

Carmarthenshire County Council

Cross Hands Economic Link Road Phase 2

**WelTAG Stage 2 – Environmental Appraisal
Report**

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Carmarthenshire County Council (CCC) has commissioned Jacobs UK Ltd (Jacobs) to carry out a WelTAG Stage2 environmental appraisal of the three corridor options taken forward from the WelTAG Stage 1 phase of the Cross Hands Economic Link Road Phase 2 (ELR 2).

1.1 Background

The ELR 2 scheme is highlighted within the Regional Transport Plan (South West Wales Integrated Transport Consortium SWWITCH) and will be delivered in three phases. Phase 1 (A48 diamond junction to Black Lion Road) has planning permission and is due to start construction in 2013. ELR 2 is approximately 2km long and connects Black Lion Road and Llandeilo Road. The scheme location is shown on Figure 1.

The scheme objectives for the ELR 2 are:

- *Improve access to the proposed East Strategic Employment Site and other proposed economic developments within Cross Hands and the surrounding area.*
- *Relieve congestion and improve safety on the A48 Cross Hands roundabout which is on a Trans-European Route.*
- *Relieve congestion and improve safety on the A476 Gorslas “six-ways” Junction*
- *Improve journey time reliability through the A48 Cross Hands roundabout and the A476 Gorslas “six-ways” Junction.*
- *Improve safety on the A476 Llandeilo Road as part of the ‘Safer Routes in Communities’ programme.*
- *Improve noise and air quality on the A476 Llandeilo Road.*
- *Support the delivery of the overarching objectives of the Regional Transport Plan.*
- *Facilitate the scheme being delivered in phases.*

1.2 WelTAG

WelTAG is the Welsh Government’s transport planning appraisal guidance and it is applied to all transport strategies, plans or schemes being promoted or requiring funding from the Welsh Government.

The primary purposes of WelTAG are:

- *To assist in the development of proposals to enable the most appropriate scheme to be identified and progressed – one that is focused on objectives, maximises the benefits and minimises the impacts; and*
- *To allow the comparison of competing schemes on a like for like basis, so decision-makers can make difficult funding decisions.*

The WelTAG appraisal is carried out across three sets of criteria: Economy, Environment and Society. Stage 1 of this appraisal, completed in early 2013, concluded that three Route Options should be taken forward for further consideration at WelTAG Stage 2. These are the Orange Route (Option 5), Green Route (Option 6) and Pink Route (Option 7).

1.3 Public and Stakeholder Participation

1.3.1 Statutory Consultees

Building on initial consultation carried out during the WelTAG Stage 1 process, a statutory consultee workshop was held on the 2nd July 2013 with the following attendees:

David Ellar - Natural Resources Wales
Charles Hill – Dyfed Archaeological Trust
Jill Howells - Natural Resources Wales
Isabel Macho - Carmarthenshire County Council Biodiversity Officer
David Watkins - Natural Resources Wales
Bonnie Wiles – Natural Resources Wales
Huw Williams – Natural Resources Wales

1.3.2 Public Consultation

A two day public consultation event was held in May 2013. One day was held at the Gorslas Church Hall on Thursday 2nd May and one day was held at the Gate Community Hall on Friday 3rd May.

There was good attendance at both these sessions and a full summary of community responses is included in the Arup WelTAG 2 stage 2 Appraisal report.

1.4 This Report

The scheme corridor options have been assessed using the WelTAG guidelines (Welsh Assembly Government, 2008) and this report presents the findings of the WelTAG Stage 2 environment appraisal.

The following environment criteria have been used in the appraisal of each of the four corridor options:

- *Noise;*
- *Local Air Quality;*
- *Greenhouse Gas Emissions;*
- *Landscape and Townscape;*
- *Biodiversity;*
- *Soil;*
- *Heritage; and*
- *Water Environment.*

This report only considers the environmental appraisal and must be read in conjunction with the Arup's Cross Hands Economic Link Road Phase 2: WelTAG Stage 2 Appraisal report.

1.4.1 Objectives

This report builds on the information set out in the WelTAG Stage 1 report and provides a fuller appraisal of the options taken forward from Stage 1.

For each of the environmental criteria the existing conditions for the study area were described. Each of the corridor options was appraised in terms of the effects on the environmental criteria and the significance of that effect was set out using the WeITAG seven-point scale.

The environmental significance of each of the corridor options was compared using the appraisal summary tables (AST), together with the results of the other appraisal work (economic and social), to inform the decision as to which corridor options are worth pursuing and funding.

Following the WeITAG Stage 1 Appraisal and further design work on the Scheme three routes have been brought forward for WeITAG Stage 2 Appraisal. These are summarised below, with detailed descriptions included in the Arup WeITAG 2 report and illustrated on Figure 1.

2.1 Orange Route

The Orange Route connects with the Cross Hands Economic Link Road Phase 1B on Black Lion Road. It then is routed in a broadly northerly direction towards the B4556 Norton Road and on towards the A476 Llandeilo Road before the junction of the B4297 Gate Road.

2.2 Green Route

The Green Route connects with the Cross Hands Economic Link Road Phase 1B on Black Lion Road. It then is routed in a broadly northerly direction towards the B4556 Norton Road. From this point it diverges from the Orange corridor and continues north towards an intersection with the B4297 Gate Road where it is then routed north west along Gate Road to its junction with the A476 Llandeilo Road.

2.3 Pink Route

The Pink Route connects with the Cross Hands Economic Link Road Phase 1B on Black Lion Road. It then is routed in a broadly northerly direction towards the B4556 Norton Road. From this point it diverges from the Orange corridor and continues north towards an intersection with the B4297 Gate Road. From here it diverges from the Green Route continuing beyond Gate Road and connects with the A476 Llandeilo Road north of the existing B4297 junction.

3.1 WeITAG Guidelines

This WeITAG stage 2 environment appraisal has been carried out using the Welsh Government Transport Planning Appraisal guidelines (WAG 2008).

The significance of the effects of each corridor option on any environmental topic will be described using the seven point significance scale as shown in Table 3-A. Appendix A provides some examples of how the significance of effect is determined within different topic areas.

Table 3-A *Seven point significance scale used within this appraisal*

Significance of Effect	
Large beneficial	+++
Moderate beneficial	++
Slight beneficial	+
Neutral	0
Slight adverse	-
Moderate adverse	--
Large adverse	---

3.2 Sources of baseline data

The environmental baseline has been created using existing information, generally collated as part of the Cross Hands East Strategic Employment Site (CHESSES) project in 2009/2010 and the WeITAG Stage 1 appraisal data, collected in October 2012.

Subsequent to the WeITAG Stage 1 appraisal, site visits have been undertaken to consider the potential of each option for the topic areas. Where appropriate, data from the area have been recorded and modelled. Individual topic approaches to assessment have been described in each of the respective topic area sections.

Table 3-B below, indicates the sources of baseline data relevant to each of the topic areas at Stages 1 and 2.

Table 3-B Data used within the WelTAG environment stage 2 topic appraisals

Topic	Data	Sources at WelTAG Stage 1	Additional Sources at WelTAG Stage 2
Noise	Sensitive receptors <ul style="list-style-type: none"> Residential Schools 	<ul style="list-style-type: none"> OS Master map data 	<ul style="list-style-type: none"> Additional on site monitoring
Local Air Quality & Greenhouse Gas Emissions	Sensitive receptors <ul style="list-style-type: none"> Residential properties Schools Sites of Special Scientific Interest CO ₂ Emissions calculations based on traffic model	<ul style="list-style-type: none"> OS Master map data Statutory Nature Conservation Sites – CCW (2012 download) Atkins traffic model for the Cross Hands area rerun with the proposed ELR2 corridor options 	<ul style="list-style-type: none"> CCC NO₂ DT monitoring data (2012). APIS deposition rates / Background Concentrations. Defra - National Bias adjustment data (Gradko DT analysis). NO₂ DT monthly concentrations, Gradko UK Ltd Defra UKAIR mapped background concentrations AL2 property layer Emissions database – EFT 5.2.2 for regional assessment.
Landscape & Townscape	Receptors - Residential Contours/Landform Public rights of way Areas of woodland Tree Preservation Orders	<ul style="list-style-type: none"> OS Master map data OS 1:50000 raster data Carmarthenshire County Council data from 2010 CCW All Wales Phase 1 Habitat Survey data (1994) Carmarthenshire County Council - data supplied as part of the CHESSES 2010 assessment 	<ul style="list-style-type: none"> Site Visit August 2013 Deposit Carmarthenshire Local Development Plan 2011 Carmarthenshire County Council Tree Preservation Orders interactive mapping Aerial photos to help determine extent of existing vegetation
Biodiversity	Statutory Nature Conservation Sites Ancient Woodland Inventory Marsh Fritillary habitat Marsh Fritillary records General species records Phase 1 Habitat Survey data	<ul style="list-style-type: none"> CCW (2012 download) CCW data collated as part of ELR phase 1 in 2010 Carmarthenshire County Council Marsh fritillary habitat data collected in 2009 and 2010. Butterfly Conservation provided their 2011 data to Carmarthenshire. West Wales Biodiversity Information Service – collated as part of ELR1 in 2010 and study area updated in 2012 	<ul style="list-style-type: none"> Meetings with CCW (now part of NRW) Further review of CCW All Wales Phase 1 Habitat Survey data (1994) Phase 1 habitat survey of area between Black Lion Road and Norton Road in September 2012. Visit 1 of Dormouse Tube Survey in August 2013

