to Unadjusted Modelled Road NOx Concentrations. The dashed lines show ± 25%.

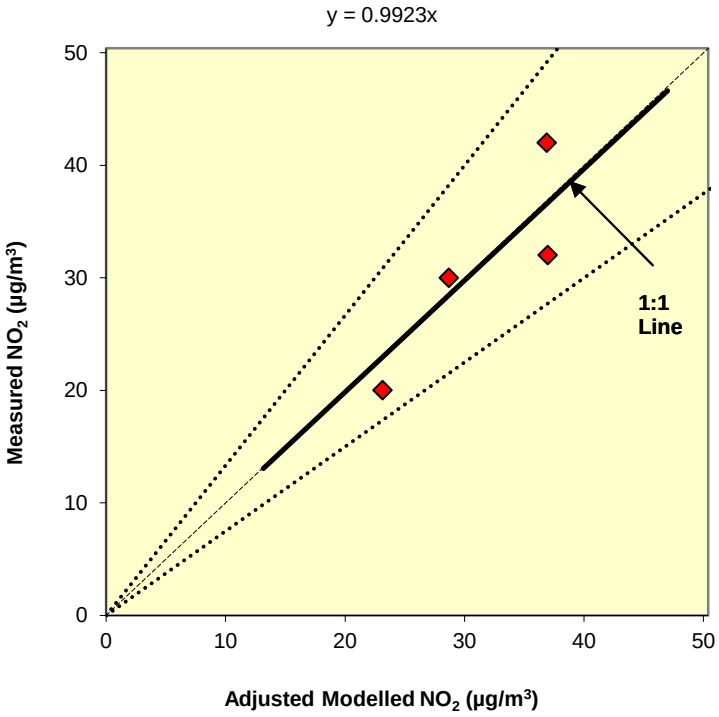

Figure A7.5.2: Comparison of Measured Total NO_2 to Primary Adjusted Modelled Total NO_2 Concentrations. The dashed lines show ± 25%.

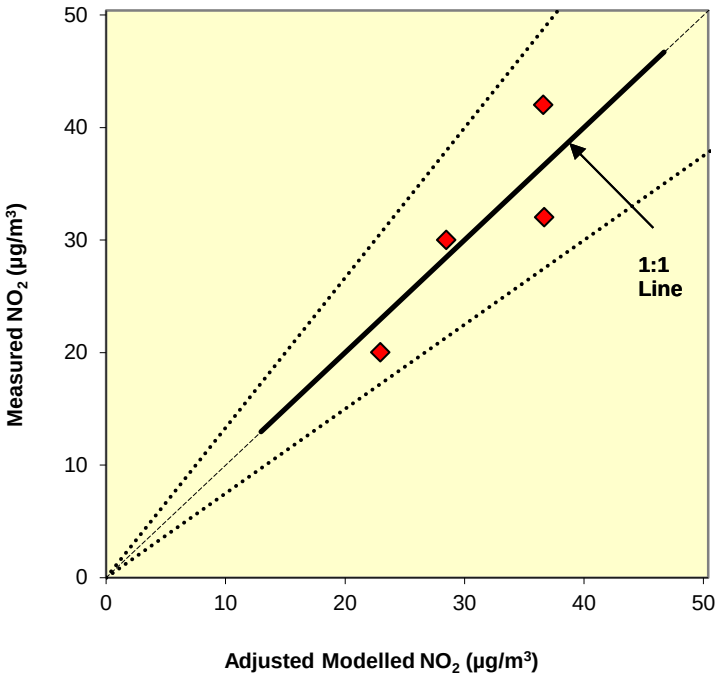

Figure A7.5.3: Comparison of Measured Total NO_2 to Final Adjusted Modelled Total NO_2 Concentrations. The dashed lines show ± 25%.

PM_{10} and $PM_{2.5}$

A7.5.9 There are no nearby PM_{10} monitors. It has therefore not been possible to verify the model for PM_{10}. The model outputs of road-PM_{10} have therefore been adjusted by applying the primary adjustment factor calculated for road NO_x.

Model Post-processing

Nitrogen oxides and nitrogen dioxide

A7.5.10 The model predicts road-NOx concentrations at each receptor location. These concentrations have then been adjusted using the primary adjustment factor, which, along with the background NO_2, is processed through the NOx from NO_2 calculator available on the Defra LAQM Support website (Defra, 2012). The traffic mix within the calculator was set to "All non-urban UK traffic" which is considered suitable for the study area. The calculator predicts the component of NO_2 based on the adjusted road-NOx and the background NO_2, this is then adjusted by the secondary adjustment factor to provide the final predicted concentrations.

PM_{10}

A7.5.11 Predicted road-PM_{10} concentrations are adjusted using the primary adjustment factor. This adjusted road concentration is then added to the background concentration to provide the final predicted concentration.

A7.6 Construction Mitigation

A7.6.1 The following is a set of measures that should be incorporated into the specification for the works:

Communications

- Implement a stakeholder communications plan that includes community engagement before and during work on site; and
- Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environmental manager/engineer or the site manager.

Dust Management Plan

- Implement a Dust Management Plan (DMP) approved by the Local Authority which documents the mitigation measures to be applied, and the procedures for their implementation and management.

Site Management

- Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken. Make the complaints log available to the local authority when asked;' and
- Record any exceptional incidents that cause dust and/or air emissions, either on- or off- site, and the action taken to resolve the situation in the log book.

Monitoring

- Undertake daily on-site and off-site inspection where receptors (including roads) are nearby, to monitor dust, record inspection results, and make available the log to the local Authority when asked;
- When activities with a high potential to produce dust are being carried out, and during prolonged dry or windy conditions, increase the frequency of inspections;
- Carry out regular dust soiling checks of surfaces such a street furniture, cars and window sills within 100m of site boundary;
- Implement a monitoring scheme for dust deposition/flux consistent with IAQM guidance. Agree monitoring locations and Site Action Levels with the Local Authority; and
- Implement a scheme for real-time continuous PM_{10} monitoring consistent with IAQM guidance. Agree monitoring locations and Site Action Levels with the Local Authority.

Preparing and maintaining the site

- Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible. Use intelligent screening where possible – e.g. locating site offices between potentially dusty activities and the receptors;
- Erect solid screens or barriers around the site boundary;
- Avoid site runoff of water or mud;
- Keep site fencing, barriers and scaffolding clean;
- Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below; and
- Depending on the duration that stockpiles will be present and their size - cover, seed, fence or water to prevent wind whipping.

Operating vehicle/machinery and sustainable travel

- Ensure all vehicles switch off engines when stationary – no idling vehicles;
- Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable;
- Impose and signpost a maximum-speed-limit of 15 mph on surfaced and 10 mph on un-surfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate);
- Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials; and
- Implement a Travel Plan that supports and encourages sustainable staff travel (public transport, cycling, walking, and car-sharing).

Operations

- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems;
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible;
- Use enclosed chutes, conveyors and covered skips, where practicable; and
- Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.

Waste Management

- Only use registered waste carriers to take waste off-site; and
- Avoid bonfires and burning of waste materials.

Measures Specific to Earthworks

- Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable. Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable. Only remove the cover in a small areas during work and not all at once.

Measures Specific to Construction

- Avoid scabbling, if possible;
- Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place; and
- Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.

Measures Specific to Trackout

- Use water-assisted dust sweeper(s) on the access and local roads, to remove, as soon as practicable any material tracked out of the site. This may require the sweeper being continuously in use;
- Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport;
- Record all inspections of haul routes and any subsequent action in a site log book;
- Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned;
- Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as practicable;
- Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site); and
- Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits. This can be in the form or a static drive through facility or a manually operated power jet.

Appendix 7.1

Air Quality Appendices

Appendix 8.1

Gazetteer of Cultural Heritage Features

Appendix 8.1: Gazetteer of Cultural Heritage Features

The following table lists the sites and monuments listed in the West of Scotland Archaeology Service (WOSAS) Historic Environment Record and the National Monuments Record of Scotland (NMRS) as identified through historical references, archaeological investigation, cartographic evidence and aerial photographs. The gazetteer includes all sites within the proposed development area and assets within a 250m radius of the proposed development area. The information gathered for the table has been obtained from the HER and NMR records.

Reference number	Site Name	HER Reference Number	NMR Reference Number	Grid Reference	Site Type	Designation	Description	Value
1	Blair Estate	53570		230542, 647906	Landscape	Designed Garden and Landscape	An attractive, complete and intact designed landscape including a mid 19th-century landscaped park, with an 'old-fashioned' garden built in the 1920s beside the house. The site itself is much older with gardens recorded in the early 17th century.	High
2	North Lodge and gatepiers, Blair Estate	42912	206115	230519, 648810	Building	Listed building-category C (S)	Dated 1858. Single storey cruciform-plan lodge. Stugged ashlar with ashlar dressings, plinth and raised quoins. Central advanced ball-finialled gabled bay to south-east, with canted mullioned and transomed window; cill course and coped parapet; raised at centre. Lying-pane glazing. Cornice with parapet to flanking wings. Square date-crest in pedimented gable. Coped parapet and skews. Central panelled, corniced stack and slate roof. Square gate-piers, inner 2 larger with ball finials. Rectangular decorative cast-iron gates to main and side entrances.	Medium
3	1 Hillside Cottages	1244	232236	230268, 649040	Building	Listed building-category C (S)	Mid 19th century, 2 storeys, 2 bays. Painted rubble and margins. Off-centre door with flanking sash windows. 2 sash windows to 1st floor with blocked door to left approached by stone steps from building to left. Mainly 12-pane glazing. Slate roof.	Medium

Reference number	Site Name	HER Reference Number	NMR Reference Number	Grid Reference	Site Type	Designation	Description	Value
4	3 Hillside Cottages	1245	232238	230262, 649032	Building	Listed building-category C (S)	Mid 19th century. 2 storey, 3 bays. Painted rubble and margins. Broad segmental-headed pend and door to left,small window off-centre, and forestair rising to 1st floor door. 12-pane sash windows in central and left bays. Modern doors and glazing inserted under stair. End stacks. Slate roof.	Medium
5	4 Hillside Cottages	1246	232239	230253, 649023	Building	Listed building-category C (S)	Mid 19th century row of 3 single storey, 3-bay cottages.Harled with painted margins. Each has central door and small window beside doors; sash windows in outer bays. Central and left cottages have modern porch. Slate roof throughout.	Medium
6	5 Hillside Cottages	1246	266535	230250, 649014	Building	Listed building-category C (S)	Mid 19th century row of 3 single storey, 3-bay cottages.Harled with painted margins. Each has central door and small window beside doors; sash windows in outer bays. Central and left cottages have modern porch. Slate roof throughout.	Medium
7	6 Hillside Cottages	1246	266536	230243, 649006	Building	Listed building-category C (S)	Mid 19th century row of 3 single storey, 3-bay cottages.Harled with painted margins. Each has central door and small window beside doors; sash windows in outer bays. Central and left cottages have modern porch. Slate roof throughout.	Medium
8	Caaf Bridge	5557	40980	229232, 648419	Enclosure		Circular enclosure, surrounded by a rectangular bank 20m in overall width, within 50m of the road.	Low
9	Site of Dalry chapel	5257 5569	40992	229532, 648321	Buried feature		There were originally two churches in Dalry parish, one on the E of the village, and the other (NS24NE 11) on the W. Remains of the former still existed up to about the middle of the 18th century. It was superseded by the church (built at NS 2916 4944) about 1600-8 (see NS24NE 7). The	Low/ Negligible

Reference number	Site Name	HER Reference Number	NMR Reference Number	Grid Reference	Site Type	Designation	Description	Value
							site of the chapel is now occupied by a colliery and slag-heap.	
10	Hillend		204239	229423, 648102	Building		Farmstead marked on 1858 Ordnance Survey map.	Low
11	Railway Signal box		223728	229781, 648270	Building		Marked on 1858 and 1896 Ordnance Survey maps. Two roomed building shown as roofless on google (2012). Unable to see during walkover due to access and vegetation cover.	Low
12	River Garnock Snuff Mill		317747	229601, 648002	Site of building		Mill along River Garnock. Location uncertain.	Low
13	Kilcush			229842, 648282	Building		Kilcush marked on 1858 and 1896 Ordnance Survey map. Well also shown. Demolished by 1967 Ordnance Survey map but remains in 1910. Ruined building identified during walkover survey and shown as roofless square building on google maps (2012).	Low
14	Gas House			229800, 648212	Structure		Gas House and Dlary Junction marked on 1858 Ordnance Survey map. Not shown on 1967 Ordnance Survey map.	Low
15	Wall			229719, 648645 to 229831, 648060	Structure		Sandtone wall running alongside railway and forming field boundary. Probably 19th century.	Low
16	Blairland			229964, 648704	Building		Farmstead shown and labelled n 1858 Ordnance Survey map. Stone built farmhouse with sandstone dressings. Collection of other stone farm buildings.	Low
17	Limekiln			230254, 648927	Earthwork		Limekiln shown on 1858 Ordnance Survey map and visible as mound in ground.	Low
18	Stoopshill			230433, 648859	Building		Farmstead shown and labelled n 1858 Ordnance Survey map. Farmhouse is of two stories with double pile plan. Constructed of stone with pitched slate roof. Single storey extension.	Low

Reference number	Site Name	HER Reference Number	NMR Reference Number	Grid Reference	Site Type	Designation	Description	Value
19	Mineral Railway			231050, 648795 to 229838, 648060	Earthwork		Shown on 1858 Ordnance Survey map. Extends to Kilcush and main railway line to south by 1896 and 1910 Ordnance Survey maps. Dismantled by 1967 Ordnance Survey map. Visible as earthwork.	Low
20	Stables			230290, 649017	Site of building		Site of stables. Shown on 1858 Ordnance Survey map. Visible as earthwork.	Low
21	Spoil or bing?			230344, 648957	Earthwork		Large mound next to site of former mineral railway. Possible spoil heap (or bing).	Low
22	Stoopshill Pit			230547, 648965	Site of building		Stoopshill Pit marked on 1858 Ordnance Survey map. 'Disused' by 1911 Ordnance Survey map. Includes 'Engine House'. Visible as spoil heaps (or bings).	Low
23	Spoil heap or bing			229238, 648507	Earthwork		Spoil heap (or bing) shown on 1896 Ordnance Survey map. Visible as mound.	Low
24	Blair Colliery			229575, 648459	Site of building		Colliery complex shown on 1896 Ordnance Survey maps.	Low
25	Engine House and spoil heap			230442, 649407	Site of building		Marked on 1858 Ordnance Survey map. Removed by 1896 Ordnance Survey. Spoil heap or bing visible as mound close to location of former engine house.	Low
26	Coalheughglen Pit			230560, 649590	Site of building		Marked on 1858 Ordnance Survey map with Engine House. Removed by 1896 Ordnance Survey.	Low
27	Coalheughglen			230653, 649976	Building		Marked on 1858 Ordnance Survey map. Farmstead and probably part of coal works. Site next to coal pit. Framhouse is probably constructed of stone (rendered) with a brick extension to east. Pitched slate roof. Large single storey stone farm buildings (probably barns). Ruined pigsty on adjacent side of road.	Low
28	Creepies or Littleacres			230865, 650111	Building		Building marked on 1858 Ordnance Survey.	Low

Reference number	Site Name	HER Reference Number	NMR Reference Number	Grid Reference	Site Type	Designation	Description	Value
29	Highfield Cottage			230956, 650299	Building		Building marked on 1858 Ordnance Survey.	Low
30	Limekilns			230944, 649913	Earthwork		Marked on 1858 Ordnance Survey map. 'Old Limekiln' by 1911 Ordnance Survey map. Visible as mound with some loose stone walls.	Low
31	Kersland Colliery			230971, 649739	Site of building		Working mine shaft shown on 1896 Ordnance Survey map.	Low
32	Highfield and Highfield Pit			231083, 650061	Building		Shown on 1858 Ordnance Survey map. Number of limestone and sandstone quarries surrounding property.	Low
33	Southfield			231034, 650309	Building		Shown on 1858 Ordnance Survey map. Number of limestone and sandstone quarries surrounding property. Two storey building with rendered and white washed walls and pitched slate roof.	Low
34	Hairshaw			231717, 651170	Building		Shown on 1858 Ordnance Survey map. Number of limestone and sandstone quarries surrounding property.	Low
35	Quarry			231633, 650856	Earthwork		Shown on 1858 and 1896 Ordnance Survey maps.	Low
36	Sandstone quarry			231551, 650372	Earthwork		Shown on 1858 Ordnance Survey map. Marked as old quarries in 1896.	Low
37	Limestone quarry			231193, 649953	Earthwork		Shown on 1858 Ordnance Survey map.	Low
38	Quarry			231448, 650590	Earthwork		Shown on 1896 Ordnance Survey along with 'old shaft'. Replaced by Birkentop Cottage.	Low
39	Easter Highfield			231391, 650471	Building		Shown on 1911 Ordnance Survey map.	Low
40	Highfield Cottage			231344, 650022	Building		Shown on 1911 Ordnance Survey map.	Low
41	Railway underpass			229728, 648351	Structure		Railway underpass constructed of sandstone with iron supports. Probably 19th century.	Low
42	7 Beith Road			230906, 650214	Building		Large two-storey house probably constructed of stone but rendered with stone dressings and rusticated quoins. Central	Low

Reference number	Site Name	HER Reference Number	NMR Reference Number	Grid Reference	Site Type	Designation	Description	Value
							door with square doorcase. Two storey extension to north side. Shown on 1856 Ordnance Survey map.	
43	Blair Estate Stables		1203	230477, 647888	Building	Listed building-category B	Early 19th century. 2 storey U-plan castellated stable block; courtyard with retaining wall at north. South entrance front; 7 bays; coarsely droved rubble with polished dressings, Symmetrical. Slightly advanced wider and taller entrance bay with pilaster strip at angles, segmental-headed pend below 2 blind quatrefoils and crest in octagonal panel. Sash windows in flanking wings, outer broader bays slightly advanced. Original 9 and 12 pane glazing throughout. Eaves course and cornice and flat capped merlons. Piended slate roof. Interior of courtyard harled, with single window over entrance and stone steps leading to 2 doors at the angles. Wings have broad segmental-headed carriage entrances. Venetian windows in gable ends to north.	High
44	Blair House		1196	230453, 648034	Building	Listed building-category A	Composite building whose dates range from 16-19th centuries. Scottish Jacobean. Originally a 16th century tower house, altered at different periods. Now roughly 'T'-plan. A reset lintel dated 1617 suggests some building then; the substantial south wing is dated 1668 on the pedimented dormer heads; 18th century east wing; 1893 north wing and re-fronting of east range by Thomas Leadbetter. 3 and 4 storeys. Rubble built, with ashlar dressings throughout. Principal doorway in square tower in south re-entrant angle with decorative pilastered	High

Reference number	Site Name	HER Reference Number	NMR Reference Number	Grid Reference	Site Type	Designation	Description	Value
							doorcase and Blair arms above, supported by elaborate scrolls; small turret, also with doorway, to right. East wing is on 2 levels, that nearer central tower raised by Leadbetter, and corbelled 2-storey crow-stepped gabled projection added to right. Leadbetter's west is in similar style to the 17th century south wing, but with corbel tables included below gables. Crow-stepped gables, corniced end, ridge and wallhead stacks and slate roof throughout. Good turnpike stair and some late 18th/early 19th century interiors in south wing. Further interior work by Leadbetter.	
45	Blair Estate Garden Walls		1198	230322, 648053	Building	Listed building-category B	18th century rubble-built garden walls with ashlar dressings and flat coping stones. Side gates in north east and north west walls have elaborate ironwork patterns, former with round head, latter with thistle pattern hinges, cusped lintel and 2 conical finials on wall.	High
46	Blair Estate Forester's Cottage		1197	230821, 648564	Building	Listed building-category C (S)	Mid 19th century, Single storey and attic, 3-bay Gothic cottage. Harled, with painted margins. Later central porch with small square windows; door on left return elevation, and piended roof. Flanking sash windows under pointed heads with 'Y'-tracery. 2 dormers with pointed heads. End stacks and slate roof.	Medium
47	Blair Estate North Bridge over Bombo Burn		1199	230853, 648647	Structure	Listed building-category C (S)	Date 1849. Single span bridge. Coursed rubble with ashlar arch-ring and parapet rising to centre with straight -sectioned coping supporting iron railings and tall corniced central and terminal piers. Inscription on plinth of central piers has	Medium

Reference number	Site Name	HER Reference Number	NMR Reference Number	Grid Reference	Site Type	Designation	Description	Value
							initials "WFB, CIB" and date.	
48	4 Kilwinning Road		1218	228884, 648921	Building	Listed building-category C (S)	Originally a mid 19th century single storey, centre-doored, 3-bay cottage but a 1st floor added when road level was raised in late 19th century. Coursed tooled rubble, with painted margins. 1st floor door with fanlight, over original door, approached by steps from left. 8-pane sash windows throughout. Eaves course and cornice. Straight skews. End stacks and slate roof.	Medium
49	5 and 7 Blair Road		1189	229941, 649157	Building	Listed building-category B	Mid 19th century. 2 storeys, 3 bays. Painted ashlar and contrasting dressings. Flat end pilasters. Central recessed door with architraves and cornice, flanked by fluted Doric columns in antis, supporting cornice and blocking course. Ground floor windows with architraves and entablatures. 12-pane sash windows throughout. Eaves course, cornice and blocking course. End stacks. Shallow piended slate roof. Original square plan gatepiers, with moulded panels and shallow pyramidal caps.	High
50	Garnock Bridge		1185	229583, 649348	Building	Listed building-category C (S)	18th century bridge, west side rebuilt when widened in later 19th century. 2 coursed rubble arches with centre splayed cutwater on east side.	Medium
51	Bridgend Textile Mills		1189	229593, 649321	Building	Listed building-category B	Circa 1877. 3-storey, 16-bay main block. Yellow brick with red brick dressings, and	High

Reference number	Site Name	HER Reference Number	NMR Reference Number	Grid Reference	Site Type	Designation	Description	Value
							ashlar cills, lintels and cornice. North elevation: windows, with slender cast-iron mullions, set in recessed segmental-headed panels, bay to right recessed, with 2 windows to ground floor. Bracketed cornice and pienided slate roof. Low 'L'-plan brick extension to left. Decorative cast-iron railings. 2-storey house to west is same date. Stugged ashlar with polished dressings and quoins. West elevation set in slope; 3 bays with deeply projecting off-centre canted bay with porch in re-entrant angle at left. Band courses below ground and 1st floors, cill courses to advanced bay. All windows architraved, those to ground floor lugged, with segmental heads. North elevation: 2 storeys, 3 bays; left bay recessed. Similarly detailed. Cornice and bracketed cornice stack. Pienided slate roof.	
52	Carsehead Bridge		1205	230067, 649743	Structure	Listed building-category B	Probably John Patton Architect. Circa 1822. Bridge over river Garnock. Rubble-built with ashlar arches in shallow recess and late 19th century parapet. Broad central span flanked by single smaller flood relief arches.	High
53	Kersland Farm		1247	230554, 650527	Building	Listed building-category B	Early 19th century. 2-storey, 3-bay farmhouse attached to a 17th century 'L'-plan house, now used as farm building. 'U'-plan yard. House built of coursed droved rubble, with painted ashlar margins, lugged to windows. Central door behind modern rubble and glass porch, re-used datestone above with dog-tooth moulding, crest, and inscription "Kersland 1604 Daniel Ker". Eaves course,	High

Reference number	Site Name	HER Reference Number	NMR Reference Number	Grid Reference	Site Type	Designation	Description	Value
							cornice, scrolled skewputts, end stacks and slate roof. 17th century house with some visible small window openings, crowstepped gables and slate roof. Farm buildings to left are single storey with loft, rubble-built, with a number of original openings and small ventilating slits to loft. 17th/18th century garden wall with flat stone coping has blocked, narrow gateway and round tower at north-west corner.	
54	Brownhill House		1204	231324, 651439	Building	Listed building-category B	Late 18th century. 2 storeys and attic, 3 bays, with similarly detailed earlier 19th century 2-bay extension to left. Painted ashlar and margins. Pilastered doorpiece with cornice and blocking course centrally placed in earlier front. 12-pane sash windows throughout. Eaves course and cornice and 2 piended dormers. End stacks and slate roof. 2-bay extension has 2 windows to ground and 1st floors, eaves course, cornice, end stack and slate roof. Lower service buildings to rear and to right.	High
55	Monk Castle		13661	229150, 647354	Building	Listed building-category B	An example of a small Laird's House, possibly early 17th century - Roofless, but walls are quite entire; coarsed stone blocks; crowstepped gables with skews; a long rectangle on plan with square projecting staircase turret; low wide doorway has three pieces of grotesque sculpture over it - ground floor originally vaulted.	High

Appendix 8.1

Gazetteer of Cultural Heritage Features

Appendix 8.2

Table of Impact on Cultural Heritage Features

Appendix 8.2: Table of Impact on Cultural Heritage Assets

The following table lists the sites and monuments listed in the West of Scotland Archaeology Service (WOSAS) Historic Environment Record and the National Monuments Record of Scotland (NMRS) as identified through historical references, archaeological investigation, cartographic evidence and aerial photographs. The gazetteer includes all sites within the proposed development area and assets within a 250m radius of the proposed development area. The information gathered for the table has been obtained from the HER and NMR records.

Reference number	Site Name	Site Type	Designation	Value	Impacts from construction and operation	Magnitude of Impact (Unmitigated)	Recommended mitigation	Magnitude of Impact (Mitigated)	Significance of Effects (Mitigated)
1	Blair Estate	Landscape	Designed Garden and Landscape	High	Moderate visual impact from new road and bridge over railway and river during construction and following completion. Majority of estate is well concealed by trees and topography.	Minor	Photographic record of the landscape and its wider setting prior to commencement of works.	Minor	Moderate
2	North Lodge and gatepiers, Blair Estate	Building	Listed building-category C (S)	Medium	Minor visual and noise impact from new road during construction and once operational. This includes impact on the setting of the listed building.	Minor	The majority of the road will be placed in a cut to reduce this impact. Hedgerows around sections of road where it is likely to be visible. Photographic record of the asset and its setting prior to commencement of works.	Negligible	Slight
3	1 Hillside Cottages	Building	Listed building-category C (S)	Medium	Minor visual and noise impact from new road during construction and following completion.	Minor	The majority of the road will be placed in a cut to reduce this impact. Photographic	Minor	Slight

Reference number	Site Name	Site Type	Designation	Value	Impacts from construction and operation	Magnitude of Impact (Unmitigated)	Recommended mitigation	Magnitude of Impact (Mitigated)	Significance of Effects (Mitigated)
					This includes impact on the setting of the listed building.		record of the asset and its setting prior to commencement of works.		
4	3 Hillside Cottages	Building	Listed building-category C (S)	Medium	Minor visual and noise impact from new road during construction and following completion. This includes impact on the setting of the listed building.	Minor	The majority of the road will be placed in a cut to reduce this impact. Photographic record of the asset and its setting prior to commencement of works.	Minor	Slight
5	4 Hillside Cottages	Building	Listed building-category C (S)	Medium	Minor visual and noise impact from new road during construction and following completion. This includes impact on the setting of the listed building.	Minor	The majority of the road will be placed in a cut to reduce this impact. Photographic record of the asset and its setting prior to commencement of works.	Minor	Slight
6	5 Hillside Cottages	Building	Listed building-category C (S)	Medium	Minor visual and noise impact from new road during construction and following completion. This includes impact on the setting of the listed building.	Minor	The majority of the road will be placed in a cut to reduce this impact. Photographic record of the asset and its setting prior to commencement of works.	Minor	Slight
7	6 Hillside Cottages	Building	Listed building-category C (S)	Medium	Minor visual and noise impact from new road during construction and following completion. This includes impact on the setting of the listed	Minor	The majority of the road will be placed in a cut to reduce this impact. Photographic record of the asset and its setting prior to	Minor	Slight

Reference number	Site Name	Site Type	Designation	Value	Impacts from construction and operation	Magnitude of Impact (Unmitigated)	Recommended mitigation	Magnitude of Impact (Mitigated)	Significance of Effects (Mitigated)
					building.		commencement of works.		
9	Site of Dalry chapel	Buried feature		Low/ Negligible	Potential for unknown associated remains i.e. burials during construction	Major	Trail trenching to identify potential for associated buried remains within area of proposed scheme. Trenching will determine further mitigation where appropriate. Once operational, condition surveys may be required to ensure that the site has adequate drainage/ protection.	Moderate	Slight
10	Hillend	Building		Low	Minor visual and noise impact during construction and following completion to the north side of the asset.	Moderate	Hedgerows to be planted to reduce visual impact. Photographic record of building and its setting prior to commencement of construction.	Moderate	Slight
11	Railway Signal box	Building		Low	Building is expected to be retained as part of scheme but the new bridge over the railway will have a visual and noise impact on the asset and its setting both during construction and once	Moderate	Site was inaccessible during walkover due to location on railway land. Determine if asset is still standing and if so, undertake historic building recording of asset and its setting prior to	Moderate	Slight

Reference number	Site Name	Site Type	Designation	Value	Impacts from construction and operation	Magnitude of Impact (Unmitigated)	Recommended mitigation	Magnitude of Impact (Mitigated)	Significance of Effects (Mitigated)
					operational.		commencement of works.		
13	Kilcush	Building		Low	Buildings stands close to proposed bridge construction and is expected to be retained as part of scheme. The close proximity to the bridge and working area, however, could potentially damage or destroy the structure. The new bridge will have a visual and noise impact upon the asset and its setting both during construction and once operational.	Major	Clearance of vegetation / spoil covering ruined building to be undertaken by or monitored by an archaeologist. Historic building recording of asset and its setting prior to construction.	Moderate	Moderate
15	Wall	Structure		Low	The proposed new bridge will be constructed over the stone wall and may involve partial demolition of the wall. Visual and noise impact during construction and once operational.	Major	Historic building recording of feature prior to commencement of works.	Moderate	Moderate
16	Blairland	Building		Low	Visual and noise impact during construction and once operational.	Major (during construction) Moderate (short term post construction)	The majority of the road will be placed in a cut to reduce this impact. Hedgerows to be planted to reduce long distance views of	Minor	Slight

Reference number	Site Name	Site Type	Designation	Value	Impacts from construction and operation	Magnitude of Impact (Unmitigated)	Recommended mitigation	Magnitude of Impact (Mitigated)	Significance of Effects (Mitigated)
							road. Photographic record of the asset and its setting prior to commencement of works.		
17	Limekiln	Earthwork		Low	Potential impact during construction depending on size of working areas and access roads. Visual and noise impact during construction and once operational.	Moderate	The majority of the road will be placed in a cut to reduce this impact. Photographic and topographic record of the asset and its setting prior to commencement of works.	Minor	Slight
18	Stoopshill	Building		Low	Visual and noise impact during construction and once operational.	Major (during construction) Moderate (short term post construction)	The majority of the road will be placed in a cut to reduce this impact. Photographic record of the asset and its setting prior to commencement of works.	Moderate	Slight
19	Mineral Railway	Earthwork		Low	Feature to be largely retained but truncated by proposed road. Feature may be affected by working areas and access roads.	Major	Photographic and topographic record of feature prior to commencement of works.	Moderate	Moderate
21	Spoil or bing?	Earthwork		Low	Feature to be removed as part of proposed scheme.	Major	Archaeological investigation and recording of feature prior to commencement of	Moderate	Slight

Reference number	Site Name	Site Type	Designation	Value	Impacts from construction and operation	Magnitude of Impact (Unmitigated)	Recommended mitigation	Magnitude of Impact (Mitigated)	Significance of Effects (Mitigated)
							works. Ensure feature is not a limekiln.		
20	Stables	Site of building		Low	Potential for disturbance and destruction of buried remains	Major	Trial trenching to identify potential for buried remains within area of proposed scheme. Trenching will determine further mitigation where appropriate.	Moderate	Slight
27	Coalheughglen	Building		Low	Visual and noise impact during construction and once operational to north and north-east. SUDS basin to be placed to west. Proposed hedgerows/ woodland will take time to develop and the visual and noise impacts are likely to be long term in the meantime.	Major (during construction) Moderate (short term post construction)	Woodland and hedgerows to be planted to reduce views of road and SUDS basin. Photographic record of the asset and its setting prior to commencement of works.	Moderate	Slight
28	Creepies or Littleacres	Building		Low	Visual and noise impact during construction and once operational.	Moderate	The majority of the road will be placed in a cut to reduce this impact. Photographic record of the asset and its setting prior to commencement of works.	Moderate	Slight

Reference number	Site Name	Site Type	Designation	Value	Impacts from construction and operation	Magnitude of Impact (Unmitigated)	Recommended mitigation	Magnitude of Impact (Mitigated)	Significance of Effects (Mitigated)
30	Limekilns	Earthwork		Low	Proposed scheme is located at edge of feature and has potential to disturb it during construction and through working areas and access roads. Visual and noise impact.	Major	If not possible to avoid feature, undertake archaeological investigation and recording of feature prior to commencement of works. Archaeological watching brief to monitor works where it is not possible to avoid feature. Once operational, condition surveys may be required to ensure that the site has adequate drainage/ protection.	Moderate	Moderate
31	Kersland Colliery	Site of building		Low	Potential for works to disturb features associated with colliery through working areas and cutting.	Moderate	Avoid feature where possible. Archaeological watching brief to monitor works where this is not possible.	Minor	Slight
32	Highfield and Highfield Pit	Building		Low	Visual and noise impact during construction and once operational to north-west. Proposed hedgerows/ woodland will take time to develop and the visual and noise impacts are likely to be long term in the meantime.	Major (during construction) Moderate (short term post construction)	The majority of the road will be placed in a cut to reduce this impact. Photographic record of the asset and its setting prior to commencement of works.	Moderate	Slight

Reference number	Site Name	Site Type	Designation	Value	Impacts from construction and operation	Magnitude of Impact (Unmitigated)	Recommended mitigation	Magnitude of Impact (Mitigated)	Significance of Effects (Mitigated)
33	Southfield	Building		Low	Visual and noise impact during construction and operational to south-east.	Minor	The majority of the road will be placed in a cut to reduce this impact. Photographic record of the asset and its setting prior to commencement of works.	Negligible	Slight
39	Easter Highfield			Low	Visual and noise impact during construction and once operational to south-west. Proposed hedgerows/ woodland will take time to develop and the visual and noise impacts are likely to be long term in the meantime.	Major (during construction)Moderate (short term post construction)	The majority of the road will be placed in a cut to reduce this impact. Photographic record of the asset and its setting prior to commencement of works.	Moderate	Slight
41	Railway underpass	Structure		Low	Visual and noise impact during construction and once operational.	Moderate	Photographic recording of feature and its setting prior to commencement of works.	Moderate	Slight
42	7 Beith Road	Building		Low	Visual and noise impact during construction and once operational to south-east.	Minor	The majority of the road will be placed in a cut to reduce this impact. Photographic record of the asset and its setting prior to commencement of works.	Negligible	Slight

Appendix 8.2

Table of Impacts on Cultural Heritage Features

Appendix 9.1

Landscape Resource Assessment (See Figures 9.2a-b Baseline Landscape Sheet 1 and 2, Figures 9.3a-b, Landscape Appraisal Sheet 1 and 2, Figures 9.4a-b Landscape Quality Sheet 1 and 2.)