Topic	Data	Sources at WelTAG Stage 1	Additional Sources at WelTAG Stage 2
		<ul style="list-style-type: none"> NBN gateway data collated as part of ELR stage 1 in 2010 CCW All Wales Phase 1 Habitat Survey data (1994) 	
Soil	Envirocheck report including the following data types: <ul style="list-style-type: none"> Agency and Hydrological Geological Industrial Land Use Waste Hazardous Substances 	<ul style="list-style-type: none"> Soil Mechanics 2009 – Cross Hands ELR Desk Study. Includes a Landmark Envirocheck report. Data sources in the Envirocheck report are dated between 1998 and 2008. Ordnance Survey Maps from 1880 	<ul style="list-style-type: none"> No further data obtained
Heritage	<ul style="list-style-type: none"> CADW - Scheduled Ancient Monuments, Listed Buildings, Registered Landscapes and Parks and Gardens; Dyfed Archaeological Trust's (Curatorial Section) Historic Environment Record (HER); Royal Commission on Ancient and Historical Monuments of Wales (RCAHMW) - archaeological sites, areas and historic buildings; Carmarthenshire County Council Conservation Officer - locally listed buildings, listed buildings and conservation areas and historic parks; Countryside Commission for Wales' (CCW) LANDMAP database - 	<ul style="list-style-type: none"> CADW data – collated as part of CHESES assessment in 2010 Dyfed Archaeological Trust HER and RCAHMW – data supplied as part of the CHESES 2010 assessment Carmarthenshire County Council - data supplied as part of the CHESES 2010 assessment Countryside Commission for Wales' (CCW) LANDMAP database – downloaded October 2012 	<ul style="list-style-type: none"> No further data obtained

Topic	Data	Sources at WelTAG Stage 1	Additional Sources at WelTAG Stage 2
	cultural heritage aspect areas		
Water Environment	<p>Contours and landform</p> <p>Envirocheck report including the following data types:</p> <ul style="list-style-type: none"> • Flood map • Groundwater vulnerability • Source Protection Zones 	<ul style="list-style-type: none"> • OS Landform DTM data • Soil Mechanics 2009 – Cross Hands ELR Desk Study. Includes a Landmark Envirocheck report. Data sources in the Envirocheck report are dated between 1998 and 2008. 	<ul style="list-style-type: none"> • Review of data on EA website (now part of NRW) • Review of Water Framework Directive Requirements.

4.1 Noise

4.1.1 Introduction

A quantitative assessment of the potential noise impacts for each of the three routes has been undertaken.

Calculations have been performed for all residential receptors contained within the “calculation area” as defined for a “Simple Assessment” in the *Design Manual for Roads and Bridges, Volume 11, Section 3, Part 7 - Noise and Vibration, Revision 1 – November 2011 (HD 213/11)*. The calculation area included all residential receptors within at least 600 m of the route option and within at least 600 m of any bypassed routes as a result of the route option.

For each route, analysis has been undertaken following the guidance contained in *WeITAG Unit 7.4* (which refers to *WebTAG Unit 3.3.2*). The WebTAG calculation spread sheet provided on the *Department for Transport* website under unit 3.3.2 has been used to determine the Net Present Value (NPV) of noise (in £ over a 60 year period), and the Net Noise Annoyance Change in 15th year of opening (in number of people). These values have been used in order to rank the three route options from best to worst in terms of noise impact.

4.1.2 Existing Conditions

At this stage of the project, no baseline data has been collected. Baseline data will be measured at a later stage of assessment as monitoring locations would be likely to vary for each of the three route options.

For the noise modelling exercise, sensitive residential receptors within the calculation area were selected using Ordinance Survey (OS) Address Layer 2 data. Receptor points have been positioned on the likely worst affected façade of each residential property to carry out a worst case assessment of the noise impact for each corridor option. Existing ground contour data has been obtained from the InterMap Technologies product NextMap Britain 2 m contours.

Predicted noise levels for the Do Minimum situation have been calculated based on the layout of the existing road network, existing traffic flows, percentage of heavy vehicles and vehicle speeds for use in this assessment. All traffic data were provided by Arup for use in this assessment.

4.1.3 Appraisal of Route Options

Noise level predictions have been carried out using the CadnaA noise modelling software package. CadnaA utilises the calculation protocols contained within both the *Calculation of Road Traffic Noise (CRTN)* and *HD 213/11* guidance documents. Predictions have been undertaken for both the Do Minimum (without scheme) and Do Something (with the scheme in place) scenarios, in both the year of opening (2017) and the design year (2032). The calculations take into account factors such as (but not limited to):

- *Predicted 18-hour AAWT traffic flow;*
- *Percentage of heavy vehicles;*
- *Predicted traffic speed (kph);*
- *The vertical and horizontal alignment of the road in relation to the receptor points;*
- *Distance between source and receptor;*
- *Road surfacing type;*
- *Intervening ground type; and*
- *Screening objects such as other buildings/barriers.*

The traffic data for each route option were provided by Arup.

These predicted noise levels have been used to determine the NPV and net noise annoyance change for each of the corridor options.

The calculation sheets have been provided in Appendix B.

(a) Orange Route

Appendix B provides the WelTAG tables “Number of households experiencing ‘without scheme’ & ‘with scheme’ noise levels (given in dBLeq)” for both the Opening and Design Years.

The greatest adverse impacts for this route option are at properties:

- *Near to where the scheme connects to Black Lion Road;*
- *At the rear of some properties on the west side of Gors Ddu Road;*
- *Near to where the scheme connects to A476 Llandeilo Road;*
- *Near to where it crosses Norton Road.*

There are potential noise benefits to properties that are bypassed as a result of the route option, including some properties along:

- *Gors Ddu Road;*
- *Waterloo Road;*
- *Gate Road;*
- *Part of the A476 Llandeilo Road.*

This corridor option has a NPV (a positive value reflects a net benefit (i.e. noise reduction)) of £4,355,971, which is the highest of the three corridor options considered.

It also has a net noise annoyance change in 15th year after opening (positive value reflects an increase in people annoyed by noise) of -92, which is the lowest of the three route options considered.

Based on these values, this route option would result in the highest beneficial noise impact compared to the other two route options considered.

(b) Green Route

Appendix B provides the WelTAG tables “Number of households experiencing ‘without scheme’ & ‘with scheme’ noise levels (given in dBLeq)” for both the Opening and Design Years.

The greatest adverse impacts for this route option are at properties:

- *Near to where the scheme connects to Black Lion Road;*
- *At the rear of some properties on the west side of Gors Ddu Road;*
- *Close to where the corridor option connects to part of Gate Road and part of Llandeilo Road;*
- *Near to where it crosses Norton Road.*

There are potential noise benefits to properties that are bypassed as a result of the route option, including some properties along:

- *Gors Ddu Road;*
- *Waterloo Road;*
- *Part of Gate Road.*

This route option has a NPV of £3,301,125, which is the lowest of the three route options considered.

It also has a net noise annoyance change in 15th year after opening (no. of people) of -70, which is the highest of the three route options considered.

Based on these values, this route option would result in the lowest beneficial noise impact compared to the other route options considered.