Resource	Description	Sensitivity	Nature of Effect	Magnitude	Mitigation Measures	Significance of Effects
Landform and Topography	From the southern tie in with the A737 the proposed route passes through a wooded incised river valley progressing into more open gently undulating rolling farmland character. Generally landform falls towards the River Garnock valley.	Medium	Re-modelling of topography and skylines due to introduced landform of road embankments/cuttings and bridge structures. Large visually intrusive embankments to either side of the viaduct structure crossing the River Garnock valley and the southern area of the scheme. Long stretch of cutting for most of the proposed scheme to the north with an area of deeper cutting either side of Blair Road.	Substantial: Direct impact to topography. Stretches of cutting to the northern end of the route with deeper cutting either side of Blair Road. Stretch of visually intrusive embankment to the central and southern area of the proposed route. Additional earth embankments proposed to screen traffic movement.	Road alignment is integrated by responding to existing landform and retaining significant existing vegetation where possible. Proposed embankments have been designed to tie into existing landform and are no steeper than 1 in 3 with tops of embankments graded to soften the impact. Where required scrub and woodland is proposed to screen embankments.	Short Term: Major Adverse Long Term: Minor Adverse
Land-use	Existing road corridor with urban influences in the western part of the study area. The proposed route passes through predominantly agricultural farmland, delineated by hedgerows with hedgerow trees. Footpaths and tracks associated with the River Garnock. Existing River Garnock SINC.	Medium	Changes in land use/management due to required land take in relation to the proposed road design resulting in a loss of agricultural farmland. Indirect effect on segregated land and future management/ use.	Substantial: Direct/indirect impact to resource.	Mitigation strategy developed to retain existing agricultural fields where possible with earthworks designed to maximize usable space and tie into existing landscape features where possible. Footpaths/tracks retained or relocated. Reinstatement of recognised landscape character (native mixed broad-leaved woodland and strong field delineation). The road has been located to minimize impacts on the River Garnock SINC.	Short Term: Major Adverse Long Term: Moderate Adverse

Resource	Description	Sensitivity	Nature of Effect	Magnitude	Mitigation Measures	Significance of Effects
Vegetation/ Landcover (of significance)	Pastoral fields often with mature hedgerows, hedgerow trees and copses. Maturing screen planting around existing railway line.	Medium	Loss of semi-natural woodland between railway line and River Garnock during construction of the proposed viaduct. Removal of stretches of hedgerow and hedgerow trees particularly as a result of the proposed northern roundabout. No direct effect on the adjacent woodland within Blair Estate.	Moderate	Mitigation strategy developed to reduce land take, minimise disturbance to existing woodland/vegetation, new planting of woodland, scrub, conservation grassland, native hedgerows and hedgerow trees. Replacement of hedgerows and hedgerow trees to provide suitable habitats and reinstate field patterns.	Short Term: Moderate Adverse Long Term: Moderate Beneficial
Access	Transport routes, A737 and the B780 & minor roads; and main railway line. Access to countryside/ recreational resource, National Cycle Network route 7 and route protected in Local Plan for potential off road diversion, tracks and informal paths. Access to fields for agricultural uses. (See Chapter 14 – Effects on All Travellers for further details).	Medium	Improved access to the south of Dalry. Creation of physical barrier between agricultural fields affecting access. Realignment of National Cycle Network Route 7. Existing roads stopped up where severed by the Proposed Scheme.	Moderate	Existing roads providing vehicular access to residential properties retained. New access points provided to agricultural fields where necessary. National Cycle Network route 7 accommodated as part of the scheme. Cattle passes provided in two locations to accommodate the movement of livestock across the road scheme.	Short Term: Moderate Adverse Long Term: No Change
Drainage features in the landscape	River Garnock and associated minor watercourses.	Medium	Disturbance to existing resource adjacent to the Proposed Scheme through operational activities and any residual adverse effects. Section of Coalheughglen Burn physically diverted under the road through a new culvert. A section of an additional unnamed burn would also be culverted.	Moderate	Road alignment integrated by responding to existing landform and retains significant existing watercourses. New embankments for viaduct crossing do not extend into the floodplain of River Garnock.	Short Term: Moderate Adverse Long Term: Minor Adverse

Resource	Description	Sensitivity	Nature of Effect	Magnitude	Mitigation Measures	Significance of Effects
Landscape Character Area – Estate Land (High Quality)	Designated Designed Landscape with extensive gently undulating landform and visually prominent large areas of woodland.	High	There will be no direct impact on the estate land.	Negligible/None	The siting, design and the landscape strategy developed to assist in accommodating the new road within the existing adjacent landscape infrastructure mitigates for any impacts upon the resource.	Short Term: Minor Impact Long Term: No Change
Landscape Character Area – Rolling Farmland (High Quality)	High quality areas of rolling farmland adjacent to Blair Estate and to the west of the A737. The landscape adjacent to the Blair Estate consists of well maintained hedgerows and copses of trees with few detracting features. The landscape to the west of the A737 has an attractive unified character providing long distance views.	High	The proposed road is located within an area of high quality landscape. The proposals will result in changes to land use and topography and will result in the severance and loss of existing hedgerow field boundaries. A new roundabout is proposed adjacent to the A737 resulting in changes to landform over a small area and removal of small areas of existing vegetation.	Substantial	The siting and design of the road and the landscape strategy have been developed to assist in accommodating the new road within the existing landscape framework. Where appropriate, landform associated with the road has been designed to provide false cutting screening and to tie in with existing landform. As part of the landscape strategy new hedgerow planting and hedgerow trees are proposed.	Short Term: Major Adverse Long Term: Minor Adverse
Landscape Character Area – Rolling Farmland (Medium Quality)	Medium quality areas of rolling farmland with both attractive and unattractive landscape features and visual detractors such as telegraph wires, poles and masts.	Medium	The proposals will result in changes in land use and topography and will result in the severance and loss of existing hedgerow field boundaries in parts of this landscape character area.	Substantial	The siting and design of the road and the landscape strategy have been developed to assist in accommodating the new road within the existing landscape framework. Where appropriate, landform associated with the road has been designed to provide false cutting screening and to tie in with existing landform. As part of the landscape strategy new hedgerow planting with hedgerow trees and woodland on viaduct abutments are proposed.	Short Term: Major Adverse Long Term: Minor Adverse

Resource	Description	Sensitivity	Nature of Effect	Magnitude	Mitigation Measures	Significance of Effects
Landscape Character Area – Rolling Farmland (Low Quality)	Low quality area of rolling farmland adjacent to the River Garnock. The area is also situated adjacent to the railway with degraded elements resulting in a fragmented landscape.	Low	The proposed viaduct will span the river valley to the north of this landscape character area introducing a large scale manmade feature. There will be no direct effect on this landscape character area.	Slight	Where appropriate, screening planting and the slackening of steep engineered slopes will mitigate for these impacts.	Short Term: Minor Impact Long Term: No Change
Landscape Character Area – River Valley (Medium Quality)	Medium quality area of river valley located to the north of the proposed viaduct associated with the new road. The landscape consists of gently undulating landform surrounding the River Garnock and other associated burns and watercourses. Part of this area is designated as a Wildlife Site/SINC by the Scottish Wildlife Trust.	Medium	The proposed viaduct will span the river valley and will change the landscape character of part of this relatively small area by introducing a large scale manmade feature.	Substantial	Due to the scale and location of the viaduct structure it is impossible to mitigate fully for its impact. In the long term existing vegetation will provide screening of the viaduct reducing its impact on the visual character of this area.	Short Term: Major Adverse Long Term: Moderate Adverse
Landscape Character Area – River Valley (Low Quality)	Low quality area of the river valley located to the south of the proposed viaduct associated with the new road. The landscape is fragmented in nature with degraded elements particularly along the railway and surrounding parts of the river.	Low	The proposed viaduct is located immediately to the north of this landscape area and will change the landscape character.	Substantial	Due to the scale and location of the viaduct structure it is impossible to mitigate fully for its impact. In the long term existing vegetation will provide screening of the viaduct reducing its impact on the visual character of this area.	Short Term: Moderate Adverse Long Term: Minor Adverse

Resource	Description	Sensitivity	Nature of Effect	Magnitude	Mitigation Measures	Significance of Effects
Landscape Character Area – Dalry Urban Areas (Unclassified Quality)	Dalry is a small settlement with a fine grain and human scale, narrow streets and small residential units. Drakemyre Works situated to the north of Dalry is of much larger scale with large buildings set out in a grid system. To the east of the railway line is the Blairland housing estate. Urban areas consist of high quality areas such as Dalry Conservation Area as well as degraded areas, particularly on the urban fringes.	Medium	There will be no direct effect on the Dalry urban areas landscape character area as the proposed road runs to the southeast of Dalry.	Negligible / None	Siting of the road is to the southeast of Dalry and does not effect (directly or indirectly) this character area.	Short Term: No Change Long Term: No Change

Appendix 9.1

Landscape Resource Assessment

Appendix 9.2

Visual Effects

Appendix 9.2

Visual Effects (See Figures 9.1 Photo Viewpoint Location Plan, Figure 9.5a-9.5b Visual Effects-Temporary Sheet 1 and 2, Figure 9.6a-9.6b Visual Effects-Permanent Sheet 1 and 2 and Figure 9.7-9.30: Photo Viewpoints A-U.)

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR1	Residential properties at East Kersland	2 storey courtyard farm house with roof windows facing south	Open views to the southwest along the railway and river corridor. Views to the south & east enclosed by topography.	High	650m	None	No predicted views of the Proposed Scheme.	Construction: No change Short Term: No change Long Term: No change
VR2	Residential properties at Wester Kersland	Single storey detached bungalow with dormer window facing north-northwest	Open views to the north of medium quality open rolling farmland and to the west over the Dalry urban area.	High	500m	None	No predicted views of the Proposed Scheme.	Construction: No change Short Term: No change Long Term: No change
VR3	Residential properties at Carsehead and Jimmary Lodge	2 storey semi-detached houses and single storey detached bungalow with dormer windows facing east-northeast	Views from the rear of properties of moderate quality rolling farmland partially screened by vegetation.	High	400m	Slight	Partial views south east predicted of the northern roundabout, and north section of road. Likely views of traffic and the SuDs basin located near Coalheughglen Farm.	Construction: Moderate Adverse Short Term: Minor Adverse Long Term: Minor Adverse
VR4	Residential properties at Glenfeld and Ashleen	Single storey detached bungalows facing north west	Views from the rear of properties of moderate quality open rolling farmland rising to the east.	High	320m	Negligible	No predicted views of the Proposed Scheme in the short or long term but possible views of construction traffic during the construction stage on the existing road network.	Construction: Minor Adverse Short Term: No change Long Term: No change

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR5	Residential properties at Coalheughglen	2 storey courtyard farm house with roof windows facing south	Open views of surrounding moderate quality rolling farmland enclosed to the south by topography.	High	90m	Substantial	The Proposed Scheme is in close proximity to this receptor and would be visible from this property in two locations. The northern roundabout would be in close proximity to this receptor, requiring the minor road on which the receptor is located to be blocked off. There would also be significant removal of vegetation which is visible from the receptor, and the introduction of a new road on an embankment running through the adjacent field to the east of the property.	Construction: Major Adverse Short Term: Moderate Adverse Long Term: Minor Adverse

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR6a	Residential properties in West Highfield facing west-northwest	Single storey detached bungalows facing west-northwest – rear windows facing east-southeast.	Views from rear windows of moderate quality open rolling farmland enclosed by topography and vegetation.	High	40m	Substantial	Close proximity to the Proposed Scheme. During construction the scheme would be clearly visible from the rear of these properties however views may be partially screened by existing vegetation within rear gardens. However in the short and long term mitigation proposals would aid in reducing this initial impact by screening the road and traffic with landscape bunds and screening planting. The existing road would be blocked off to the front of the properties and incorporate a new turning head. As a consequence traffic movements outside these properties are likely to be significantly reduced.	Construction: Major Adverse Short Term: Moderate Adverse Long Term: Minor Adverse

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR6b	Residential properties in West Highfield facing east-southeast	Single storey detached bungalows facing east-southeast	Partial views from rear windows of existing A737 road corridor. Partial views from front windows of moderate quality open rolling farmland enclosed by built form, landform and vegetation.	High	40m	Moderate	Close proximity to the Proposed Scheme. The existing A737 is visible from the rear of these properties through gaps in existing vegetation. The proposals include altering this stretch of road to form a new junction. During construction the scheme would be partially visible through gaps in built form and vegetation. There would also be significant removal of vegetation to enable the construction of the northern roundabout which is visible from these properties in oblique views. However in the short and long term mitigation proposals would aid in reducing this initial impact by screening the road and its traffic with landscape bunds and screen planting and by the provision of new hedgerow tree planting. The existing road would be blocked off and incorporate a new turning head. As a consequence traffic movements outside these properties are likely to be significantly reduced.	Construction: Major Adverse Short Term: Moderate Adverse Long Term: Minor Adverse

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR7	Residential properties in East Highfield	2 storey courtyard farm houses facing south-southeast	Open views south and west of moderate quality rolling farmland and the Dalry urban area, enclosed to the north by vegetation.	High	90m	Substantial	Close proximity to the Proposed Scheme. During construction the road scheme would be clearly visible from these properties. Beneficial effects in the short and long term due to the movement of traffic away from the receptor and mitigation proposals providing screening.	Construction: Major Adverse Short Term: Minor Beneficial Long Term: Minor Beneficial
VR8	Residential property Pasturehill Cottage	Detached bungalow with dormer windows facing northwest towards the Blaeloch Hills	Open views to northwest towards the distant Blaeloch Hills with the existing A737 road traffic in the foreground.	High	10m	Substantial	Close proximity to the Proposed Scheme. Although the scheme would be visible from this property, the proposed alignment is set further away from the property than existing with proposed mitigation planting between the receptor and the road, including the retention and enhancement of the existing roadside hedge. The existing A737 would become an access road to the property significantly reducing traffic movements.	Construction: Major Adverse Short Term: Minor Adverse Long Term: No Change

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR9	Residential property Birkentop Cottage	Detached bungalow facing northwest towards the Blaeloch Hills	Open views to northwest towards the distant Blaeloch Hills with the existing A737 road traffic in the foreground.	High	10m	Substantial	Close proximity to the Proposed Scheme. Although the scheme would be visible from this property, the proposed alignment is set further away from the property on lower ground and there is the potential to retain and enhance the existing roadside hedgerow and provide screen planting to mitigate the impacts. A new cattle crossing access would be located opposite the property.	Construction: Major Adverse Short Term: Moderate Adverse Long Term: Minor Adverse

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR10	Residential property at Easter Highfield	2 storey courtyard house facing southwest over rolling farmland	Views to the southwest of rolling farmland framed by trees and vegetation.	High	120m	Substantial	The Proposed Scheme would be clearly visible to the southwest and west during construction and in the short term. To the southwest the scheme would result in a loss of trees which form visual elements in views from the property. These views would include views of the northern roundabout and the new lighting located here. However extensive new tree planting and proposed earthworks would provide screening of the road and mitigate for the loss of trees in this view. To the west the road and associated traffic movements would be located further away from the receptor.	Construction: Major Adverse Short Term: Minor Adverse Long Term: Minor Adverse

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR11	Residential properties at north east Highfield.	Mixed group of bungalows and 2 storey terraced style houses facing southwest, west and north.	Views of moderate quality open rolling farmland enclosed by topography and vegetation.	High	90m	Moderate	Close proximity to the Proposed Scheme. To the southwest and west the road alignment would be located further from the receptor than the existing road. Due to the proposed levels of the road and associated earthworks, hedge and tree planting it is likely that views of the road and traffic would be screened. To the north partial views of the new road and traffic would be gained through existing planting with additional hedge and tree planting providing further screening. As a result of the proposed road and roundabout several mature trees would be removed.	Construction: Major Adverse Short Term: Moderate Adverse Long Term: Minor Adverse
VR12	Residential properties at Lambridden Farm	2 storey courtyard farm house facing southwest.	Views are enclosed by vegetation and landform.	High	820m	None	No predicted views of the Proposed Scheme.	Construction: No change Short Term: No change Long Term: No change

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR13a	Residential property at Stoopshill Farm	2 storey farm house facing north-northeast.	Open views of high quality rolling farmland to the north and the Dalry urban area to the east.	High	85m	Substantial	Close proximity to the Proposed Scheme. The scheme would be partly visible from Stoopshill Farm, including a stretch of visually intrusive highway set in a deep cutting and oblique views of the new bridge on Blair Road. However due to mitigation these features would not dominate the view.	Construction: Major Adverse Short Term: Moderate Adverse Long Term: Minor Adverse
VR13b	Residential property at North Lodge	Single storey gatehouse facing southeast into Blair Estate.	Views are enclosed by vegetation and built form.	High	85m	Negligible	No predicted views of the proposed road scheme in the short or long term but possible views of construction traffic during the construction stage.	Construction: Minor Adverse Short Term: No change Long Term: No change
VR14	Residential properties on the north-eastern and south-eastern edges of Blairland housing estate	2 storey estate semi detached houses with occasional dormer windows facing northwest/southwest – rear windows facing southeast/northeast with views from lower floor windows through gaps in vegetation and upstairs windows	Views to the south and west of high quality rolling farmland and Blair Estate from rear upstairs windows and rear ground floor windows where gaps in hedgerow vegetation occur. Views enclosed by topography and vegetation associated with the Blair Estate.	High	140m	Substantial	Only the properties on the edge of Blairland housing estate would have direct views of the Proposed Scheme during construction with short and long term effects mitigated through screening landform and planting.	Construction: Major Adverse Short Term: Minor Adverse Long Term: Minor Adverse

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR15	Residential property at Blairland Farm	2 storey farm house with facing south-east	Open views to the east, south and west of high quality rolling farmland and the Blair Estate. Views enclosed by topography and vegetation associated with the Blair Estate.	High	260m	Substantial	During the construction stage the Proposed Scheme, including the viaduct structure over the Garnock valley, would be clearly visible from this property. In the short and long term this effect would be reduced through mitigation landform and planting screening however the impacts from the viaduct would unable to be mitigated against due to the scale and nature of the structure.	Construction: Major Adverse Short Term: Moderate Adverse Long Term: Moderate Adverse
VR16	Residential property on western edge of Blair Estate	Single storey detached house with dormer windows set within Blair Estate, facing southwest	Open views to the east, south and west of high quality rolling farmland and the Blair Estate. Views enclosed by topography and vegetation associated with the Blair Estate.	High	350m	Moderate	The Proposed Scheme would be partially visible from this property. The copses of mixed and coniferous woodland to the north west, the vegetation associated with the river and rail corridor to the south west and mitigation planting on the road embankment and surrounding the adjacent SuDs basin would aid in screening the proposed road and its traffic.	Construction: Major Adverse Short Term: Moderate Adverse Long Term: Minor Adverse
VR17	Residential properties at Blair House and Carriage House	Large estate manor house with associated outbuildings and residential houses	Views enclosed by high quality estate woodland.	High	560m	None	No predicted views of the proposed road scheme.	Construction: No change Short Term: No change Long Term: No change

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR18	Residential property at Laigh Monkcastle	Detached courtyard style farmhouse – bungalow with dormer windows. Facing north-northeast over the River Garnock valley towards Dalry	Views facing north-northeast over the River Garnock valley towards Dalry, partially screened by vegetation within the curtilage of the property.	High	780m	Slight	The proposed viaduct and road would be visible from the property. However whilst these features would not be prominent in the view it is unlikely for views to be completely screened due to the scale of the viaduct structure and the orientation of the road in relation to the property.	Construction: Moderate Adverse Short Term: Moderate Adverse Long Term: Moderate Adverse
VR19	Residential property at Hillend	Single storey farmhouse with dormer windows facing south-southeast	Open views to the south and east from the front of the property towards moderate – high quality rolling farmland. Views north partially screened by vegetation.	High	90m	Substantial	Close proximity to the Proposed Scheme - the viaduct structure and the road would be visible from the property. The viaduct structure would be very visually prominent and is unlikely to be fully mitigated against. The close proximity of the new roundabout would have an adverse effect on views from the rear of the property.	Construction: Major Adverse Short Term: Major Adverse Long Term: Moderate Adverse
VR20	Residential properties at Craighead	Two single storey farm houses with dormer windows facing northeast over Dalry and the Garnock valley	Distant views facing northeast over Dalry and the Garnock valley partially screened by vegetation within the curtilage of the properties.	High	750m	Slight	Partial, distant views predicted of the Proposed Scheme, which may be partially screened by areas of vegetation within the curtilage of the individual residential properties and mitigated by screening landform and planting.	Construction: Moderate Adverse Short Term: No change Long Term: No change

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR21	Residential properties on the southern edge of Dalry on Trinity Drive/St Andrews Gardens	Mixed estate of single and 2 storey houses generally inward facing, with some plots along the southern edge having views from rear windows southeast along the Garnock valley	Generally the houses within the estate are inward facing, however some plots along the southern edge have views from rear windows southeast along the Garnock valley which are partially screened by built form and vegetation.	High	750km	Slight	Partial or distant views predicted of the Proposed Scheme including the proposed viaduct behind existing vegetation. Views would be partially screened by topography, built form and vegetation. Screening landform and planting would aid in the long term mitigation of impacts for the sections of road not on the viaduct structure.	Construction: Moderate Adverse Short Term: Minor Adverse Long Term: Minor Adverse
VR22	Residential properties in the south of Dalry on Garnock Street	2 storey semi-detached estate houses on Garnock St, generally inward facing. Properties along the southern edge face north with rear views along the Garnock valley through gaps in vegetation and upstairs windows	Partial views from individual properties south of moderate quality rolling farmland and the Garnock river valley from rear upstairs windows of properties through gaps in the vegetation along the Putyan Burn.	High	750m	Moderate	Partial views predicted of the southern roundabout where the new road meets the existing A737, and the southern section of road including the viaduct embankments. Screening and hedgerow planting would aid in the mitigation of these impacts.	Construction: Major Adverse Short Term: Moderate Adverse Long Term: Moderate Adverse

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR23	Residential properties at Manse	Mixed estate of 2 storey semi-detached houses and single storey detached bungalows, generally inward facing	Views to the south are screened by vegetation and built form.	High	850m	Negligible	No predicted views of the proposed road scheme in the short or long term but likely views of construction traffic during the construction stage.	Construction: Minor Adverse Short Term: No change Long Term: No change
VR24	Residential properties on the western edge of Dalry on elevated land – recent estate off Kittyshaw Road	Modern development of 2 storey detached houses, generally inward facing	The properties in the estate are generally inward facing with views obstructed by built form. However some of the properties have rear windows or views through gaps in the built form over Dalry and the Garnock valley.	High	1.2km	Slight	Partial, distant views predicted of the Proposed Scheme partially screened by vegetation, landform and built form from some properties. The scheme forms minor element in view and would be viewed in context of the Dalry urban area.	Construction: Moderate Adverse Short Term: No change Long Term: No change
VR25	Residential property at Mount Pleasant	Single detached bungalow facing northeast over Dalry and the Garnock valley	Open elevated views facing northeast over Dalry and the Garnock valley.	High	1.5km	Slight	Partial, distant views predicted of the proposed road scheme partially screened by vegetation, landform and built form. The scheme forms a minor element in the view and would be viewed in context of the Dalry urban area including detractors such as Drakemyre Works. Screen landform and planting would aid in the mitigation of these impacts. However the viaduct structure would be visible and is unlikely to be able to be fully mitigated against.	Construction: Moderate Adverse Short Term: Minor Adverse Long Term: Minor Adverse

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR26	Residential properties in the western part of Dalry on elevated land – St Margaret Avenue	Estate of 2 storey detached houses, generally inward facing	The properties in the estate are generally inward facing with views obstructed by built form. However some of the properties have views through gaps in the built form over Dalry and the Garnock valley.	High	1.2km	Slight	Partial, distant views predicted of the proposed road scheme through gaps in the housing layout from some properties. These views would be partially screened by vegetation, landform and built form. The scheme forms a minor element in view and would be viewed in context of the Dalry urban area.	Construction: Moderate Adverse Short Term: No change Long Term: No change
VR27	Residential properties on the south east edge of Dalry Conservation Area	2 storey detached houses and commercial properties and single storey detached bungalows along New Street facing north-northwest	Partial views from individual properties south-southeast of moderate quality rolling farmland and the Garnock river valley from rear of properties through gaps in vegetation.	High	1km	Moderate	Partial views predicted of the southern roundabout, southern section of road and viaduct from rear of properties and oblique views from front windows. It is likely that the Proposed Scheme would be visible during construction due to loss of vegetation and construction traffic, however screening landform and planting would aid in the mitigation of these impacts in the short and long term.	Construction: Major Adverse Short Term: Moderate Adverse Long Term: Minor Adverse

Visual Receptor	Residential Property/ Area	Description	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR28	Residential property opposite Doggartland	Single storey detached house facing southeast over Dalry and Drakemyre Works	Views facing southeast towards Dalry. Drakemyre works forms main feature of the view with elevated rolling farmland in the background, partially screened by vegetation.	High	2km	Negligible	Partial views of the Proposed Scheme predicted – the scheme would form a minor element in the view and be viewed in the context of Drakemyre Works in the foreground. However, screen planting, landform and the minor nature of the changes in the context of the view would aid in the mitigation of these effects.	Construction: Minor Adverse Short Term: No change Long Term: No change
VR29	Residential property at Langside	Detached farm house facing east-southeast over the Garnock valley	Open elevated view facing east-southeast over open rolling farmland and the Garnock valley, partially screened by blocks of vegetation and individual trees.	High	2.5km	Negligible	Distant views of elements of the Proposed Scheme are predicted – however these elements would form minor features in the view and be viewed in the context of the wider transport infrastructure of the Dalry area, including visual detractors such as Drakemyre Works. Maturing screen planting and screening landform would aid mitigate these effects in the long term.	Construction: Minor Adverse Short Term: No change Long Term: No change
VR30	Residential properties on the eastern edge of Dalry	Mixed estate of 2 storey and single storey detached houses and bungalows, generally inward facing	Generally inward facing, views are enclosed by built form and the railway line embankment.	High	700m	None	No predicted views of the Proposed Scheme	Construction: No change Short Term: No change Long Term: No change

Visual Receptor	Local Roads	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR31	Users of the Auchengree Road north of Highfield to Longbar	Open views of surrounding moderate quality rolling farmland landscape enclosed by roadside hedgerows.	Medium	<150m	Slight	The alignment and position of this section of new road is similar to the existing road alignment. However the new road would be located away from the existing properties at Highfield slightly changing views of this area from the road.	Construction: Minor Adverse Short Term: No change Long Term: No change
VR32	Users of A737 north of Dalry	Open views of surrounding moderate quality rolling farmland landscape.	Medium	0m Connected to proposed road	Substantial	The proposed road would connect to the existing road and would, therefore, be highly visible during construction. Following completion proposed landform would also block views of the surrounding countryside from the road. In addition, the viaduct structure over the Garnock valley and the proposed southern roundabout would be clearly visible. However, in the long term the mitigation proposals would aid in the integration of the new road and the viaduct into the context of the surrounding road and infrastructure network.	Construction: Major Adverse Short Term: Major Adverse Long Term: Moderate Adverse

Visual Receptor	Local Roads	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR33	Users of B707 east of Highfield	Views of surrounding moderate quality rolling farmland landscape partially enclosed by roadside hedgerows and occasional hedgerow trees.	Medium	<40m (Connected to proposed road via roundabout)	Moderate	The proposed road connects to this existing road via the new northern roundabout and would, therefore, be highly visible at this location. However, in the long term the new road would be viewed in the context of the surrounding roads.	Construction: Moderate Adverse Short Term: Minor Adverse Long Term: No change
VR34	Users of the C93 south of Highfield to Blair Estate (National Cycle Network Route)	Open views of moderate to high quality rolling farmland in the Garnock valley and Dalry urban area. Hedgerows provide low level screening. National Cycle Network route.	Medium	<300m (Connected to proposed road via roundabout)	Moderate	The proposed road connects to this existing road at the northern roundabout and would, therefore, be visible at this location. In addition views of users of this part of the NCN route would be affected as the rote would be diverted in this location. In the long term, once vegetation becomes established the scheme would be viewed in the context of the surrounding roads.	Construction: Moderate Adverse Short Term: Minor Adverse Long Term: No change

Visual Receptor	Local Roads	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR35	Users of Blair Road east of Blairland	Open views of surround high quality landscape and contained to the northwest by Blairland Housing Estate and to the south by the Blair Estate.	Medium	0m (Road crosses proposed route by a proposed bridge)	Moderate	The proposed road alignment crosses this existing road under a new bridge and would, therefore, be highly visible from this location. The new bridge would have a railed parapet and therefore provide views of the proposed road and the surrounding countryside from the bridge. Existing hedgerows screen the road scheme from other stretches of the road.	Construction: Moderate Adverse Short Term: Minor Adverse Long Term: Minor Adverse
VR36	Users of A737 south of Dalry	Open views over the Garnock valley (moderate to low quality landscape) towards open rolling farmland and the Blair Estate (high quality landscape).	Medium	0m (Connected to proposed road)	Substantial	The Proposed Scheme would connect to this existing road via the new southern roundabout and would, therefore, be highly visible during construction. The new roundabout, lighting, viaduct and earthworks associated with the new road alignment and roundabout would be visible in the short and long term. In addition, there would be a loss of existing hedgerows to facilitate the scheme.	Construction: Major Adverse Short Term: Major Adverse Long Term: Moderate Adverse
VR37	Users of B714 south west of Dalry	Elevated open views over surrounding moderate quality rolling farmland, the Garnock valley and Dalry urban area partially screened by landform and contained by roadside hedgerows.	Medium	>750m	Slight	Partial or distant views predicted of the Proposed Scheme, which may be partially screened by areas of vegetation.	Construction: Minor Adverse Short Term: Minor Adverse Long Term: No change

Visual Receptor	Local Roads	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR38	Users of B780 west of Dalry	Open views of surrounding moderate quality rolling farmland and the Dalry urban area, partially screened by built form and vegetation. Enclosed by roadside hedgerows.	Medium	>1.5km	Slight	Partial views of the Proposed Scheme viewed in context of the Dalry urban area and other transport infrastructure.	Construction: Minor Adverse Short Term: Minor Adverse Long Term: No change
VR39	Users of B780 north of Dalry	Views are enclosed by built form and vegetation associated with Drakemyre Works and the Dalry urban area.	Medium	1.6km	Negligible / None	No predicted views of the Proposed Scheme.	Construction: No change Short Term: No change Long Term: No change

Visual Receptor	Miscellaneous Receptors – (e.g.: paths, tracks and cycleways)	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR40	Users of Blair Estate parkland and gardens	Views within the Estate are enclosed by high quality and long-established woodland associated with the Blair Estate.	High	<300m	Slight	Glimpse views of the proposed road scheme from paths in the western part of Blair Park Estate may be possible during the construction stage.	Construction: Moderate Adverse Short Term: Minor Adverse Long Term: No change

Visual Receptor	Miscellaneous Receptors – (e.g.: paths, tracks and cycleways)	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR41	Users of path running southwest from Blairland estate	Views south and east are enclosed by topography and vegetation associated with Blair Estate, with open views over the River Garnock valley to the west. Landscape quality is high.	High	<200m	Substantial	The Proposed Scheme is in close proximity to the receptor and crosses over the path as the road crosses the River Garnock valley via the viaduct. The proposed road embankment and viaduct over the river would be very visually dominant. However, screening landform would aid in the mitigation of effects in the short term and screening planting would aid in the mitigation of the visual impacts of the road in the long term.	Construction: Major Adverse Short Term: Major Adverse Long Term: Moderate Adverse
VR42	Users of path south of railway crossing	Views are generally enclosed by topography associated with the valley sides. Landscape quality is moderate - high.	High	0m (Located below proposed route viaduct structure)	Substantial	The Proposed Scheme crosses over the route on the viaduct structure. The road embankment and viaduct over the river would be very visually dominant from locations along this path.	Construction: Major Adverse Short Term: Major Adverse Long Term: Moderate Adverse
VR43	Users of the River Garnock and paths along the river	Views along the river corridor are enclosed by topography associated with the valley sides and vegetation within the valley. Landscape quality is moderate – low.	High	0m (Located below proposed route viaduct structure)	Substantial	The Proposed Scheme would cross the river and the paths along it and would, therefore, be highly visible and may cause disruption to the recreational users and cause a detrimental effect to the visual appreciation of the river corridor. The proposed viaduct over the river would be very visually dominant.	Construction: Major Adverse Short Term: Major Adverse Long Term: Major Adverse

Visual Receptor	Miscellaneous Receptors – (e.g.: paths, tracks and cycleways)	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR44	Users of Caaf Water	Views along the valley are partially enclosed by topography associated with the valley sides and vegetation within the valley, opening up to the north towards the Dalry urban area. Landscape quality is moderate.	Medium	<200m	Substantial	The Proposed Scheme would cross the River Garnock in close proximity to where the Caaf Water joins it and would therefore be highly visible and may cause disruption to the recreational users and cause a detrimental effect to the visual appreciation of the river corridor. The proposed viaduct over the river would be very visually dominant.	Construction: Major Adverse Short Term: Major Adverse Long Term: Major Adverse
VR45	Users of the paths on both sides of the River Garnock and footbridge near Lynn Holms	Views south along the river corridor are enclosed by topography associated with the valley sides and vegetation within the valley. Landscape quality is moderate.	High	800m	Substantial	The proposed viaduct, associated earthworks and infrastructure would be clearly visible from locations along these routes and the River Garnock valley. However screen planting would aid in the mitigation of the embankments and roundabout in the long term.	Construction: Major Adverse Short Term: Major Adverse Long Term: Moderate Adverse
VR46	Users of Dalry Public Park in the north east of Dalry	Views from within the park are generally well contained by vegetation and built form around the park perimeter. Partial views east towards elevated rolling farmland can be seen in gaps in the vegetation.	Medium	1.4km	Slight	The Proposed Scheme would form minor changes in partial views of the project area, and would be viewed in the context of other visual detractors already present such as Drakemyre works.	Construction: Minor Adverse Short Term: No change Long Term: No change

Visual Receptor	Miscellaneous Receptors – (e.g.: paths, tracks and cycleways)	Visual Amenity	Sensitivity	Distance To Project (Approx)	Magnitude	Nature of Predicted Effects	Predicted Significance of Effects
VR47	Users of the Ayr-Glasgow train line	Views from the train line are generally screened by vegetation along its corridor, with breaks in the vegetation providing open and partial views over the River Garnock valley to the east.	Medium	0m (Located below proposed route viaduct structure)	Substantial	The Proposed Scheme would cross over the rail line on the viaduct and therefore would be highly visible at this location and may cause a detrimental effect to the visual appreciation of the river corridor. Due to the scale of the proposed structure and the constraints at this location it is unlikely to be able to fully mitigate these visual effects.	Construction: Major Adverse Short Term: Major Adverse Long Term: Major Adverse

A737 Dalry Bypass

Appendix 10.1 Habitat Survey

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Section Break (Next Page)

Document Control Sheet

Project Title A737 Dalry Bypass

Document Title Habitat Survey

Report Number -

Revision -

Status FINAL

Control Date February 2013

Record of Issue

Issue	Status	Author	Date	Check	Date	Authorised	Date
01	DRAFT	P Hanson	04/09/12	J. North	24/10/12	S.Ireland	15/01/13
02	FINAL	P Hanson	04/09/12	J. North	24/10/12	S.Ireland	15/01/13

Distribution

Organisation	Contact	Copies
Transport Scotland	Sandy Jamieson Yvette Sheppard	Paper/e e
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Contents

1 Introduction

1.1 Background and Survey Objectives

A Phase 1 Habitat Survey was undertaken by Mouchel Fairhurst on the 27th and 28th of September 2007. Mouchel were commissioned to undertake an update of the Phase 1 Habitat Map and Target Notes. The updated work is presented in Figure 10.1 and Annex 1 of this report.

The updated survey was undertaken in August 2012.

The Blairland Bing and River Garnock Wildlife Site / Site of Importance for Nature Conservation (SINC) is located between the River Garnock and the Glasgow to Ayr railway line, to the east of the existing A737, south of Dalry.

A National Vegetation Classification (NVC) survey was previously undertaken in 2008, to provide additional information regarding the nature of vegetation communities present within the Wildlife Site / SINC, some of which may be affected by the proposed Dalry Bypass route options.

Due to the previous survey being carried out more than four years ago, this survey aims to update the information concerning vegetation communities at the site, using the same NVC survey techniques and noting any changes which have occurred in the intervening four year period.

The survey was undertaken on the 16th August 2012.

2 Methodology

2.1 Phase 1 Habitat Survey

An updated Phase 1 Habitat survey of the field survey area was undertaken. The habitats present were identified using the standard Phase 1 Habitat survey methodology (JNCC, 2007). Habitat types and dominant flora were mapped with target notes to highlight features of interest.

Detailed species surveys were not undertaken as part of the updated Phase 1 survey, rather the potential for the field survey area to support any legally protected or ecologically valuable species, e.g. Biodiversity Action Plan (BAP) priority species, was assessed. Field signs or sightings of these species were recorded as target notes and the presence of any invasive plant species listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) was also identified.

2.2 NVC Survey

2.2.1 *Overview*

The methodology employed for the NVC surveys followed the methods outlined in *British Plant Communities* (Rodwell *et al.* 1991a, 1991b, 1992, 1995 & 2000). The extent of areas of homogeneous vegetation was mapped and sample quadrats (relevés) were located within these areas to record the abundance and frequency of vascular plants, bryophytes and lichens within each compartment. The field data was then analysed and each compartment was assigned, where possible, to a particular plant community. The extent of these community types is represented within mapping of the survey area in Figure 10.2. Additional information in the form of Target Notes is provided in Annex 2; Table 8.8 and photographs of the site are presented in Annex 3.

2.2.2 *Sampling* Compartments

Prior to undertaking vegetation sampling, boundaries of all homogeneous plant communities were mapped, as accurately as possible, on large-scale field maps. An attempt was made to determine the most typical habitats for sampling. When defining the extent of the community areas not all plant community boundaries were sharply defined and ecotones (botanical gradational zones) were present on occasions. In these instances, plant community boundaries were defined by drawing a line through the centre of the ecotone between communities.

For each homogenous stand identified, samples were taken using appropriate quadrat size (see Section 2.3). Within each stand selected for analysis an appropriate number of quadrats were positioned in areas supporting representative vegetation. This inevitably involved some surveyor bias, but avoided problems of the arrangement of random samples and incorporating obvious vegetation boundaries or unrepresentative floristic features.

2.2.3 Quadrat *Size*

Throughout the NVC surveys, the size of the sampling quadrats reflected the scale of the vegetation being sampled. Thus the following quadrat dimensions were employed:

- 2 m x 2 m for short, herbaceous vegetation and dwarf-shrub heaths;
- 4 m x 4 m for taller or more open herb communities, sub-shrub heaths and low woodland field layers;
- 10 m x 10 m for species-poor or very tall herbaceous vegetation or tall woodland field layers/low understorey and dense scrub;
- 50 m x 50 m for sparse scrub, woodland canopy and tall understorey.

The woodland within the survey area was too small to accommodate 50 m x 50 m canopy layer relevés and so was sampled using the 10 m x 10 m units for canopy and understorey layers. Mosaics were treated as a single vegetation type where they were repeatedly encountered in the same form or where it is was impossible to sample their elements separately due to their small scale.

Woodland was sampled at different scales, within the same area, to accommodate the varying scales of vegetation present within woodland plots, with further quadrats of 4 m x 4 m within each canopy / understorey layer quadrat being sampled for ground flora. It was also necessary to distinguish tree seedlings / saplings from mature trees, with young trees included in the field layer / understorey quadrats and mature trees in the canopy quadrats.

2.2.4 *Measuring Species Abundance*

Within each quadrat, a quantitative measure of the relative abundance of every vascular plant, bryophyte and lichen species was undertaken using the ten point Domin scale. Cover was assessed by eye as a vertical projection on to the ground of all live, above-ground parts of the plants within the quadrat. The Domin scale categories are presented below:

- Cover of **91-100%** is recorded as Domin **10**
- Cover of **76-90%** is recorded as Domin **9**
- Cover of **51-75%** is recorded as Domin **8**
- Cover of **34-50%** is recorded as Domin **7**
- Cover of **26-33%** is recorded as Domin **6**
- Cover of **11-25%** is recorded as Domin **5**

- Cover of **4-10%** is recorded as Domin **4**
- Cover of **<4%** with many individuals is recorded as Domin **3**
- Cover of **<4%** with several individuals is recorded as Domin **2**
- Cover of **<4%** with few individuals is recorded as Domin **1**

2.2.5 *Species Frequency*

Frequency was used in conjunction with abundance when determining the community type, either using dichotomous keys within *British Plant Communities* or the MATCH computer program. Roman numerals I-V are used to measure frequency with:

- **I** signifying a species present in **1-20%** of samples (**scarce**)
- **II** signifying a species present in **21-40%** of samples (**occasional**)
- **III** signifying a species present in **41-60%** of samples (**frequent**)
- **IV** signifying a species present in **61-80%** of samples (**constant**)
- **V** signifying a species present in **81-100%** of samples (**constant**)

Floristic tables were compiled from the quadrat data, showing the range of Domin scores of a particular species, and its frequency class within the community. Species with frequencies of IV and V are described as constants within the community, with species of other frequencies described as companions.

2.2.6 *Determining Vegetation Community Type*

Shortlists of possible communities were identified using the computer program MATCH (v.2.16) from the Unit of Vegetation Science, Lancaster University. The program compares the survey data with floristic tables of NVC communities. The lists were then refined using NVC keys and the appropriate community descriptions as given in *British Plant Communities.*

The community descriptions were read for the top five matches, before assigning communities, as the programs can sometimes give misleading results. This is because certain species-poor sites such as mires may give high percentage matches which are only achieved due to the short species list for the site. Woodlands, however, usually have a long species list which means it is harder to achieve a high percentage match. Similarly with grassland communities, a short species list is statistically more likely to fit acid grassland than calcicolous grassland which is far more species-rich.

2.2.7 *Taxonomy*

Names of vascular plants generally follow Stace (2010) with bryophytes following Hill *et al.* (2008).

3 Survey Results

3.1 Updated Phase 1 Survey

The updated Phase 1 Map is shown Figure 10.1 with the updated Target Note List shown in Annex 1. There were no significant changes between the initial Phase 1 survey undertaken in 2008 and the current updated Phase 1.

The survey area consists predominantly of managed agricultural habitats with low ecological value, with some areas of greater ecological value to the north and south ends of the scheme. Limited areas of mature semi-natural broad-leaved woodland and mixed plantation woodland are present, the majority within the Blair Estate on the periphery of the scheme. The River Garnock is located at the southern extent of the scheme, with other smaller watercourses, including the Caaf Water, the Bombo Burn, the Coalheughglen Burn and numerous drainage ditches present throughout the survey area. Scattered and occasionally dense scrub is present throughout the survey area as is marsh and marshy grassland, though these occur mainly in isolated patches along field edges where set-aside areas exist.

Overall, the majority of the survey area is generally of limited interest in that the habitats present are typical of the surrounding countryside and of local importance only. In many areas the habitats are subject to varying levels of human disturbance due to the presence of municipal housing, local road and rail networks and intensive land management in the form of agricultural practices (predominately livestock farming).

3.1.1 Broad-Leaved Woodland

Broad-Leaved woodland (semi-natural and plantation) is the most common woodland habitat type within the ecological survey area. Mature semi-natural broad-leaved woodland is present to the south east of the survey area, around Blair Estate and Crow Grove. The woodland is dominated by sycamore *Acer pseudoplatanus*, with abundant ash *Fraxinus excelsior*, beech *Fagus sylvatica*, large leaved lime *Tilia platyphyllos* and occasional oak *Quercus robur*. Ground flora is dominated in areas by broad-buckler fern *Dryopteris dilatata*, black bent *Agrostis gigantea* and bramble *Rubus fruticosus*, and in other areas by a scrub layer of rhododendron *Rhododendron ponticum*.

A thin strip of mature semi-natural broad-leaved woodland is also present along both banks of the River Garnock on the southern edge of the scheme, south of the Blairland Bing and River Garnock Wildlife Site. The woodland is dominated by sycamore and ash, with occasional English elm *Ulmus procera*, hawthorn *Crataegus monogyna*, willow *Salix* spp. and beech. The woodland lacks a scrub layer but the ground flora of this riparian woodland is dominated by bramble and creeping thistle *Cirsium arvense*. Broom *Cytisus scoparius*, field woodrush *Luzula campestris*, butterbur *Petasites hybridus*, meadowsweet *Filipendula ulmaria*, red campion *Silene dioica* and lesser stitchwort *Stellaria graminea* are also frequent.

Semi-natural broad-leaved woodland also predominates within the riparian habitat along the eastern bank of the River Garnock, which is adjacent to the Blairland Bing

and River Garnock wildlife site. The woodland is dominated by alder *Alnus glutinosa* and willow, with frequent ash and hawthorn and occasional silver birch *Betula pendula* and hazel *Corylus avellana*. The woodlands ground flora is dominated by tall ruderal species, particularly common nettle *Urtica dioica* and bramble, with broad-buckler fern also frequent. The ground within the woodland is marshy in places, with raised earth banks in others.

A thin corridor of mature broad-leaved plantation borders a short stretch either side of the A737 road towards the north of the scheme alignment in the vicinity of Coalheughglen. Ash, beech and lime are present. The woodland has a scarce ground flora dominated by common nettle and bramble.

Given the species present, the majority of this habitat within the study area is assessed as being of value **within the local area only.**

3.1.2 Coniferous Plantation

A small dense stand of young sitka spruce *Picea sitchensis* plantation is located towards the south east of the scheme alignment. Occasional young ash are growing around the edge of the plantation. Ground flora is scarce within the plantation, but is dominated by creeping soft-grass and common nettle.

The coniferous plantation within the survey area is assessed as being of value **within the local area only.**

3.1.3 Mixed Plantation Woodland

A thin strip of mature mixed plantation is present to the north east area of the scheme alignment, south of Highfield and continuous with Barjocks Plantation. The woodland is dominated by hawthorn, ash and beech, with occasional oak, European larch *Larix decidua* and willow. The woodland lacks a scrub layer but has ground flora dominated by tall ruderal species and grasses, including bramble, common nettle, common bent *Agrostis capillaris* and creeping soft-grass *Holcus mollis*.

Another thin strip of mature mixed plantation (TN 20) is present towards the south east section of the scheme, south east of Blairland. The woodland is dominated by beech, with occasional Scots pine *Pinus sylvestris*, ash, oak and sycamore. The ground flora within the woodland is dominated by grasses with cock's-foot *Dactylis glomerata*, black bent and creeping soft-grass.

The mixed plantation within the survey area is assessed as being of value **within the local area only.**

3.1.4 Scrub

Scattered and occasionally dense scrub composed mainly of gorse *Ulex europaeus and broomFabaceae spp.* with some hawthorn is present within the survey area. At the northern end of the scheme the remains of two disused lime quarries have become overgrown with dense gorse, broom and hawthorn scrub. Another feature to the south,

likely to be the remains of a lime kiln is also densely vegetated with gorse, broom and hawthorn scrub. Towards the centre of the survey area, just north of a Blairland residential development on the outskirts of Dalry is an area of marshy ground and scattered scrub on a slope down to the River Garnock. The vegetation is dominated by gorse, hawthorn and bramble scrub.

Towards the south of the survey area, the railway sidings and verges represent an extended area dominated by tall ruderal species and scrub. Rosebay willowherb *Epilobium angustifolium*, common nettle, black knapweed *Centaurea nigra* and bramble are dominant, with scattered semi-mature ash, hawthorn and willow scrub.

Given the relatively low species diversity and limited extent, the scrub habitat is assessed as being of value **within the local area only.**

3.1.5 Improved Grassland

Agricultural land is the most dominant habitat type within the ecological survey area. Of the agricultural habitats present, the most prevalent is improved grassland, present throughout the survey area. This grassland is dominated by perennial rye-grass *Lolium perenne*, annual meadow-grass *Poa annua* and timothy grass *Phleum pratense*. Common chickweed *Stellaria media*, common sorrel *Rumex acetosa*, broad-leaved dock and creeping buttercup are also frequent. Less common were semi-improved grassland and arable land, restricted to the southern end of the survey area. Boundary features throughout the ecological survey area were predominately hedges with fences and walls also common.

Given its relatively low species diversity and the abundance of similar habitats in the wider area; the improved grassland habitat within the survey area is assessed as being of value **within the local area only.**

3.1.6 Marshy Grassland

Marsh and more commonly marshy grassland are scattered but not extensive throughout the survey area. At the northern extent of the proposed scheme an area of marsh and marshy grassland surrounds the entrance to a disused quarry (TN 2). Stagnant pools of water in heavily poached ground were present at the time of survey, with soft rush *Juncus effusus*, lesser duckweed *lemna minor* and creeping buttercup *Ranunculus repens* the dominant vegetation.

An area of marsh, continuous with an area of marshy grassland is present in a low lying patch of ground at the bottom of an improved grassland field towards the centre of the survey area (TN 10). The marsh borders a drainage ditch. Vegetation is dominated by reed canary-grass *Phalaris arundinacea* and soft rush, with abundant creeping thistle and creeping buttercup and occasional marsh thistle *Cirsium palustre* and greater willowherb *Epilobium hirsutum*. The area is lightly poached by cattle.

An extended area of marsh and marshy grassland is present between the railway line and the River Garnock towards the southern extent of the survey area (TN 25). The vegetation comprises locally dominant reed canary grass, possibly where ponds used

to be located, and bordered by marsh thistle, meadowsweet, soft rush and creeping thistle. Broad-leaved ragwort *Senecio fluviatilis* and Indian balsam *Impatiens glandulifera* are also present in locally dominant patches on the banks of the River Garnock. The marshy area is continuous with an area of marshy woodland (TN 26). An area of marshy grassland dominated by soft rush, with frequent marsh thistle, meadowsweet, creeping thistle, cock's-foot and Yorkshire fog is present within a low lying field at the southern extent of the scheme, to the east of the A737. Other less extensive areas of marshy grassland are present within the agricultural grasslands throughout the survey area.

This habitat is considered to be of value **within the local area only.**

3.1.7 Arable

The survey identified several fields toward the southern end of the survey route to the east of the River Garnock.

Given its low botanical diversity and highly artificial nature, this habitat is assessed as being of value **of less than local.**

3.1.8 Hedgerows

Hedgerows are present throughout the route; hedges are the most common boundary feature within the survey area, including several intact species-rich hedges (TN1) containing hawthorn, willow, bramble, rowan *Sorbus aucuparia*, privet *Ligustrum ovalifolium*, elder *Sambucus nigra* and ash. The majority of hedgerows in the survey area area species-poor consisting predominantly of hawthorn.

The hedgerows are assessed as being of value **within the local area only.**

3.1.9 Watercourses

River Garnock

The River Garnock (Rye Water to Caaf Water) is classified as a small, mid-altitude, calcareous watercourse. The stretch of the River Garnock from Rye Water to the Caaf Water confluence is classified as having an overall status of Bad with Medium confidence in 2008 with overall ecological status of Bad and overall chemical status of Pass.

The stretch of the River Garnock where the propose work is to be undertaken (Caaf Water to tidal limit) is classified as a medium, lowland, calcareous watercourse. The stretch of the River Garnock from the Caaf Water confluence to the tidal limit is classified as having an overall status of Bad with Medium confidence in 2008 with overall ecological status of Bad and overall chemical status of Fail.

The River Garnock is a typical lowland watercourse at the survey area exhibiting a diverse environment. The watercourse is dominated by deeper pools split by a series of small weirs built across the channel. There is variation in depth throughout the

surveyed stretch. The deeper pools display low flow with unbroken waves dominating. The deeper pools are separated by shallower areas attributed to the weirs. At such points, the shallower areas result in moderate flows and consequently, rippled flow. There is little variation in the width of the watercourse throughout the surveyed area.

The differing environments result in a diverse substrate size present throughout the surveyed stretch. Sand/silt dominate in the pools with gravel/pebble dominating in areas around the weirs. Cobble is also present in the surveyed reach albeit a limited presence. This varied substrate composition is not uncommon in lowland watercourses.

The River Garnock has been subject to significant modification, none of these modifications are considered likely to significantly influence the movement of organisms or the transport of sediment through the watercourse.

The structure of the riparian habitat shows some signs of influence from surrounding land-use, with agricultural and suburban land dominating. However, despite this there are scattered trees and extensive areas of tall herbs along the eastern bank of the watercourse in the surveyed area.

The River Garnock receives classification under the WFD, and receives designation under the FFD as a Salmonid watercourse. As such, it is considered to be of intrinsic biodiversity value at **no more than the District scale.**

Caaf Water

The Caaf Water is classified as a small, lowland calcareous watercourse. The Caaf Water is modified and as such, receives an overall status of Poor ecological potential with Medium confidence in 2008 with overall ecological status of Poor and overall chemical status of Pass.

It is important to note that the five classification ecological potential classes for Heavily Modified Water Bodies (HMWBs) and Artificial Water Bodies (AWBs) combine the level of mitigation measures for water levels and flow and physical habitat with measurements of the biological and chemical water quality. For example, a HMWB could have all the mitigation measures in place for the use (e.g. hydropower) to allow it to reach good ecological potential, but if water quality is poor due to elevated phosphorus levels, its overall ecological potential assessment could be moderate, poor or bad depending on the severity of the impact.

The stretch of the Caaf Water within the study area exhibits a more typical pool-riffle structure than the River Garnock, resulting in a more even distribution of flow rates and substrate size.

The pools display low flow and unbroken waves dominate, while through the extended areas of riffle, moderate flows and rippled flow are present. There is little variation in the width of the watercourse throughout the surveyed area.

The differing environments results in a diverse substrate size present throughout the surveyed stretch. Sand/silt dominate in the pools with gravel/pebble dominating in areas around the weirs. Cobble is also present in the surveyed reach albeit a negligible presence. A larger proportion of gravel pebble is present in the Caaf Water compared to the River Garnock; this is due to the shallower watercourse and a larger proportion of moderate flow are areas of riffle.

Like the River Garnock, the Caaf Water has been subject to significant modification, none of these modifications are considered likely to significantly influence the movement of organisms or the transport of sediment through the watercourse.

The structure of the riparian habitat shows many signs of influence from surrounding land-use, with agricultural land dominating. Both banks are heavily poached by cattle and consequently, much sediment will be washed into the watercourse during spate conditions. This also has a major impact on the stability of the banks, making the banks prone to erosion, increasing the potential for sediment to enter the watercourse.

The Caaf Water receives classification under the WFD but is not designated under the FFD. The Caaf Water is considered to be of intrinsic biodiversity value at **no more than the District scale.**

Rye Water

The Rye Water enters the River Garnock upstream of the proposed works and from the west. As such, is unlikely to be effected by the proposed works. However, it has been included as it is a major watercourse in the catchment.

The Rye Water is classified as a small, mid-altitude calcareous watercourse. The Rye Water is modified and as such, receives an overall status of Bad ecological potential with Medium confidence in 2008 with overall ecological status of Bad and overall chemical status of Pass.

The Rye Water will not be directly affected by the proposed works (it enters the River Garnock upstream of the proposed works from the west of the Garnock; the proposed works are primarily to the east of the river Garnock). As such, it will not be considered further.

Unclassified Watercourses

There are unclassified watercourses in the immediate survey area. These are a combination of ephemeral field drains (identified in Figure 10.5) and the Coalheughglen Burn in the eastern end of the scheme.

The ephemeral ditches are of limited ecological value but will act as a vector aiding sediment migration. The Coalheughglen burn is highly modified (although a RHS was not undertaken, there are many culverts (including the confluence with the River Garnock). The Coalheughglen burn is of limited ecological value (the culverts limit

connectivity of habitat) but, like the ephemeral ditches, will act as a vector carrying sediment to the River Garnock.

The Coalheughglen Burn is a highly modified watercourse. There is a series of culverts along the watercourse (including the confluence with the Garnock; the burn emptying through a pipe then falling (rather than flowing) into the River Garnock. During spate conditions, a rise in water levels of the River Garnock may permit flow between the Coalheughglen Burn and the river Garnock. Such a confluence limits opportunity for upstream / downstream migration as well as connectivity of habitat for other ecological interests. Given the highly modified nature of the watercourse and the low ecological quality of the habitat (shown by the benthic invertebrate populations), it is highly likely that the watercourse is currently unsuitable for fish.

The Bombo Burn flows parallel to the proposed route; approximately 1 km to the south east. The Bombo Burn flows into the River Garnock approximately 650 m downstream of the proposed crossing point of the River Garnock. There is no connectivity to the proposed works and as it falls outwith the study area, the Bombo Burn will not be discussed further in the report.

The unclassified watercourses are considered to constitute a priority habitat in the UK BAP and a broad habitat type in the Local BAP. Consequently, the unclassified watercourses are considered to be of intrinsic biodiversity value **at no more than the Local scale**.

3.2 NVC Survey

3.2.1 Overview

The survey site is shown in Figure 10.2, with plant communities mapped by NVC code. Detailed results of sampling quadrats for each area are presented in the floristic tables in Annex 2 (Tables 7.1.1 to 7.1.8), with summaries of each vegetation community given below.

3.2.2 Woodland Communities

W6a *Alnus glutinosa-Urtica dioica* woodland; typical sub-community

The majority of the southern half of the site is covered in alder-dominated woodland. Quadrat sampling was undertaken within this area, with 10 m x 10 m quadrats used for canopy and understorey sampling, due to the small size of the woodland not allowing for the use of 50 m x 50 m quadrats. Ground layer vegetation was sampled using 4 m x 4 m quadrats. The results of the sampling are presented in Annex 2; Table 7.1.4.

Four out of the top five highest MATCH community co-efficients are for the W6 woodland community, with the greatest similarity (43.8%) being for the W6a *Alnus glutinosa-Urtica dioica* woodland; typical sub-community. Within this community alder *Alnus glutinosa* is typically the dominant canopy species, although ash *Fraxinus excelsior* is also a constant species at Blairland Bing. Ash is usually present at lower frequencies within this woodland community but it is more frequent within the W6a typical sub-community than in other W6 sub-communities.

The ground layer within this woodland contains constant common nettle *Urtica dioica,* as is typical for W6 woodland but there is also a large component of non-native trees within the canopy / understorey, including grey alder *Alnus incana* and white poplar *Populus alba.* Another non-native species which is scattered throughout the woodland and along the River Garnock is the invasive herbaceous species Indian (Himalayan) balsam *Impatiens glandulifera.*

W21a *Crataegus monogyna-Hedera helix* scrub*; Hedera helix-Urtica dioica* sub-community

Small patches of this community occur throughout the site, mostly as narrow linear stands along field margins and the railway embankment to the east of the site. Fragments of hawthorn *Crataegus monogyna* dominated woodland / scrub also occur at the centre of the survey area, around the site of demolished buildings (TN4) and near the south of the site (TN1), adjacent to more extensive alder dominated woodland.

Due to the small size of the patches, quadrat sampling was not undertaken within these areas but the community identity was evident due to the dominance of hawthorn in the canopy, with frequent bramble *Rubus fruticosus* agg. underscrub. Frequent species within the ground layer, typical of the *Hedera helix-Urtica dioica* sub-community include common nettle, cleavers *Galium aparine* and red campion *Silene dioica*.

3.2.3 Wetland Communities

There are three distinct wetland areas within the site. At the southern end of the site there is a triangular area of river floodplain containing a mosaic of vegetation communities including marshy grassland and swamp, as described below:

S5a *Glyceria maxima* swamp; *Glyceria maxima* sub-community

Patches of reed sweet-grass *Glyceria maxima* swamp are clearly distinct from the surrounding marshy grassland, forming tall bright green stands dominated by this grass species (Photograph 1, Annex 3). These areas were sampled using 4 m x 4 m quadrats, with the results of the sampling shown in Annex 2; Table 7.1.1. The *Glyceria maxima* sub-community is species-poor, compared to the S5b *Alisma plantago-aquatica-Sparganium erectum* sub-community, although at Blairland Bing there is also high coverage of creeping bent *Agrostris stolonifera* and creeping buttercup *Ranunculus repens*, below the *Glyceria*. This is not typical of the community but is due to the patchy nature of the swamp vegetation allowing species from the surrounding marshy grassland to colonise below the *Glyceria*. The extent of the S5a community appears to have increased, since the 2008 survey, with a decrease in the area of adjacent marshy grassland.

MG13 *Agrostris stolonifera-Alopecurus geniculatus* grassland

Between the areas of swamp vegetation, described above, the vegetation is far shorter and more diverse (Photograph 2, Annex 3). The dominant species, within the sampling quadrats (Annex 2; Table 7.1.2) are creeping bent and marsh foxtail *Alopecurus geniculatus.* There does, however, appear to be a mosaic within the marshy grassland, with some patches containing more frequent soft rush *Juncus effusus* and Yorkshire-

fog *Holcus lanatus.* These areas seem to bear more resemblance to the MG10 *Holcus lanatus-Juncus effusus* rush-pasture community, although the whole area is mapped as MG13 due to the small scale of the variation.

Along the western edge of the site, between the River Garnock and the main alder woodland, there is a small area of tall-herb fen (Photograph 3, Annex 3), dominated by bulrush *Typha latifolia,* which is described below:

S12b *Typha latifolia* swamp; *Mentha aquatica* sub-community

Within this area vegetation was sampled using 10 m x 10 m quadrats, with the results of the sampling shown in Annex 2; Table 7.1.5. Bulrush and water mint *Mentha aquatica* were found to be constant within the samples. The greatest community similarity co-efficient for this sampled area (48.9%) is for the *Mentha aquatica* sub-community which is characterised by a shorter, less dense coverage of bulrush, with an understorey which may include water mint, marsh bedstraw *Galium palustre,* soft rush *Juncus effusus,* water horsetail *Equisetum fluviatile* and great willowherb *Epilobium hirsutum.* This sub-community is the most species-rich of the sub-communities.

During the 2008 NVC surveys this area was classified as S28b *Phalaris arundinacea* tall-herb fen; *Epilobium hirsutum-Urtica dioica* sub-community. The S28b sub-community is overwhelmingly dominated by reed canary-grass *Phalaris arundinacea.* Although there were scattered clumps of this species present within the area in August 2012, bulrush was constant and dominant throughout the area, with reed canary-grass being scarce throughout.

At the north-east of the site there is a large marshy area, covered in scattered scrub, adjacent to a development of industrial units on land to the east (Photograph 4, Annex 3). This area was sampled using 4 m x 4 m quadrats with the results of the sampling shown in Annex 2; Table 7.1.7. This area seems to be most similar to the:

M23b *Juncus effusus / acutiflorus*-Galium palustre rush-pasture; *Juncus effusus* sub-community

The greatest sub-community similarity co-efficient for this sampled area (51.1%) is for M23b. Within this community constant species include Yorkshire-fog, soft rush and greater bird's-foot trefoil *Lotus pedunculatus.* These species, however, are also constant within the MG10 *Holcus lanatus-Juncus effusus* rush-pasture community, which the area was classified as during the 2008 NVC surveys. There is considerable overlap between the MG10 and M23 communities, which are often difficult to differentiate between. In this report, however, the area is classified as M23b due to the higher percentage similarity co-efficient and the presence of good distinguishing species such as marsh willowherb *Epilobium palustre* and common sedge *Carex nigra* which are not usually found within the MG10 community.

3.2.4 Grassland Communities

There are several areas of grassland within the survey site, which are described below:

MG7a *Lolium perenne* leys and related grasslands; *Lolium perenne-Trifolium repens* leys sub-community

The largest expanse of grassland habitat is to the north and east of an access track which runs across the middle of the site and along the east of the River Garnock in the northern half of the site (Photograph 5, Annex 3). This area was sampled, using 2 m x 2 m quadrats (Annex 2; Table 7.1.6) within land to the east of the field boundary hedgerow separating the two large pasture fields. This grassland community is very species-poor, consisting predominantly of perennial rye-grass *Lolium perennne,* with very high Domin scores of 9-10. Grasslands of this type are generally sown as part of an arable / ley rotation and are especially valuable for hay or silage.

During the 2008 NVC survey this area was classified as MG6 *Lolium perenne-Cynosurus cristatus* grassland, although no crested dog's-tail *Cynosurus cristatus* was found to be present within any of the 2012 sampling quadrats and it is felt that this grassland is closer to the MG7 community than the relatively more species-rich, though still impoverished, MG6 community.

The grassland directly to the west of the boundary hedge, which continues towards the River Garnock, appeared to be of a similar species composition, although at the time of the survey was cut extremely short and may possibly have been subject to herbicide application due to the overall yellow colouration of the vegetation (Photograph 6, Annex 3). This area was therefore classified as the same community present to the east of the boundary hedge.

MG6 *Lolium perenne-Cynosurus cristatus* grassland

Towards the south-west of the improved grassland described above, there is a small area of amenity grassland (Photograph 7, Annex 3). This area possesses a denser sward than the MG7 grassland and appears to be regularly mown. Although this small area was not subject to quadrat sampling it did appear to belong to the MG6 community, with frequent crested dog's-tail present and a greater diversity of herbaceous species present within the turf, compared to the MG7 grassland. This community type is almost universal throughout lowland Britain and forms the majority of improved pasture in many parts of the country. This community is also widespread as a recreational sward and on village greens, road verges and lawns.

MG1e *Arrhenatherum elatius* grassland; *Centaurea nigra* sub-community

Towards the south-east of the alder woodland there is a small, narrow area of mesotrophic grassland (Photograph 8, Annex 3). Within this area vegetation was sampled using 2 m x 2 m quadrats, with the results of the sampling shown in Annex 2; Table 7.1.3. Although the highest similarity co-efficient (58.0%) for this area is for the MG9b *Holcus lanatus-Deschampsia cespitosa* grassland; *Arrhenatherum elatius* sub-community this is problematic as tufted hair-grass *Deschampsia cespitosa* is a constant and usually dominant species within MG9 communities. In the sampling quadrats this species is present in only one square, with a Domin score of only 1.

The other four highest similarity co-efficients for these grassland samples are all for the MG1 community, with the greatest similarity being for the MG1e common knapweed *Centaurea nigra* sub-community. This area was also classified as belonging to the MG1e community during the 2008 NVC survey. Within the MG1 community the coarse tussocky grass species cock's-foot *Dactylis glomerata* and false oat-grass *Arrhenatherum elatius* are constant and usually very conspicuous. Here they are the dominant species, both with a frequency of V and minimum Domin scores of 6. The *Centaurea nigra* sub-community is the most species-rich MG1 community and typically contains constant common knapweed, as is the case here. Other characteristic herbaceous species for this sub-community include frequent yarrow *Achillea millefolium*, ribwort plantain *Plantago lanceolata*, meadow vetchling *Lathyrus pratensis* and germander speedwell *Veronica chamaedrys*.

The MG1e sub-community is also present as a narrow strip between two barbed-wire fences, running between the southern MG7a improved grassland field and the area of MG6 amenity grassland (Photograph 9, Annex 3).

3.2.5 Unclassified Areas

During the 2008 NVC survey, thin strips of MG13 *Agrostris stolonifera-Alopecurus geniculatus* grassland were identified along the eastern bank of the River Garnock, with overlying scattered scrub. During the 2012 survey, however, it was evident that scrub encroachment, including osier *Salix viminalis* and goat willow *Salix caprea* has increased along the edge of the river. Tall herbaceous species, including broad-leaved dock *Rumex obtusifolius*, butterbur *Petasites hybridus* and particularly the non-native (originating from central and southern Europe) broad-leaved ragwort *Senecio fluviatilis* are also beginning to dominate along the edge of the river (Photograph 14, Annex 3), with the resultant loss of much of this grassland community, which is not mapped within this report.

3.2.6 Invasive Alien Plant Species

Schedule 9 of the Wildlife and Countryside Act 1981 lists certain invasive alien plant species. It is an offence to plant or otherwise cause any of the species included within the Schedule to grow in the wild. The species included on Schedule 9 differ in Scotland and England / Wales. Originally there were only two non-marine species included in Schedule 9 (giant hogweed *Heracleum mantegazzianum* and Japanese knotweed *Fallopia japonica*). In Scotland, however, a further thirteen species were added as a variation to the Schedule in 2005. In England and Wales a further thirty six non-marine plant species were added in 2010.

Species currently included on Schedule 9 in Scotland are listed below:

- Japanese knotweed *Fallopia japonica*
- Giant hogweed *Heracleum mantegazzianum*
- Carolina water-shield *Cabomba caroliniana*

- Water hyacinth *Eichhornia crassipes*
- Water lettuce *Pistia stratiotes*
- Giant salvinia *Salvinia molesta*
- Water fern *Azolla filiculoides*
- Parrot's-feather *Myriophyllum aquaticum*
- Floating pennywort *Hydrocotyle ranunculoides*
- New Zealand pygmyweed *Crassula helmsii*
- Curly waterweed *Lagarosiphon major*
- False-acacia *Robinia pseudoacacia*
- Hottentot fig *Carpobrotus edulis*
- Few-flowered leek *Allium paradoxum*
- Shallon *Gaultheria shallon*

Any Schedule 9 (Scotland) plant species present at the site may provide a constraint to the bypass scheme if located beneath or adjacent to the footprint of the chosen route and should be considered at an early stage in the design and planning of the road.

Currently, however, the only Scottish Schedule 9 species found to be present is Japanese knotweed, the locations of which are given in the Target Notes in Annex 2; Table 7.1.8 and shown in Photographs 11, 12 and 13 in Annex 3. Indian (Himalayan) balsam *Impatiens glandulifera* is scattered throughout woodland at the site and along the eastern bank of the River Garnock but although this is an invasive non-native species, currently included on Schedule 9 in England and Wales, it is not on Schedule 9 in Scotland.

4 NVC Discussion

4.1 Site Evaluation

The following gives a brief evaluation of plant communities present at the survey site, with reference to UK Biodiversity Action Plan (BAP) Priority Habitats. Certain NVC plant communities can be accommodated within broader UK BAP Priority Habitats to help evaluate the habitat present as shown below:

4.1.1 Woodland Communities

The majority of woodland habitat present at the site is W6 *Alnus glutinosa-Urtica dioica* woodland. This NVC type is accommodated within the broader UK BAP definition of wet woodland. Despite the woodland containing a high non-native species component it is still recognisable as a UK BAP Priority Habitat and as such is one of the more valuable habitats present at Blairland Bing. However, this habitat type is quite common and widespread, and therefore is of intrinsic biodiversity value at **no more than the Local scale.**

The W21 *Crataegus monogyna-Hedera helix* scrub vegetation, present along field margins and in localised patches is not intrinsically a UK BAP Priority Habitat but where this vegetation type forms hedgerows it can be classed as a UK BAP Priority Habitat where the hedgerow contains at least 80% of at least one UK native species, which would be the case with hawthorn dominated W21 vegetation. Never the less, species poor hedges are common and widespread in the county and thus this habitat is considered to be of and therefore is of intrinsic biodiversity value at **no more than the Local scale.**

4.1.2 Wetland Communities

The two most valuable wetland areas are the expanse of S12 *Typha latifolia* swamp, between the wet woodland and the eastern bank of the River Garnock and the M23 *Juncus effusus / acutiflorus-Galium palustre* rush-pasture at the northern end of the site. Both of these vegetation communities would be classed as Priority Habitats, with the S12 *Typha latifolia* swamp belonging to the broader UK BAP classification of lowland fen and the M23 *Juncus effusus / acutiflorus-Galium palustre* rush-pasture being included within the purple moor-grass and rush pastures habitat classification.

The wetland area to the south of the site, consisting of S5 *Glyceria maxima* swamp and marshy grassland would also be accommodated within the Priority Habitats described above but this area is smaller and habitats are more fragmented than the larger wetland areas and so would be classed as less valuable. Wetland commutnties within the survey area are considered to be of intrinsic biodiversity value at **no more than the Local scale.**

4.1.3 Grassland Communities

None of the grassland vegetation types present at the survey site would be included within UK BAP Priority Habitat. Within the UK BAP definition of lowland meadow, the three types of neutral grassland included within the definition are MG4 *Alopecurus pratensis-Sanguisorba officinalis* grassland, MG5 *Cynosurus cristatus-Centaurea nigra grassland* and MG8 *Cynosurus cristatus-Caltha palustris* grassland.

NVC communities MG6 and MG7 are both generally species-poor and intensively managed. MG1 is less intensively managed but tends to be species-poor due to the large tussocks of cock's-foot and false oat-grass which out-compete smaller herbaceous species but if left unmown or ungrazed these grasses will in-turn be outcompeted by invading scrub.

Overall the grasslands within the survey site are of low ecological value, with the large MG7 fields being of negligible ecological interest due to the lack of structural or plant species diversity present. Grassland commutnties within the survey area are considered to be of intrinsic biodiversity value at **no more than the Local scale.**

5 References

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6 Annex 1

Table 6-1 Phase 1 Target Notes.

Target Note	Grid Reference
1	NS 31018 50277. Species rich hedge containing hawthorn *Crataegus monogyna*, a willow species *Salix spp.*, bramble *Rubus fruticosus* agg., rowan *Sorbus aucuparia*, garden privet *Ligustrum ovalifolium* (garden escape species), elder *Sambucus nigra* and ash *Fraxinus excelsior*. Hedge recently heavily pruned. Fence within hedge and small gaps in places. A drainage ditch lies between the hedge and the improved grassland to the south. Freshly cleared, the ditch is relatively small; 1 m wide and 1 m deep, and lacks in channel vegetation due to the recent excavation. The remains of occasional soft-rush *Juncus effusus*, common nettle *Urtica dioica* and meadowsweet *Filipendula ulmaria* can still be occasionally seen. The ditch banks and substrate consist of clay and soil and stagnant water is present throughout the ditch displaying orange algae and oil residue on the water surface.
2	NS 31342 50233. Dense gorse *Ulex europaeus* scrub surrounding disused quarry. Very marshy around entrance to quarry, standing water with soft-rush, common duckweed *Lemna minor* and creeping buttercup *Ranunculus repens*. Heavily poached by cattle.
3	NS 31131 50172. Scattered mature trees in hedgerows bordering fields. Dominated by ash, sycamore *Acer pseudoplatanus* and beech *Fagus sylvatica* also present. Improved grassland in surrounding fields dominated by perennial rye-grass *Lolium perenne*, annual meadow-grass *poa annua* and Timothy grass *Phleum pratense*. Common chickweed *Stellaria media*, common sorrel *Rumex acetosa*, broad-leaved dock *Rumex obtusifolius* and creeping buttercup also frequent. Drainage ditch present beneath hawthorn hedge.
4	NS 30969 50168. Disused quarry creating low lying area in field. Quarry surrounded by hawthorn and gorse scrub.
5	NS 30834 50134. Coalheughglen Burn. Drainage ditch. Banks dominated by bramble and hedge bindweed *Calystegia sepium*.
6	NS 30669 50041. Thin corridor of mature broad-leaved plantation bordering road and watercourse, with ash, beech and large-leaved lime *Tilia platyphyllos*. Trees display some features with potential to support roosting bats.