(c) Pink Route

Appendix B provides the WelTAG tables "Number of households experiencing 'without scheme' & 'with scheme' noise levels (given in dBLeq)" for both the Opening and Design Years.

The greatest adverse impacts for this route option are at properties:

- *Near to where the scheme connects to Black Lion Road;*
- *At the rear of some properties on the west side of Gors Ddu Road;*
- *Near to where the scheme connects to A476 Llandeilo Road;*
- *Near to where it crosses both Norton Road and Gate Road.*

There are potential noise benefits to properties that are bypassed as a result of the route option, including some properties along:

- *Gors Ddu Road;*
- *Waterloo Road;*
- *Gate Road;*
- *Part of the A476 Llandeilo Road.*

This corridor option has a NPV of £4,284,388, which is marginally less than the highest NPV (which is for the Orange Route).

It also has a net noise annoyance change in 15th year after opening (no. of people) of -90, which is marginally more than that calculated for the Orange Route.

Based on these values, this route option would result in the second highest beneficial noise impact compared to the other route options considered. It is only marginally behind first placed Orange Route.

4.1.4 Summary

Table 4-A provides a summary of the findings for each of the three route options considered.

Table 4-A Summary of Results

Route	NPV (£) - positive value reflects a net benefit (i.e. noise reduction)	Net noise annoyance change - positive value reflects an increase in people annoyed by noise	Ranking
Orange	£4,355,971	-92	1
Green	£3,301,125	-70	3
Pink	£4,284,388	-90	2

Although the Orange Route has been rated as the most beneficial from a noise point of view, the Pink Route follows marginally behind, providing a very similar NPV and net noise annoyance change.

The Green Route is the least beneficial from a noise point of view, as it has a 20-25% lower NPV than the Orange and Pink Routes, with 20-22 more people annoyed compared to the Orange and Pink Routes.

4.2 Local Air Quality

4.2.1 Introduction

This section details the assessment of air quality effects associated with the proposed route options and considers whether the air quality in the locality is suitable for the proposed scheme.

The scheme area is characterised as predominantly residential in a rural area with sensitive receptors located in close proximity to the existing transport network. The proposed route options will cut across undeveloped grassland and are likely to divert traffic away from existing relatively busy areas on the network, and as such has the potential to impact new sensitive receptors.

Two properties are likely to be demolished as a result of the proposed scheme (all options) and as such remove sensitive receptors that may otherwise have been adversely impacted.

There are no Air Quality Management Areas (AQMAs) within the vicinity of the scheme and local air quality is considered to be good.

There are three declared sites of special scientific interest (SSSI) and one proposed (pSSSI) within 200m of 'affected' roads under the proposed route options. These have the potential to be adversely impacted as a result of traffic emissions generated by the proposed route options. On this basis, an assessment of the potential impacts on air quality is presented using the Design Manual for Roads and Bridges (DMRB)¹ screening spread sheet tool.

The key objectives are to assess:

- *Operational Effects (Local and Regional Air Quality): to describe the significance of the potential air quality effects resulting from changes in traffic flow characteristics on the local road network due to the operation of the proposed route options, with due regard for any impacts on the human-health and sensitive vegetation and ecosystems.*

The main pollutants of concern in this assessment are those specified in WelTAG2 guidance associated with vehicle exhaust emissions, nitrogen dioxide (NO₂) and fine particulate matter (PM₁₀).

Air pollution can have both chronic (long term) and acute (short term) adverse effects on health. The main pollutants in vehicle emissions that are of concern in relation to human health are nitrogen dioxide (NO₂) and particulate matter smaller than 10 microns in diameter (PM₁₀; i.e. very small smoke or dust particles, which can penetrate deep into the lungs). NO₂ can cause respiratory problems; PM₁₀ can cause a wide range of health problems, particularly by making existing respiratory and cardiovascular conditions worse.

¹ Design Manual for Roads and Bridges, Volume 11, Section 3, Part 1, HA 207/07

² Welsh Transport Planning and Appraisal Guidance (WelTAG), June 2008.

Emissions of oxides of nitrogen (NO_x) and acid deposition on vegetation can have detrimental impacts on species and habitats, particularly on more nitrogen sensitive ecosystems.

The principal human health receptors considered in this assessment are the residents in properties along roads serving the proposed route options and which meet the DMRB screening criteria for 'affected' roads, outlined below:

- *Road alignment change by 5 m or more; or*
- *Daily traffic flows will change by 1,000 AADT (annual average daily traffic) or more; or*
- *Heavy Duty Vehicles (HDV) flows will change by 200 AADT or more; or*
- *Daily average speed will change by 10 km/hr or more; or*
- *Peak hour speed will change by 20 km/hr or more.*

The ecological sites with potential to be impacted are Caeau Blaen-Yr-Orfa, Caeau Ffos Fach and Caeau Blanenau-Mawr (SSSI) and Gorslas Bog (pSSSI) and are presented in Figure 2.2.

For the pollutants NO₂, NO_x and PM₁₀, the UK Air Quality Objectives (AQOs), Air Quality Standards and the EU Limit Values are all identical. The limit values and objectives of relevance to this assessment are summarised in Table 4-B. The AQOs are health-based standards. They are set at a level to provide protection to the whole population.

Table 4-B Air Quality Objectives

Pollutant	Air Quality Objectives (AQO)		Date to be achieved by
	Pollutant	As measured	
Nitrogen Dioxide (NO ₂) [Impacts on Human Health]	200 µg/m ³ not to be exceeded more than 18 times/yr (99.79th percentile)	1 hour mean	31-12-2005
	40 µg/m ³	Annual mean	31-12-2005
Nitrogen Oxides (NO _x) ^a [Impacts on ecosystems]	30 µg/m ³	Annual mean	19-07-2001
Particulate Matter (PM ₁₀) [Impacts on Human Health]	50 µg/m ³ , not to be exceeded more than 35 times/yr (90.41 th percentile)	24 hour mean	31-12-2004
	40 µg/m ³	Annual mean	31-12-2004

^a for the protection of vegetation and ecosystems

4.2.2 Assessment Methodology

This assessment has been carried out, following guidance detailed in the Design Manual for Roads and Bridges (DMRB)³ and LAQM Guidance (TG(09))⁴ where appropriate.

The key elements of the assessment are listed below:

- *Consideration of relevant Air Quality Review and Assessment (R&A) documents;*

³ Highways Agency, 2007, The Design Manual for Roads and Bridges Volume 11, Section 3, Part 1.

⁴ Defra's Local Air Quality Management Technical Guidance TG(09).

- *Assessment of existing local air quality conditions through a review of air quality monitoring data for the area;*
- *Local air quality assessment for NO₂ and PM₁₀ at human receptors within 200m of affected roads;*
- *Ecological assessment of NO_x concentrations at Designated Sites within 200m of affected roads; and*
- *Regional assessment calculating mass emissions of NO_x, PM₁₀ and carbon dioxide (CO₂).*

This assessment considers the air quality in five scenarios:

- *2012 Baseline scenario (i.e. existing conditions at the start of the assessment);*
- *2017 Interim Opening Year 'without scheme'; and*
- *2017 Interim Opening Year 'with scheme' – Orange Route;*
- *2017 Interim Opening Year 'with scheme' – Green Route;*
- *2017 Interim Opening Year 'with scheme' – Pink Route;*

The study area has been defined based on the air quality scoping criteria in DMRB (HA 207/07) that have been applied to the traffic data produced by the Saturn traffic model. A consistent study area has been applied based on the amalgamation of all qualifying links from each scheme. The traffic network data and 'affected' roads are presented in Figure 2.1.

The local air quality and ecological assessments have been undertaken using the HA's DMRB screening tool (v1.03c). Traffic flow, speed and composition have been used to calculate vehicle emissions on the network. The baseline model (2012) results are compared to local monitoring data and adjusted to match measurements made near the road, which is known as model verification. The calculated adjustment factors are then applied to modelled road concentrations at receptor locations.

In July 2011 Defra published a report⁵ examining the long term air quality trends in NO_x and NO₂ concentrations, which identified that ambient concentrations are not decreasing in the future as is predicted using the current best practice methods of assessment. The consequence of the conclusions of Defra's advice on long term trends is that there is now a gap between current projected vehicle emission reductions and projections on the annual rate of improvements in ambient air quality, which are built into the vehicle emission factors, the projected background maps and the NO_x to NO₂ calculator. To account for this, future year modelling in this assessment utilises baseline year emission factors and background data, which is a conservative approach and will lead to overestimation of predicted impacts.