Target Note	Grid Reference
7	NS 30936 49933. Remains of a lime kiln. Site dominated by hawthorn scrub with occasional mature ash. Located in the corner of an improved field, heavily poached by cattle. Trees display some features with potential to support roosting bats.
8	NS 30979 49720. Feature under mound of earth, possibly another old lime kiln. Densely vegetated with gorse and hawthorn scrub.
9	NS 30981 49636. Thin strip of mature mixed plantation dominated by hawthorn, ash and beech, with occasional, native oak species *quercus* sp., European larch *Larix decidua* and a willow species. Ground flora dominated by tall ruderal species and grasses, species include bramble, common nettle, common bent *Agrostis capillaris* and creeping soft-grass *Holcus mollis*.
10	NS 30688 49042. Drainage ditch present along a field margin towards the centre of the survey area. The ditch lies beneath an overgrown hawthorn hedge, surrounded by improved grassland fields. Ca. 1 m wide and ca. 0.5 m – 1.5m deep, banks and substrate consist of earth, reinforced with rocks in places. Slack flow with water <0.2 m in depth. In channel vegetation consists of nettles, brambles and marsh woundwort *Stachys palustris*. The ditch becomes a diffuse marshy area downstream. Marshy area in low lying site at the bottom of an improved grassland field. Marshy area borders hedge and drainage ditch. Vegetation dominated by reed canary-grass *Phalaris arundinacea* and soft-rush, with abundant creeping thistle *Cirsium arvense* and creeping buttercup and occasional marsh thistle *Cirsium palustre* and great willowherb *Epilobium hirsutum*.
11	NS 30559 48819. Mature broad-leaved plantation (enclosed by a high stone wall) dominated by sycamore and silver birch *Betula pendula*. Occasional ash, horse chestnut *Aesculus hippocastanum*, hawthorn and hazel *Corylus avellana*. Ground flora dominated by rhododendron *Rhododendron ponticum*. Woodland provides excellent habitat for foraging bats, but few trees near the edge of the woodland display features with potential to support roosting bats. Trees deeper into the woodland may be of higher potential. Woodland poor habitat for red squirrel *Sciurus vulgaris* due to gaps in the canopy, a lack of coniferous species and the presence of grey squirrel *Sciurus carolinensis* which were observed within the woodland.

Target Note	Grid Reference
12	NS 30856 48647. Bombo burn passes under road and bridge. Burn flows through strip of mature mixed plantation containing mature pedunculate oak *Quercus robur* and Scots pine *Pinus sylvestris.* Burn flows into woodland garden described in TN 11.
13	NS 30852 48719. Mature, native oak species and beech in hedge bordering road.
14	NS 30864 48845. Abutments of old rail bridge on route of disused railway. Largely in good condition but mortar missing in places with crevices with potential to support roosting bats.
15	NS 30299 49301. Area of marshy ground and scattered scrub on a slope. Vegetation dominated by gorse, hawthorn, bramble and soft-rush. Good foraging habitat for bats.
16	NS 30491 49216. Remains (base of trunk) of old, dead beech tree. Very exposed at top of a hill, but some features with limited potential to support roosting bats.
17	NS 30300 49150. Drainage ditch along hedge containing hawthorn, gorse and bramble. Ditch heavily vegetated with soft-rush, Yorkshire fog *Holcus lanatus*, creeping thistle, black knapweed *Centaurea nigra*, broad-leaved dock and great willowherb. Ditch is about 1 m wide by 1 m deep with no water at the time of survey. Banks and substrate of bud, reinforced with rocks in places. Enters culvert where housing development begins.
18	NS 30224 48874. Continuation of drainage ditch described in TN 17 re-emerges from culverted section in centre of an improved grassland field. Ditch is about 1 wide x 1 m deep with a gentle flow of water. Water depth up to 0.2 m. Marshy grassland with soft-rush either side of ditch. Mature ash in hedge adjacent to ditch.
19	NS 30075 48744. Mature ash in residential property back garden. Ash has features with high potential to support roosting bats.
20	NS 30213 48386. Thin strip of mature mixed plantation dominated by beech, with occasional Scots pine, ash, oak and sycamore. Ground flora dominated by grasses with cock's-foot *Dactylis glomerata*, black bent *Agrostis gigantean* and creeping soft-grass. Bramble also present. Pine cones observed on ground but no squirrel feeding signs recorded.

Target Note	Grid Reference
21	NS 30223 48352. Small dense stand of young Sitka spruce *Picea sitchensis* plantation. Occasional young ash planted around edge. Ground flora dominated by creeping soft-grass and common nettle. No potential to support roosting bats but good foraging and flight line habitat.
22	NS 31313 48265. Area of mature broad-leaved semi natural woodland dominated by sycamore, with abundant ash, beech and lime and occasional oak. Ground flora dominated in areas by broad buckler-fern *Dryopteris dilatata*, black bent and bramble, and in other areas by rhododendron. Coniferous plantation set back behind broad-leaved woodland, good potential as red squirrel habitat but several grey squirrels observed in close proximity. Ditch with slack flow of water runs between woodland and improved grassland field.
23	NS 29809 48289. Railway sidings and verges dominated by tall ruderal species and scrub. Rosebay willowherb *Chamerion angustifolium*, common nettle, black knapweed and bramble dominant with scattered semi-mature ash, hawthorn and a willow species. No roost potential for bats but good foraging and flight line habitat.
24	NS 29763 48355. Railway bridge constructed from red coloured sandstone, bricks and metal on the ceiling. Bridge mostly in good state of repair but mortar missing in places creating crevices with potential to support roosting bats.

Target Note	Grid Reference
25	NS 29708 48233. Area of marsh and marshy grassland between train line, river and woodland. Areas dominated by reed canary-grass (possible old ponds) and bordered by marsh thistle, meadowsweet, soft-rush and creeping thistle. Rest of the field dominated by Yorkshire fog, perennial rye-grass, false oat-grass *Arrhenatherum elatius*, creeping buttercup, broad-leaved dock and common ragwort *Senecio jacobaea*. Area offers good potential for amphibians. Area also good foraging habitat for bats. River banks dominated by butterbur *Petasites hybridus* and broad-leaved ragwort *Senecio fluviatilis*, reed canary-grass and stands of Indian balsam. River is slow flowing and about 5 m wide with glides in this vicinity. May get Daubentons bat *Myotis daubentonii* feeding on the watercourse.
26	NS 29641 48531. Area of semi-mature to mature broad-leaved semi-natural woodland dominated by alder and a willow species, with frequent ash and hawthorn and occasional silver birch and hazel. Ground flora dominated by tall ruderal species with common nettle and bramble, broad buckler-fern also frequent. Ground extremely marshy in areas of woodland, other areas raised into banks. Trees have little potential to support roosting bats but provide good foraging habitat.
27	NS 29697 47763. Thin strip of mature broad-leaved semi-natural woodland on both banks of river. Woodland dominated by sycamore and ash, with occasional wych elm *Ulmus glabra*, hawthorn, a willow species and beech. Ground flora/river banks dominated by bramble and creeping thistle. Broom *Cytisus scoparius* spp. *scoparius*, field woodrush *Luzula campestris*, butterbur, meadowsweet, red campion *Silene dioica* and lesser stitchwort *Stellaria graminea* also frequent. Most trees have limited potential to support roosting bats, but some have moderate potential. Trees provide excellent foraging and flight line habitat.
28	NS 29599 48105. Wet ditch along hedge row between improved grassland fields, dominated by reed canary-grass, great willowherb and soft-rush. Tall ruderal species and hawthorn and willow scrub along the banks. Marshy grassland in field to west of drainage ditch. Mature, native oak species and ash along southern end of ditch.

Target Note	Grid Reference
29	River Garnock. Large, natural watercourse, 20 to 30 m wide. Flow direction is from north to south. River banks are typically steep, 2 m high, and composed of alluvium (flood plain deposits). The downstream section of the river is dominated by slow flowing water, with a water depth of greater than 1 m. However, the majority of the reach of the river, within the survey area, comprises moderately fast flowing water, with water depth on average 0.5 m. Channel substrate is variable, being composed of either silt (slower flowing sections of river), and beds of gravel or cobbles. Boulders are occasionally present. Stone weirs are present along the survey stretch. Bankside vegetation comprises mixture of stands of broad-leaved ragwort, Indian balsam, reed sweet-grass *Glyceria maxima* and reed canary-grass. Riparian woodland is virtually absent on the western bank, but there is abundant riparian woodland by the eastern banks of the river, composed of semi-mature osier willow *Salix viminalis*, some of which is overhanging.
30	Caaf Water. Natural watercourse which is tributary of River Garnock. Width approximately 1-2 m wide. The watercourse is generally shallow (less than 0.3 m), although pools of up to 0.5 m. Banks are variable, with evidence of undercutting by the stream resulting in suitable habitat for sand martin *Riparia riparia* and common kingfisher. Otter spraint was found under the Caaf bridge (NS 29209 48486) whilst spraint and footprints were found under the Lynn Bridge (NS 28717 48651).

7 Annex 2

Table 7-1 Floristic Table of Quadrats Sampled within Swamp Vegetation at Southern End of Site.

Latin Name	Common Name	1 NS 29686 48327	2 NS 29701 48345	3 NS 29704 48298	4 NS 29703 48277	5 NS 29655 48316	Frequency	Range
Agrostis stolonifera	Creeping Bent	5	5	4	6	3	V	3-6
Glyceria maxima	Reed Sweet-grass	10	10	10	10	10	V	10
Myosotis scorpioides	Water Forget-me-not	2	1	1	3	2	V	1-3
Ranunculus repens	Creeping Buttercup	2	5	7	5	2	V	2-7
Poa trivialis	Rough Meadow-grass		3	3	3		III	3
Holcus lanatus	Yorkshire-fog		6	3			II	3-6
Juncus effusus	Soft-rush		1	2			II	1-2
Persicaria hydropiper	Water-pepper	2				3	II	2-3
Cerastium fontanum	Common Mouse-ear		1				I	1
Epilobium ciliatum	American Willowherb		2				I	2
Filipendula ulmaria	Meadowsweet		1				I	1
Galium palustre	Marsh-bedstraw		1				I	1
Mimulus guttatus	Monkeyflower		1				I	1
Phalaris arundinacea	Reed Canary-grass					3	I	3
Phleum pratense	Timothy		5				I	5
Rhinanthus minor	Yellow-rattle		2				I	2
Rumex obtusifolius	Broad-leaved Dock				1		I	1
Senecio jacobaea	Common Ragwort			1			I	1
Veronica beccabunga	Brooklime	2					I	2

MATCH coefficients (%)

S5	46.0
S5a	35.8
S28	33.4
S26d	31.9
S5b	30.3

Table 7-2 Floristic Table of Quadrats Sampled within Marshy Grassland at Southern End of Site.

		1	2	3	4	5		
Latin Name	**Common Name**	**NS 29660 48314**	**NS 29669 48311**	**NS 29686 48320**	**NS 29695 48318**	**NS 29697 48327**	**Frequency**	**Range**
Agrostis stolonifera	Creeping Bent	9	6	3	4	5	V	3-9
Alopecurus geniculatus	Marsh Foxtail	9	8	10	9	5	V	5-10
Ranunculus repens	Creeping Buttercup	5	8	3	4	8	V	3-8
Rumex crispus	Curled Dock	1	2	3	4	4	V	1-4
Senecio jacobaea	Common Ragwort	1	1	2	3	5	V	1-5
Lolium perenne	Perennial Rye-grass	2	1	2	2		IV	1-2
Myosotis scorpioides	Water Forget-me-not	2			2	1	III	1-2
Phleum pratense	Timothy	2	2			2	III	2
Poa trivialis	Rough Meadow-grass	4	6	5			III	4-6
Barbarea vulgaris	Winter-cress	2	1				II	1-2
Galium palustre	Marsh-bedstraw				2	2	II	2
Holcus lanatus	Yorkshire-fog				5	7	II	5-7
Juncus effusus	Soft-rush	2	2				II	2
Rumex obtusifolius	Broad-leaved Dock	1	2				II	1-2
Cerastium fontanum	Common Mouse-ear					1	I	1
Persicaria hydropiper	Water-pepper	6					I	6
Trifolium repens	White Clover		2				I	2

MATCH coefficients (%)

MG13	54.3
MG10b	52.8
OV28a	52.6
MG10	51.6
MG10a	50.4

Table 7-3 Floristic Table of Quadrats Sampled within Coarse Semi-improved Grassland at Southern End of Site.

		1	2	3	4	5		
Latin Name	**Common Name**	NS 29678 48377	NS 29673 48369	NS 29668 48358	NS 29641 48319	NS 29626 48306	Frequency	Range
Achillea millefolium	Yarrow	7	6	5	3	6	V	3-7
Agrostis capillaris	Common Bent	7	2	5	4	2	V	2-7
Arrhenatherum elatius	False Oat-grass	7	6	6	10	8	V	6-10
Calliergonella cuspidata	Pointed Spear-moss	6	7	6	6	5	V	5-7
Centaurea nigra	Common Knapweed	7	5	6	1	5	V	1-7
Dactylis glomerata	Cock's-foot	6	9	8	6	9	V	6-9
Plantago lanceolata	Ribwort Plantain	6	4	6	6	7	V	4-7
Rhytidiadelphus squarrosus	Springy Turf-moss	6	4	4	2	3	V	2-6
Holcus lanatus	Yorkshire-fog	3		5	4	5	IV	3-5
Ranunculus repens	Creeping Buttercup	7		4	5	6	IV	4-7
Rhinanthus minor	Yellow-rattle	1	1	2		1	IV	1-2
Epilobium montanum	Broad-leaved Willowherb		3		3	3	III	3
Festuca rubra	Red Fescue	7		5		5	III	5-7
Lathyrus pratensis	Meadow Vetchling		4	2	4		III	2-4
Prunella vulgaris	Selfheal		4	1		2	III	1-4
Rumex crispus	Curled Dock	2		2	3		III	2-3
Trifolium repens	White Clover	2		2	5		III	2-5
Angelica sylvestris	Wild Angelica			2	5		II	2-5
Cirsium arvense	Creeping Thistle				5	3	II	3-5
Filipendula ulmaria	Meadowsweet	2			2		II	2
Potentilla anserina	Silverweed		3		3		II	3
Trifolium pratense	Red Clover				3	1	II	1-3
Veronica chamaedrys	Germander Speedwell	6		2			II	2-6
Vicia sepium	Bush Vetch			1		3	II	1-3
Anthoxanthum odoratum	Sweet Vernal-grass			4			I	4
Cerastium fontanum	Common Mouse-ear				1		I	1
Cynosurus cristatus	Crested Dog's-tail			2			I	2
Deschampsia cespitosa subsp. cespitosa	Tufted Hair-grass					1	I	1
Galium aparine	Cleavers				1		I	1
Galium palustre	Marsh-bedstraw				1		I	1
Heracleum sphondylium	Hogweed				3		I	3
Holcus mollis	Creeping Soft-grass	3					I	3
Phleum pratense	Timothy			1			I	1
Phragmites australis	Common Reed				2		I	2
Poa pratensis	Smooth Meadow-grass					2	I	2
Potentilla reptans	Creeping Cinquefoil			8			I	8
Ranunculus acris	Meadow Buttercup			2			I	2
Stellaria graminea	Lesser Stitchwort			1			I	1
Stellaria media	Common Chickweed				1		I	1
Taraxacum officinale agg.	Dandelion		1				I	1
Tussilago farfara	Colt's-foot					1	I	1
Urtica dioica	Common Nettle				4		I	4
Valeriana officinalis	Common Valerian		2				I	2

MATCH coefficients (%)

MG9b	58.0
MG1	55.4
MG1e	54.7
MG1a	54.3
MG1c	53.8

Table 7-4 Floristic Table of Quadrats Sampled within Main Woodland in Southern half of Site.

		1	2	3	4	5		
Latin Name	**Common Name**	NS 29659 48404	NS 29615 48486	NS 29639 48389	NS 29632 48472	NS 29615 48529	Frequency	Range
Alnus glutinosa (canopy)	Alder	6	8	8	7	6	V	6-8
Crataegus monogyna (understorey)	Hawthorn	6	7	7	5	6	V	5-7
Dryopteris filix-mas	Male-fern	1	2	2	3	3	V	1-3
Fraxinus excelsior (canopy)	Ash	6	6	4	5	4	V	4-6
Urtica dioica	Common Nettle	7	6	5	4	4	V	4-7
Populus alba (canopy)	White Poplar	1		1	2	4	IV	1-4
Silene dioica	Red Campion	9		7	5	4	IV	4-9
Alnus incana (canopy)	Grey Alder	4		4		2	III	2-4
Alnus incana (understorey)	Grey Alder			5	5	3	III	3-5
Dactylis glomerata	Cock's-foot		4		2	3	III	2-4
Plagiomnium undulatum	Hart's-tongue Thyme-moss		1	3	2		III	1-3
Rubus fruiticosus agg	Bramble			3	5	3	III	3-5
Salix caprea (understorey)	Goat Willow		5	2	3		III	2-5
Salix fragilis (canopy)	Crack-willow	1		2		4	III	1-4
Geum urbanum	Wood Avens	1				2	II	1-2
Heracleum sphondylium	Hogweed		2		3		II	2-3
Ranunculus repens	Creeping Buttercup			3		5	II	3-5
Aegopodium podagraria	Ground-elder				4		I	4
Filipendula ulmaria	Meadowsweet		4				I	4
Fragaria vesca	Wild Strawberry		3				I	3
Galium aparine	Cleavers					6	I	6
Impatiens glandulifera	Indian Balsam			1			I	1
Lapsana communis	Nipplewort				1		I	1
Oenanthe crocata	Hemlock Water-dropwort		2				I	2
Prunella vulgaris	Selfheal					2	I	2
Ranunculus acris	Meadow Buttercup					1	I	1
Salix cinerea (understorey)	Grey Willow		4				I	4
Senecio jacobaea	Common Ragwort		2				I	2
Symphytum officinale x asperum = S. x uplandicum	Russian Comfrey					2	I	2
Veronica chamaedrys	Germander Speedwell					2	I	2

MATCH coefficients (%)

W6a	43.8
W6	43.3
W6d	41.5
W8e	34.0
W6b	33.6

Table 7-5 Floristic Table of Quadrats Sampled within Swamp Vegetation between the River Garnock and Main Woodland.

Latin Name	Common Name	1 NS 29575 48430	2 NS 29573 48431	3 NS 29563 48444	4 NS 29547 48449	5 NS 29548 48441	Frequency	Range
Mentha aquatica	Water Mint	6	5	5	2	6	V	2-6
Typha latifolia	Bulrush	8	9	8	9	7	V	7-9
Hippuris vulgaris	Mare's-tail	3	5	5	5		IV	3-5
Eleocharis palustris	Common Spike-rush	10	9	3			III	3-10
Valeriana officinalis	Common Valerian			2	3	6	III	2-6
Alnus glutinosa	Alder				2	2	II	2
Angelica sylvestris	Wild Angelica			2		2	II	2
Filipendula ulmaria	Meadowsweet				5	6	II	5-6
Glyceria maxima	Reed Sweet-grass				1	3	II	1-3
Oenanthe crocata	Hemlock Water-dropwort			2	5		II	2-5
Alisma plantago-aquatica	Water-plantain				1		I	1
Athyrium filix-femina	Lady-fern				1		I	1
Epilobium hirsutum	Great Willowherb		2				I	2
Epilobium palustre	Marsh Willowherb			2			I	2
Equisetum fluviatile	Water Horsetail			8			I	8
Galium aparine	Cleavers	1					I	1
Galium palustre	Marsh-bedstraw			1			I	1
Juncus articulatus	Jointed Rush			5			I	5
Juncus effusus	Soft-rush					2	I	2
Lotus pedunculatus	Greater Bird's-foot-trefoil					5	I	5
Pellia epiphylla	Overleaf Pellia			4			I	4
Potentilla anserina	Silverweed			2			I	2
Salix cinerea	Grey Willow				2		I	2

MATCH coefficients (%)

S12b	48.9
S12	43.7
S4	42.6
S26	40.4
S14c	38.2

Table 7-6 Floristic Table of Quadrats Sampled within Improved Grassland in Northern Half of Site.

		1	2	3	4	5		
Latin Name	**Common Name**	**NS 29658 48545**	**NS 29652 48575**	**NS 29648 48613**	**NS 29642 48657**	**NS 29648 48719**	**Frequency**	**Range**
Lolium perenne	Perennial Rye-grass	10	10	9	10	10	V	9-10
Phleum pratense	Timothy	2	4	3	2	4	V	2-4
Poa pratensis	Smooth Meadow-grass	2	2	6	3	2	V	2-6
Trifolium repens	White Clover	5	6	7	2	4	V	2-7
Rumex obtusifolius	Broad-leaved Dock		2	4	3	2	IV	2-4
Ranunculus repens	Creeping Buttercup	2	4		3		III	2-4
Alopecurus geniculatus	Marsh Foxtail	2					I	2
Cerastium fontanum	Common Mouse-ear				1		I	1
Holcus lanatus	Yorkshire-fog					2	I	2
Ranunculus acris	Meadow Buttercup				1		I	1

MATCH coefficients (%)

MG7a	57.9
MG7b	56.2
MG11a	45.1
MG10a	38.5
MG6a	38.0

Table 7-7 Floristic Table of Quadrats Sampled within Rush Pasture at Northern End of Site.

		1	2	3	4	5		
Latin Name	**Common Name**	**NS 29600 49081**	**NS 29583 49065**	**NS 29573 49036**	**NS 29570 49025**	**NS 29601 48996**	**Frequency**	**Range**
Anthoxanthum odoratum	Sweet Vernal-grass	4	5	6	4	6	V	4-6
Holcus lanatus	Yorkshire-fog	8	7	7	5	6	V	5-8
Juncus effusus	Soft-rush	6	9	7	9	8	V	6-9
Lotus pedunculatus	Greater Bird's-foot-trefoil	6	1	4	7	6	V	1-6
Ranunculus repens	Creeping Buttercup	4	5	3	3	5	V	3-5
Calliergonella cuspidata	Pointed Spear-moss		8	9	3	7	IV	3-9
Epilobium palustre	Marsh Willowherb		3	2	2	3	IV	2-3
Equisetum arvense	Field Horsetail		4	2	2	3	IV	2-4
Plantago lanceolata	Ribwort Plantain	7	4		2	3	IV	2-7
Cynosurus cristatus	Crested Dog's-tail	3		2		2	III	2-3
Filipendula ulmaria	Meadowsweet	1		3	4		III	1-3
Prunella vulgaris	Selfheal		3		4	4	III	3-4
Ranunculus acris	Meadow Buttercup	1	2	1			III	1-2
Rhytidiadelphus squarrosus	Springy Turf-moss		8		8	6	III	6-8
Rumex acetosa subsp. acetosa	Common Sorrel		1		1	2	III	1-2
Angelica sylvestris	Wild Angelica		3		2		II	2-3
Carex nigra	Common Sedge			8		4	II	4-8
Juncus articulatus	Jointed Rush			4		3	II	3-4
Lathyrus pratensis	Meadow Vetchling		2		2		II	2
Salix cinerea	Grey Willow			1		1	II	1
Trifolium pratense	Red Clover	2		2			II	2
Carex flacca	Glaucous Sedge	3					I	3
Carex spicata	Spiked Sedge	3					I	3
Carex viridula subsp. oedocarpa	Common Yellow-sedge					1	I	1
Centaurea nigra	Common Knapweed				2		I	2
Cirsium palustre	Marsh Thistle		2				I	2
Festuca arundinacea	Tall Fescue	2					I	2
Odontites vernus	Red Bartsia	4					I	4
Philonotis fontana	Fountain Apple-moss					3	I	3
Phleum pratense	Timothy	2					I	2
Potentilla anserina	Silverweed	2					I	2
Pseudoscleropodium purum	Neat Feather-moss					3	I	3
Ranunculus flammula	Lesser Spearwort				1		I	1
Rhinanthus minor	Yellow-rattle		3				I	3
Thuidium tamariscinum	Common Tamarisk-moss					6	I	6
Vicia cracca	Tufted Vetch	3					I	3

MATCH coefficients (%)

M23	51.3
M23b	51.1
MG10a	48.6
M23a	47.8
SD17c	47.7

Table 7-8 Target Notes from NVC.

Target Note	Description	Photograph
1	Small section of hawthorn *Crataegus monogyna* dominated woodland, adjacent to larger area of alder *Alnus glutinosa* dominated woodland.	NA
2	Short section of dry ditch with bramble *Rubus fruticosus* agg. and hawthorn scrub.	NA
3	Narrow linear strip of MG1 *Arrhenatherum* grassland growing between two barbed-wire fences.	9
4	Small section of hawthorn dominated woodland, around the site of demolished buildings.	NA
5	Location of Japanese knotweed *Fallopia japonica* around OS Grid Reference NS 29404 48804, along eastern bank of River Garnock.	NA
6	Embankment to the north-west of new Reid's (Food Service Ltd) factory, adjacent to rush pasture. Frequent species growing on the sparsely vegetated slope include broom *Cytisus scoparius*, tufted hair-grass *Deschampsia cespitosa*, several small Japanese knotweed stems, rosebay willowherb *Chamerion angustifolium*, broad-leaved dock *Rumex obtusifolius*, Russian comfrey *Symphytum* x *uplandicum*, common ragwort *Senecio jacobaea*, creeping thistle *Cirsium arvense*, colt's-foot *Tussilago farfara* and great mullein *Verbascum Thapsus*.	10
7	The area previously assigned as MG1 grassland is now beneath the footprint of the new Reid's factory. This area is now fenced-off from the rest of the site and is not included within the survey area.	NA
8	Japanese knotweed growing along soil mound to the south of new Reid's factory, between OS grid references NS 29652 48918 to NS 29680 48926.	11
9	Japanese knotweed at OS grid reference NS 29646 48911.	12
10	Japanese knotweed at OS grid reference NS 29638 48901.	13

8 Annex 3

Photograph 1: Patches of tall reed sweet-grass swamp vegetation (S5a) within shorter marshy grassland (MG13) at the southern end of the site from NS2967 4829.

Photograph 2: View across marshy grassland (MG13)and swamp vegetation (S5a) from NS 2967 4833 at the southern end of the site, facing east towards the railway underpass.

Photograph 3: Bulrush swamp vegetation (S12b) along the western edge of the site, between the River Garnock and the main alder woodland (W6a) from NS 2957 4843.

Photograph 4: Rush pasture community (M23b) with scattered scrub at the northern end of the site at NS 2955 4903, adjacent to industrial

Photograph 5: Species-poor improved grassland (MG7a) around the centre of the site from approx. NS 295 487.

Photograph 6: Closely mown species-poor improved grassland (MG7a) near the northern end of the site from approx. NS 294 489.

Photograph 7: Small area of amenity grassland (MG6) near the centre of the site at NS 2951 4858.

Photograph 8: Coarse semi-improved *Arrhenatherum* grassland (MG1e) located near the southern end of the site at NS 2966 4836.

Photograph 9: Thin strip of *Arrhenatherum* grassland (MG1e) growing between barbed wire fences at TN3 (NS 29577 48598).

Photograph 10: Embankment to the north-west of new Reid's factory building, adjacent to rush pasture at TN6 at NS 29612 49105.

Photograph 11: Japanese knotweed growing along soil mound to the south of new Reid's factory building (TN8), between OS grid references NS 29652 48918 to NS 29680 48926.

Photograph 12: Japanese knotweed (TN9) at OS grid reference NS 29646 48911.

Photograph 13: Japanese knotweed (TN10) at OS grid reference NS 29638 48901.

Photograph 14: Broad-leaved ragwort *Senecio fluviatilis* and butterbur *Petasites hybridus* growing along eastern bank of River Garnock at approx. NS 2948 4846..

Appendix 10.1

Habitat Survey

Appendix 10.2

Protected Mammal Appraisal

PLEASE NOTE THAT THIS APPENDIX CONTAINS SENSITIVE WILDLIFE DATA AND THEREFORE IS NOT INCLUDED IN THE ENVIRONMENTAL STATEMENT BUT IS AVAILABLE SEPERATELY UPON REQUEST

A737 Dalry Bypass

Appendix 10.3 Bat Ecology Appraisal

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Section Break (Next Page)

Document Control Sheet

Project Title A737 Dalry Bypass

Document Title Bat Ecology Appraisal

Report Number -

Revision -

Status FINAL

Control Date March 2013

Record of Issue

Issue	Status	Author	Date	Check	Date	Authorised	Date
01	DRAFT	R. Oliver	12/08/12	J. North	23/10/12	S. Ireland	12/12
02	DRAFT	R. Oliver	24/10/12	S. Ireland	12/12	R. McEvan	01/13
03	DRAFT	R. Oliver	01/02/13	S. Ireland	02/13	R. McEvan	02/13
04	FINAL	R. Oliver	03/13	S. Ireland	03/13	R. McEvan	03/13

Distribution

Organisation	Contact	Copies
Transport Scotland	Sandy Jamieson	paper
MFJV	Malcolm Bissett	e

Contents

Abbreviations

BAPs	Biodiversity Action Plans
DWS	District Wildlife Site
EA	Environment Agency
IEEM	Institute of Ecology and Environmental Management
LWS	Local Wildlife Site
NBN	National Biodiversity Network
NNR	National Nature Reserve
SAC	Special Area of Conservation
SEPA	Scottish Environment Protection Agency
SINCs	Sites of Interest for Nature Conservation
SNH	Scottish Natural Heritage
SSSI	Site of Special Scientific Interest

1 Introduction

This report presents an assessment of the bat species within the study area for the proposed bypass on the A737 at Dalry. The aim of the study was to reasonably appraise the ecological value of the bat species within the study area, with the following objectives set to achieve this aim:

- To review available information concerning bat species in the vicinity of the proposed scheme;
- To assess the value of habitats present in the survey area to bat species; and
- To investigate the survey area for indications of the presence and/or activity of bat species.

1.1 Legislation for Bats

All bat species are listed within Annex IV of the EC Habitats Directive (Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) and are designated as 'European Protected Species' (EPS) under Regulation 39 (1) of the Conservation (Natural Habitats & c.) Regulations 1994 ('Habitat Regulations') and subsequent Scottish amendments. The 2007 amendments removed protection of EPS from the Wildlife and Countryside Act 1981 (as amended), with sole protection being afforded within the Habitat Regulations. This means that it is an offence to:

- deliberately or recklessly capture, injure or kill a bat;
- deliberately or recklessly harass a bat or group of bats; disturb a bat while it is occupying a structure or place which it uses for shelter or protection; disturb a bat while it is rearing or otherwise caring for its young; obstruct access to a maternity or wintering roost or deny a bat the use of such breeding or resting places; disturb a bat in a manner that is, or circumstances which are, likely to significantly affect the local distribution or abundance of that particular species; disturb a bat in a manner that is, or in circumstances which are likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young;
- damage or destroy a breeding site or resting place of a bat. There are legal implications for sites with bats present, Licences must be obtained to disturb or handle bats (bat workers licence) and European Protected Species (EPS) licences must be obtained for development proposals and works. In order to obtain an EPS licence there is a strict three point test that must be met which includes demonstration that there will be no changes to the species' favourable conservation status.

Common pipistrelle *Pipistrellus pipistrellus* is listed on Appendix III (protected fauna) of the Bern Convention, while other bat species within the Microchiroptera are listed on Appendix II (strictly protected fauna) of this Convention. Common pipistrelle bats are

also listed in the Ayrshire Local Biodiversity Action Plan (LBAP) and as such have dedicated Action Plans to promote their conservation.

1.2 Study Area and Field Survey Area

An area of 1km surrounding the proposed bypass route was identified for consideration in the desk study. However this was extended to 10km for the identification of sites of European importance.

For bat species, a corridor of 250m either side of the proposed route was identified as the field survey area and was initially surveyed to identify bat habitat and potential. Following the initial assessment, a series of manual transects and automatic (static) surveys were undertaken at pre-determined locations / route. Photographs of the field survey area are shown in Annex A.

1.3 Desktop Study

A detailed desktop study was undertaken to identify any statutory, non-statutory or designated/classified sites within the study area. A review of the desktop study information obtained during the completion of the Extended Phase 1 Habitat survey assessment for the scheme was undertaken to identify the presence of any bat species or designated sites for bat species, and to help inform the field survey locations.

In addition, the following web-based sources were utilised for this:

- E-maps website (www.emapsite.com);
- Scottish Natural Heritage (SNH) Sitelink website (http://gateway.snh.gov.uk/sitelink/) – for location of any European, national an localised statutorily protected species or habitats; and
- National Biodiversity Network (NBN) (www.nbn.org.uk) – for localised species records, and focused on legally protected and ecologically significant species. Mouchel have written permission from the dataset providers to publish the data for the purposes of this report. Mouchel would like to credit the data providers and data recorders listed in Table 2-1 Section 2.1.3, for the use of the data. All interpretation of the data has been undertaken by Mouchel alone.

Finally, previous studies undertaken for bat within the survey area were reviewed (Amec 2008).

1.4 Field Survey

1.4.1 Initial Walkover Survey

The initial walkover permitted an appraisal of the habitats present which may be suitable for bat species as well as the identification of potential for bat species within the survey area (both in terms of roosts and feeding / commuting routes).

Suitable woodland habitat within the field survey area identified during the Extended Phase 1 Habitat survey was subject to further assessment to identify the presence of

suitable features that have potential to support roosting bat species, including: rot holes; cracks; splits; raised/loose bark; deadwood; snags; woodpecker holes and thick ivy coverage. The assessment was made from the ground level and binoculars were used to search for evidence of bat droppings, worn entrances and staining.

All trees identified with potential to support roosting bats were grouped into one of the following categorisations regarding their suitability to support bat roosts: high potential; medium potential; low potential and negligible bat roost potential.

Any built structures (including bridges, buildings and existing substation infrastructure) falling within the field survey area were also subject to assessment for their potential to support roosting bats (Photograph 4 in Annex A)

Following initial walkover surveys and the desk study, it was concluded that the survey area was used by bat species primarily for foraging and commuting. It was decided that a combination of walked transect surveys and static surveys would be undertaken to inform the ES.

All surveys were carried out in accordance with methods identified in the Bat Workers Manual (Mitchell-Jones & McLeish, 2004) and the Bat Survey Good Practice Guidelines (BCT, 2012).

1.4.2 Static Surveys

Three static surveys were undertaken over the months of August, September and October 2012. These surveys were undertaken using two Anabat SD1 bat detectors (automated recording equipment).

Areas thought to support bat activity were identified and Anabats were used to record bat activity over a period of three nights (the Anabats were set to record as follows: dusk (30 minutes before sunset until 2 hours after sunset) and dawn (2 hours prior to sunrise until 30 minutes following sunrise). Sunset and sunrise times for the survey dates were obtained from www.sunrisesunsetmap.com. The locations and dates of the static Anabat surveys are shown in Table 1.1. Locations are shown in Figure 10.4.

Table 1-1. Locations and dates of static Anabat surveys

Location	Anabat Reference	NGR	Survey Dates
Stoopshill Farm	1	230427 648895 230427 648895	30th August to 2nd September; 20th September to 24th September.

Location	Anabat Reference	NGR	Survey Dates
Railway Line	2a 2b 2b	229767 648295 229812 648265 * 229812 648265	30th August to 2nd September; 20th September to 24th September; 12th October to 14th October.
Highfields	3	230852 650010	12th October to 14th October.

* Survey location was changed as the location of the first survey was thought to be unsuitable; little bat data and much interference during each night of the first survey led to this conclusion.

Following each survey, data was downloaded from the Anabats and analysed using Analook.

1.4.3 Transect Surveys

In addition to the static surveys, a single dusk transect was walked across the survey area. Such surveys were undertaken by two experienced ecologists using a single Anabat SD1 Bat detector. Details of the methodology used can be seen in the above guidance (Mitchell-Jones & McLeish, 2004) and Bat Survey Good Practice Guidelines (BCT, 2012).

The route of the dusk transect is shown in Figure 10.4. The transect survey was undertaken from 30 minutes prior to sunset until 2 hours after sunset (details of sunrise and sunset times were collected from http://www.sunrisesunsetmap.com. During the survey, notes were taken and NGR noted when calls were recorded. This allowed species activity to be mapped across the transect. The dusk transect survey took place on the 16th August 2012.

Following each survey, data was downloaded from the Anabats and analysed using Analook.

1.5 Limitations

Prolonged heavy rain during the first activity surveys of the 16th and 17th of August limited the planned surveys (dusk and dawn walked transect plus two static surveys) to a dusk transect.

Due to the general timing of the surveys (toward the end of the optimal survey period), the weather conditions during some of the surveys were not optimal for bat activity (below 5°C, wet and windy). As the Anabats were not always deployed in optimal conditions, this should be taken into consideration when assessing the results.

Locating the Anabat at Highfields became problematic due to land access issues. As such, the location had to be moved a negligible distance (less than 30 m).

1.6 Assessment Methodology

1.6.1 Determining Biodiversity Value

Various characteristics can be used to identify important biodiversity features (sites, habitats and species) that are likely to represent potentially significant constraints to a project. These include:

- Rarity at various geographical scales;
- Threat status and vulnerability at various geographical scales;
- Diversity and/or it's synergistic associations;
- Population size; and
- Location in relation to it's known geographical distribution and range at various geographical scales.

The characteristics listed above help define the conservation status of a feature, which can be used to help determine its biodiversity value. The Institute of Ecology and Environmental Management (IEEM) provides further information on how the relative value and importance of a receptor can be determined and states that its *biodiversity value* should be measured against published selection criteria where available (IEEM, 2006).

It is also useful to distinguish between the *biodiversity value* of a receptor and its *legal status*. Features of high *biodiversity value* may not necessarily attract *legal protection* and vice versa. For example, a viable area of ancient woodland is likely to be considered of high biodiversity value even if it does not receive any formal statutory designations.

In the evaluation of biodiversity value reference is also made to UK and Local BAPs, inclusion on national or county Red Data Books, and to conservation status (such as nationally notable/scarce etc.). However, the inclusion within a BAP reflects the fact that the population of the species/habitat concerned is in a sub-optimal state (and hence that conservation action is required) and does not necessarily imply any specific level of value. Despite this, priority BAP species/habitats may represent a significant ecological constraint if their presence triggers *planning guidance implications*.