The background concentrations used in this assessment for NO_x, NO₂ and PM₁₀ have been derived from the Defra maps for 2012⁶ and sector removed (to avoid double counting of modelled traffic emissions), using the NO₂ sector removal tool available from Defra (v.3.2).

Modelled concentrations have been calculated at worst-case representative receptors to determine opening year concentrations at receptors where the maximum concentrations or greatest change in concentration due to the scheme are expected to occur.

⁵ Defra, Trends in NO_x and NO₂ emissions and ambient measurements in the UK, July 2011

⁶ <http://laqm.defra.gov.uk/maps/maps2010.html>

4.2.3 Assessment of Impacts

The WelTAG guidance requires that 7-point scale is used to define the effects of a scheme. There are no specified criteria for the air quality scale, and it is determined on a project by project basis. The criteria for this assessment has therefore been developed based on the Highways Agency's (HA) Interim Advice Note (IAN 174/13)⁷ – 'Updated air quality advice for evaluating significant local air quality effects' and is presented in Table 4-C. This IAN specifies that no significant effect can occur at receptors that are not in exceedance of AQOs.

If there are no receptors in exceedance of AQOs then the WelTAG overall air quality score would be considered to be Neutral. In this event then no further detailed assessment is required, and the effects of the scheme can be determined based on the change in annual mass emissions calculated for the DMRB Regional Assessment.

Table 4-C WelTAG Air Quality Overall Score Definition

Score	Comment
Very large beneficial (positive) effect	Improvement of AQO already above objective or removal of an exceedance at greater than 60 more properties than there are experiencing a worsening in air quality.
Large beneficial (positive) effect	Improvement of AQO already above objective or removal of an exceedance at 31 to 60 more properties than there are experiencing a worsening in air quality.
Moderate beneficial (positive) effect	Improvement of AQO already above objective or removal of an exceedance at 11 to 30 more properties than there are experiencing a worsening in air quality.
Slight beneficial (positive) effect	Improvement of AQO already above objective or removal of an exceedance at 1 to 10 more properties than there are experiencing a worsening in air quality.
Neutral effect	No significant impact can occur if there are no receptors in exceedance of AQOs.
Slight adverse (negative) effect	Worsening of AQO already above objective or creation of a new exceedance at 1 to 10 more properties than there are experiencing improvements in air quality.
Moderate adverse (negative) effect	Worsening of AQO already above objective or creation of a new exceedance at 11 to 30 more properties than there are experiencing improvements in air quality.
Large adverse (negative) effect	Worsening of AQO already above objective or creation of a new exceedance at 31 to 60 more properties than there are experiencing improvements in air quality.
Very large adverse (negative) effect	Worsening of AQO already above objective or creation of a new exceedance at greater than 60 more properties than there are experiencing improvements in air quality.

⁷ HA, Interim Advice Note 174/13 - Updated air quality advice for evaluating significant local air quality effects; for users of DMRB Volume 11, Section 3, Part 1 Air Quality', June 2013

4.2.4 Existing (Baseline) Conditions

The baseline conditions provide a reference level against which any potential change in air quality can be assessed and are used to make a judgment as to whether the scheme area is appropriate for the proposed land use.

Consultation was undertaken with the Council Officer for Local Air Quality Management in Carmarthenshire. The officer confirmed that air quality in the Cross Hands area is considered to be good and there are no Air Quality Management Areas (AQMAs), or measured exceedances of AQOs in the vicinity of the proposed route options or local network. A review of the latest Updating and Screening Assessment, 2012⁸ showed that the county declared an AQMA for annual mean NO₂ in Llandeilo, in 2011 (approximately 10 km east north east of the proposed scheme) and an Air Quality Action Plan (AQAP) is being prepared in accordance with the Local Air Quality Management (LAQM) process.

CCC does not operate any automatic monitoring stations, but is responsible for a network of diffusion tubes across the county.

CCC measurements from diffusion tube sites near the Cross Hands roundabout and Gorslas 6-arm junction (pertinent to this assessment) are summarised in Table 4-D. Monitoring between 2007 and 2012 has been scaled back over this period due to relatively low, reported concentrations.

(a) CCC NO₂ Monitoring

Table 4-D Annual Mean Nitrogen Dioxide Measurements

Tube Location	OS Co-ordinates		Annual mean NO ₂ Concentration (µg/m ³)					
	X	Y	2007	2008	2009	2010	2011	2012
Llandeilo Rd - Cross Hands (carm/060)	256362	212940	25.8	30.4	31.4	36.3	27.4	-
Gorslas – Sixways (carm/061)	257028	213774	18.7	24.3	25.1	24.7	-	-
A48 Cwmgwili (carm/063)	257081	210527	23.3	24.9	25.4	-	-	-
Gorslas – Sixways (2) (carm/092)	257024	213776	-	-		20.5	18.2	-
Llandeilo Rd - Cross Hands (2) (carm/093)	256459	213067	-	-		42.8	43.3	-
Cross Hands - County Cycles (carm/120)	256355	212954	-	-	-	-	24.4	26.5
Cross Hands - 61 Llandeilo Road (carm/121)	256466	213083	-	-	-	-	26.1	25.6

The measurements suggest a relatively static trend in concentrations at each site. Most of the results are well within AQOs. The measured exceedances (in bold type

⁸ 2012 Air Quality Updating and Screening Assessment for Carmarthenshire County Council.

within the table) in 2010 and 2011 were reported at kerbside locations and as such, are not representative of annual mean exposure. Sites 120 and 121 replaced the site ID locations of 60 and 93 and the exceedances were subsequently removed.

(b) Proposed Scheme Diffusion Tube Monitoring

There is no local authority monitoring in the immediate vicinity of the proposed route options. Therefore a six month nitrogen dioxide diffusion tube survey (from January 2013 to June 2013) has been undertaken by Jacobs to inform this assessment. The results are presented in Table 4-E and the site locations are shown in Figure 2.1.

Table 4-E Annualised 6 month Diffusion Tube Monitoring in Vicinity of the Scheme

ID	Tube Location	OS Co-ordinates		Annual Mean (2012) NO ₂ Concentrations (µg/m ³)	Data Capture (%)
		X	Y		
1	Adjacent to 'Oak Tree Cottage'	257342	212745	9.4	83%
2	'Dolwerdd' Black Lion Rd	257555	212942	12.6	83%
3	'Waitaki' Black Lion Rd (B4556)	257757	213562	14.8	100%
4	111 Gate Road (B4279)	258093	214196	11.0	83%
5	185 Gate Rd (B4297)	257824	214616	10.7	100%
6	Opposite Castle Villa 2 (A476)	257930	214867	15.5	100%
7	8 Maesymeillion Flats (A476)	257686	214690	23.1	83%
8	71 Llandeilo Rd (A476)	257303	214139	24.3	100%
9	3 Llandeilo Rd (A476)	257086	213853	28.8	100%
10	Gorslas (pSSSI)	257396	213804	14.3	100%

Bias adjustment was undertaken using the national bias adjustment survey results for the diffusion tube supplier (Gradko, 20% TEA in water). A review of the bias factors from 2002-2012 (from Defra spreadsheet version 07/13) was undertaken. This showed the Gradko bias adjustment factor ranged between 0.90 and 1.0. The maximum bias adjustment factor of 1.0 has been applied to this assessment, which is a conservative approach.

The six months of measured data have been adjusted to represent a 2012 annual mean concentration following guidance in LAQM TG(09) and based on monitoring data taken from urban background locations at Newport, Cwmbran and Cardiff Centre. These produced an annualisation factor of 0.98, which was applied to the measured data.

With the exception of site ID1 (a background site), the monitoring locations are all roadside and are likely to be exposed to greater concentrations than relevant nearby human health receptor locations. Site ID 2, 3 and 7 are positioned close to where the proposed routes will pass. The measured concentrations are well below the AQO of 40.0 µg/m³ and based on this and the other monitoring results, it is concluded that air quality in the vicinity of the proposed scheme is suitable for the change in land-use.