In accordance with IEEM (2006), and following the Ratcliffe criteria (Ratcliffe, 1977), Table 1.2 identifies the criteria used to provide an ecological, or potential ecological, value for each biodiversity feature.

Table 1-2. Criteria for Determination of Biodiversity Value of an Ecological Receptor

Value	Criteria
International (European)	**Habitats** An internationally designated site or candidate site, i.e. Special Areas of Conservation (SAC), candidate SAC (cSAC), Ramsar site, or an area which would meet the published selection criteria for designation. A viable area of a habitat type listed in Annex I of the Habitats Directive or smaller areas of such habitat that is essential to maintain the viability of a larger whole. Any waterbody classified under the WFD, and has an overall water status of high or good. Any river designated as a Salmonid water under the FFD, and likely to support a substantial salmonid population. Any river with a Habitat Quality/Modification score indicating that it is Pristine/Semi-natural.
	Species Any regularly occurring population of internationally important species, threatened or rare in the UK, i.e. a UK Red Data Book species, UK BAP or of uncertain conservation status or of global conservation concern. A regularly occurring, nationally significant population/number of an internationally important species.
National (Scotland)	**Habitats** A nationally designated site, i.e. Site of Special Scientific Interest (SSSI), National Nature Reserve (NNR) or a discrete area, which would meet the published selection criteria for national designation (e.g. SSSI selection guidelines). A viable area of a priority habitat identified in the UK BAP or smaller areas of such habitat essential to maintain wider viability. Any waterbody classified under the WFD, and has an overall water status of high or good. Any river designated as a Salmonid water under the FFD and likely to support a substantial salmonid population. Any river with a Habitat Quality/Modification Score indicating that it is Pristine/Semi-natural to Obviously Modified
	Species A regularly occurring, regionally or county significant population/number of an internationally important species. Any regularly occurring population of a nationally important species that is of a threatened or rare conservation status in the region or county (see local BAP). A species identified as of critical importance in the UK BAP.

Value	Criteria
Regional (Ayrshire)	**Habitats** Sites that exceed the County-level designations but fall short of SSSI selection criteria. Viable areas of key habitat identified in the UK BAP or smaller areas of habitat essential to maintain wider viability. Any waterbody classified under the WFD and has an overall water status of good or moderate. Any river designated as a Salmonid or Cyprinid water under the FFD and likely to support a salmonid or cyprinid population. Any river with a Habitat Quality/Modification Score indicating a range that is Pristine/Semi-natural to Significantly Modified.
	Species Any regularly occurring, locally significant population of a species listed as being nationally scarce which occurs in 16-100 10km squares in Great Britain and the Isle of Man. A regularly occurring, locally significant population/number of a regionally important species. Sites maintaining populations of internationally/nationally important species that are not threatened or rare in the region or county.
County (North Ayrshire)	**Habitats** Sites recognised by local authorities, e.g. Sites of Interest for Nature Conservation (SINCs). County sites that the designating authority has determined, meet the published ecological selection criteria for designation. A diverse and/or ecologically valuable hedgerow network. Semi-natural ancient woodland greater than 025 ha. Any waterbody classified under the WFD (2000/60/EC), and has an overall surface water status of good or moderate. Any river designated as a Salmonid or Cyprinid water under the FFD (2006/44/EC), and likely to support a salmonid or cyprinid population. Any river with a Habitat Quality/Modification Score indicating a range that it is Pristine/Semi-Natural to Significantly Modified.
	Species Any regularly occurring, locally significant population of a species listed in a Local BAP due to county rarity or localisation. A regularly occurring, locally significant population of a County important species. Sites supporting populations of regionally important species that are not threatened or rare in the region or county and not integral to maintaining those populations. Sites/features scarce in the County or which appreciably enrich the County habitat resource.

Value	Criteria
District (Kilwinning)	**Habitats** Sites recognised by local authorities, e.g. District Wildlife Sites (DWS) or those identified by the designating authority as meeting published ecological selection criteria for designation at this level. A diverse and/or ecologically valuable hedgerow network and semi-natural ancient woodland greater than 0.25ha in area. Any waterbody classified under the WFD that has an overall water status of moderate to poor. Any river designated as a Salmonid or Cyprinid water under the FFD and likely to support a salmonid or cyprinid population. Any river with a Habitat Quality/Modification Score indicating a range that is Obviously Modified to Severely Modified.
	Species Any regularly occurring, locally significant population of a species listed in a Local BAP due to district rarity or localisation. A regularly occurring, locally significant population of a District important species. Sites/features scarce in the District or which appreciably enrich the District habitat resource.
Local (Dalry)	**Habitats** Areas of habitat that appreciably enrich the local habitat resource (e.g. species-rich hedgerows, ponds) or have been identified for designation at this level, i.e. Local Wildlife Site (LWS). Sites that retain other elements of semi-natural vegetation that due to their size, quality or the wide distribution within the local area are not considered for the above classifications. Semi-natural ancient woodland smaller than 0.25ha. Any waterbody classified under the Water Framework Directive (2000/60/EC), and has an overall surface water status of moderate. Any river not likely to support a cyprinid population / likely absence of fish fauna. Any river with a Habitat Quality/Modification Score indicating Significantly Modified to Severely Modified.
	Species Populations/assemblages of species that appreciably enrich the biodiversity resource within the local context. Sites supporting populations of county/district important species that are not threatened or rare in the region or county and are not integral to maintaining those populations.

Value	Criteria
Less than Local (Limited Ecological Value)	Sites that retain habitats and/or species of limited ecological importance due to their size, species composition or other factors. Any waterbody classified under the Water Framework Directive (2000/60/EC), and has an overall surface water status of poor, bad or not classified at all. Any river not likely to support a cyprinid population / likely absence of fish fauna. Any river with a Habitat Quality/Modification Score indicating Severely Modified.

2 Baseline Conditions

2.1 Desktop Study

2.1.1 European Protected Sites

There are no sites of European nature conservation importance within the study area that are of relevance for bats. There are however, three within 10km of the proposed works. It should be noted that there is limited connectivity between the proposed works and the designated sites. Although bats are not listed as qualifying interests of the European sites, the sites do offer suitable foraging habitat for several species. These sites are potentially within the foraging range of some species recorded within the study area (Entwhistle *et al* 2001). For this reason, these sites are summarised below.

Bankhead Moss SAC & SSSI

Bankhead Moss, lying 3.3km kilometres east of the north-eastern end of the proposed works, is one of the best examples of active raised bog in North Ayrshire. A large expanse of the bog remains intact and is remarkably free of disturbance caused by drainage, grazing or burning. It demonstrates a wide range of typical mire features.

Cockinhead Moss SAC & SSSI

Cockinhead Moss, lying approximately 7km east of the proposed works, is one of the largest remaining raised bogs in west-central Scotland.

The bog surface is dominated by an active carpet of Sphagnum bog mosses with hummock and hollow, and ridge and hollow formations throughout the site. The central part of the bog is sunken, where *Sphagnum cuspidatum* dominated hollows and runnels are more frequent. Heather, bog asphodel, cranberry and hare's tail cottongrass are all present within the field layer.

Dykeneuk Moss SAC & SSSI

Dykeneuk Moss, lying 5km to the east-south-east of the proposed works, is one of the largest remaining examples of intact raised bog in west-central Scotland. It is an example of a type which is of national importance for its actively-growing Sphagnum-rich vegetation.

2.1.2 Nationally Protected Sites

There are two nationally protected sites within 10km of the scheme.

Ashgove Loch SSSI

Ashgrove Loch, located approximately 4km south west of the proposed works, is a mesotrophic loch which supports a succession of wildlife habitats from open water through fen and swamp to marshy grassland. The loch is the only example of a mineral enriched mesotrophic loch in North Ayrshire.

Bogside Flats SSSI

Bogside Flats is designated for littoral sediment (coast); saltmarsh and littoral sediment (marine); mudflats.

Bogside Flats, situated around the common estuary of the Rivers Irvine and Garnock (approximately 12km South of the proposed works), contains the only extensive expanse of saltmarsh and mudflats between the Solway Firth and the Inner Clyde Estuary.

The biologically productive saltmarsh and mudflats are the best example of this habitat type in Ayrshire and displays a variety of plant and animal communities representative of different degrees of tidal inundation. The upper, middle, and lower saltmarsh habitat zones are present, which is unusual as lower saltmarsh is not common in Scotland. Transitions from saltmarsh to terrestrial habitats are also present and intact.

2.1.3 Species Data

National Biodiversity Network

A search of the NBN database identified the presence of bat species within 10 km of the study area within the last ten years, which are identified in Table 2.1.

Table 2-1 Existing Species Data (NBN)

Species	Date of Latest Records	Location	No. of Records	Data Provider
Brown Long-eared Bat; *Plocotus auritus*	-	NW of proposed work	-	SNH - Bat Records for Scotland (1970 – 2007)
Pipistrelle bat; *pipistrellus spp.*	-		-	SNH - Bat Records for Scotland (1970 – 2007)
Soprano Pipistrelle; *Pipistrellus pygmeaus*	-		-	SNH - Bat Records for Scotland (1970 – 2007)
Common Pipistrelle; *Pipistrellus pipistrellus*	-	SW of proposed work	-	SNH - Bat Records for Scotland (1970 – 2007)

Species	Date of Latest Records	Location	No. of Records	Data Provider
Soprano Pipistrelle; *Pipistrellus pygmeaus*	2007		2	BCT – Noctule, Serotine and Pipistrelle Field Survey
Common Pipistrelle; *Pipistrellus pipistrellus*	2007 - 2008	SE of proposed works	4	BCT - THE BCT /MTUK Bats & Roadside Mammals Survey
	2005 - 2011		4	BCT – Noctule, Serotine and Pipistrelle Field Survey
Daubenton's bat; *Myotis daubentonii*	2005 - 2011		13	BCT – Daubentons Bat Waterway Survey
	2008		1	SWT – Brain Dawkins
Nyactalus / Eptesicus agg	2009 – 2011		3	BCT – Noctule, Serotine and Pipistrelle Field Survey
Soprano Pipistrelle; *Pipistrellus pygmeaus*	2005 – 2008		23	BCT - THE BCT /MTUK Bats & Roadside Mammals Survey
	2002 – 2011		24	BCT – Noctule Serotine and Pipistrelle Field Survey
	2002 – 2011		19	BCT – Colony Count Survey (Pat Emslie)
	2005 – 2011		12	BCT – Noctule Serotine and Pipistrelle Field Survey
Common Pipistrelle; *Pipistrellus pipistrellus*	2005 – 2008	NE of proposed works	8	BCT - THE BCT /MTUK Bats & Roadside Mammals Survey

Species	Date of Latest Records	Location	No. of Records	Data Provider
Brown Long-eared Bat; *Plocotus auritus*	2002 – 2011		17	BCT – Colony Count Survey (Pat Emslie)
Daubenton's bat; *Myotis daubentonii*	2003		2	BCT – Daubentons Bat Waterway Survey
Myotis spp.	2007		1	BCT - THE BCT /MTUK Bats & Roadside Mammals Survey
Nathusius's Pipistrelle; *Pipistrellus nathusii*	2011		1	SNH – compilation of records of 12 Article 17 terrestrial mammal species in Scotland
Natterers bat; *Myotis nattereri*	-		1	SNH - Bat Records for Scotland (1970 – 2007)
Noctule bat; *Nyctalus noctula*	2006		1	BCT - THE BCT /MTUK Bats & Roadside Mammals Survey
Soprano Pipistrelle; *Pipistrellus pygmeaus*	2005 - 2008		89	BCT - THE BCT /MTUK Bats & Roadside Mammals Survey
	2002- 2008		12	BCT – Noctule Serotine and Pipistrelle Field Survey
	2002 – 2011		19	BCT – Colony Count Survey (Pat Emslie)
Pipistrellus spp.	2002-2005		2	BCT – Noctule Serotine and Pipistrelle Field Survey

Species	Date of Latest Records	Location	No. of Records	Data Provider
	2011		1	BCT – Colony Count Survey (Paula Baker)

Amec

Data obtained form previous surveys undertaken in late May 2008 on the site are shown below in Table 2-2. Amec split the survey area into three sub-areas considered to have the potential to be used by bats for roosting or foraging (A: Railway & Underpass, B: Blair Estate, and C: Barjocks Plantation). These records are plotted in Figure 10.4.

Table 2-2 Existing Species Data (Amec, 2008)

Time	Location	Species (No.)	Behaviour
A			
22:10	229719 648343	Soprano Pipistrelle (1)	Commuting through railway underpass
22:14	229719 648343	Soprano Pipistrelle (2)	Foraging by railway embankment
22:16	229719 648343	Soprano Pipistrelle (1)	Foraging by railway embankment
22:19	229719 648343	Soprano Pipistrelle (1)	Foraging by railway embankment
22:22	229719 648343	Soprano Pipistrelle (2)	Foraging by railway embankment
22:24	229719 648343	Soprano Pipistrelle (2)	Commuting through railway underpass
22:27	229719 648343	Soprano Pipistrelle (1)	Commuting through railway underpass
22:29	229719 648343	Soprano Pipistrelle (2)	Foraging by railway embankment
22:33	229682 648235	Pipistrellus spp (2)	Foraging by railway embankment
22:42	229682 648235	Soprano Pipistrelle (2)	Foraging by railway embankment
22:52	229682 648235	Soprano Pipistrelle (1)	Foraging by railway embankment

Time	Location	Species (No.)	Behaviour
22:55	229682 648235	Soprano Pipistrelle (1)	Foraging by railway embankment
22:56	229719 648343	Soprano Pipistrelle (1)	Foraging by railway embankment
23:00	229719 648343	Soprano Pipistrelle (3)	Commuting through railway underpass
B			
22:00	230538 648785	Soprano Pipistrelle (2)	Foraging
22:05	230538 648785	Soprano Pipistrelle (1)	Foraging
22:08	230542 648713	Soprano Pipistrelle (1)	Foraging
22:10	230542 648713	Soprano Pipistrelle (2)	Resting
22:10	230542 648713	Soprano Pipistrelle (2)	Foraging
22:16	230524 648586	Soprano Pipistrelle (2)	Foraging
22:16	230524 648586	Soprano Pipistrelle (1)	Foraging
22:25	230376 648309	Soprano Pipistrelle (1)	Foraging
22:26	230376 648309	Soprano Pipistrelle (1)	Foraging
22:30	230341 648262	Soprano Pipistrelle (1)	Foraging
22:40	230603 648800	Common Pipistrelle (2)	Foraging
22:40	230603 648800	Soprano Pipistrelle (1)	Resting
22:45	230851 648683	Soprano Pipistrelle (2)	Resting
04:14	230851 648699	Soprano Pipistrelle (1)	Resting
04:24	230542 648709	Soprano Pipistrelle (2)	Resting
C			
22:00	230925 649893	Soprano Pipistrelle (4)	Foraging
22:10	230925 649893	Soprano Pipistrelle (1)	Foraging

Time	Location	Species (No.)	Behaviour
22:15	230925 649893	Soprano Pipistrelle (1)	Foraging
22:20	230911 649612	Soprano Pipistrelle (3)	Foraging
22:25	230911 649612	Soprano Pipistrelle (7)	Foraging
22:35	231159 649608	Soprano Pipistrelle (3)	Foraging
22:45	231305 649610	Pipistrellus spp (12)	Foraging
22:56	230895 649180	Soprano Pipistrelle (1)	Commuting

2.2 Field Survey Results

2.2.1 Walkover Survey

A detailed walkover survey of the site was carried out and included any structures and areas of woodland within the field survey area. In general terms, the site is thought to be used mainly for commuting and feeding. The open farmland has little potential for bats (Photographs 8, 17 and 18 in Annex A); with the exception of the hedgerows crossing the proposed route which offer potential in terms of commuting and feeding (Photographs 7, 13, 14, 19 and 20 in Annex A). Wetter areas (areas of bog and those areas associated with poaching by cattle) in the farmland and the presence of livestock offer limited potential insect sources for bat species.

No potential roost sites were identified along the proposed route. The woodland of Blair Estates; Crow Grove (located approximately 300m – 400m to the south east of the proposed works) was deemed suitable for bat roosts and feeding. This is reflected in the results obtained from the NBN, Amec and results in the current study.

Mature trees at the location of the proposed roundabout to the south of Highfields were identified as having low roosting potential. An underpass on the railway line (Photograph 4 in Annex A) located to the north of the proposed crossing point was identified as having medium potential for roosting bats (‘Habitat 2’ shown in Figure 10.4). There are a group of four dead trees (‘Habitat 1’ shown in Figure 10.4) which have been identified as having medium to high bat roosting potential (Photograph 12 in Annex A) Trees along the railway line (Photographs 5 and 6 in Annex A) at the proposed crossing point of the railway were identified as having potential for feeding and commuting bats.

2.2.2 Dusk Transect

The surveys discussed in Section 1.4 were undertaken and the results from the dusk transect survey are shown in Table 2-3. The data is mapped in Figure 10.4.

Table 2-3 Dusk Transect

Time	Location	Species (No.)	Behaviour
16/08/2012			
21:20	230098 648489	Soprano Pip (1)	Foraging along hedgerow
21:20	230098 648489	Soprano Pip (1)	Foraging along hedgerow
21:21	230116 648478	Soprano Pip (1)	Foraging along hedgerow
21:21	230116 648478	Soprano Pip (1)	Foraging along hedgerow
21:22	230167 648439	Soprano Pip (1)	Foraging along hedgerow
21:23	230167 648439	Soprano Pip (1)	Foraging along hedgerow
21:23	230167 648439	Soprano Pip (1)	Foraging along hedgerow
21:28	230210 648421	Soprano Pip (1)	Foraging by broadleaf woodland
21:29	230210 648421	Soprano Pip (1)	Foraging by broadleaf woodland
21:29	230210 648421	Soprano Pip / Common Pip	Foraging by broadleaf woodland
21:29	230210 648421	Soprano Pip / Common Pip	Foraging by broadleaf woodland
21:29	230210 648421	Soprano Pip / Common Pip	Foraging by broadleaf woodland
21:30	230267 648455	Soprano Pip / Common Pip	Foraging by broadleaf woodland
21:30	230267 648455	Soprano Pip / Common Pip	Foraging by broadleaf woodland
21:30	230267 648455	Soprano Pip (1)	Foraging by broadleaf woodland
21:31	230324 648500	Soprano Pip (1)	Foraging by broadleaf woodland
21:31	230324 648500	Soprano Pip (1)	Foraging by broadleaf woodland
21:34	230206 648610	Soprano Pip (1)	Foraging along hedgerow
21:34	230206 648610	Soprano Pip (1)	Foraging along hedgerow
21:34	230206 648610	Soprano Pip (1)	Foraging along hedgerow
21:35	230206 648610	Soprano Pip (1)	Foraging along hedgerow

Time	Location	Species (No.)	Behaviour
21:42	230419 648874	Common Pip (1)	Foraging around farm buildings
21:42	230419 648874	Common Pip (1)	Foraging around farm buildings
21:43	230437 648895	Common Pip (1)	Foraging along hedgerow
21:44	230437 648895	Soprano Pip (1)	Foraging along hedgerow
21:45	230437 648895	Common Pip (1)	Foraging along hedgerow
21:48	230437 648895	Soprano Pip (1)	Foraging along hedgerow
21:49	230437 648895	Soprano Pip (1)	Foraging along hedgerow
21:52	230437 648895	Soprano Pip (1)	Foraging along hedgerow
21:52	230437 648895	Soprano Pip (1)	Foraging along hedgerow
21:55	230437 648895	Soprano Pip (1)	Foraging along hedgerow
21:56	230437 648895	Soprano Pip (1)	Foraging along hedgerow
22:03	230293 648964	Soprano Pip (1)	Foraging along hedgerow
22:06	230515 649051	Soprano Pip (1)	Foraging along hedgerow
22:09	230611 649351	Soprano Pip (1)	Foraging along hedgerow

2.2.3 Static Surveys

From the static Anabat surveys, an overview is given in the main body of the report with the raw data shown in Annex B. The tables on the following pages show bat activity (passes per species); Stoopshill (Table 2-4) Railway Line (Table 2-5) and Highfields (Table 2-6). Please note that due to resourcing issues, the Anabats were left recording for the minimum recommended by the BCT (3 consecutive nights) but on occasion, were left for longer. All data is tabulated and the values are comparable on a night-by-night basis.

Table 2-4 Survey Data - Stoopshill (230427 648895)

Date	Species Present	Bat Activity	Comments
Trip 1			
30.8.12	Common Pip Soprano Pip	All activity was recorded in the evening. 1st call was recorded at 20:46 last call at 22:24. Common Pip: 5 passes Soprano Pip: 6 passes	Sunset: 20:17 Sunrise: 06:22 Weather; mild (minimum of 12C), dry and calm
31.8.12	Common Pip Soprano Pip	All activity (apart from two soprano calls) were made prior to midnight 1st call was recorded at 20:39 last call at 01:59. Common Pip: 125 passes Soprano Pip: 501 passes	Sunset: 20:14 Sunrise : 06:24 Weather; mild (minimum of 13C), dry and calm
01.09.12	Common Pip Soprano Pip	All activity was recorded throughout the night. 1st call was recorded at 20:46 last call at 06:31. Common Pip: 121 passes Soprano Pip: 1111 passes	Sunset: 20:12 Sunrise: 06:24 Weather; mild (minimum of 13C), dry and calm
02.09.12	Common Pip Soprano Pip	All activity was recorded throughout the night. 1st call was recorded at 20:58 last call at 06:15. Common Pip: 34 passes Soprano Pip: 793 passes	Sunset: 20:09 Sunrise: 06:26 Weather; mild (minimum of 12C), dry and calm
Trip 2			
20.09.12	Common Pip Soprano Pip Noctule spp.	Activity was recorded mostly prior to midnight (all but 2 passes). 1st call was recorded at 20:14, last call at 23:29 (noctule). Common Pip: 42 passes Soprano Pip: 68 passes Noctule spp: 1 pass	Sunset: 19:22 Sunrise: 07:03 Weather; cool (minimum of 4C), wet and breezy
21.09.12	Common Pip Soprano Pip	All activity was recorded prior to midnight. 1st call was recorded at 20:04 last call at 00:16. Common Pip: 7 passes Soprano Pip: 7 passes	Sunset: 19:20 Sunrise: 07:05 Weather; cool (minimum of 4C), wet and breezy
22.09.12	Common Pip Soprano Pip	Most activity was recorded prior to midnight. 1st call was recorded at 19:52 last call at 06:13. Common Pip: 9 passes Soprano Pip: 9 passes	Sunset: 19:17 Sunrise: 07:07 Weather; cool (minimum of 3C), wet and breezy
23.09.12	Common Pip Soprano	Most activity was recorded prior to midnight. 1st call was recorded at 19:53 last call at 06:40.	Sunset: 19:14 Sunrise: 07:09

Date	Species Present	Bat Activity	Comments
	Pip	Common Pip: 15 passes Soprano Pip: 134 passes	Weather; cool (minimum of 3C), wet and breezy

Table 2-5 Survey Data – Railway Line (229767 648295 / 229812 648265)

Date	Species Present	Bat Activity	Comments
Trip 1			
30.8.12		Poor records – possible due to location of Anabat	Sunset: 20:17 Sunrise: 06:22 Weather; mild (minimum of 12C), dry and calm
31.8.12	Soprano Pip	Poor records – possibly location of Anabat. Single call at 22:27 Soprano Pip: 1 pass	Sunset: 20:14 Sunrise : 06:24 Weather; mild (minimum of 13C), dry and calm
01.09.12	Soprano Pip	Poor records – possibly location of Anabat. 1st call was recorded at 23:50 last call at 03:57. Soprano Pip: 3 passes	Sunset: 20:12 Sunrise: 06:24 Weather; mild (minimum of 13C), dry and calm
Trip 2			
20.09.12	Soprano Pip	Activity throughout the night. 1st call was recorded at 20:04 last call at 06:16. Soprano Pip: 42 passes	Sunset: 19:22 Sunrise: 07:03 Weather; cool (minimum of 4C), wet and breezy
21.09.12	Common Pip Soprano Pip	All activity was recorded prior to midnight. 1st call was recorded at 19:45 last call at 21:28. Common Pip: 4 passes Soprano Pip: 52 passes	Sunset: 19:20 Sunrise: 07:05 Weather; cool (minimum of 4C), wet and breezy
22.09.12	Common Pip Soprano Pip Noctule spp.	Most activity was recorded prior to midnight. 1st call was recorded at 19:41 last call at 06:31. Common Pip: 2 passes Soprano Pip: 136 passes Noctule spp. 2 passes	Sunset: 19:17 Sunrise: 07:07 Weather; cool (minimum of 3C), wet and breezy

Date	Species Present	Bat Activity	Comments
23.09.12	Common Pip Soprano Pip	Activity was recorded throughout the night. The majority of calls made between 00:00 and 04:00. 1st call was recorded at 19:42 last call at 06:30. Common Pip: 13 passes Soprano Pip: 722 passes	Sunset: 19:14 Sunrise: 07:09 Weather; cool (minimum of 3C), wet and breezy
Trip 3			
12.10.12	Soprano Pip	Activity was recorded throughout the night. 1st call was recorded at 19:03 last call at 06:45 Soprano Pip: 42 passes	Sunset: 18:25 Sunrise: 07:46 Weather; cool (minimum of 6C), dry and calm with breezes
13.10.12	Common Pip Soprano Pip	All activity was recorded throughout the night but mainly prior to dawn. 1st call was recorded at 18:58 last call at 07:18 Common Pip: 1 pass Soprano Pip: 245 passes	Sunset: 18:23 Sunrise: 07:48 Weather; cool (minimum of 6C), dry (occasional shower) and calm with breezes
14.10.12	Common Pip Soprano Pip	Most activity was recorded prior to midnight. 1st call was recorded at 18:57 last call at 01:59 Common Pip: 3 passes Soprano Pip: 331 passes	Sunset: 18:20 Sunrise: 07:50 Weather; cool (minimum of 6C), dry (shower) and calm

Table 2-6 Survey Data – Highfields (230852 650010)

Date	Species Present	Bat Activity	Comments
Trip 1			
12.10.12	Common Pip Soprano Pip	Very low levels of activity were recorded throughout the night. 1st call was recorded at 19:03 last call at 06:44 Common Pip: 1 pass Soprano Pip: 6 passes	Sunset: 18:25 Sunrise: 07:46 Weather; cool (minimum of 6C), dry and calm with breezes
13.10.12	Common Pip Soprano Pip	Most activity was recorded prior to midnight. 1st call was recorded at 19:04 last call at 02:13. Common Pip: 2 passes Soprano Pip: 54 passes	Sunset: 18:23 Sunrise: 07:48 Weather; cool (minimum of 6C), dry (shower) and calm with breezes
14.10.12	Soprano Pip	All activity was recorded prior to 8pm. 1st call was recorded at 18:52 last call at 19:24 Soprano Pip: 10 passes	Sunset: 18:20 Sunrise: 07:50 Weather; cool (minimum of 6C), dry (shower) and calm

3 Evaluation of Baseline Conditions

3.1 Bats

The immediate survey area has potential for bats in terms of feeding and commuting; linear structures such as hedgerows and edges of woodland are present in the survey area.

There are several hedgerows crossing the proposed route of the bypass while bats will use the edge of the woodland for feeding and commuting. It is highly likely that bat roosts are present within the forested area but this will not be affected by the proposed development and along the edge of broadleaf woodland (Blair Estates) to the south of the proposed route.

There are several main points to be taken from established data and the data collected in the current surveys:

- Hedgerows throughout the survey area are used by commuting bats (transect data and static data).
- In particular the hedgerows running north to south at Stoopshill Farm and the tree line at the railway line are heavily used by commuting and feeding bats.
- The dominant species present / using in the survey area are Common Pipistrelle and Soprano Pipistrelle (Soprano Pipistrelle dominant over Common Pipistrelle).

Data obtained from the National Biodiversity Network and provided from Amec (2008) provide extensive evidence of Common Pipistrelle P*ipistrellus pipistrellus* and *S*oprano pipistrelle *Pipistrellus pygmeaus* activity in the local area. As found in the current surveys, the records show extensive commuting and foraging behaviour – high numbers of both Common Pipistrelle and Soprano Pipistrelle were frequently recorded along the hedgerow at Stoopshill and the treeline along the railway.

It should be noted that in Scotland, Common pipistrelle *Pipistrellus pipistrellus* bat species are currently exhibiting significant upward trends in population status, with soprano pipistrelle *Pipistrellus pygmaeus* showing a borderline significant upward trend (BCT, 2012).

The presence of bats is considered to be of intrinsic biodiversity value **at no more than the County scale**. However, the discovery of a significant roosting population, hibernation roost or maternity roost during pre-construction surveys is likely to increase the biodiversity value of the roost.

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Annexes

Annex A – Photographs & Site Identifications

Photograph 1: Looking upstream from DVLA bridge. River Garnock; commuting / feeding corridor for bat spp.

Photograph 2: Looking downstream from DVLA bridge. River Garnock; commuting / feeding corridor for bat spp.

Photograph 3: Looking over river valley at proposed crossing point.

Photograph 4: Underpass on railway line; medium to high potential for bat roost.

Photograph 5: Looking west toward railway line (linear commuting / feeding route).

Photograph 6: Looking west toward railway line (linear commuting / feeding route).

Photograph 7: Looking east from the railway line across fields of improved grassland toward Stoopshill Farm.

Photograph 8: Looking east across the proposed route toward Stoopshill Farm.

Photograph 9: Row of mature trees running east to west by Blairland Farm.

Photograph 10: Coniferous plantation to the south of the proposed scheme, to the North of Blair Estates and to the west of Stoopshill Farm.

Photograph 11: Broadleaf woodland to the south of the proposed scheme, to the North of Blair Estates and to the west of Stoopshill Farm.

Photograph 12: 4 large dead trees located between the woodland shown in photographs 10 &11. The trees have bat roost potential.

Photograph 13: Looking west from the location of the Anabat deployed at Stoopshill Farm.

Photograph 14: Looking west toward the hedge on which the Anabat deployed at Stoopshill Farm was located.

Photograph 15: Area of semi mature woodland located to the north of Stoopshill Farm. It is growing on an artificially raised area of the field.

Photograph 16: Looking east from Stoopshill Farm, more expansive areas of improved grassland.

Photograph 17: Looking west toward Stoopshill and Blair Estates from a strip of woodland next to Barjocks Plantation.

Photograph 18: Looking east toward Stoopshill Farm from Peesweep Mount.

Photograph 19: Looking east at Stoopshill. The Anabat was located in the hedge in the foreground.

Photograph 20: Looking east toward Highfields through the hedge from where the Anabat was deployed.

Appendix 10.3

Bat Ecology

A737 Dalry Bypass

Appendix 10.4 Aquatic Ecology Appraisal

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Document Control Sheet

Project Title A737 Dalry Bypass

Document Title Aquatic Ecology Appraisal

Report Number -

Revision -

Status FINAL

Control Date March 2013

Record of Issue

Issue	Status	Author	Date	Check	Date	Authorised	Date
01	DRAFT	R. Oliver	16/08/12	J. North	24/10/12	S. Ireland	12/12
02	DRAFT	R. Oliver	12/12	S. Ireland	12/12	R. McEvan	01/13
03	DRAFT	R. Oliver	01/02/13	S. Ireland	02/13	R. McEvan	02/13
04	FINAL	R. Oliver	03/13	S. Ireland	03/13	R. McEvan	03/13

Distribution

Organisation	Contact	Copies
Transport Scotland	Sandy Jamieson Yvette Sheppard	Paper/e e
MFJV	Malcolm Bissett	e

Contents

Abbreviations

ASPT	Average Score Per Taxon
BAPs	Biodiversity Action Plans
BMWP	Biological Monitoring Working Party
DWS	District Wildlife Site
EA	Environment Agency
EQR	Environmental Quality Ratio
FFD	Freshwater Fisheries Directive
HMC	Habitat Modification Classification
HMS	Habitat Modification Score
HQA	Habitat Quality Assessment
IEEM	Institute of Ecology and Environmental Management
LWS	Local Wildlife Site
NBN	National Biodiversity Network
NIEA	Northern Irish Environment Agency
NNR	National Nature Reserve
NTAXA	Number of Taxa (species)
RHS	River Habitat Survey
SAC	Special Area of Conservation
SEPA	Scottish Environment Protection Agency
SINCs	Sites of Interest for Nature Conservation
SNH	Scottish Natural Heritage
SSSI	Site of Special Scientific Interest
TDS	Total Dissolved Solids
WFD	Water Framework Directive

1 Introduction

This report presents an assessment of the protected sites, habitats and species for the aquatic environment within the study area. The aim of the study was to reasonably appraise the ecological value of the study area, with the following objectives set to achieve this aim:

- To complete a desk study of the study area gathering information relating to legally protected/ecologically important sites, habitats and/or species, and provide supporting information for the assessment of the aquatic environment;
- Present survey data to enable analysis of the ecological status or potential (biological, hydro-morphological and chemical and physico-chemical) under the Water Framework Directive (2000/60/EC) (WFD); and
- Provide a baseline condition of the survey area, against which any potential changes resulting from the works can be measured.

1.1 Study Area and Field Survey Area

Watercourses to be crossed by the proposed scheme were identified for consideration as the study area (see Figure 10.5). This was extended to 10km for the identification of sites of European importance.

All waterbodies within 50m of the proposed bypass scheme were identified for consideration as part of the field survey, with the field survey area encompassing 500m of each identified watercourse (250m upstream and 250m downstream of the bypass crossing point).

The field survey area is identified in Figure 10.5, with photographs presented in Annex A to provide additional context of the survey area. The relevant legislative protection for sites, habitats and species relevant to the proposed scheme are identified in Annex B.

1.2 Desktop Study

A detailed desktop study was undertaken to identify any statutory, non-statutory or designated/classified sites within the study area. The following web-based sources were utilised for this:

- E-maps website (www.emapsite.com);
- Scottish Environment Protection Agency (SEPA) website (www.sepa.org.uk) – for classified/designated waterbodies under the Water Framework Directive (2000/60/EC) (WFD) and Freshwater Fisheries Directive (2006/44/EC) (FFD);
- Scottish Natural Heritage (SNH) Sitelink website (http://gateway.snh.gov.uk/sitelink/) – for location of any European, national an localised statutorily protected species or habitats; and

- National Biodiversity Network (NBN) (www.nbn.org.uk) – for localised species records, and focused on legally protected and ecologically significant species. Mouchel have written permission from the dataset provider to publish the data for the purposes of this report. Mouchel would like to credit Scottish Wildlife Trust (SWT) as the data provider and Michaela Hunter (field recorder) for the use of the data. All interpretation of the data is Mouchel's work.

In addition to this, previous survey data obtained from the Ayrshire Rivers Trust to provide a larger, more robust data set of protected species within the study area.

1.3 Field Survey

The following methodologies were undertaken to appraise the ecological value of habitats present within the field survey area and to identify the presence/likely absence of protected species.

1.3.1 River Habitat Survey

River Habitat Surveys (RHS) were carried out on the River Garnock and the Caaf Water. These were identified as the only watercourses within the field survey area considered to exhibit geo-morphological diversity. This included a combination of named and un-named watercourses that were identified prior to the commencement of survey work. Refer to Figure 10.5 for field survey locations, and Annex A for site photographs and identifications. The RHS surveys were undertaken on the 26th of July 2012.

RHS is a methodology designed to characterise and assess, in broad terms, the physical structure of freshwater streams and rivers, which has been developed by the Environment Agency (EA), SEPA and Northern Ireland Environment Agency (NIEA, 2003).

In accordance with the above document, RHS were carried out along a 500m stretch of the River Garnock and of the Caaf Water (shown in Figure 10.5). All surveys were led by a competent surveyor.

The information gathered was then used to identify the diversity and naturalness of the physical features of the habitat through a Habitat Quality Assessment (HQA) and the level of modification and construction of artificial structures that have been undertaken within the reach through a Habitat Modification Score (HMS). Both are assessment tools that have been developed by the EA to analyse RHS data collected.

1.3.2 Aquatic Flora

Composition and abundance of aquatic flora within the watercourse of the survey area was assessed by identifying vascular plant and bryophyte species using Haslam *et al*., (1987). For specimens that were not recognisable in-situ, samples were obtained and analysed using the key produced by Lansdown (2008). In addition, the location and extent of other floral communities, i.e. lichens and algae, were recorded within the RHS methodology. The survey was undertaken on the 26th July, 2012.

Assessment of the aquatic floral species used the Leafpacs tool to determine the equivalent biological status of the element under the Water Framework Directive (WFD). Leafpacs is identified as the optimal methodology by the WFD Technical Advice Guidance. The methodology uses reference index scores for nutrient and hydraulic parameters for each plant species and compares these to reference sites to determine an Ecological Quality Ratio (EQR) for the site, which correlates to a status under the WFD.

1.3.3 Benthic Invertebrate Fauna

Composition and abundance of benthic invertebrate fauna within the surveyed watercourses were assessed using a kick-sampling methodology, and followed the criteria set out in the SEPA guidelines and the British Standard (BS EN 27828:1994).