(c) Model Verification

The model results were found to systematically under-predict measured 2012 annual mean concentrations from the NO₂ diffusion tubes in the vicinity of the scheme. In order to remove this under prediction at modelled receptors, adjustment factors for the modelled NO_x road component (3.17) and the modelled NO₂ road component (1.059) were derived following guidance in LAQM TG(09).

In the absence of local PM₁₀ monitoring data for model verification, the modelled NO_x road component adjustment factor has been applied to the modelled PM₁₀ road component.

These model adjustment factors have been applied to the results presented in this report and the appropriate background concentrations applied.

(d) Receptors

Modeling has been undertaken for selected representative human and ecological receptor locations, which are presented in Table 4-F and shown in Figure 2.2.

Table 4-F Sensitive Human Health and Ecological Receptors (ecological receptors in bold)

Site ID	Receptor Name	OS Co-ordinate	
		X	Y
1	61 Llandeilo Road (A476)	256356	212955
2	Landeilo Road (A476)	256991	213702
3	Landeilo Road (A476)/ Gorslas 6-arm Jn	257015	213736
4	3 Llandeilo Road (A476)	257079	213845
5	Landeilo Road (A476)	257275	214118
6	Caeau Blaen-yr-Orfa (SSSI)	257546	214500
7	Landeilo Road (A476)	257630	214640
8	Caeau Blaen-yr-Orfa (SSSI)	257636	214425
9	Landeilo Road (A476)	257712	214676
10	199 Llandeilo Road (A476)	257755	214725
11	Landeilo Road (A476)	258137	214994
12	Llwynyrynn	258128	214730
13	The Hollies' Gate Road (B4297)	257981	214386
14	Gate Road (B4297)	258054	214189
15	Norton Road	257755	213538
16	99 Norton Road	257862	213570
17	51 Norton Road	258457	213691
18	Bridge Street/ Plas-Gwyn Road	258494	213685
19	Black Lion Road	257630	212903
20	Heol Derwen	257589	212774
21	Green Grove	257407	212672
22	Black Lion Road	257730	212819
23	Black Lion Road	257946	212629
24	Bridge Street	258625	213429
25	Gorslas Bog (p SSSI)	257243	213239
26	Gorslas Bog (p SSSI)	257098	213643

Site ID	Receptor Name	OS Co-ordinate	
		X	Y
27	Gorslas Bog (p SSSI)	257497	213760
28	Caeau Ffos Fach (SSSI)	257423	212442
29	Caeau Blaenau-Mawr (SSSI)	258989	212208

The Air Pollution Information System (APIS)⁹ contains data for assessing impacts at habitats. The Gorslas Bog pSSSI is a peat bog, with interest features including mosses and bryophytes. The closest matching habitat class in APIS is 'raised and blanket bogs'.

The Caeau Blaen-yr-Orfa, Caeau Ffos Fach and Caeau Blaenau-Mawr SSSI are notable for their variety of grazed swards, which range from acidic fen-meadow communities dominated by purple moor-grass and meadow thistle *Cirsium dissectum* to drier, more mesotrophic grassland characterized by common knapweed *Centaurea nigra* and crested dog's-tail *Cynosurus cristatus*. The closest matching habitat classes in APIS are 'Moist and wet oligotrophic grasslands' and 'Low and medium altitude hay meadows'.

Table 4-G sets out the critical loads for nitrogen deposition and the site specific deposition rates at respective selected receptors.

Table 4-G Site Specific Critical Loads per Habitat type (www.Apis.ac.uk)

APIS Habitat Class	APIS Habitat Sub Class	Pollutant Deposition	Site specific N deposition	Critical Load
			kg N ha ⁻¹ year ⁻¹	
Bogs	Raised and Blanket Bogs ^a	Nitrogen Deposition	19.9	1 – 3
Acid Grassland	Moist and wet oligotrophic grasslands ^b	Nitrogen Deposition	19.9	8 - 15
Neutral Grasslands	Low and medium altitude hay meadows	Nitrogen Deposition	19.9	20 - 30

^a Table 7.3 Critical Levels for ammonia for the protection of vegetation as referenced within AQTAQ 06 Habitats directive, version 10.

^b Acid grassland carries a more stringent CL and as such is referenced in this assessment.

There are widespread exceedances of critical loads across Wales. The background nitrogen deposition rate is exceeded for the habitat types, Bogs and Acid grassland at the selected receptors. However, HA IAN174/13 guidance states that the effects of the scheme on nutrient nitrogen deposition can be screened out of assessment if the predicted NO_x concentration does not exceed the annual mean AQO (30.0 µg/m³) and increases in modelled NO₂ concentrations at the designated site are not greater than 0.4 µg/m³ as a result of the scheme. The Critical Loads are presented here, for completeness.

Background NO_x concentrations were taken from the Defra background maps.

⁹ www.APIS.ac.uk

4.2.5 Route Options Appraisal – Local Air Quality Assessment (Human Health)

(a) Orange Route

The results of the local air quality modelling are presented for each scenario in Table 4-H for NO₂ and Table 4-I for PM₁₀.

Table 4-H Orange Route - Predicted NO₂ Concentrations at Selected Sensitive Receptors

Receptor	Modelled Concentration (ug/m ³)			
	Base	Without Scheme	With Scheme	Change due to Scheme (with-without)
1	36.7	37.5	36.0	-1.5
2	28.5	24.1	17.5	-6.7
3	29.1	23.8	16.9	-6.9
4	19.2	19.3	13.3	-6.0
5	14.1	14.3	9.6	-4.6
7	16.6	16.8	12.0	-4.8
9	14.8	15.0	15.6	0.6
10	17.2	17.4	17.2	-0.3
11	15.8	16.0	16.0	0.0
12	6.6	6.6	6.6	0.0
13	8.2	8.2	7.4	-0.9
14	7.4	7.4	6.9	-0.5
15	12.3	12.5	12.4	-0.1
16	13.8	13.5	21.8	8.3
17	15.3	15.4	15.5	0.1
18	19.1	20.1	17.4	-2.7
19	13.2	19.3	25.1	5.8
20	8.5	14.1	17.9	3.9
21	8.1	9.9	11.2	1.4
22	13.6	18.0	15.3	-2.7
23	14.9	14.7	15.6	0.9
24	11.0	11.7	9.0	-2.6

Receptors 6,8,25,26,27,28 and 29 are ecological sites and not relevant exposure for NO₂ concentrations.

Table 4-I Orange Route - Predicted PM₁₀ Concentrations at Selected Sensitive Receptors

Receptor	Modelled Concentration (ug/m ³)			
	Base	Without Scheme	With Scheme	Change due to Scheme (with-without)
1	19.9	20.2	19.8	-0.4
2	18.1	17.0	15.6	-1.4
3	17.3	16.0	14.5	-1.5
4	14.7	14.7	13.7	-1.0
5	12.8	12.9	12.1	-0.7
7	13.2	13.3	12.5	-0.8
9	13.0	13.0	13.2	0.1
10	13.4	13.5	13.4	-0.1

Receptor	Modelled Concentration (ug/m ³)			
	Base	Without Scheme	With Scheme	Change due to Scheme (with-without)
11	12.7	12.7	12.7	0.0
12	11.1	11.1	11.1	0.0
13	11.9	11.9	11.7	-0.2
14	11.3	11.3	11.2	-0.1
15	13.7	13.7	13.6	-0.1
16	14.0	13.9	15.7	1.8
17	16.4	16.4	16.4	0.0
18	17.2	17.5	16.8	-0.7
19	13.6	14.9	16.1	1.2
20	12.7	13.7	14.4	0.7
21	12.6	12.9	13.2	0.2
22	13.7	14.7	14.1	-0.6
23	13.9	14.0	14.2	0.2
24	15.5	15.7	15.1	-0.6

Receptors 6,8,25,26,27,28 and 29 are ecological sites and not relevant exposure for PM₁₀ concentrations.

The results show that there are no predicted exceedances of the annual mean AQOs for either NO₂ or PM₁₀ at the modelled worst case receptor locations. Improvements in NO₂ concentration of up to 6.9 ug/m³ are predicted at Receptor 3, and a worsening of up to 8.3 ug/m³ at Receptor 16. The magnitudes of change are considerably smaller for PM₁₀ concentration with a predicted improvement of 1.5 ug/m³ and a worsening of 1.8 ug/m³.

However, because there are no exceedances of the AQOs at any receptor location, the route will have a **neutral** impact on local air quality.