A four minute combined kick-sweep sample, which included 3 minutes kicking and sweeping, 30 seconds collecting surface activity and 30 seconds collecting benthic invertebrates adhered to stones, logs, etc. The samples were collected using a wire framed mesh net (1.0mm) and the sampling time was divided between component habitats and meso-habitats proportionally where possible. Once collected, the samples were stored in 90ml containers containing fixative (99.95% Industrial Methylated Spirit) for sorting and identification in a laboratory.

Benthic invertebrate fauna samples were collected on the 26th July 2012, from areas of riffle within three locations on the watercourse; downstream (NGR NS 29695 48163), proposed crossing point (NGR NS 29650 48236) and on the Caaf Water (NGR NS 29525 48293) upstream of the confluence with the River Garnock. Access to the River Garnock upstream of the proposed crossing location was not possible due to the eroded banks and dense vegetation at the time of survey. All samples were collected from within the RHS survey reaches on the River Garnock and the Caaf Water. An additional sample was collected from the Coalheughglen Burn (16th August, 2012) at NGR NS 30978 50150. All sampling locations are shown in Figure 10.5.

All individuals within the samples were identified to family level, and species level where necessary, using the following identification keys: Friday (1988); Wallace *et al*. (1990); Hynes (1977); Elliot *et al*. (1988); and Edington and Hildrew (1981).

For calculation of biological quality, the Biological Monitoring Working Party (BMWP) and Average Score Per Taxon (ASPT) assessment methodologies were used. These methodologies are commonly used to measure quality, and make use of the presence of different species of benthic invertebrate fauna as biological indicators. The BMWP and ASPT methodologies utilise the fact that each species can have different pollution tolerance levels, and on this basis provides a score according to the species assemblages recorded. The BMWP score is the sum of the tolerance scores of all families present within a sample, with higher scores reflecting better biological water quality. The ASPT is an average value, which is less prone to variation with sampling effort. However, there is a slight tendency for the ASPT to increase with an increase in the number of scoring taxa, as the high scoring taxa tend to occur at lower abundance levels than the lower scoring taxa.

Assessment of the benthic invertebrate species composition used the River Invertebrate Classification Tool (RICT) to determine the current biological status under the WFD, with RICT identified as the optimal methodology by the WFD Technical Advice Guidance (UK TAG). The methodology uses the observed number of taxon and ASPT to compare the results with that of reference sites to determine an Environmental Quality Ratio (EQR), which correlates to a status under the WFD.

1.3.4 Fish

Assessment of the composition, abundance and age class of fish fauna using electrofishing techniques was undertaken by the Ayrshire Rivers Trust (ART).

ART visited a total of three survey locations during October 2012 in order to assess and quantify existing fish populations. Two of the locations surveyed were on the main stem of the River Garnock, one above the proposed bypass and one below. The third site was on the Caaf Water, a nearby tributary to the river that has the potential to be affected by the development area. The sites are in locations that can be readily identified in the future for the post work surveys.

The River Garnock does not have a District Salmon Fishery Board, and as such electrofishing surveys are not regular on this catchment. However, ART has historically electrofished a number of sites in the past decade. The Trust provide management and conservation advice in order to protect and improve the fisheries, habitat and ecological diversity. ART also provides expert opinion, comment and monitoring for developments with potential to impact the freshwater environment across Ayrshire.

Fish populations at each of the selected sites were assessed using electrofishing. This is a widely used technique to examine freshwater fish communities. The method uses electricity to attract and stun fish, which allows operators to remove them from the water. The fish are transferred to a holding container until they have recovered and then anaesthetised using a mild solution of MS222 (Tricaine Methane Sulphonate). Each individual is then identified, measured and returned unharmed to the area from which they were captured.

A generator powered electrofishing set (Electracatch International model WFC#7) was used at all sites. Smooth DC, with a minimum voltage of 200V was used at all sites, to maximise catch efficiency while minimising potential damage to fish and other wildlife. The methodology undertaken conformed to British Standard guidance (BS EN 14011:2003).

All sites were sampled using an area-delimited survey so that fish densities could be calculated. All salmon and trout captured during the survey were separated into year classes on the basis of length frequency histograms. As fish grow at very different rates between sites, this was repeated for each site individually. Age classifications were checked by examining the number of annual rings on scales taken from reference fish of each age class. Other fish species found were counted and recorded.

A fully quantitative 3-run depletion technique, using upstream and downstream stop nets, was used at all sites. Where sufficient fish were present, absolute fish densities were calculated, together with a measure of statistical confidence, otherwise a minimum density estimate was used. Thus, data from all the sites can be compared accurately, regardless of whether catch efficiency changes.

The results from surveys where fish densities are obtained are now classified according to the Scottish Fisheries Co-ordination Centre (SFCC) Scottish national classification scheme which was derived using data from over 1600 Scottish sites covering the period 1997-2002 (Godfrey, 2005). This allows interpretation of local fish populations in a Scotland-wide context as of 2012. The classification is shown in Tables 1-1 (Salmon) and Table 1-2 (Trout) below.

Throughout this report the following notation has been used to distinguish fish year classes: salmonid fish less than one year old, are recorded as 0+ year class or fry, whilst fish one year or older are recorded as 1+ (parr), 2+ or 3+.

Table 1-1 SFCC classification salmon fry and parr density breakpoints

Salmon Fry (No / 100m^2)	Classification	Salmon parr (No / 100m^2)
0.0	Absent	0.0
< 4.7	E – Very Poor	< 2.6
4.7 - < 10.3	D - Poor	2.6 - < 5.1
10.3 - < 20.3	C - Moderate	5.1 - < 9.1
20.3 - < 42.1	B - Good	9.1 - < 15.8
> 42.1	A - Excellent	> 15.8

Table 1-2 SFCC classification trout fry and parr density breakpoints

Salmon Fry (No / 100m^2)	Classification	Salmon parr (No / 100m^2)
0.0	Absent	0.0
< 2.5	E – Very Poor	< 1.6
2.5 - < 5.3	D - Poor	1.6 - < 3.1
5.3 - < 12.4	C - Moderate	3.1 - < 5.6
12.4 - < 30.3	B - Good	5.6 - < 10.4
> 30.3	A - Excellent	>10.4

ART is a full member of the Scottish Fisheries Coordination Centre (SFCC), which is an association of Scottish fisheries management organisations including the River and

Fisheries Trusts Scotland (RAFTS) and Marine Scotland (MS). ART staff are SFCC qualified to conduct electrofishing surveys and have permission to carry out electrofishing work in Ayrshire. At all sites, an SFCC accredited team leader was present.

1.3.5 Hydromorphological, Chemical and Physico-chemical Conditions

The hydro-morphological and chemical elements were assessed using existing data and data/parameters recorded during the RHS and targeted species surveys. For this assessment the hydrological regime, river continuity, morphological conditions and surface water chemistry (total dissolved solids (TDS), conductivity, temperature and pH) were determined.

1.4 Limitations

1.4.1 Mouchel

Prolonged heavy rain prior to the initial surveys was a limitation in terms of access to the watercourse and collection of samples.

The hydrogeomorphology of the River Garnock upstream of the proposed crossing location did not allow access to the river to collect a benthic invertebrate sample. Consequently, the 'upstream' sample was collected on the Caaf Water from an area of riffle upstream of the confluence with the River Garnock.

1.4.2 Ayrshire Rivers Trust

Electrofishing is a common means of obtaining data on fish populations (SEERAD 2007). The electrofishing techniques used by ART are specifically designed for assessing juvenile salmonid populations therefore fish from other groups may not be quantified effectively.

The survey sites chosen were selected to be representative of the general habitat type present within each sub-catchment and to include a range of flow and substrate types. The SFCC protocol recommends that the minimum survey length is six times the mean channel width at the site, with a minimum of 20m length (Godfrey 2005). If the site selected is representative of the local habitat the survey should provide a robust estimate of local fish populations. However it is possible that if fish populations are low or have a clumped distribution, the survey data may not sample the full fish population in that area.

It is usually impossible to capture all the fish present within a site, therefore depletion sampling, where fish are removed from a site in a series of successive electrofishing runs, are used to provide an estimate of the total fish population present. The rate of decline in each run and the total number of fish captured are used to estimate fish stocks. However, if fish numbers are low (less than 40 per site) the confidence limits will be wide and the depletion estimates will be unreliable (Schnute, 1983).

It is considered that it is impossible to prove the absence of fish by electrofishing, therefore, whilst the failure to capture fish at a site may indicate that the population is low, but it cannot be assumed that fish are necessarily absent.

1.5 Assessment Methodology

1.5.1 Determining Biodiversity Value

Various characteristics can be used to identify important biodiversity features (sites, habitats and species) that are likely to represent potentially significant constraints to a project. These include:

- Rarity at various geographical scales;
- Threat status and vulnerability at various geographical scales;
- Diversity and/or it's synergistic associations;
- Population size; and
- Location in relation to it's known geographical distribution and range at various geographical scales.

The characteristics listed above help define the conservation status of a feature, which can be used to help determine its biodiversity value. The Institute of Ecology and Environmental Management (IEEM) (2006) provides further information on how the relative value and importance of a receptor can be determined and states that its *biodiversity value* should be measured against published selection criteria where available.

It is also useful to distinguish between the *biodiversity value* of a receptor and its *legal status*. Features of high *biodiversity value* may not necessarily attract *legal protection* and vice versa. For example, a viable area of ancient woodland is likely to be considered of high biodiversity value even if it does not receive any formal statutory designations.

In the evaluation of biodiversity value reference is also made to UK and Local BAPs, inclusion on national or county Red Data Books, and to conservation status (such as nationally notable/scarce etc.). However, the inclusion within a BAP reflects the fact that the population of the species/habitat concerned is in a sub-optimal state (and hence that conservation action is required) and does not necessarily imply any specific level of value. Despite this, priority BAP species/habitats may represent a significant ecological constraint if their presence triggers *planning guidance implications*.

In accordance with IEEM (2006), and following the Ratcliffe criteria (Ratcliffe, 1977), Table 1.3 identifies the criteria used to provide an ecological, or potential ecological, value for each biodiversity feature.

Table 1-3 Criteria for Determination of Biodiversity Value of an Ecological Receptor

Value	Criteria
International (European)	**Habitats** An internationally designated site or candidate site, i.e. Special Areas of Conservation (SAC), candidate SAC (cSAC), Ramsar site, or an area which would meet the published selection criteria for designation. A viable area of a habitat type listed in Annex I of the Habitats Directive or smaller areas of such habitat that are essential to maintain the viability of a larger whole. Any waterbody classified under the WFD, and has an overall water status of high or good. Any river designated as a Salmonid water under the FFD, and likely to support a substantial salmonid population. Any river with a Habitat Quality/Modification score indicating that it is Pristine/Semi-natural.
	Species Any regularly occurring population of internationally important species, threatened or rare in the UK, i.e. a UK Red Data Book species, UK BAP or of uncertain conservation status or of global conservation concern. A regularly occurring, nationally significant population/number of an internationally important species.
National (Scotland)	**Habitats** A nationally designated site, i.e. Site of Special Scientific Interest (SSSI), National Nature Reserve (NNR) or a discrete area, which would meet the published selection criteria for national designation (e.g. SSSI selection guidelines). A viable area of a priority habitat identified in the UK BAP or smaller areas of such habitat essential to maintain wider viability. Any waterbody classified under the WFD, and has an overall water status of high or good. Any river designated as a Salmonid water under the FFD and likely to support a substantial salmonid population. Any river with a Habitat Quality/Modification Score indicating that it is Pristine/Semi-natural to Obviously Modified
	Species A regularly occurring, regionally or county significant population/number of an internationally important species. Any regularly occurring population of a nationally important species that is of a threatened or rare conservation status in the region or county (see local BAP). A species identified as of critical importance in the UK BAP.

Value	Criteria
Regional (Ayrshire)	**Habitats** Sites that exceed the County-level designations but fall short of SSSI selection criteria. Viable areas of key habitat identified in the UK BAP or smaller areas of habitat essential to maintain wider viability. Any waterbody classified under the WFD and has an overall water status of good or moderate. Any river designated as a Salmonid or Cyprinid water under the FFD and likely to support a salmonid or cyprinid population. Any river with a Habitat Quality/Modification Score indicating a range that is Pristine/Semi-natural to Significantly Modified.
	Species Any regularly occurring, locally significant population of a species listed as being nationally scarce which occurs in 16-100 10km squares in the UK BAP. A regularly occurring, locally significant population/number of a regionally important species. Sites maintaining populations of internationally/nationally important species that are not threatened or rare in the region or county.
County (North Ayrshire)	**Habitats** Sites recognised by local authorities, e.g. Sites of Interest for Nature Conservation (SINCs). County sites that the designating authority has determined, meet the published ecological selection criteria for designation. A diverse and/or ecologically valuable hedgerow network. Semi-natural ancient woodland greater than 025 ha. Any waterbody classified under the Water Framework Directive (2000/60/EC), and has an overall surface water status of good or moderate. Any river designated as a Salmonid or Cyprinid water under the Freshwater Fish Directive (2006/44/EC), and likely to support a salmonid or cyprinid population. Any river with a Habitat Quality/Modification Score indicating a range that it is Pristine/Semi-Natural to Significantly Modified.
	Species Any regularly occurring, locally significant population of a species listed in a Local BAP due to county rarity or localisation. A regularly occurring, locally significant population of a County important species. Sites supporting populations of regionally important species that are not threatened or rare in the region or county and not integral to maintaining those populations. Sites/features scarce in the County or which appreciably enrich the County habitat resource.

Value	Criteria
District (Kilwinning)	**Habitats** Sites recognised by local authorities, e.g. District Wildlife Sites (DWS) or those identified by the designating authority as meeting published ecological selection criteria for designation at this level. A diverse and/or ecologically valuable hedgerow network and semi-natural ancient woodland greater than 0.25ha in area. Any waterbody classified under the WFD that has an overall water status of moderate to poor. Any river designated as a Salmonid or Cyprinid water under the FFD and likely to support a salmonid or cyprinid population. Any river with a Habitat Quality/Modification Score indicating a range that is Obviously Modified to Severely Modified.
	Species Any regularly occurring, locally significant population of a species listed in a Local BAP due to district rarity or localisation. A regularly occurring, locally significant population of a District important species. Sites/features scarce in the District or which appreciably enrich the District habitat resource.
Local (Dalry)	**Habitats** Areas of habitat that appreciably enrich the local habitat resource (e.g. species-rich hedgerows, ponds) or have been identified for designation at this level, i.e. Local Wildlife Site (LWS). Sites that retain other elements of semi-natural vegetation that due to their size, quality or the wide distribution within the local area are not considered for the above classifications. Semi-natural ancient woodland smaller than 0.25ha. Any waterbody classified under the Water Framework Directive (2000/60/EC), and has an overall surface water status of moderate. Any river not likely to support a cyprinid population / likely absence of fish fauna. Any river with a Habitat Quality/Modification Score indicating Significantly Modified to Severely Modified.
	Species Populations/assemblages of species that appreciable enrich the biodiversity resource within the local context. Sites supporting populations of county/district important species that are not threatened or rare in the region or county and are not integral to maintaining those populations.

Value	Criteria
Less than Local (Limited Ecological Value)	Sites that retain habitats and/or species of limited ecological importance due to their size, species composition or other factors. Any waterbody classified under the Water Framework Directive (2000/60/EC), and has an overall surface water status of poor, bad or not classified at all. Any river not likely to support a cyprinid population / likely absence of fish fauna. Any river with a Habitat Quality/Modification Score indicating Severely Modified.

2 Baseline Conditions

2.1 Desktop Study

2.1.1 European Protected Sites

There are no sites of European nature conservation importance within the study area that are of relevance for aquatic ecology. There are however, three within 10km of the proposed works. In addition to this, there are a two sites of national nature conservation importance with 10km of the site. It should be noted that there is limited connectivity between the proposed works and the designated sites.

Bankhead Moss SAC & SSSI

Bankhead Moss, lying 4km kilometres east of the north-eastern end of the proposed works, is one of the best examples of active raised bog in North Ayrshire. A large expanse of the bog remains intact and is remarkably free of disturbance caused by drainage, grazing or burning. It demonstrates a wide range of typical mire features.

The bog originally formed around a waterlogged depression in the undulating plateau above the north-facing slope of the Garnock Valley. The south eastern section of the dome remains intact and is characterised by a pattern of very low ridges and shallow hollows, and supports several species of bog-mosses, the most prevalent of which are *Sphagnum papillosum* and *S. magellanicum*. Subtle variations in the microtopography, which are mirrored by local variations in the water table, control the distribution of additional *Sphagnum* species including *S. tenellum* and *S. cuspidatum*. *Sphagnum recurvum* and bog asphodel *Narthecium ossifragum* are restricted to areas where the movement of surface water causes local nutrient enrichment.

Cockinhead Moss SAC & SSSI

Cockinhead Moss, lying approximately 7km east of the proposed works, is one of the largest remaining raised bogs in west-central Scotland.

The bog surface is dominated by an active carpet of Sphagnum bog mosses with hummock and hollow, and ridge and hollow formations throughout the site. The central part of the bog is sunken, where *Sphagnum cuspidatum* dominated hollows and runnels are more frequent. Heather, bog asphodel, cranberry and hare's tail cottongrass are all present within the field layer.

Dykeneuk Moss SAC & SSSI

Dykeneuk Moss, lying 5km to the east-south-east of the proposed works, is one of the largest remaining examples of intact raised bog in west-central Scotland. It is an example of a type which is of national importance for its actively-growing Sphagnum-rich vegetation.

2.1.2 Nationally Protected Sites

Ashgove Loch SSSI

Ashgrove Loch, located approximately 6 km south west of the proposed works, is a mesotrophic loch which supports a succession of wildlife habitats from open water through fen and swamp to marshy grassland. The loch is the only example of a mineral enriched mesotrophic loch in North Ayrshire.

Bogside Flats SSSI

Bogside Flats SSSI is designated for littoral sediment (coast); saltmarsh and littoral sediment (marine); mudflats.

Bogside Flats, situated around the common estuary of the Rivers Irvine and Garnock (approximately 12 km South of the proposed works), contains the only extensive expanse of saltmarsh and mudflats between the Solway Firth and the Inner Clyde Estuary.

The biologically productive saltmarsh and mudflats are the best example of this habitat type in Ayrshire and displays a variety of plant and animal communities representative of different degrees of tidal inundation. The upper, middle, and lower saltmarsh habitat zones are present, which is unusual as lower saltmarsh is not common in Scotland. Transitions from saltmarsh to terrestrial habitats are also present and intact.

2.1.3 Water Framework Directive Classification

Both the River Garnock and the Caaf Water receive classification under the WFD.

River Garnock

The River Garnock (Rye Water to Caaf Water) is classified as a small, mid-altitude, calcareous watercourse. The stretch of the River Garnock from Rye Water to the Caaf Water confluence is classified as having an overall status of Bad with Medium confidence in 2008 with overall ecological status of Bad and overall chemical status of Pass.

The stretch of the River Garnock where the propose work is to be undertaken (Caaf Water to tidal limit) is classified as a medium, lowland, calcareous watercourse. The stretch of the River Garnock from the Caaf Water confluence to the tidal limit is classified as having an overall status of Bad with Medium confidence in 2008 with overall ecological status of Bad and overall chemical status of Fail.

Images of the River Garnock are shown in Annex A (Photographs 1 – 6 inclusive and 19 -21 inclusive).

Caaf Water

The Caaf Water is classified as a small, lowland calcareous watercourse. The Caaf Water is modified and as such, receives an overall status of Poor ecological potential with Medium confidence in 2008 with overall ecological status of Poor and overall chemical status of Pass.

It is important to note that the five classification ecological potential classes for Heavily Modified Water Bodies (HMWBs) and Artificial Water Bodies (AWBs) combine the level of mitigation measures for water levels and flow and physical habitat with measurements of the biological and chemical water quality. For example, a HMWB could have all the mitigation measures in place for the use (e.g. hydropower) to allow it to reach good ecological potential, but if water quality is poor due to elevated phosphorus levels, its overall ecological potential assessment could be moderate, poor or bad depending on the severity of the impact.

Images of the Caaf Water are shown in Annex A (Photographs 7 – 11 inclusive).

Rye Water

The Rye Water enters the River Garnock upstream of the proposed works and from from the west. As such, is unlikely to be effected by the proposed works. However, it has been included as it is a major watercourse in the catchment.

The Rye Water is classified as a small, mid-altitude calcareous watercourse. The Rye Water is modified and as such, receives an overall status of Bad ecological potential with Medium confidence in 2008 with overall ecological status of Bad and overall chemical status of Pass.

The note on modified watercourses written under the Caaf Water applies here also.

The Rye Water will not be directly affected by the proposed works (it enters the River Garnock upstream of the proposed works from the west of the Garnock; the proposed works are primarily to the east of the river Garnock). As such, it will not be considered further in the report.

Unclassified Watercourses

There are unclassified watercourses in the immediate survey area. These are a combination of ephemeral field drains (identified in Figure 10.5) and the Coalheughglen Burn in the eastern end of the scheme (Photographs 11 – 18 inclusive in Annex A).

The ephemeral ditches are of limited ecological value but will act as a vector carrying sediment to classified watercourses (River Garnock). The Coalheughglen burn is highly modified (although a RHS was not undertaken, there are many culverts (including the confluence with the River Garnock). The Coalheughglen burn is of limited ecological

value (the culverts limit connectivity of habitat) but, like the ephemeral ditches, will act as a vector carrying sediment to the River Garnock.

The Bombo Burn flows parallel to the proposed route; approximately 1 km to the south east. The Bombo Burn flows into the River Garnock approximately 650 m downstream of the proposed crossing point of the River Garnock. There is no connectivity to the proposed works and as it falls outwith the study area, the Bombo Burn will not be discussed further in the report.

2.1.4 Freshwater Fish Directive (FFD)

The River Garnock is classified as a Salmonid water under the FFD. The water quality of the watercourses pass the mandatory status, however they fail the guideline status.

2.1.5 Species Data

National Biodiversity Network

A search of the NBN database revealed no records the presence of Atlantic salmon; *Salmo salar* or brown trout *Salmo trutta* within the immediate survey area; the closest record is taken from the mouth of the River Garnock (SWT / Michaela Hunter).

Ayrshire Rivers Trust

The Ayrshire Rivers Trust were contracted to undertake electrofishing surveys. As part of their work, they provided a report incorporating current data as well as historical data collected from previous electrofishing surveys on the relevant watercourses.

2.2 Field Survey Results

2.2.1 River Habitat Survey

RHS were completed for the watercourses in the survey area that demonstrated geomorphological diversity. The River Garnock and Caaf Water were surveyed for RHS but field and drainage ditches were not surveyed. Due to limited access, an RHS of the Coalheughglen Burn was not undertaken but as discussed previously, the number of culverts and indication of channel re-alignment would indicate that it is significantly modified.

The results obtained from the RHS surveys were utilised to calculate the HQA and HMS for the watercourses. The HQA and HMS for each watercourse is presented in Table 2.1 below, along with the corresponding Habitat Modification Class (HMC). The location of each surveyed watercourse can be seen in Figure 10.5.

Table 2-1 RHS Assessment Results

Watercourse	HQA	HMS	HMC	Confidence
River Garnock	48	1165	Significantly Modified	Very High
Caaf Water	37	635	Significantly Modified	Very High

2.2.2 Hydromorphological Conditions

River Garnock

The River Garnock is a typical lowland watercourse at the survey area exhibiting a diverse environment. The watercourse is dominated by deeper pools split by a series of small weirs built across the channel.

There is variation in depth throughout the surveyed stretch. The deeper pools display low flow with unbroken waves dominating. The deeper pools are separated by shallower areas attributed to the weirs. At such points, the shallower areas result in moderate flows and consequently, rippled flow. There is little variation in the width of the watercourse throughout the surveyed area.

The differing environments result in a diverse substrate size present throughout the surveyed stretch. Sand/silt dominate in the pools with gravel/pebble dominating in areas around the weirs. Cobble is also present in the surveyed reach albeit a negligible presence. This varied substrate composition is not uncommon in lowland watercourses.

Although the results of the HMS assessment identifies that the watercourse has been subject to significant modification, none of these modifications are considered likely to significantly influence the movement of organisms or the transport of sediment through the watercourse.

The structure of the riparian habitat shows some signs of influence from surrounding land-use, with agricultural and suburban land dominating. However, despite this there are scattered trees and extensive areas of tall herbs along the eastern bank of the watercourse in the surveyed area.

Caaf Water

The Caaf Water a typical lowland watercourse at the survey area exhibiting a diverse environment; perhaps a more typical watercourse than the River Garnock with a series of pools and riffles throughout the survey stretch.

The variation in depth along the surveyed reach is less than that observed in the River Garnock. The stretch of the Caaf Water is a more even split of extended areas of riffle and pools, resulting in a more even distribution of flow rates and substrate size.

The pools display low flow and unbroken waves dominate, while through the extended areas of riffle, moderate flows and rippled flow are present. There is little variation in the width of the watercourse throughout the surveyed area.

The differing environments results in a diverse substrate size present throughout the surveyed stretch. Sand/silt dominate in the pools with gravel/pebble dominating in areas around the weirs. Cobble is also present in the surveyed reach albeit a negligible presence. A larger proportion of gravel pebble is present in the Caaf Water compared to the River Garnock; this is due to the shallower watercourse and a larger proportion of moderate flow are areas of riffle.

Although the results of the HMS assessment identifies that the watercourse has been subject to significant modification, none of these modifications are considered likely to significantly influence the movement of organisms or the transport of sediment through the watercourse.

The structure of the riparian habitat shows many signs of influence from surrounding land-use, with agricultural land dominating. Both banks are heavily poached by cattle and consequently, much sediment will be washed into the watercourse during spate conditions. This also has a major impact on the stability of the banks, making the banks prone to erosion, increasing the potential for sediment to enter the watercourse.

Coalheughglen Burn

The Coalheughglen Burn is a highly modified watercourse. There is a series of culverts along the watercourse (including the confluence with the Garnock; the burn emptying through a pipe then falling (rather than flowing) into the River Garnock. During spate conditions, a rise in water levels of the River Garnock may permit flow between the Coalheughglen Burn and the river Garnock. Such a confluence limits opportunity for upstream / downstream migration as well as connectivity of habitat for other ecological interests. Given the highly modified nature of the watercourse and the low ecological quality of the habitat (shown by the benthic invertebrate populations), it is highly likely that the watercourse is currently unsuitable for fish.

2.2.3 Chemical and Physico-chemical Conditions

The assessment results for surface water chemistry were recorded prior to the collection of benthic invertebrate samples; at the same location. The results are presented in Table 2.2 below and mapped in Figure 10.5.

Table 2-2 Surface Water Chemistry Results

Parameter	Sampling Location			
	Downstream (TN 01)	Crossing (TN 02)	Upstream / Caaf Water (TN 03)	Coalheugh – glen Burn (TN 04)
Temperature (°C)	11.2	11.3	11.9	10.5
pH	7.21	7.27	7.07	7.13
Conductivity (µS)	243	240	263	221
Total Dissolved Solids (ppm)	124	121	129	113

2.2.4 Aquatic Flora

The aquatic flora within the watercourses in the field survey area was sparse and only consisted of mosses and some filamentous algae. Each of the watercourse was subject to assessment using Leafpacs methodology (where applicable).

The aquatic flora identified as present within each of the sampling locations are listed in Table 2.3 with the results of analysis of this data presented in Table 2.4.

Table 2-3 Aquatic Flora Identification Results

Watercourse	Species		Cover Value
River Garnock	River Grimmia	*Schistidium rivulare*	0.1% < 1%
Caaf Water	None present	None present	-
Coalheughglen Burn	None present	None present	-

Table 2-4 Aquatic Flora Analysis Results

Watercourse	Leafpacs EQR	WFD Status
River Garnock	0.62	Good
Caaf Water	Not Applicable	Not Applicable
Coalheughglen Burn	Not Applicable	Not Applicable

2.2.5 Benthic Invertebrate Fauna

Numbers of individual animals of each BMWP scoring taxa recorded at each sampling location are listed in Table 2.5 with the results of the analysis of this data presented in Table 2.6. The samling locations are shown in Figure 10.5.

Table 2-5 Benthic Invertebrate Identification

Benthic Invertebrate Taxa	BMWP Score	Sampling Location			
		Downstream	Crossing	Upstream / Caaf Water	Coalheugh – glen Burn
Ancyllidae	6	-	5	-	-
Baetidae	4	12	5	13	-
Chrinomidae	2	-	-	-	2
Dytiscidae	5	-	-	2	-
Elmidae	5	2	-	-	-
Gammaridae	5	2	11	-	1
Glossiphoniidae	3	-	2	-	-
Haliplidae	5	4	-	1	1
Heptageniidae	10	8	4	8	-
Hydrophilidae	5	-	-	-	1
Hydropsychidae	5	1	-	-	-
Leuctridae	10	11	-	12	-
Odoncentridae	10	-	-	-	5
Oligochaeta	1	-	-	-	3
Perlodidae	10	-	3	-	-
Philopotamidae	8	2	-	-	-
Scirtidae	5	17	20	14	-

Benthic Invertebrate Taxa	BMWP Score	Sampling Location			
		Downstream	Crossing	Upstream / Caaf Water	Coalheugh – glen Burn
Sericostomatidae	10	1	6	1	-
Simuliidae	5	2	-	-	-
Sphaeridae	3	-	-	-	1
Taeniopterygidae	10	11	-	1	-
Tipulidae	5	1	-	22	1
Number of Taxa		13	8	9	8
BMWP		88	64	59	35
ASPT		6.77	8	6.56	4.375

Table 2-6 Benthic Invertebrate Analysis

Assessment	Sampling Location			
	Downstream	Crossing	Upstream	Coalheugh – glen Burn
Number of Taxa	13	8	9	8
BMWP Score	88	64	59	35
ASPT Score	6.77	8	6.55	4.375
EQR (NTaxa)	0.677	0.41	0.47	0.3988
WFD Status (NTaxa)	Moderate	Bad	Poor	Bad
EQR (ASPT)	1.12	1.26	1.07	0.731
WFD Status (ASPT)	High	High	High	Good

2.2.6 Fish Fauna

The below tables show the records taken from the current fish fauna surveys. '0+' refers to salmonid species less than 1 year old (referred to as fry), while '1++' refers to fish at least 1 year old (referred to as parr).

River Garnock (Upper Site)

Table 2-7 Current and historical fish fauna data from the upper survey location on the River Garnock

Code	Date	NGR	Classification	Species				
				Salmon		Trout		Other Species
				0 +	1++	0+	1++	
GaM1	22/10/12	229576 649334	Fish Densities (Number / 100m^2)	6.2	1.1	0.0	0.0	Stoneloach (1-10), Minnow (1-10),
			SFCC Classification	D	E	Absent	Absent	
	15/10/03	230100 648700	Fish Densities (Number / 100m^2)	47.7	9.5	2.4	0.0	Stoneloach (1-10), Minnow (1-10) & Eel (1-10)
			SFCC Classification	A	B	E	Absent	
GaM2	15/10/03	229700 648250	Fish Densities (Number / 100m^2)	23.2	2.8	1.9	0.9	Stoneloach (11-100), Minnow (11-100), Stickleback (1-10) & Eel (1-10)
			SFCC Classification	C	D	E	E	

River Garnock (Downstream)

Table 2-8 Current and historical fish fauna data from the lower survey location on the River Garnock

Code	Date	NGR	Classification	Species				
				Salmon		Trout		Other Species
				0 +	1++	0+	1++	
GaM3	22/10/12	229576 649334	Fish Densities (Number / 100m^2)	13.1	4.1	0.0	0.2	Stoneloach (1-10), Minnow (1-10),
			SFCC Classification	C	D	E	E	
GaM2	15/10/03	229700 648250	Fish Densities (Number / 100m^2)	23.2	2.8	1.9	0.9	Stoneloach (11-100), Minnow (11-100), Stickleback (1-10) & Eel (1-10)
			SFCC Classification	C	D	E	E	
GaM1	15/10/03	230100 648700	Fish Densities (Number / 100m^2)	47.7	9.5	2.4	0.0	Stoneloach (1-10), Minnow (1-10) & Eel (1-10)
			SFCC Classification	A	B	E	Absent	

Caaf Water

Table 2-9 Current and historical fish fauna data from the Caaf Water

Code	Date	NGR	Classification	Species				
				Salmon		Trout		Other Species
				0 +	1++	0+	1++	
GaCW2	22/10/12	229188 648495	Fish Densities (Number / 100m^2)	61.6	1.3	0.0	2.7	Stoneloach (11-100), Minnow (101-1000), Stickleback (1-10), Lamprey (1-10) & Eel (1-10)
			SFCC Classification	A	E	Absent	D	
GaCW1	25/09/06	228600 648700	Fish Densities (Number / 100m^2)	40.5	1.5	2.7	0.8	Stoneloach (11-100), Minnow (101-1000) & Eel (1-10)
			SFCC Classification	B	E	D	E	
GaCW1	15/10/03	228600 648700	Fish Densities (Number / 100m^2)	15.7	2.1	2.1	4.2	Stoneloach (11-100), Minnow (11-100) & Stickleback (1-10)
			SFCC Classification	C	E	E	C	

3 Evaluation of Baseline Conditions

3.1 Statutorily Designated Sites

3.1.1 European Protected Sites

There are no European protected sites within the immediate survey area or in a location that could be effected by the proposed works.

3.1.2 National Protected Sites

There are no nationally protected sites within the immediate area but Bogside Flats SSSI I located approximately 12 km downstream of the proposed works and could be affected by the proposed works. It is designated for littoral sediment (coast); saltmarsh and littoral sediment (marine); mudflats. It is considered to be of intrinsic value **at the National scale.**

3.2 Habitats

3.2.1 Watercourses

Watercourse Classification

The River Garnock receives classification under the WFD and designation under the FFD. The stretch of the River Garnock at the site of the proposed work (Caaf Water to tidal limit) receives classification as a medium, lowland calcareous watercourse. As the River Garnock has been identified as significantly modified and of bad ecological status, and a Salmonid Water it is considered to be of intrinsic biodiversity value at **no more than the District scale.**

The Caaf Water receives classification under the WFD but is not designated under the FFD. The Caaf Water receives classification as a small, lowland calcareous watercourse. As the River Garnock has been identified as significantly modified and of poor ecological potential, it is considered to be of intrinsic biodiversity value at **no more than the District scale.**

Unclassified Watercourses

There are no unclassified watercourses in the immediate survey area. There are however ephemeral watercourses that run along hedgerows (identified in Figure 10.5). These watercourses are typical ephemeral drainage ditches containing low flow following periods of prolonged heavy rainfall. These ditches are of limited ecological value but will act as vector carrying sediment to classified watercourses (River Garnock).

The unclassified watercourses are considered to constitute a priority habitat in the UK BAP and a broad habitat type in the Local BAP. Consequently, the unclassified watercourses are considered to be of intrinsic biodiversity value **at no more than the Local scale**.

3.3 Aquatic Flora

The aquatic flora composition identified within the field survey area is relatively typical of high energy watercourses, with an absence of vascular plant species and presence of mosses. Given that only a single specimen of aquatic flora was recorded during the surveys, species composition and/or abundance will not be discussed further.

While the aquatic flora composition of the watercourses in the survey area is considered to be Good to Moderate status under the WFD, the species identified are common nationally and locally, are not identified in any BAP or identified as being of conservation concern and are therefore of intrinsic biodiversity value **at less than the Local scale only.**

3.4 Benthic Invertebrate Fauna

The benthic invertebrate fauna composition identified within the field survey area is typical of that expected in lowland watercourses, and a diverse range of species including the larvae of stoneflies, mayflies, true flies, beetles and caddis-flies were identified as present; indicative of the range of habitats in the survey area.

Both the Caaf Water and River Garnock contain areas of riffle (occurring naturally on the Caaf Water and created through the construction of small weirs on the River Garnock) as well as intermittent deeper pools which exhibit lower energy slow deeper intermittent pools Consequently, a relatively high diversity of species was recorded. A lower diversity of pollution-tolerant species were present in the Coalheughglen Burn which is reflected in the lower ASPT and BMWP scores.

The EQR scores (discussed in Section 1.3.3) for the ASPT indicate that the benthic invertebrate fauna populations are indicative of totally, or near totally, undisturbed conditions under the WFD, and thus a high status. However, the EQR scores for the number of taxa suggests that a number of taxa are missing from the watercourse that would otherwise be expected. Benthic invertebrate sampling rarely captures all of the species present within a watercourse and thus the EQR score for the ASPT is considered to be the most accurate, and correlates with that identified for the WFD classification summary sheet where applicable.

From Table 2-6, it can be seen that the NTaxa (number of species) ranges from *Bad* to *Moderate* while the ASPT (Average Score Per Taxon) ranges from *Good* to *High*. Essentially, this shows that the diverstiy of the benthic invertebrate commutnties in the watercourses is low, but those species present are intolerant to pollution, and have a high score when assessed using the River Invertebrate Classification Tool (RICT). Consequently, the benthic invertebrate composition for the watercourses in the field survey area is considered to be of *High* status under the WFD. However, as none of the species identified within the field survey area are legally protected, identified on the UK or Local BAP or listed as being of conservation importance, the benthic invertebrate composition for the watercourses has an intrinsic biodiversity value **at no more than the Local scale**.

3.5 Fish Fauna

River Garnock (Upper)

The River Garnock site GaM1, is the same site as surveyed in 2003. Therefore direct comparisons can be made between the results. The Stone Loach and Minnow range count remains the same, but unlike in 2003 no eels were present. The salmonid densities have reduced since 2003 and no trout were found in the 2012 survey.

The salmon densities in 2003 were in the excellent and good category, whereas these have now reduced to poor and very poor. The main channel had a strong current, which would not be suitable for fry (0+), but ideal for parr (1++). The upper part of the site was best suited for fry. Bankside cover was low as the right bank was garden walls and with the lower flow the left bank was an exposed gravel bed.

Surface water run-off from the A737 road and surrounding gardens would contribute to the already strong flow, therefore younger salmonids may move upstream of this site to weaker flows.

River Garnock (Lower)

The lower site on the River Garnock was situated downstream on the Dalgarven road bridge; this is a readily accessible site with a good mixture of habitat. The historic survey was further upstream, but looking at the results for the two years the classifications for the salmonids are the same.

The main channel in the 2012 site was over 0.5m in depth, with good boulders for fish cover and protection with shallower depths either side of the main channel. This was the widest site surveyed, which would be expected as it is the main stem of a lower river. There is no livestock access to this part of the river and both bankface's were bare with the odd boulder providing cover.

One trout parr was found at GaM3, hence the reason why the classification is very poor, instead of absent with the result of 0.0/100m^2. Moderate numbers of salmon fry were found, good gravel and pebbles were present at the site, but as a result of the lower flows these were left dry.

Caaf Water

Salmon fry densities were 'A' class (excellent) with parr in the 'E' class (very poor). Trout fry were absent from the survey results but parr were present. Both salmon and trout have access to the Caaf Water, although no trout fry were present during our recent survey, but in the historic data both fry and parr for salmon and trout were present.

In Ayrshire on this particular river catchment the maximum number of fish species that can be present is seven, which was achieved at this site. This particular site contained varied depths and substrates suitable to each fish species; lamprey (3), eel, stone loach, eel and minnow numbers were recorded. The numbers for stone loach, eel and minnow and were similar to those values recorded in 2006. No lamprey have been recorded historically at the survey site.

Conclusions

The Caaf Water has proven both historically and in the current surveys to be a successful spawning tributary of the River Garnock for salmon. This water is located just upstream of the proposal for the new by-pass and is vital that disturbance is minimal during the construction phase. Although salmon fry and parr were present in the River Garnock, these numbers are lower than the densities found in the Caaf Water. Trout numbers recorded were low or a value of zero across the survey areas. Historically, trout numbers in the River Garnock are low. It would appear from the data that while the River Garnock is falling under the SFCC classification, the SFCC classification of the Caaf Water (particularly for salmon fry) is improving.

Numbers of salmon fry recorded in the Caaf Water in particular are considered to be *Excellent* under the SFCC classification. Following consultation with the ART, it is thought that such records are considered above average for the local watercourses. However, given the lack of electrofishing data from the local watercourses, this cannot be confirmed. Numbers of salmon parr recorded in the Caaf Water are considered to be *Very Poor* under the SFCC classification. Numbers of salmon (fry and parr) in the River Garnock range from *Very Poor* to *Moderate* under the SFCC classifications.

Numbers of trout in both the Caaf Water and the River Garnock are considered to be Very Poor under the SFCC classification. Trout were absent from the upstream survey location on the River Garnock.

Both the Caaf Water and River Garnock are both classified under the WFD with the River Garnock designated under the FFD. Given the range of values achieved under the SFCC classifications, salmonid populations are considered to have an intrinsic biodiversity value at **no more than the County scale.**

3.6 Summary of Significant Biodiversity Receptors

Following the guidance contained in IEEM (2006), only those receptors considered of biodiversity value at a scale beyond the immediate survey area or with legal or policy implications are considered as potentially significant receptors. Those relevant to the current study area are summarised in Table 3.1.

Table 3-1 Summary of Significant Ecological Receptors within the Survey Area

Biodiversity Feature	Biodiversity Value	Legal Status and Relevant Protective Policies/Guidance
River Garnock & Caaf Water	District	Some protection through the Water Environment (Controlled Activities) (Scotland) Regulations 2011.
Unclassified Watercourses	Local	None

Biodiversity Feature	Biodiversity Value	Legal Status and Relevant Protective Policies/Guidance
Aquatic Flora	Local	None
Benthic Invertebrates	Local	None
Fish	County	Atlantic salmon and lamprey species receive some protection through the Environmental Liability (Scotland) Regulations 2009. No direct legal protection, but indirectly protected through the Water Environment (Controlled Activities) (Scotland) Regulations 2011. UKBAP

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Annexes

Annex A

Photograph 1: Garnock; US of proposed crossing point. Looking US.

Photograph 2: Garnock; US of proposed crossing point. Looking DS.

Photograph 3: Weir near upper limit of survey reach.

Photograph 4: Upper limit of survey reach ; looking upstream.

Photograph 5: Caaf water entering Garnock; notice the sediment load from Caaf Water.

Photograph 6: Caaf Water; looking US toward road bridge on A737.

Photograph 7: Caaf Water; looking DS from A737 roadbridge.

Photograph 8: Caaf Water; looking US for A737 roadbridge.

Photograph 9: Caaf Water; looking DS from upper limit of survey reach.

Photograph 10: Caaf Water; looking DS from road bridge (B714).

Photograph 11: Caaf Water; looking US from road bridge (B714).

Photograph 11: Coalheughglen Burn; US of Highfields.

Photograph 13: Coalheughglen Burn; field drain (this photo was taken following heavy rainfall.

Photograph 14: Coalheughglen Burn; highly modified (culverted in this image).

Photograph 15: Coalheughglen Burn; looking upstream from side road (A737 to east Kersland) toward B737.

Photograph 16: Coalheughglen Burn; looking at upper end of culvert running under the side road (A737 to east Kersland).

Photograph 17: Coalheughglen Burn; looking upstream between rail line and side road (A737 to east Kersland).

Photograph 18: Coalheughglen Burn; looking upstream between rail line and side road (A737 to east Kersland).

Photograph 19: Confluence of Coalheughglen Burn with the River Garnock.

Photograph 20: Garnock; looking DS from confluence with the Coalheughglen Burn

Photograph 21: Garnock; looking US from confluence with the Coalheughglen Burn

Annex B

Protected Watercourses

Water Framework Directive (2000/60/EEC)

The key purpose of the Water Framework Directive (WFD) is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. Member states are required under the WFD to achieve "good ecological status" in inland surface waters.

The WFD is formally transposed into national legislation through the Water Environmental (Controlled Activities) (Scotland) Regulations 2011. Through these regulations the Scottish Environment Protection Agency (SEPA) is empowered to control activities likely to have an impact upon the water environment (i.e. pollution, abstraction, impoundment and engineering). Consequently, SEPA can recommend/enforce regulations upon controlled activities, including the development of monitoring programmes.

Freshwater Fish Directive (2006/44/EC)

The aim of the Freshwater Fish Directive (FFD) is "to protect or improve the quality of those running or standing freshwaters which support, or which, if pollution were reduced or eliminated, would become capable of supporting, fish belonging to:

- Indigenous species offering natural diversity; or
- Species the presence of which is judged desirable for water management purposes by the competent authorities of the Member States".

Waterbodies receive classification as either Salmonid or Cyprinid waters, according to the likely species assemblages for the watercourse, and physical and chemical water quality objectives are identified according to the classification. The FFD is formally transposed into national legislation through the Surface Waters (Fishlife) (Classification) (Scotland) Direction 1999, which identifies the standards that are required for Scotland. There are differences in the parameters set, with those for Salmonid waters being more stringent.

Water Environment (Controlled Activities) (Scotland) Regulations 2011

The Water Environment (Controlled Activities) (Scotland) Regulations 2011 makes it an offence to undertake a controlled activity, that is the direct or indirect discharge or and activity likely to cause a direct or indirect discharge into groundwater of a substance listed in Schedule 2 of the regulations and/or any activity which directly or indirectly has or is likely to have a significant adverse impact on the water environment, unless it is authorised under the regulations (licensed) and carried out in accordance with that authorisation. Through the licensing, SEPA may impose conditions it considers necessary or expedient for the protection of the water environment.

Wildlife Protection/Control under National Legislation

Controlled Activities

Potential negative impacts on water resources, such as pollution, are controlled by The Water Environment (Controlled Activities) (Scotland) Regulations 2011. This legislation makes it an offence to undertake a controlled activity (the direct or indirect discharge, or an activity likely to cause a direct or indirect discharge into groundwater of certain substances) that may negatively affect the water environment. Such actions are controlled and licensed by the Scottish Environmental Protection Agency (SEPA), which may impose conditions it considers necessary or expedient for the protection of the water environment.

Freshwater Fish

Atlantic salmon, brown trout and freshwater fish receive protection through the Salmon and Freshwater Fisheries Act 1975, which makes it an offence to knowingly take, kill or injure or attempt to take, kill or injure any freshwater fish that are unclean or immature. The Act also makes it an offence to cause or knowingly permit to flow, or puts or knowingly permits to be put, into any waters containing fish or into any tributaries containing fish, any liquid or solid matter to such an extent as to cause the waters to be poisonous or injurious to fish or the spawning grounds, spawn or food of fish. However, defences exist where it can be proved that best practicable means, within a reasonable cost, has been undertaken to prevent such an event. Brown trout and Atlantic salmon also receive protection under legislation implementing EU directives.

Further species specific legislation exists for freshwater fish species, which are detailed in the following sections.

Atlantic salmon

Atlantic salmon are listed in Annexes II and V of the Habitats Directive as a species of European importance and Appendix III of the Bern Convention. As a result of its listing in Annex II of the Habitats Directive the species and its habitat receives legal protection under the Environmental Liability (Scotland) Regulations 2009 from damage, where an operator has intended to cause damage or has been negligent as to whether damage would be caused, such that it has a significant adverse effect on the ability of the species to reach or maintain favourable conservation status.

Through inclusion of the Atlantic salmon in Schedule 3 of the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended), the species also receives protection from certain methods of capture and killing.

Atlantic salmon are listed as lower risk by the IUCN and as a priority species on the UK BAP.

All three lamprey species are listed in Annex II of the Habitats Directive, Appendix III of the Bern Convention, and in the UK BAP. Through their listing in Annex II of the Habitats Directive the species and its habitat receives legal protection under the Environmental Liability (Scotland) Regulations 2009 from damage, where an operator

has intended to cause damage or has been negligent as to whether damage would be caused, such that it has a significant adverse effect on the ability of the species to reach or maintain favourable conservation status.

Through inclusion in Schedule 3 of the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended), the river lamprey also receives protection from certain methods of capture and killing. The river lamprey is also listed in Annex V of the Habitats Directive.

Although European eel do not receive any further direct legislative protection, it is important to identify that the species has been identified as being critically endangered by the IUCN as a result of recent declines across much of Western Europe. As a result, the European eel has been listed on the UK BAP.

Planning Context

In addition to the species and habitats protected under wildlife legislation, many more are listed as UK BAP priority species and habitats. While inclusion does not confer any direct protection, government agencies and local authorities are obliged to have regard to those features of principal conservation importance.

Scottish Planning Policy (SPP) outlines planning guidance in relation to the conservation and enhancement of Scotland's natural heritage. SPP makes the presence of a protected species or habitats in addition to biodiversity habitats/species a material consideration in the assessment of development proposals and requires planning authorities to take particular care to avoid harm to species or habitats protected under the WCA (1981), European Directives and/or identified as priorities in the UK Biodiversity Action Plan.

Appendix 10.4

Aquatic Ecology

A737 Dalry Bypass

Addendum to Desk Study Report

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Document Control Sheet

Project Title A737 Dalry Bypass

Document Title Addendum to Geotechnical Desk Study Report

Report Number TBC

Revision -

Status FINAL

Control Date 14 February 2013

Record of Issue

Issue	Status	Author	Date	Check	Date	Authorised	Date
01	DRAFT	W Robinson	13/07/12	R Allwright	13/07/12	R Allwright	13/07/12
02	FINAL	W Robinson	14/02/13	R Allwright	14/02/13	R Allwright	14/02/13

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Contents

1 Introduction

This document forms the addendum to the Geotechnical Desk Study Report for the A737 Dalry Bypass issued by Mouchel Fairhurst Joint Venture (MFJV) in June 2008. Its purpose is to describe any subsequent changes to the proposed scheme and the results of any investigations that have been carried out since the report was issued.

2 Ammendment to Proposed Route

At the time the 2008 Desk Study was produced there was no preferred or chosen route for the bypass and the report focussed on a study area that encapsulated five possible route options at the time. The chosen route is now Option 3B and so any conclusions or recommendations relating to the other 4 options are no longer valid.

3 Site Contamination Assessment

As there is now a chosen route (Option 3B) the assessment on sources of contamination within the desk study report need to be revised to only reflect this route. In order to bring the environmental information up to date a Landmark Envirocheck Report was purchased in June 2012. The Envirocheck has highlighted several potential sources of contamination on-site. Whilst these may not specifically be on the route of construction activities they have the potential to impact on soil and groundwater conditions. The table below summarises the potential sources of contamination both on-site and off-site:

Table 3.1: Potental sources of contamination

On-site	Off-site
Railway land	Railway land
Gas house	Pits (limestone, freestone, sandstone and coal)
Tank house	colliery
Engine house	Slag/refuse heaps
Pits (coal)/mining	Quarries (infilled)
Limekiln	Limekilns
Colliery heaps	Shafts
Possible foundry	Tramway
Quarries (infilled)	Tanks
Agriculture	Brickworks
	Engine houses
	Slaughter house
	Ironworks
	Foundry
	Laundry
	Fireclay works
	Firebrick works
	Substation

3.1 Potential Contaminants

The table below summarises the contaminants that may be present in the ground and groundwater. This is based on the potential sources of contamination listed in table 3.1.

Table 3.2: Potential contaminants	
Source of contamination	**Potential Contaminants**
Gas house	TPH, BTEX, PAH, Phenols, VOCs, SVOCs, ammoniacal nitrogen, sulphates, pH, sulphides, cyanide, sulphur, cadmium, chromium, copper, iron, lead, nickel, manganese, mercury, molybdenum, vanadium, zinc, asbestos
Tank house	As gas house
Possible foundry	As gas house plus potentially aluminium and tin
Railway land	As gas house plus herbicides
Engine house	As gas house
Pits (coal)	As gas house
Limekiln	As gas house
Colliery heaps	As gas house
Quarries (infilled)	As gas house plus any other heavy metals and PCBs
Agriculture	Pesticides, nitrates and phosphates
Mining	As gas house plus aluminium, magnesium, potassium, nitrites

4 Phase 1 Ground Investigation

The Phase 1 Ground Investigation was carried out by White Young Green Environmental Limited between July and September 2008. This consisted of the following:

- Cable percussion boreholes to recover soil samples for testing and to establish the engineering characteristics of the Made Ground, drift and weathered bedrock horizons;
- Rotary cored holes to recover samples to establish the engineering characteristics of the solid strata;
- Rotary cored holes to establish the mining position and locate cavities;
- SPTs for In-situ strength characteristics;
- Standpipes and piezometers to monitor groundwater levels.
- Machine excavated trial pits to sample shallow drift deposits for earthworks and contamination testing;

- Disturbed and undisturbed sampling for geotechnical laboratory testing;
- Trenching to locate mine entries.

A summary of the ground conditions encountered is described below.

4.1 Made Ground

The made ground was noted as being a highly variable material consisting of a mixture of gravel, sand and clay. Domestic waste products were encountered in an infilled quarry and olfactory evidence of contamination was noted in a number of holes. The maximum thickness of made ground encountered was 3.6m although the true thickness was not proven at this locality.

4.2 Alluvium

Alluvial deposits were encountered within the floodplain of the River Garnock and in an isolated locality to the east of the Blairland Housing Development. The material comprises peat, soft clays, loose and medium dense sand and gravel and uncompacted silts. The material ranged in thickness from 3m up to 13m and was well developed beneath the flood plain of the River Garnock.

4.3 Glacial Till

The Glacial Till is found throughout the study area and generally comprises clay with varying amounts of sand and gravel. The shallower horizons are generally soft to firm with the material becoming stiff to very stiff at depth. The thickness of the Glacial Till varies from 1m to around 20m with the thicker areas being found around the central and southern parts of the site. Numerous boulders and cobbles were noted throughout the material with some recorded to over 1m diameter.

In some areas in the western parts of the site the Glacial Till is described as a sand and gravel with variable amounts of silt and clay.

4.4 Bedrock

The bedrock to the north of Peesweep Mount comprises predominantly slightly weathered sandstone and mudstone with siltstone and coal encountered locally. The material was found to vary in strength from very weak to strong. In the southern half of the site the bedrock generally comprises moderately strong to strong limestone with sandstone encountered locally. A weak weathered sandstone was found at rockhead beneath the River Garnock floodplain.

4.5 Geological Structure

The strata beneath the site are anticipated to dip at a shallow angle to the south east as they are on the eastern limb of a southerly plunging anticline. A number of east-west and north west-south east trending normal faults are located regionally. A number of economic limestone, coal and ironstone seams have been mined in the area and

underlie the site. These are found at shallow levels in the north east of the site and are found at depth in the south west of the site.

4.6 Groundwater

Groundwater was encountered during the Preliminary Ground Investigation in both the superficial and bedrock deposits. In a number of holes this was found to be under substantial artesian pressure.

The artesian groundwater conditions were primarily encountered in boreholes drilled at the far south west of the road corridor with the exception of one hole that was drilled immediately to the east of the Blairland Housing Development. The artesian groundwater was recorded in a number of different strata including the basal granular Glacial Till, the Glacial Till / bedrock interface and in the bedrock. At the locality to the east of the Blairland Housing Development the artesian groundwater was encountered in a thin coal seam.

Pressure gauge readings from the Preliminary Ground Investigation show that artesian groundwater heads of up to 55m above ground level to be present. The conceptual hydrogeological ground model is summarised in the next chapter.

5 Hydrogeological Ground Model

From the results of the Phase 1 Gorund Investigation it is clear that the hydrogeology of the site is complex. A detailed study of the hydrogeology has been carried out to formulate a conceptual hydrogeological ground model and it is thought that the artesian ground water is driven by water in the workings in the ironstone and claystone at depth. The ironstone / claystone workings are more or less continuous beneath the area and can feed into the artesian water pressures encountered below the River Garnock Valley. A fault zone in this area will have increased permerability due to the collapse of mine workings. The northern coal workings are discontinuous with those the south. In the north the workings are drained by a day level while the coal workings to the south are not. Water issues in higher levels along the route are thought to be due to upward migration of ground water from workings at depth. It is thought that there was previously extensive pumping at the Peesweep Shaft location (historic mapping shows a pump house). The ‘aqueduct’ appears to link into the same shaft and could be associated with the pumping and mine drainage. Current seepages arise because the upward flowing water finds seepage paths through the collapsed workings and exits at the ground surface through granular layers in the glacial till.

6 Phase 2 Ground Investigation

The Phase 2 Ground Investigation will have a number of boreholes that are specifically aimed at gaining a better understanding of the hydrogeology and will be used to confirm or refine the hydrogeological conceptual model. This includes two relatively deep holes in the River Garnock valley and a deep hole adjacent to the Peesweep Pit

to pick up the Wee and Smithy Coal seams and identify groundwater conditions at depth in the area where the seepages occur.

The investigation will also comprise a number of trial pits and boreholes to target areas of potential contamination and to confirm ground and groundwater conditions along the road alignment where there is currently no information from the Phase 1 Ground Investigation.

Appendix 11.1

Desk Study Addendum Report

KEY:

STAGE 3 INVESTIGATIONS (Red & blue)

- Trial Pit
- Borehole with Piezometer Installation
- Borehole with multi-level Piezometer Installation
- Borehole with no installation
- Borehole with rising head Permeability test

Blue colour denotes anticipated sub-artesian groundwater

Red colour denotes anticipated artesian groundwater

STAGE 2 INVESTIGATIONS (Black)

- Cable Percussive Borehole
- Combined CP/RC
- Trial Pit
- Rotary Cored Drill Hole
- Window Sample
- Rotary Open Hole

N

CLIENT: TRANSPORT SCOTLAND — The Scottish Government

PROJECT TITLE: A737 Dalry Bypass

REV	REVISIONS	BY	CHKD	APP'D	DATE
	AMENDMENTS				

DESIGN BY:	RA	CHECKED BY:	WR
DATE:	11/07/12	DATE:	11/07/12
DRAWN BY:	AG	APPROVED BY:	RA
DATE:	11/07/12	DATE:	11/07/12
DRAWING STATUS	INFORMATION		

ENGINEER: mouchel FAIRHURST

IN ASSOCIATION WITH SIAS

DRAWING TITLE

A737 Dalry Bypass
Plan Showing Borehole And Trial Pit Locations - Sheet 1 Of 2

SCALE @ A3	DRAWING NO	REV
1:5000	A737MFJV/ST3/G/003-1	

KEY:

STAGE 3 INVESTIGATIONS (Red and blue)

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REV	REVISIONS	BY	CHKD	APP'D	DATE

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DATE:	11/07/12	DATE:	11/07/12

DRAWING STATUS: INFORMATION

ENGINEER: mouchel FAIRHURST

IN ASSOCIATION WITH SIAS

DRAWING TITLE: A737 Dalry Bypass Plan Showing Borehole And Trial Pit Locations - Sheet 2 Of 2

SCALE @ A3	DRAWING NO	REV
1:5000	A737MFJV/ST3/G/003-2	

Appendix 11.2

Stage 2 and Stage 3 Ground Investigation - Locations

TRANSPORT SCOTLAND
CARBON MANAGEMENT SYSTEM

Road Infrastructure Projects Tool 2011v3.1

A737 Dalry Bypass | 23 | July | 2013

Project Details

Project type: Works Contract ☒ MTRIPS Project ☐

Project stage: Client/ Specimen design ☒ Tender/ Detailed design ☐ Construction/ As built ☐

Project Name:	A737 Dalry Bypass
Project ID:	
Network Area:	South West
Project Description:	Proposed 3.8km single carriageway bypass south of Dalry consisting of lengths of overtaking lanes, a 280 long four-span viaduct over the River Garnock with lighting provided at the two new roundabouts and sections of approach road.

Design Details

Transport Scotland Design Project Manager:	
Design Organisation:	
Design Organisation Project Manager:	

Construction Details

Transport Scotland Construction Project Manager:	
Overseeing Organisation:	
Overseeing Organisation Engineer:	
Principal Construction Contractor:	
Principal Construction Contractor Project Manager:	
Project (construction) start date:	
Project completion date:	

CMS Verification (TS use only)

Reporting Year:	
Review Date:	
Reviewer:	
Data Complete?	
Reviewer Comments:	

Use 'Alt + Enter' to drop a line

TRANSPORT **SCOTLAND** CARBON MANAGEMENT SYSTEM

Road Infrastructure Projects Tool 2011v3.1

A737 Dalry Bypass | 23 | July | 2013

Home	Emissions Summary	Emission Factors	Method of Measurement	User Guide	Links

Project Details | 300 | 400 | 500 | 600 | 700 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900/2000 | 2100/2300 | 2400 | 2500 | Waste | Plant & Utilities | Asphalt CO_2 | Not in use

Series 0300: Fencing

Total emissions: 3.2 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Fencing • Concrete footings • Transport distances • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user notes section*	• Gates • Stiles • Tree guards • Excavation	• Temporary fencing • Wire/ wire mesh to exiting fence (only >10m) • Gates (only >5#) • Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials and Transport

Fence Type	Concrete		Quantity	Unit	Source	No# Posts	Density Factor (t/m or t/no#)	Tonnes	Distance (source-site) (kilometres)	Transport mode	Tonne-kilometres	Emission Factors		Embodied emission (tCO_2e)	Transport emission (tCO_2e)	Re-used avoided (tCO_2e)	Recycling avoided (tCO_2e)
	Mix	Cement Substitution										Materials $kgCO_2e/t$	Transport $kgCO_2e/t\text{-}km$				
Timber fence			10890	m	New	6207	0.019	209.27	10	Rigid HGV	2,092.7	0.006	0.198	1.25	0.83	0.0	0.0
Chain link fence mesh			1053	m	New	537	0.025	26.40	10	Rigid HGV	264.0	0.039	0.198	1.02	0.10	0.0	0.0
																0.0	0.0
																0.0	0.0
																0.0	0.0
																0.0	0.0
																0.0	0.0
																0.0	0.0
																0.0	0.0
																0.0	0.0
																0.0	0.0
																0.0	0.0
																0.0	0.0
																0.0	0.0
																0.0	0.0
													TOTAL:	2.27	0.94		

0.0%	Embodied emissions avoided due to re-use of materials:	0.0
0.0%	Embodied emissions avoided due to using recycled materials:	0.0

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

Chain link fence assumed to be used around the SUDS basins.
All materials are assumed to be new.
Haul route assumed as 10Km.

Series 0400: Road Restraint System (Vehicle and Pedestrian)

Total emissions: 347.5 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Safety barriers • Extra concrete • Transport distances • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user notes section*	• Terminals • Connections • Crash cushions • Anti-glare screens • Post extension units • Parapets	• Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials and Transport

Feature	Barrier working width	Post footing type	Barrier faces	Quantity (see unit)	Unit	No# of Posts	Density (t/unit)	Tonnes	Source	Distance (source-site) (kilometres)	Mode	Emission factors		Embodied emission (tCO_2e)	Transport emission (tCO_2e)	Re-used avoided (tCO_2e)
												tCO_2e/t	$kgCO_2e/t$-km			
N2 safety barrier	W2	Driven	Single	3818	m	1,909	0.0302	115.3	New	10	Rigid HGV	3.010	0.198	347.0	0.5	0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
													TOTAL:	**347.0**	**0.5**	
								0.0%		**Embodied emissions avoided due to re-use of materials:**				0.0		

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

All posts are assumed to be driven.
All materials are assumed to be new.
Haul route assumed as 10Km.

TRANSPORT SCOTLAND CARBON MANAGEMENT SYSTEM

Road Infrastructure Projects Tool 2011v3.1

A737 Dalry Bypass | 23 | July | 2013

Series 500: Drainage and Service Ducts

Total emissions: 572.8 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Drains and beds • Filter drains • Chambers • Transport distances • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user notes section*	• Service Ducts • Connections • Headwalls and outfall works • Excavation and filling • Supports • Concrete bagwork • Cleaning	• Fin drains and narrow filter drains • Gullies • Grouting • Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials

Feature	Dimensions	Quantity (see unit)	Unit	Density (t/unit)	Tonnes	Source	Distance (source-site) (kilometres)	Mode	Emission factors tCO_2e/unit	Emission factors $kgCO_2e$/t-km	Embodied emission (tCO_2e)	Transport emission (tCO_2e)	Re-used avoided (tCO_2e)	Recycling avoided (tCO_2e)
Filter Drain Pipe	150mm internal diameter	8000	m	0.001	10.1	New	50	Rigid HGV	0.004	0.198	28.2	0.2	0.0	0.0
Filter Drain Virgin Filter Material	150mm internal diameter	8000	m	0.657	5,258.6	New	50	Rigid HGV	0.005	0.198	42.1	104.3	0.0	0.0
Filter Drain Pipe	250mm internal diameter	1315	m	0.003	3.9	New	50	Rigid HGV	0.008	0.198	10.9	0.1	0.0	0.0
Filter Drain Virgin Filter Material	250mm internal diameter	1315	m	0.776	1,020.3	New	50	Rigid HGV	0.006	0.198	6.3	20.2	0.0	0.0
Filter Drain Pipe	300mm internal diameter	1545	m	0.005	7.4	New	50	Rigid HGV	0.013	0.198	0.1	0.1	0.0	0.0
Filter Drain Virgin Filter Material	300mm internal diameter	1545	m	0.829	1,281.3	New	50	Rigid HGV	0.007	0.198	8.5	25.4	0.0	0.0
Carrier Drain (HDPE pipe)	150mm internal diameter	415	m	0.001	0.5	New	50	Rigid HGV	0.004	0.198	0.0	0.0	0.0	0.0
Carrier Drain (HDPE pipe)	250mm internal diameter	350	m	0.003	1.0	New	50	Rigid HGV	0.008	0.198	0.0	0.0	0.0	0.0
Carrier Drain (HDPE pipe)	300mm internal diameter	610	m	0.005	2.9	New	50	Rigid HGV	0.013	0.198	0.0	0.1	0.0	0.0
Carrier Drain (HDPE pipe)	375mm internal diameter	1740	m	0.007	11.9	New	50	Rigid HGV	0.019	0.198	0.2	0.2	0.0	0.0
Carrier Drain (HDPE pipe)	450mm internal diameter	1085	m	0.010	10.3	New	50	Rigid HGV	0.027	0.198	0.3	0.2	0.0	0.0
Carrier Drain (HDPE pipe)	600mm internal diameter	135	m	0.017	2.3	New	50	Rigid HGV	0.048	0.198	0.1	0.0	0.0	0.0
Chamber, 1200x1250mm		324	no#	2.150	696.6				0.467		325.0		0.0	0.0
													0.0	0.0
													0.0	0.0
										TOTAL:	421.8	151.0		

0.0%	Embodied emissions avoided due to re-use of materials:	0.0
0.0%	Embodied emissions avoided due to using recycled materials:	0.0

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit
Precast concrete gully	30	no#
Grouting of existing drainage pipes (225mm)	200	m

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

600mm carrier pipes used instead of designed 525mm pipes.
Assumption is made that there will be gullies along the approaches to the roundabouts and within the roundabouts themselves.

Series 0600: Earthworks - Main line (design data)

Total emissions: 0.0 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Excavation • Fill • Disposal of material • Geotextiles • Top soiling • Formation/ sub-formation • Gabion/ Crib Walling • Transport distances • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user*	• Removal of disused structures • Backfilling disused structures • Lining of watercourses • Supports • Clearing • Ground Improvement • Ground Anchorages • Instrumentation and Monitoring • Ground water lowering • Trial pits	• Processing of unacceptable material • Compaction • Soil Stabilisation • Breaking up redundant pavements and slabs • Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials and Transport

Material	Specification	Destination of excavated materials	Quantity (see unit)	Unit	Density (t/m^3 or m^2)	Tonnes	Distance (source-site) (kilometres)	Mode	Tonne-kilometres	Emission factors tCO_2e/t	Emission factors $kgCO_2e/t$-km	Embodied emission (tCO_2e)	Transport emission (tCO_2e)	Site-won avoided (tCO_2e)	Recycled avoided (tCO_2e)
Excavated Materials	Top-soil	Reused on-site	44,399	m^3	1.46	64,823.2	0	Rigid HGV	0	0.024	0.198	*1,555.8*	0.0	1,555.8	0.0
Excavated Materials	Soil/ General Fill	Reused on-site	264,537	m^3	1.46	386,224.2	0	Rigid HGV	0	0.024	0.198	*9,269.4*	0.0	9,269.4	0.0
Excavated Materials	Soil/ General Fill	Exported	9,751.6	m^3	1.46	14,237.3	10	Rigid HGV	142,373	0.024	0.198	0.0	*56.5*	0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
												TOTAL:	**0.0**	**0.0**	

0.0%	**Embodied emissions avoided due to using recycled materials:**	0.0
100.0%	**Embodied emissions avoided due to using site-won fill:**	10,825.1

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

It is assumed that all topsoil can be re-used on site. For imported material it is assumed at this stage that the material can be sourced from withni 10km of the site. Volumes are correct as at 14th May 2013. It is assumed that all excavated material will be suitable for re-use.

TRANSPORT **SCOTLAND**
CARBON MANAGEMENT SYSTEM

Road Infrastructure Projects Tool 2011v3.1

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Home	Emissions Summary	Emission Factors	Method of Measurement	User Guide	Links

Project Details	300	400	500	600	700	1100	1200	1300	1400	1500	1600	1700	1800	1900/2000	2100/2300	2400	2500	Waste	Plant & Utilities	Asphalt CO_2

Main line (design data)	Side roads (design data)	Slip roads (design data)	Other (design data)	Construction data

Series 0700: Pavements - Main line (design data)

Total emissions: **9,161.0 tCO_2e**

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Sub-base • Pavement • Regulating course • Surface treatment • Tack coat • Transport distances • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user*	• Repairs and patching • Overbanding	• In situ recycling • Reinstatement of paved areas • Crack and seat • Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials & Transport

Area	Feature	Material	Depth (mm)	Quantity (see unit)	Unit	Density (t/m³ / kg/m²)	Tonnes	Distance (source-site) (kilometres)	Mode	Emission Factors tCO_2e/t	Emission Factors $kgCO_2e/$ t-km	Embodied emission (tCO_2e)	Transport emission (tCO_2e)	Re-use avoided (tCO_2e)	Recycled avoided (tCO_2e)
1	Surface Course	Asphalt, 7% binder content	50	65,093	m²	2.30	7,485.7	30	Rigid HGV	0.081	0.198	606.3	89.1	0.0	0.0
2	Binder Course	Asphalt, 7% binder content	150	65,093	m²	2.30	22,457.1	30	Rigid HGV	0.081	0.198	1,819.0	267.3	0.0	0.0
3	Base Course	Asphalt, 7% binder content	250	65,093	m²	2.30	37,428.5	30	Rigid HGV	0.081	0.198	3,031.7	445.5	0.0	0.0
4	Sub-base	Primary Aggregates	300	65,093	m³	2.24	145,808.3	30	Rigid HGV	0.008	0.198	1,166.5	1,735.5	0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
											TOTAL:	6,623.5	2,537.4		
					0.0%	Embodied emissions avoided due to re-use of materials:						0.0			
					0.0%	Embodied emissions avoided due to using recycled materials:						0.0			

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

Assumed Source Site distance of 10km. Area shown above is total area with side roads combined.

TRANSPORT SCOTLAND CARBON MANAGEMENT SYSTEM

Road Infrastructure Projects Tool 2011v3.1

A737 Dalry Bypass | 23 | July | 2013

Series 1100: Kerbs, Footways and Paved Areas

Total emissions: 157.3 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Kerbs • Channels • Edgings • Combined drainage and kerb blocks • Footways and Paved areas • Transport distances • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user*	• Steps • Street furniture	• Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials and Transport

Feature	Type/ Dimensions	Quantity (see unit)	Unit	Density (t/m^3 or kg/m)	Tonnes	Source	Distance (source-site) (kilometres)	Mode	Tonne-km	Emission Factors tCO_2e/t	Emission Factors $kgCO_2e/t\text{-}km$	Embodied emission (tCO_2e)	Transport emission (tCO_2e)	Re-use avoided (tCO_2e)	Recycled avoided (tCO_2e)
Kerb (concrete)	125mm x 255mm (type K1, K2, K3)	2621	m	2.5	651.2	New	10	Rigid HGV	6,512	0.217	0.198	141.3	2.6	0.0	0.0
Sub-base for footways	200mm thick virgin aggregate	928	m^2	2.2	415.7	New	10	Rigid HGV	4,157	0.008	0.198	3.3	1.6	0.0	0.0
Footways	Asphalt 50mm thick	928	m^2	2.3	80.0	New	10	Rigid HGV	800	0.066	0.198	5.3	0.3	0.0	0.0
Edging	Precast concrete edging, 50 x 150mm (E1)	675	m	2.5	12.7	New	10	Rigid HGV	127	0.217	0.198	2.7	0.1	0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
														0.0	0.0
											TOTAL:	152.7	4.6		

0.0%	Embodied emissions avoided due to re-use of materials:	0.0
0.0%	Embodied emissions avoided due to using recycled materials:	0.0

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

Kerbing assumed at both roundabouts, overbridge and traffic islands.
Footpath construction taken from council guidelines for flexible surfacing (surface rounded up to 50mm, should be 30mm).
Edging assumed around total length of footpath.
All materials are assumed to be new.
Haul route assumed as 10Km.

Series 1200: Traffic Signs and Road Markings

Total emissions: 29.6 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Traffic signs • Road markings (lines and solid area only) • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user notes section*	• Road markings (letters and arrows) • Traffic signals • Crossings • Marker posts • Bollards • Node markers	• Road studs • Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Road Markings

Feature	Type/ Dimensions	Quantity (see unit)	Unit	Density (kg/m^2)	Tonnes	Emission factor (tCO_2e/t)	Embodied emission (tCO_2e)
Road Markings	thermoplastic screed/ spray continuous line 100mm wide	13031	m	6.00	7.8	0.0660	0.5
Road Markings	thermoplastic screed/ spray continuous line 150mm wide	9989	m	6.00	9.0	0.0660	0.6
Road Markings	thermoplastic screed/ spray continuous line 200mm wide	261	m	6.00	0.3	0.0660	0.0
Road Markings	Solid area in thermoplastic	4037	m^2	6.00	24.2	0.0660	1.6
						TOTAL:	2.7

Traffic Signs

Sign Dimensions	Quantity (no#)	Face Source	Posts per sign	Post type	Post Source	Footing Concrete Mix	Mass (tonnes)			Emission Factors (tCO_2e/t)			Embodied emission (tCO_2e)	Sign face re-use avoided tCO2e	Posts re-use avoided tCO2e	Recycling avoided tCO2e
							Face	Posts	Footings	Faces	Posts	Footings				
Sign face $6m^2 < 7m^2$	60	From store (off-site)	3	Coated steel	From store (off-site)	Concrete (15% PFA)	5.67	35.73	194.40	9.2	1.5	0.138	*78.8*	51.9	55.0	1.9
														0.0	0.0	
														0.0	0.0	
														0.0	0.0	
														0.0	0.0	
														0.0	0.0	
														0.0	0.0	
														0.0	0.0	
														0.0	0.0	
														0.0	0.0	
												TOTAL:	26.8			

78.8%	Embodied emissions avoided due to re-use of materials:	107.0
1.4%	Embodied emissions avoided due to using recycled materials:	1.9

Transport of Materials

Material	Distance (source-site) (kilometres)	Predominant mode of transport	Tonne-kilometres	Emission factor ($kgCO_2$/tonne-km)	Total emissions (tCO_2)
Sign face $6m^2 < 7m^2$, 60no#					
				TOTAL:	0.0

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

Road markings are based on the stage 3 design model excluding all new means of access junctions.
Solid area in thermoplastic is assumed to be the red hatching.