(b) Green Route

The results of the local air quality modelling are presented for each scenario in Table 4-J for NO₂ and Table 4-K for PM₁₀.

Table 4-J Green Route - Predicted NO₂ Concentrations at Selected Sensitive Receptors

Receptor	Modelled Concentration (ug/m ³)			
	Base	Without Scheme	With Scheme	Change due to Scheme (with-without)
1	36.7	37.5	36.2	-1.4
2	28.5	24.1	18.2	-5.9
3	29.1	23.8	17.6	-6.2
4	19.2	19.3	14.3	-5.0
5	14.1	14.3	10.7	-3.5
7	16.6	16.8	12.4	-4.5
9	14.8	15.0	12.8	-2.1
10	17.2	17.4	21.3	3.9
11	15.8	16.0	16.0	0.0
12	6.6	6.6	6.6	0.0
13	8.2	8.2	12.1	3.8

Receptor	Modelled Concentration (ug/m ³)			
	Base	Without Scheme	With Scheme	Change due to Scheme (with-without)
14	7.4	7.4	8.1	0.7
15	12.3	12.5	12.3	-0.2
16	13.8	13.5	21.1	7.6
17	15.3	15.4	15.5	0.1
18	19.1	20.1	17.5	-2.6
19	13.2	19.3	23.5	4.2
20	8.5	14.1	17.5	3.5
21	8.1	9.9	10.8	0.9
22	13.6	18.0	15.2	-2.8
23	14.9	14.7	15.5	0.8
24	11.0	11.7	9.1	-2.6

Receptors 6,8,25,26,27,28 and 29 are ecological sites and not relevant exposure for NO₂ concentrations.

Table 4-K Green Route - Predicted PM₁₀ Concentrations at Selected Sensitive Receptors

Receptor	Modelled Concentration (ug/m ³)			
	Base	Without Scheme	With Scheme	Change due to Scheme (with-without)
1	19.9	20.2	19.9	-0.4
2	18.1	17.0	15.7	-1.3
3	17.3	16.0	14.6	-1.4
4	14.7	14.7	13.9	-0.9
5	12.8	12.9	12.3	-0.6
7	13.2	13.3	12.6	-0.7
9	13.0	13.0	12.6	-0.4
10	13.4	13.5	14.2	0.7
11	12.7	12.7	12.7	0.0
12	11.1	11.1	11.1	0.0
13	11.9	11.9	12.5	0.6
14	11.3	11.3	11.4	0.1
15	13.7	13.7	13.6	-0.1
16	14.0	13.9	15.5	1.7
17	16.4	16.4	16.4	0.0
18	17.2	17.5	16.8	-0.7
19	13.6	14.9	15.8	0.9
20	12.7	13.7	14.3	0.6
21	12.6	12.9	13.1	0.2
22	13.7	14.7	14.1	-0.6
23	13.9	14.0	14.2	0.2
24	15.5	15.7	15.1	-0.6

Receptors 6,8,25,26,27,28 and 29 are ecological sites and not relevant exposure for PM₁₀ concentrations.

The results show that there are no predicted exceedances of annual mean AQOs for either NO₂ or PM₁₀ at the modelled worst case receptor locations. Improvements in NO₂ concentration of up to 6.2 ug/m³ are predicted at Receptor 3, and a worsening

of up to 7.6 ug/m³ at Receptor 16. The magnitudes of change are considerably smaller for PM₁₀ concentration with a predicted improvement of 1.4 ug/m³ and worsening of 1.7 ug/m³.

However, because there are no exceedances of the AQOs at any receptor location, the route will have a **neutral** impact on local air quality.

(c) Pink Route

The results of the local air quality modelling are presented for each scenario in Table 4-L for NO₂ and Table 4-M for PM₁₀.

Table 4-L Pink Route - Predicted NO₂ Concentrations at Selected Sensitive Receptors

Receptor	Modelled Concentration (ug/m ³)			
	Base	Without Scheme	With Scheme	Change due to Scheme (with-without)
1	36.7	37.5	36.0	-1.5
2	28.5	24.1	17.4	-6.8
3	29.1	23.8	16.8	-7.0
4	19.2	19.3	13.2	-6.1
5	14.1	14.3	9.9	-4.3
7	16.6	16.8	11.1	-5.8
9	14.8	15.0	10.4	-4.6
10	17.2	17.4	11.4	-6.1
11	15.8	16.0	12.0	-4.0
12	6.6	6.6	8.4	1.9
13	8.2	8.2	8.7	0.4
14	7.4	7.4	7.4	0.0
15	12.3	12.5	12.8	0.3
16	13.8	13.5	22.4	8.9
17	15.3	15.4	15.5	0.1
18	19.1	20.1	17.5	-2.6
19	13.2	19.3	25.0	5.7
20	8.5	14.1	18.0	3.9
21	8.1	9.9	10.9	1.0
22	13.6	18.0	15.2	-2.8
23	14.9	14.7	15.5	0.8
24	11.0	11.7	9.1	-2.5

Receptors 6,8,25,26,27,28 and 29 are ecological sites and not relevant exposure for NO₂ concentrations.

Table 4-M Pink Route - Predicted PM₁₀ Concentrations at Selected Sensitive Receptors

Receptor	Modelled Concentration (ug/m ³)			
	Base	Without Scheme	With Scheme	Change due to Scheme (with-without)
1	19.9	20.2	19.8	-0.4
2	18.1	17.0	15.6	-1.5
3	17.3	16.0	14.5	-1.5
4	14.7	14.7	13.7	-1.0

Receptor	Modelled Concentration (ug/m ³)			
	Base	Without Scheme	With Scheme	Change due to Scheme (with-without)
5	12.8	12.9	12.2	-0.7
7	13.2	13.3	12.3	-1.0
9	13.0	13.0	12.2	-0.8
10	13.4	13.5	12.4	-1.1
11	12.7	12.7	12.0	-0.7
12	11.1	11.1	11.4	0.3
13	11.9	11.9	12.0	0.0
14	11.3	11.3	11.3	0.0
15	13.7	13.7	13.7	0.0
16	14.0	13.9	15.8	1.9
17	16.4	16.4	16.4	0.0
18	17.2	17.5	16.8	-0.7
19	13.6	14.9	16.1	1.2
20	12.7	13.7	14.4	0.7
21	12.6	12.9	13.1	0.2
22	13.7	14.7	14.1	-0.6
23	13.9	14.0	14.2	0.2
24	15.5	15.7	15.1	-0.6

Receptors 6,8,25,26,27,28 and 29 are ecological sites and not relevant exposure for PM₁₀ concentrations.

The results show that there are no predicted exceedances of the annual mean AQOs for either NO₂ or PM₁₀ at the modelled worst case receptor locations. Improvements in NO₂ concentration of up to 7.0 ug/m³ are predicted at Receptor 3, and a worsening of up to 8.9 ug/m³ at Receptor 16. The magnitudes of change are considerably smaller for PM₁₀ concentration with a predicted improvement of 1.5 ug/m³ and worsening of 1.9 ug/m³.

However, because there are no exceedances of the AQOs at any receptor location, the route will have a neutral impact on local air quality.

4.2.6 Route Options Appraisal – Local Air Quality Assessment (Ecological Designations)

The results of the air quality modelling are presented in Tables 4-N, 4-O and 4-P for the respective route option for annual mean NO_x.

(a) Orange Route

Table 4-N Orange Route – Predicted NO_x Concentrations at Ecological designations

Receptor ID	Distance from receptor boundary* (m)	Modelled NO _x Concentration (ug/m ³)			
		Base	Without Scheme	With Scheme	Change due to Scheme (with-without)
6	0	24.5	24.9	15.4	-9.5
	10	20.1	20.5	13.3	-7.2
	20	16.9	17.2	11.7	-5.5
	30	14.6	14.8	10.5	-4.3
	40	12.8	13.0	9.6	-3.3
8	0	7.4	7.4	19.7	12.2
	10	7.2	7.2	16.6	9.4
25	0	17.4	12.6	11.5	-1.2
	10	15.0	11.4	10.5	-0.9
26	0	9.5	8.8	8.5	-0.3
	10	9.1	8.5	8.2	-0.4
27	0	17.6	18.0	13.9	-4.2
	10	15.2	15.5	12.3	-3.2
28	0	7.7	8.6	8.9	0.3
	10	7.7	8.5	8.7	0.2
29	0	7.4	7.3	7.3	-0.1
	10	7.3	7.3	7.3	-0.1

* Transects points start at the ecological receptor boundary (closest to the road, 0m) and extend at 10m intervals away from the road source. The maximum concentration will occur at 0m.