Series 1300: Road Lighting Columns and Brackets, CCTV Masts and Cantilever Masts

Total emissions: 63.5 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Lighting columns • Foundations • Transport distances • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user notes section*	• Wall mountings	• CCTV Masts • Cantilever Masts • Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials and Transport

Feature	Column height (m)	Quantity (see unit)	Unit	Concrete Foundation Specification		Tonnes	Source	Distance (source-site) (kilometres)	Mode	Tonne-kilometres	Emission factors		Embodied emission (tCO_2e)	Transport emission (tCO_2e)	Re-use avoided (tCO_2e)	Recycled avoided (tCO_2e)
											tCO_2e/t	$kgCO_2e$/ t-km				
Jerol or equivalent lighting column	12	33	no#	6/8 MPa	0% PFA/GGBS	4.0	New	45	Rigid HGV	182.1	9.160	0.198	37.1	0.1	0.0	0.0
Jerol or equivalent lighting column	10	29	no#	6/8 MPa	0% PFA/GGBS	2.7	New	45	Rigid HGV	123.0	9.160	0.198	25.0	0.0	0.0	0.0
Galvanised steel lighting column	5	17	no#	6/8 MPa	0% PFA/GGBS	0.8	New	45	Rigid HGV	36.9	1.540	0.198	1.3	0.0	0.0	0.0
															0.0	0.0
															0.0	0.0
															0.0	0.0
															0.0	0.0
															0.0	0.0
															0.0	0.0
															0.0	0.0
															0.0	0.0
															0.0	0.0
															0.0	0.0
															0.0	0.0
															0.0	0.0
												TOTAL:	63.4	0.1		

0.0%	Embodied emissions avoided due to re-use of materials:	0.0
0.0%	Embodied emissions avoided due to using recycled materials:	0.0

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

Assume total road length is 1.5km, with columns every 25m = 1500/25 = 60 columns
Assume 60 columns at 15m total length - this can be changed to the actual height once known
Also assumed pre-cast foundations used for all lighting columns

Note - precast foundations not recording benefits of replacement materials JF 27-2-12

Series 1400: Electrical Work for Road Lighting and Traffic Signs

Total emissions: 22.3 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Cable • Duct • Transport distances • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user notes section*	• Locating buried cable • Joints and terminals • Feeder pillars • Earth electrodes	• Chambers • Trench for Cable • Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials and Transport

Feature	Cable s.a. (mm^2)/ duct Ø (mm)	Quantity (see unit)	Unit	Source	Copper Cable			Cable Sheath/ Ducting			Distance (source-site) (kilometres)	Mode	$kgCO_2/t$-km	Embodied Emission (tCO_2e)	Transport emission (tCO_2e)	Re-use avoided (tCO_2e)
					Density (t/m^3)	Tonnes	e.f. (tCO_2e/t)	Density (t/m^3)	Tonnes	e.f. (tCO_2e/t)						
2 core copper cable	6	2872	m		8.600	0.44	2.710	1.380	0.07	3.179	45	Rigid HGV	0.198	1.43	0.01	0.0
2 core copper cable	10	640	m		8.600	0.17	2.710	1.380	0.03	3.179	45	Rigid HGV	0.198	0.53	0.00	0.0
UPVC duct x1	100	3512	m					1.380	7.23	2.789	45	Rigid HGV	0.198	20.17	0.13	0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
																0.0
														22.1	**0.14**	
							0.0%	**Embodied emissions avoided due to re-use of materials:**						0.00		

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

TRANSPORT **SCOTLAND**
CARBON MANAGEMENT SYSTEM

Road Infrastructure Projects Tool 2011v3.1

A737 Dalry Bypass | 23 | July | 2013

Home	Emissions Summary	Emission Factors	Method of Measurement	User Guide	Links

Project Details	300	400	500	600	700	1100	1200	1300	1400	1500	1600	1700	1800	1900/2000	2100/2300	2400	2500	Waste	Plant & Utilities	Asphalt CO_2

Series 1600: Piling and Embedded Retaining Walls

Total emissions: 622.2 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Piles • Pile walls • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user notes section*	• Plant (Piling and embedded wall)	• Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials

Type	Diameter (mm)	Quantity (see unit)	Unit	Source	Volume (m³)	Concrete				Steel				Plastic	Embodied emission (tCO_2e)	Steel emission tCO2	Concrete emission tCO2	Cement substitution avoided tCO2	Steel recycling avoided tCO2
						Specification		Tonnes	e.f. (tCO_2e/t)	% recycled content Actual	% recycled content Typical	Tonnes	e.f. (tCO_2e/t)	Tonnes					
Augured piles (in-situ concrete)	1200	1000	m	New	1,131.0	32/40 MPa	25% GGBS	2,714.3	0.133	24.0%	100.0%	113.1	2.309	N/A	622.2	261.2	361.0	81.4	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
																0.0	0.0	0.0	0.0
														TOTAL:	622.2				

0.0%	Embodied emissions avoided due to re-use of materials:	0.0
11.6%	Embodied emissions avoided due to using recycled materials:	81.4

Transport of Materials

Material	Distance (source-site) (kilometres)	Predominant mode of transport	Tonne-kilometres	Emission factor ($kgCO_2e$/tonne-km)	Total emissions (tCO_2e)
Augured piles (in-situ concrete), 1200mm, 1000no#					
				TOTAL:	0.0

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

Series 1700: Structural Concrete - Design data

Total emissions: 2,486.4 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• In situ concrete • Precast concrete • Reinforcement • Transport distances • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user notes section*	• N/A	• Surface finishing • Prestressing for structures • Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials

Structure reference [user defined]	Feature	Mix	Cement Substitution	Recycled aggregates/ Re-used timber (%)				Quantity (see unit)	Unit	Density (t/m^3)	Tonnes	Emission factor (tCO_2e/t)	Embodied Emission (tCO_2e)	Cement substitution avoided tCO2	Timber recycling avoided tCO2
				Actual	Standard	Good	Best								
Blair Rd Overbridge Deck	Concrete	32/40 MPa	25% GGBS	24.0%	24%	30%	44%	684	m^3	2.40	1,641.6	0.133	218.3	49.2	0.0
Blair Rd Overbridge Abutments	Concrete	32/40 MPa	25% GGBS	24.0%	24%	30%	44%	114	m^3	2.40	273.6	0.133	36.4	8.2	0.0
Blair Rd Overbridge Piers	Concrete	32/40 MPa	25% GGBS	24.0%	24%	30%	44%	226	m^3	2.40	542.4	0.133	72.1	16.3	0.0
Blair Rd Overbridge Pier Bases	Concrete	32/40 MPa	25% GGBS	24.0%	24%	30%	44%	65	m^3	2.40	156.0	0.133	20.7	4.7	0.0
Blair Rd Overbridge Abut. Bases	Concrete	32/40 MPa	25% GGBS	24.0%	24%	30%	44%	54	m^3	2.40	129.6	0.133	17.2	3.9	0.0
Blair Rd Overbridge Wingwalls	Concrete	32/40 MPa	25% GGBS	24.0%	24%	30%	44%	70	m^3	2.40	168.0	0.133	22.3	5.0	0.0
Blair Rd Overbridge WW Bases	Concrete	32/40 MPa	25% GGBS	24.0%	24%	30%	44%	24	m^3	2.40	57.6	0.133	7.7	1.7	0.0
Blair Rd Overbridge	Steel Reinforcement				100%	100%	100%	266	t	7.80	266.0	0.720	191.5	0.0	0.0
Blair Rd Overbridge	Formwork (timber)			50.0%	N/A	N/A	N/A	36	t	0.54	36.0	0.225	8.1	0.0	8.1
Viaduct Deck, Abutments & Piers	Concrete	32/40 MPa	25% GGBS	24.0%	24%	30%	44%	3119	m^3	2.40	7,485.6	0.133	995.6	224.6	0.0
Viaduct Pier & Abutment Bases	Concrete	32/40 MPa	25% GGBS	24.0%	24%	30%	44%	476	m^3	2.40	1,142.4	0.133	151.9	34.3	0.0
Viaduct Footway infill	Concrete	20/25 MPa	25% GGBS	24.0%	24%	30%	44%	448	m^3	2.40	1,075.2	0.104	111.8	30.1	0.0
Viaduct	Steel Reinforcement				100%	100%	100%	713.5	t	7.80	713.5	0.720	513.7	0.0	0.0
Viaduct	Formwork (timber)			50.0%	N/A	N/A	N/A	153.25	t	0.54	153.3	0.225	34.5	0.0	34.5
														0.0	0.0
												TOTAL:	2,402.0		
				14.9%				Embodied emissions avoided due to re-use of materials:					420.6		

Transport of Materials

Material	Distance (source-site) (kilometres)	Predominant mode of transport	Tonne-kilometres	Emission factor ($kgCO_2e$/tonne-km)	Total emissions (tCO_2e)
Blair Rd Overbridge Deck, Concrete, 684 m^3	14	Rigid HGV	22,982.4	0.19838	9.1
Blair Rd Overbridge Abutments, Concrete, 114 m^3	14	Rigid HGV	3,830.4	0.19838	1.5
Blair Rd Overbridge Piers, Concrete, 226 m^3	14	Rigid HGV	7,593.6	0.19838	3.0
Blair Rd Overbridge Pier Bases, Concrete, 65 m^3	14	Rigid HGV	2,184.0	0.19838	0.9
Blair Rd Overbridge Abut. Bases, Concrete, 54 m^3	14	Rigid HGV	1,814.4	0.19838	0.7
Blair Rd Overbridge Wingwalls, Concrete, 70 m^3	14	Rigid HGV	2,352.0	0.19838	0.9
Blair Rd Overbridge WW Bases, Concrete, 24 m^3	14	Rigid HGV	806.4	0.19838	0.3
Blair Rd Overbridge , Steel Reinforcement, 266 t	65	Artic HGV	17,290.0	0.08665	3.0
Blair Rd Overbridge, Formwork (timber), 36 t	40	Rigid HGV	1,440.0	0.19838	0.6
Viaduct Deck, Abutments & Piers, Concrete, 3119 m^3	14	Rigid HGV	104,798.4	0.19838	41.6
Viaduct Pier & Abutment Bases, Concrete, 476 m^3	14	Rigid HGV	15,993.6	0.19838	6.3
Viaduct Footway infill, Concrete, 448 m^3	14	Rigid HGV	15,052.8	0.19838	6.0
Viaduct, Steel Reinforcement, 713.5 t	65	Artic HGV	46,377.5	0.08665	8.0
Viaduct, Formwork (timber), 153.25 t	40	Rigid HGV	6,130.0	0.19838	2.4
				TOTAL:	84.4

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit
	8	no

Series 1800: Steelwork for Structures - Design data

Total emissions: 2,558.0 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Fabrication of steelwork • Erection of steelwork • Transport distances • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user notes section*	• N/A	• Miscellaneous metalwork • Corrugated steel buried structures • Metal facing units • Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials and Transport

Structure reference [user defined]	Material	Recycled content (%)		Quantity (see unit)	Unit	Distance source-site (kilometres)	Transport mode	Tonne-kilometres	Emission factors		Embodied emission (tCO_2e)	Transport emission (tCO_2e)	Recycling avoided tCO2	Re-use avoided tCO2
		Actual	Typical						tCO_2e/t	$kgCO_2e$/ tonne-km				
Viaduct	Steel plate		0.0%	1473.3	t	440	Artic HGV	648,252	1.660	0.087	2,445.7	112.3	0.0	0.0
													0.0	0.0
													0.0	0.0
													0.0	0.0
													0.0	0.0
													0.0	0.0
													0.0	0.0
													0.0	0.0
													0.0	0.0
													0.0	0.0
													0.0	0.0
													0.0	0.0
													0.0	0.0
													0.0	0.0
													0.0	0.0
											2,445.7	112.3		

0.0%	Embodied emissions avoided due to re-use of materials:	0.0
0.0%	Embodied emissions avoided due to using recycled materials:	0.0

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

Series 1900 & 2000: Protection of Steelwork & Waterproofing for Concrete Structures

Total emissions: 58.8 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Waterproofing • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user notes section*	• N/A	• Surface impregnation of concrete • Removal of existing waterproofing • Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials

Protection/ Waterproofing system	Quantity	Unit	Emission factor ($kgCO_2e/m^2$)	Embodied Emission (tCO_2e)
Bitumen emulsion	5520	m^2	10.651	58.8
			TOTAL:	58.8

The emission factor for bitumen emulsion is taken from the Hutchins' 2010 UK Building Blackbook. Specific emission factors for waterproofing systems used on roads are currently unavailable.

Transport distances are not required for waterproofing systems.

Embodied emission factors are currently unavailble for protective systems for structural steelwork. Any system used should be listed in the 'other materials' table.

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit
	387	m2

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

Series 2100 & 2300: Bridge Bearings & Bridge Expansion Joints and Sealing of Gaps

Total emissions: 11.0 tCO_2e

(A) Record	*(B) Do not record*	*(C) List as sundry items*
• Sealing of gaps • Expansion Joints • *Where exact matches for specified items are not available a close match can be used, this should be recorded in the user notes section*	• N/A	• Any items not provided for by the input tables and not listed in column (B) 'Do not record'

Materials

Feature	Type	Quantity	Unit	Emission factor (tCO_2e/m)	Embodied emission (tCO_2e)	Assumptions
Expansion joint	Expansion joint	41.5	m	0.2651	11.003	Modelled as 150 x 600 mm rubber joint with steel support (12 kg/m)
				TOTAL:	**11.003**	

Other Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

Series 2500: Special Structures

Total emissions: **0.0 tCO_2e**

Series 2500 is not included in the Roads Project Tool carbon calculations due to the complexity of elements within this series. Any simple items such as steelwork, concrete and associated earthworks should be recorded in another relevant series if available (e.g. series 1700). This should be recorded in the user notes section.

Materials

(List any significant materials not available in the tool in this table. Note: if an material does not have an exact match in the drop down options but does have a close match use this and note this in the user notes section instead than listing it in the section). Non-material items and minor components do not need to be recorded.

Description	Quantity	Unit
Culverts (pipe/box), various sizes	5	no#
Concrete headwalls, various sizes	20	no#
Discharge cascade	1	no#
Concrete drainage channel	140	m

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

Only new culverts accounted for in this assessment. No allowance made for potentail replacement of existing culverts.
There are 15 SuDS associated headwalls required in the design. Allowance is also made for other headwalls (i.e. earthworks ditch outfalls).

Project Waste (design data) - including site clearance

Total emissions: **56.5 tCO_2e**

Design Waste

- Complete based on series 200 for site clearance and all other series for 'take down and remove to... store/tip items'
- Table will auto-populate for series 600 excavated materials and series 700 road planings.

SHW Series	Waste Description	Waste management/ treatment	Total quantity (tonnes)	Distance to destination (kilometres)	Predominant mode of transport	Emission Factor $kgCO_2e/t\text{-}km$	Transport emissions tCO_2e	User Notes (add extra information on waste destination/ treatment)
600	Excavated Materials	Exported	14,237.3	10.0		0.198	56.5	
700	Road Planings	Exported	0.0				0.0	
						TOTAL:	56.5	

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

Plant, Site Vehicles and Site Utilities (construction data)

Total emissions: **824.393 tCO_2e**

Plant, Site Vehicles and Site Utilities

- Complete the table below from the contractor data template summary.
- Details should be entered for site utilities, site vehicles and plant items.
- Where data has been recorded as a bowser total enter the fuel bowser as a plant item and the total fuel consumption in the corresponding column.
- Plant items recorded which have been fuelled from this bowser should be transferred from the data template but with the fuel consumption column left blank.

Site Utilities

Item Description	Quantity	Unit	Emission Factor $kgCO_2e$/unit	Emission (tCO_2e)
Electricity supplied (metered)	780,000.0	kWh	0.5246	409.204
Gas supplied (metered)	0.0	kWh	0.1836	0.000
Water supplied/ imported (metered)	39.0	m^3	0.3400	0.013
Petrol for generators	1,000.0	litres	2.3117	2.312
Diesel for generators	19,500.0	litres	2.6676	52.018
Bottled gas (propane or butane)	50.0	kg	2.7076	0.135
Water directly abstracted (metered)	0.0	m^3	0.0000	0.000
			TOTAL:	**463.682**

Site Vehicles (including traffic management vehicles)

Vehicle Make/ Model	Vehicle Purpose (e.g. recovery vehicle, traffic management, general)	Defra Vehicle Class	Distance travelled to site (kilometres)	Total kilometres in use	Vehicle emission factor $kgCO_2e$/km	Emissions	
						In Use tCO_2e	Transport to site tCO_2e
6 No. Ford Mondeo	General Staff	Car, Diesel, 1.7-2.0l	450.0	175,500.0	0.181	31.757	0.081
4 No. Range Rover Defender	Site Staff	LGV, Diesel, 1.74-3.5t	200.0	78,000.0	0.270	21.069	0.054
Pick - Up	Recovery	LGV, Diesel, 1.74-3.5t	150.0	58,500.0	0.270	15.802	0.041
Flat Bed	Recovery	HGV, Rigid, >17t	150.0	58,500.0	0.964	56.403	0.145
4No. Pick - Up	TM	LGV, Diesel, 1.74-3.5t	800.0	312,000.0	0.270	84.275	0.216
2No. Flat Bed	TM	HGV, Rigid, >17t	400.0	156,000.0	0.964	150.409	0.386
					Totals tCO_2	**359.714**	**0.922**

Plant

Plant Item/ Description (Type/ make model)	Fuel Type	Distance travelled to site (kilometres)	Total hours in use	Average hourly fuel consumption (litres)	Total fuel consumption (litres)	Fuelled from bowser?	Emission Factors		Emissions	
							Fuel $kgCO_2e$/litre	Transport $kgCO_2e$/km	Fuel tCO_2e	Transport tCO_2e
Fuel Bowser (if used)	Diesel (100% mineral)						2.6676			
4No. Hydraulic Excavators (Large)	Diesel (100% mineral)	30	6,400.0	20.0	128,000.0	yes	2.6676	0.2496	0.000	0.007
2No. Hydraulic Excavators (Medium)	Diesel (100% mineral)	30	3,900.0	10.0	39,000.0	yes	2.6676	0.2496	0.000	0.007
2No. Hydraulic Excavators (Mini)	Diesel (100% mineral)	30	2,000.0	5.0	10,000.0	yes	2.6676	0.2496	0.000	0.007
3No. Dozers / Scrapers	Diesel (100% mineral)	30	5,850.0	35.0	204,750.0	yes	2.6676	0.2496	0.000	0.007
2No. Mobile Crane	Diesel (100% mineral)	30	1,000.0	8.5	8,500.0	yes	2.6676	0.2496	0.000	0.007
1No. Crawler Crane	Diesel (100% mineral)	30	500.0	8.0	4,000.0	yes	2.6676	0.2496	0.000	0.007
6No. Dump Trucks	Diesel (100% mineral)	30	19,500.0	25.0	487,500.0	yes	2.6676	0.2496	0.000	0.007
4No. Rollers	Diesel (100% mineral)	30	12,000.0	7.6	91,200.0	yes	2.6676	0.2496	0.000	0.007
2No. Backhoes (JCB 3CX)	Diesel (100% mineral)	30	7,800.0	7.5	58,500.0	yes	2.6676	0.2496	0.000	0.007
Paver (Bitelli BB650)	Diesel (100% mineral)	30	1,000.0	16.0	16,000.0	yes	2.6676	0.2496	0.000	0.007
								Totals tCO_2	0.000	0.075

User Notes

Please use this section to clearly state any assumptions made in the data entry tables (use 'alt' + 'enter' to drop a line).

Asphalt GHG Embodied Emissions Estimator & Pavement Layer Lifecycle Assessment Tool

This page allows users to enter details for custom asphalt mixes, either using external methodologies or the estimating tool below, and provides a pavement layer lifecycle assessment tool to estimate the whole life carbon associated with pavement construction and maintenance.

Asphalt embodied GHG emission factor estimator

Custom Asphalt Mixes

Pavement Layer Lifecycle Assessment Tool

Estimating asphalt embodied GHG emissions

The CMS Road Projects Tool uses default embodied GHG emission factors for asphalt mixes based on their binder contents, mixing temperatures and aggregate densities to estimate the GHG emissions associated with the use of asphalt in building and maintaining the trunk road network

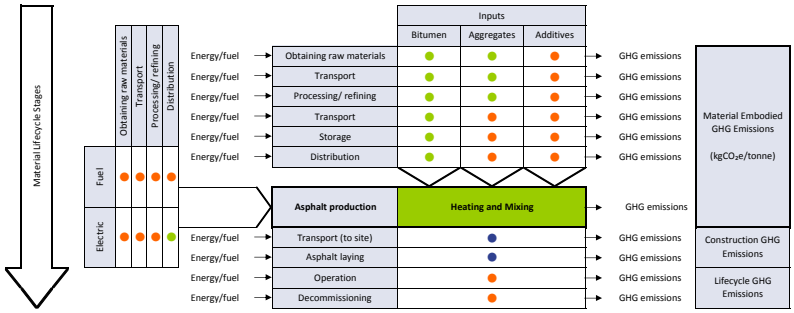
Figure 1 illustrates what is included and excluded from the calculation boundary when deriving this embodied emission factor.

The default data and emission factors and calculation data are shown in Table 1.

The Tool allows users to derive their own embodied GHG emission factors for the asphalt mixes based on the factors defined.

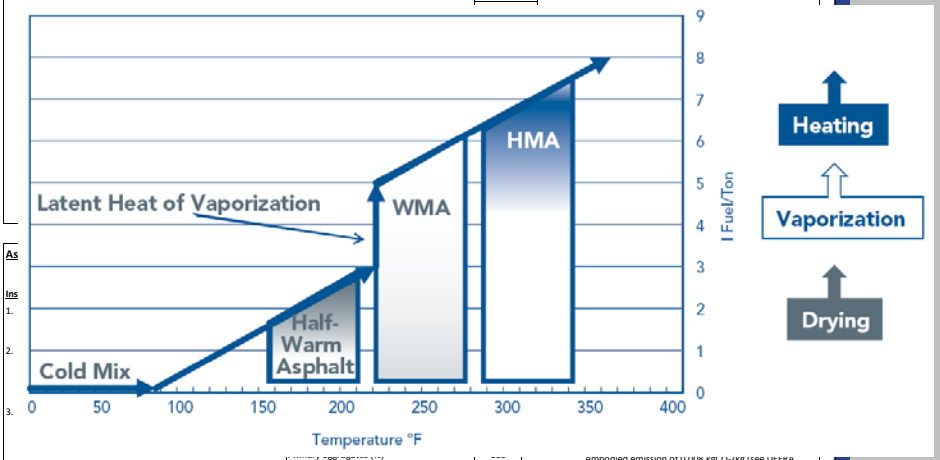
These user defined emission factors can subsequently be selected from the dropdown menu's in Series 700 (at the bottom of each dropdown menu)

Figure 1. Calculation boundaries for calculating asphalt embodied GHG emission factors in the CMS Road Projects Tool



Mixing Temperatures

Included in embodied emission factor



As

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1.

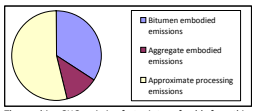
2.

3.

4. Give the aggregate density in tonnes per cubic metre

Aggregate density (t/m³)	0

embodied emission of 0.008 $kgCO_2/kg$ (see DEFRA, Annex 9, Table 9).



Results

For 1 tonne asphalt:

Bitumen embodied emissions	22.0	$kgCO_2e/t$
Aggregate embodied emissions	7.7	$kgCO_2e/t$
Approximate processing emissions	34.6	$kgCO_2e/t$
Total	**64.3**	$kgCO_2e/t$
(cell formula should be '=AG69')	64.3	$kgCO_2e/t$

- Mixing requires approximately 10kWh electrical energy per tonne asphalt (IVL, 2001) (10$kgCO_2e$ uplift added to align to ICE v2.0 emission factors)

5. The resulting GHG emission factor is transferable from this cell:

6. Copy the emission factor from the cell above and paste into the relevant cell to the right (paste as 'values only' using Edit> Paste Special> select 'Values'> click OK.

Edit the mix name if required. Mixes will be available to select in the Series 700 dropdown menus for Base, Binder and Surface courses.

Diesel (100% mineral)

Electric, UK mix

To transfer:
1. Select the pink value cell and copy.

2. Select the appropriate target cell from the custom mix tables.

3. Select Edit > Paste Special > Values and number format > OK

Custom Asphalt Mixes - Emission & Density Factors

Use the table below to enter custom asphalt mixes with custom emission factors and/or density factors. Evidence for calculations should be recorded in the evidence record table below. Emission factors can be calculated using methodologies aligned to PAS 2050, such as asPECT or the estimating tool above.

	Custom mix name	Emission factor		Density factor	
Base	Custom base mix		$kgCO_2e/t$		t/m^3
Binder	Custom binder mix		$kgCO_2e/t$		t/m^3
Surface	Custom surface mix		$kgCO_2e/t$		t/m^3

Evidence Record

Pavement layer	Custom mix name	Data		Evidence (record source of data)
Base		Mixing temperature (°C)		
		Binder content (%)		
		RSA (%)		
		RAP (%)		
		Aggregate density (t/m^3)		
Binder		Mixing temperature (°C)		
		Binder content (%)		
		RSA (%)		
		RAP (%)		
		Aggregate density (t/m^3)		
Surface		Mixing temperature (°C)		
		Binder content (%)		
		RSA (%)		
		RAP (%)		
		Aggregate density (t/m^3)		

Table 1. Default emission factors and calculation data

Mix/ Material	Mixing Temperature (°C)	Embodied GHG ($kgCO_2$/tonne)	References
Virgin Aggregates	N/A	8.00	DEFRA/ DECC GHG Conversion Factors, Annex 9, Table 9b
Recycled Aggregates	N/A	4.00	DEFRA/ DECC GHG Conversion Factors, Annex 9, Table 9b
Bitumen	N/A	550.00	IVL, 2001
Asphalt plant mixing	N/A	27.08	Based on 10kWh electric per tonne (IVL, 2001)
Asphalt plant heating - hot mix	190	19.63	Based on 7.25 litres gas oil per tonne (derived from US, WMA, 2007)
Asphalt plant heating - warm mix	110	12.70	Based on 4.69 litres gas oil per tonne (derived from US, WMA, 2007)
Asphalt plant heating - half-warm mix	90	5.98	Based on 2.21 litres gas oil per tonne (derived from US, WMA, 2007)
Asphalt plant heating - cold mix	ambient	0.00	No heating required

User Notes:

Pavement layer lifecycle assessment tool

The pavement layer lifecycle assessment tool can be used to indicate the embodied and transport GHG emissions associated with materials over a specified pavement lifecycle.

To use the tool enter the details of each pavement layer and it's design life. This should reflect its replacement frequency over the specified pavement life. The tool will enable users to determine the likely optimum pavement design in terms of GHG emissions based on pavement layer replacement frequency. For example, the tool can be used to indicate the benefits of patching versus partial reconstruction versus full reconstruction.

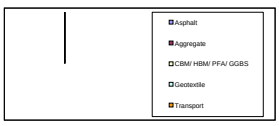
Pavement design life: 40 years

Pavement layer	Thickness	Material specification	Embodied emission factor	Material density	Transport distance	Replacement frequency	Estimated pavement lifecycle emission	mass	materials CO	terials (lc C	transport CO2	transport (lc CO2)	material
Surface course	mm	Not Included in Project	0.000 tCO_2/t	0.00 t/m^3	km	times	0.00 tCO_2/lane-km	0.00	0.00	0.00	0.00	0.00	0.00
Binder course	mm	Not Included in Project	0.000 tCO_2/t	0.00 t/m^3	km	times	0.00 tCO_2/lane-km	0.00	0.00	0.00	0.00	0.00	0.00
Base course	mm	Not Included in Project	0.000 tCO_2/t	0.00 t/m^3	km	times	0.00 tCO_2/lane-km	0.00	0.00	0.00	0.00	0.00	0.00
Sub-base	mm	Not Included in Project	0.000 tCO_2/t	0.00 t/m^3	km	times	0.00 tCO_2/lane-km	0.00	0.00	0.00	0.00	0.00	0.00
Capping	mm	Not Included in Project	0.000 tCO_2/t	0.00 t/m^3	km	times	0.00 tCO_2/lane-km	0.00	0.00	0.00	0.00	0.00	0.00
Geotextile		Not Included in Project	0.000 $kgCO_2/m^2$	0.00 kg/m^2	km	times	0.00 tCO_2/lane-km	0.00	0.00	0.00	0.00	0.00	0.00

Total estimated pavement lifecycle CO_2 emissions based on material embodied emissions and transport of materials: **0.0** **tCO_2/lane-km (over 40 years)**

Detailed Summary:

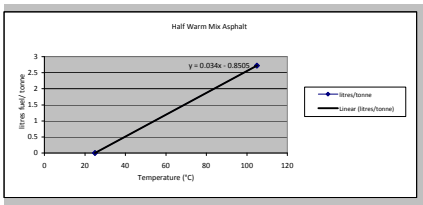
Asphalt	0.00	tCO_2/lane-km
Aggregate	0.00	tCO_2/lane-km
CBM/ HBM/ PFA/ GGBS	0.00	tCO_2/lane-km
Geotextile	0.00	tCO_2/lane-km
Transport	0.00	tCO_2/lane-km
TOTAL	**0.00**	tCO_2/lane-km

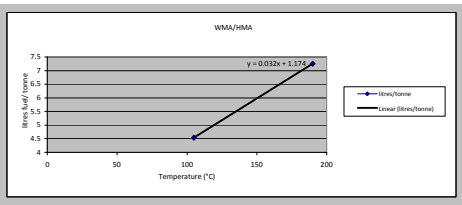


Assumptions:

- lane width = 3.65 m (default = 3.65m)
- density factors set to ICE default unless custom mix specified
- only focuses on pavement materials embodied carbon and their transport, does not include transport of waste or construction plant
- 17t rigid HGV used for all transport, distance doubled to account for return journey

User Notes:





Capping	Primary Aggregates	Cap	Aggregate, Primary	Aggregate, Primary	ag
Capping	Recycled Aggregates	Cap	Aggregate, Secondary	Aggregate, Secondary	ag
Capping	Soil, Cement stabilised @ 5%	Cap	Soil, Cement stabilised @ 5%	Soil, Cement stabilised @ 5%	o
Capping	Soil, Cement stabilised @ 8%	Cap	Soil, Cement stabilised @ 8%	Soil, Cement stabilised @ 8%	o
Capping	Wet Lean Concrete	Cap	Concrete, 6/8 MPa, 0% PFA/G	Concrete, 6/8 MPa, 0% PFA/G	c
Capping	Soil, Fly ash stabilised	Cap	Soil, Fly ash stabilised	Soil, Fly ash stabilised	o
Capping	Soil, GGBS stabilised	Cap	Soil, GGBS stabilised	Soil, GGBS stabilised	o
Capping	Not Included in Project	Cap	N/A	N/A	
Sub-base	Primary Aggregates	Sub	Aggregate, Primary	Aggregate, Primary	ag
Sub-base	Recycled Aggregates	Sub	Aggregate, Secondary	Aggregate, Secondary	ag
Sub-base	Soil, Cement stabilised @ 5%	Sub	Soil, Cement stabilised @ 5%	Soil, Cement stabilised @ 5%	o
Sub-base	Soil, Cement stabilised @ 8%	Sub	Soil, Cement stabilised @ 8%	Soil, Cement stabilised @ 8%	o
Sub-base	Wet Lean Concrete	Sub	Concrete, 6/8 MPa, 0% PFA/G	Concrete, 6/8 MPa, 0% PFA/G	o
Sub-base	Soil, Fly ash stabilised	Sub	Soil, Fly ash stabilised	Soil, Fly ash stabilised	o
Sub-base	Soil, GGBS stabilised	Sub	Soil, GGBS stabilised	Soil, GGBS stabilised	o
Sub-base	Not Included in Project	Sub	N/A	N/A	
Base course	Asphalt, 4% binder content	Bas	Asphalt, 4% binder content	Asphalt, 4% binder content	a
Base course	Asphalt, 5% binder content	Bas	Asphalt, 5% binder content	Asphalt, 5% binder content	a
Base course	Asphalt, 6% binder content	Bas	Asphalt, 6% binder content	Asphalt, 6% binder content	a
Base course	Asphalt, 7% binder content	Bas	Asphalt, 7% binder content	Asphalt, 7% binder content	a
Base course	Asphalt, 8% binder content	Bas	Asphalt, 8% binder content	Asphalt, 8% binder content	a
Base course	Custom base mix	Bas	Custom base mix	Custom base mix	a
Base course	Not Included in Project	Bas	N/A	N/A	
Binder course	Asphalt, 4% binder content	Bin	Asphalt, 4% binder content	Asphalt, 4% binder content	a
Binder course	Asphalt, 5% binder content	Bin	Asphalt, 5% binder content	Asphalt, 5% binder content	a
Binder course	Asphalt, 6% binder content	Bin	Asphalt, 6% binder content	Asphalt, 6% binder content	a
Binder course	Asphalt, 7% binder content	Bin	Asphalt, 7% binder content	Asphalt, 7% binder content	a
Binder course	Asphalt, 8% binder content	Bin	Asphalt, 8% binder content	Asphalt, 8% binder content	a
Binder course	Custom binder mix	Bin	Custom binder mix	Custom binder mix	a
Binder course	Not Included in Project	Bin	N/A	N/A	
Surface course	Asphalt, 5% binder content	Sur	Asphalt, 5% binder content	Asphalt, 5% binder content	a
Surface course	Asphalt, 6% binder content	Sur	Asphalt, 6% binder content	Asphalt, 6% binder content	a
Surface course	Asphalt, 7% binder content	Sur	Asphalt, 7% binder content	Asphalt, 7% binder content	a
Surface course	Asphalt, 8% binder content	Sur	Asphalt, 8% binder content	Asphalt, 8% binder content	a
Surface course	Custom surface mix	Sur	Custom surface mix	Custom surface mix	a
Surface course	Not Included in Project	Sur	N/A	N/A	
Geotextile	Geotextile (polypropylene based) 100 g/m²	Geo	Geotextile (polypropylene bas	Geotextile (polypropylene bas	g
Geotextile	Geotextile (polypropylene based) 250 g/m²	Geo	Geotextile (polypropylene bas	Geotextile (polypropylene bas	g
Geotextile	Geotextile (polypropylene based) 500 g/m²	Geo	Geotextile (polypropylene bas	Geotextile (polypropylene bas	g
Geotextile	Geotextile (polypropylene based) 750 g/m²	Geo	Geotextile (polypropylene bas	Geotextile (polypropylene bas	g
Geotextile	Geotextile (polypropylene based) 1000 g/m²	Geo	Geotextile (polypropylene bas	Geotextile (polypropylene bas	g
Geotextile	Geotextile (coir based) 400 g/m²	Geo	Geotextile (coir based) 400 g/	Geotextile (coir based) 400 g/	g
Geotextile	Geotextile (coir based) 700 g/m²	Geo	Geotextile (coir based) 700 g/	Geotextile (coir based) 700 g/	g
Geotextile	Geotextile (coir based) 900 g/m²	Geo	Geotextile (coir based) 900 g/	Geotextile (coir based) 900 g/	g
Geotextile	Not Included in Project	Geo	N/A	N/A	

Hot ##	7
Wa ##	5
Hal 90	2
Col am	0

Assumptions

- Road plannings are obtained from TS jobs and therefore have a 'zero emission' for this project as emissions from obtaining and processing planings have already been accounted for.
- the energy required to heat and mix 1 tonne of asphalt does not vary with recycled content
- additives are not included because whilst it may be possible to account for their embodied emissions and affect on aggregate:binder ratios their effect on mixing temperatures cannot be accounted for (% usually low)
- the energy required to heat and mix 1 tonne of asphalt does not vary depending on the binder:aggregate ratio
- asphalt is mixed in the UK

Data not used

- planning of 1m³ of asphalt pavement requires 1.7MJ diesel energy (Swedish IVL)
- embodied emission factors for some additives (e.g. PFA, GGBS, lime)

Appendix 12.1

CMS Tool.