The majority of sites experience a reduction in NO_x as a result of the orange route option, because traffic flow is diverted onto the orange route option and directed away from the existing network. Concentrations at the SSSIs along the existing network are subsequently reduced. Receptor 8 (Caeau Blaen-yr-Orfa SSSI) is the exception, as the orange route option would bring traffic emissions closer to the eastern part of the SSSI, although concentrations at the northern end of the same SSSI (Receptor 6) are reduced due to the scheme. However, there is no exceedance of the annual mean NO_x AQO (30.0 ug/m³) at any SSSI in any modelled scenario. Therefore significant effects are not predicted, and the overall effect on ecological designations is considered to be neutral.

(b) Green Route

Table 4-O Green Route – Predicted NO_x Concentrations at Ecological designations

Receptor ID	Distance from receptor boundary* (m)	Modelled Concentration (ug/m ³)			
		Base	Without	With	Change due to Scheme (with-without)
6	0	24.5	24.9	16.1	-8.8
	10	20.1	20.5	13.8	-6.7
	20	16.9	17.2	12.1	-5.1
	30	14.6	14.8	10.8	-4.0
	40	12.8	13.0	9.8	-3.1
8	0	7.4	7.4	6.9	-0.5
	10	7.2	7.2	6.8	-0.4
25	0	17.4	12.6	11.3	-1.3
	10	15.0	11.4	10.4	-1.0
26	0	9.5	8.8	8.5	-0.3
	10	9.1	8.5	8.3	-0.3
27	0	17.6	18.0	15.0	-3.0
	10	15.2	15.5	13.2	-2.3
28	0	7.7	8.6	8.9	0.2
	10	7.7	8.5	8.7	0.2
29	0	7.4	7.3	7.3	-0.1
	10	7.3	7.3	7.3	-0.1

* Transects extend away from the road and from the ecological receptor boundary.

There is a predicted reduction in NO_x concentration with green route option at the majority of the ecological receptors. The largest improvement is at Receptor 6 (Caeau Blaen-yr-Orfa SSSI). A slight increase in NO_x is predicted at Receptor 28 (Caeau Ffos Fach SSSI), albeit an imperceptible change.

There is no exceedance of the annual mean NO_x AQO (30.0 ug/m³) at any SSSI in any modelled scenario. Therefore significant effects are not predicted, and the overall effect on ecological designations is considered to be neutral.

(c) Pink Route

Table 4-P Pink Route – Predicted NO_x Concentrations at Ecological designations

Receptor ID	Distance from receptor boundary* (m)	Modelled Concentration (ug/m ³)			
		Base	Without	With	Change due to Scheme (with-without)
6	0	24.5	24.9	14.1	-10.8
	10	20.1	20.5	12.3	-8.2
	20	16.9	17.2	10.9	-6.3
	30	14.6	14.8	9.9	-4.9
	40	12.8	13.0	9.1	-3.8
8	0	7.4	7.4	6.8	-0.6
	10	7.2	7.2	6.7	-0.5
25	0	17.4	12.6	11.4	-1.2
	10	15.0	11.4	10.5	-0.9
26	0	9.5	8.8	8.5	-0.3
	10	9.1	8.5	8.3	-0.2
27	0	17.6	18.0	15.5	-2.6
	10	15.2	15.5	13.6	-1.9
28	0	7.7	8.6	9.2	0.5
	10	7.7	8.5	8.7	0.2
29	0	7.4	7.3	7.3	-0.1
	10	7.3	7.3	7.3	-0.1

* Transects extend away from the road and from the ecological receptor boundary.

A reduction in NO_x with the pink route option is predicted at a majority of sites. The largest improvement is at Receptor 6 (Caeau Blaen-yr-Orfa SSSI). A slight increase in NO_x is predicted at Receptor 28 (Caeau Ffos Fach SSSI), albeit an imperceptible change.

There is no exceedance of the annual mean NO_x AQO (30.0 ug/m³) at any SSSI in any modelled scenario. Therefore significant effects are not predicted, and the overall effect on ecological designations is considered to be neutral.

4.2.7 Regional and Greenhouse Gas Emissions Results

In order to compare the route options, annual mass emissions from traffic for each route have been calculated for the opening year using the Defra's emission factor toolkit (v5.2.2) The results are presented in Table 4-Q, Table 4-R and Table 4-S.

Table 4-Q Annual Emissions of NO_x in the Opening Year

Pollutant	Do Minimum (without scheme)	Orange Route	Green Route	Pink Route
NO _x (kg/yr)	43,756	43,683	43,715	43,766
% change versus DM		0%	0%	0%

A slight reduction in annual mean NO_x emissions is predicted for the Orange route, in contrast to the Green and Pink routes, which show slight increases in NO_x mass

emissions. All of the changes however, equate to less than 1% and are considered to be insignificant in terms of overall impact.

Table 4-R Annual Emissions of PM₁₀ in the Opening Year

Pollutant	Do Minimum (without scheme)	Orange Route	Green Route	Pink Route
PM ₁₀ (kg/yr)	2,933	2,945	2,949	2,955
% change versus DM		0%	1%	1%

All route options predict slight increases in annual mass emissions of PM₁₀. However, the overall changes are considered to be insignificant and equate to less than 1%. The Orange route indicates the smallest increase in emissions.

Table 4-S Annual Emissions of CO₂ in the Opening Year

Pollutant	Do Minimum (without scheme)	Orange Corridor option 5	Green Corridor option 6	Pink Corridor option 7
CO ₂ (tonnes/yr)	14,317	14,319	14,335	14,360
% change versus DM		0%	0%	0%

All route options predicted slight increases in annual mass emissions of CO₂. The smallest increase is predicted for the Orange route. However, the overall changes are less than 1% and considered to be insignificant.

4.2.8 Summary

The predicted concentrations for each of the proposed route options do not cause an exceedance of AQOs for either NO₂ or PM₁₀ at any modelled human receptor or ecological receptor location. It is, therefore, considered that there are no significant effects on local air quality associated with any of the three proposed route options.

The regional assessment indicates that the change in annual mass emissions is similar across each route option, equates to less than 1% of the total emission and is not considered to be significant. The Orange route option would be most beneficial in terms of overall annual mass emissions.

Greenhouse Gas Emissions are predicted to increase slightly with all route options considered, however, the change in mass emissions is less than 1% and is considered to be insignificant.

The overall WelTAG score is therefore considered to be neutral for each of the three route options assessed.

4.3 Greenhouse Gas Emissions

In order to compare the route options, approximate carbon dioxide emissions from traffic for each route option have been calculated for the opening year for comparative purposes, using the DMRB Screening Spread sheet. The results are presented in Table 4-T. All the corridor options show slight increases over the Do Minimum situation.

Table 4-T Greenhouse Gas Emissions in Opening Year (tonnes of CO₂) and Percentage Change against Do Minimum

Pollutant	Do Minimum (DM)	Orange Route	Green Route	Pink Route
CO ₂ (tonnes/yr)	6,500	6,600	6,600	6,600
% change versus DM	0%	1%	2%	1%

4.4 Landscape and Townscape

4.4.1 Introduction

The purpose of this landscape and townscape appraisal is to identify and assess the potential impacts associated with the construction and operation of each of the three proposed route options, and the effects that these options would have on the landscape resource, visual amenity and landscape and townscape character within the study area.

4.4.2 Methodology

The study area has been determined using the extent of the Zone of Visual Influence (ZVI or visual envelope) in the Stage 1 report, which was refined during the Stage 2 landscape and visual field survey undertaken by a Jacobs Landscape Architect on 8th August 2013. The study area is shown on Figures 3.1 and 3.2.

Landscape, townscape and visual impacts have been assessed using data gathered from desk study work, previous studies, aerial photographs, Ordnance Survey data and a photographic record of the site from the field survey.

The assessment has been undertaken in accordance with best practice guidelines¹⁰ and the detailed methodology is available within Appendix C – Landscape and Visual Impact Assessment Methodology. The assessment has been carried out on the route proposals set out in Figure 1.

4.4.3 Assumptions and Limitations

- *No Important Hedgerow information available;*
- *No Definitive Footpath Plan update available since Stage 1 assessment – assumed no change;*
- *The properties listed in the Visual Effects Schedule in Appendix E have not been accessed so views described have been assumed;*
- *The assessment of effects for the Future Year¹¹ has taken into account mitigation vegetation. It has been assumed that the average height of proposed tree and shrub planting would be between 8-10m after 15 years of establishment.*
- *Two footpaths could not be accessed during the site visit and appear to be unused, therefore, they have not been assessed (see Appendix E for more details);*
- *Existing vegetation shown on Figures 3.1 and 3.2, and assessed in this report, is based on aerial photography rather than a detailed survey; and,*
- *The site visit was carried out in summer so winter views considered in the assessment have been assumed.*

¹⁰ Guidelines for Landscape and Visual Assessment, 3rd Edition – Landscape Institute and IEMA Apr. 2013; Natural England/ Scottish Natural Heritage, 2002, Landscape Character Assessment Guidance for England and Scotland; The Welsh Assembly Government, June 2008, Welsh Transport Planning and Appraisal Guidance (WelTAG)

¹¹ 15 years after the Opening Year following establishment of mitigation vegetation.

4.4.4 Baseline Landscape and Townscape Character, Designations and Visual Amenity

This section provides a description of the existing baseline conditions of the site and the surrounding area, from which an assessment of the sensitivity of the landscape resource, character and visual amenity of the area can be determined.

(a) Definitions

The landscape takes its character from a combination of elements, including landform, watercourses, land use and pattern, land cover / vegetation, open space and cultural heritage influences. Landscapes are a key component of the distinctiveness of any local area.

Townscape relates to the physical and social features of the urban environment, hence it applies to built-up areas. Townscapes possess a mix of characteristics and perceptions that make up and contribute to townscape character and give a 'sense of place' or identity.

(b) Topography

The study area undulates in height and forms part of a wider area of rolling hills and localised valleys between the Brecon Beacons, approximately 8km to the east, and the River Loughor valley, 3-4km to the south.

Within the study area, the topography is predominantly higher in the north than in the south. It is noticeably higher on the A476 south of Carmel and on the B4297 north of Llandeilo Road. The topography drops to the south and east into a local stream valley (Afon Lash) before climbing back to a high point in the area around Gorslas on the B4556. A second rolling slope extends to Black Lion Road before continuing to dip further south towards the industrial fringe of Cross Hands on Heol Parc Mawr / Heol Stanllyd.

(c) Hydrology

There are no major watercourses within the study area although there are numerous minor streams and ditches flowing generally in a south westerly direction. The largest streams are Gwendraeth Fawr to the western edge of the study area and Afon Lash to the northern edge. Llyn Llech Owen is a large lake surrounded by coniferous plantation, which is to the north of the study area near the B4297.

(d) Land Cover and Vegetation

The study area has a well vegetated feel with linear native tree belts and hedgerows lining roads and field boundaries (see Figure 3.1). The majority of hedgerows are overgrown and contain hedgerow trees, which provides a sense of enclosure and filters views out of and around the study area. Many of the hedgerows border small pastoral fields, although there is also a large area of open grassland at Gorslas Peat Bog proposed SSSI. There are larger tree belts, woodlands and scrub areas to the north of the study area along stream valleys such as Afon Lash, along the north west ridgeline and around Llyn Llech Owen lake. Some of the woodland blocks are coniferous plantation. There are no Tree Preservation Orders (TPOs) within the study area and the TPOs in the local area are shown on Figure 3.1.

(e) Landscape Pattern

Much of the study area is made up of small, semi regular, pastoral fields bordered by dense hedgerows and hedgerow trees, which creates a strong pattern in the landscape. The pattern is broken up by a large open grassland area at Gorslas Peat Bog proposed SSSI, an open area of proposed development land south of Norton Road (the proposed Parc Emlyn development site), and by the larger woodland blocks and Llyn Llech Owen lake in the north. The landscape pattern is also interrupted by a series of local roads such as Gate Road, Llandeilo Road and Black Lion Road, and their associated linear residential development. The A48 dual carriageway, and industrial buildings along it, is a dominant feature in the landscape less than 1km to the south of the study area.

(f) Public Rights of Way

There are five rights of way within the study area (see Figure 3.2):

- *51/55A/1 Footpath between Black Lion Road and Norton Road;*
- *51/117/1 Footpath between Gors Ddu Road and Norton Road;*
- *31/22A/1 & 50/1/2 & 50/1/1 Footpath between Penygroes Road and Gate Road;*
- *51/50/1 & 51/49/1 & 50/2/2 & 50/3/1 Footpath between Gate Road and Llandeilo Road; and,*
- *50/2/1 & 50/7/2 Footpath north of Llandeilo Road.*

There are two rights of way located just outside of the study area:

- *31/22/1 & 51/52/1 Footpath between Black Lion Road and Grove Hill Park; and,*
- *51/55/1 Footpath between Norton Road and Gate Road.*

National Cycle Route 47 passes approximately 2km to the southwest of the study area. A National Cycle Route network is proposed along the Cross Hands ELR.

(g) Designations and Policy Background

The Deposit Carmarthenshire Local Development Plan 2011 contains the following policies relevant to landscape:

- *Policy SP14 Protection and Enhancement of the Natural Environment – Development should protect and enhance the natural environment. The countryside and landscape should be given due consideration in development proposals;*
- *Policy EQ1 Protection of Buildings, Landscapes and Features of Historic Importance - Proposals should not adversely affect the distinctiveness, character or integrity of the landscape or townscape; and,*
- *Policy EQ6 Special Landscape Areas (SLA) – SLAs are a non statutory designation based on the quality of the landscape. Proposals should be sensitive enough to ensure they make a positive contribution to the landscape and should not have an unacceptable impact on the specific distinctive features or characteristics of the landscape. The Carmarthenshire Limestone Ridge SLA is located less than 1km to the north of the study area.*

The Local Plan also designates an area adjacent to the northern part of the study area as a Country Park. This is Llyn Llech Owain Country Park, which covers the Llyn Llech Owen lake and the surrounding plantation woodland.

There are no National Parks, Areas of Outstanding Natural Beauty, historic parks, gardens and landscapes, conservation areas or heritage coasts within the study area.

The following international and national designations within or close to the study area are discussed further in the Biodiversity section:

- *Caeau Mynydd Mawr Special Area of Conservation;*
- *Caeau Blaen-yr-Orfa Site of Special Scientific Interest (SSSI); and,*
- *Gorslas Bog proposed SSSI.*

(h) Landscape Character

Detailed landscape character datasets are available in Wales for distinct Aspect Areas. These have been compiled by Natural Resources Wales (NRW) (formerly Countryside Council for Wales CCW) and are available on the LANDMAP and NRW websites:

<http://landmap.ccw.gov.uk>

www.naturalresourceswales.gov.uk

The LANDMAP classifications for the study area are summarised in Table 4-U - Table 4-Y below:

Table 4-U Landmap Classification Visual and Sensory

Landmap classification	Visual & Sensory
Aspect Area Name	Cross Hands – Capel Hendre
Aspect Area Classification	Mosaic Rolling Lowland
Aspect Area Code	CRMRTVS277
Description	<p>Area of rolling hills crossed by a network of medium sized roads and the A48 [T] with a strong pattern of recent linear development associated with mining, giving it a suburban character. Between settlements is relatively poor, often wet, rush-dominated grazing land. High hedgerows with some large hedgerow trees are the typical field boundary - often holly-rich.</p> <p>The aspect area is considered of moderate value. The repeated pattern of linear development, alongside un-intensively managed agricultural land and areas of restored open cast land, gives this area a sense of place.</p> <p>*The pink option extends into the very outer edge of the Crwbin ridge, which is classified as mosaic of hillside & scarp slopes and is associated with bracken, heather and rock exposures. (Aspect Area Code: CRMRTVS665). This aspect area is considered of high value due its attractive and varied land cover and views across adjacent valleys.</p>

Table 4-V Landmap Classification Habitat Landscape

Landmap classification	Habitat Landscape
Aspect Area Name	Carmarthen Coalfield
Aspect Area Classification	Mosaic
Aspect Area Code	CRMRTH039
Description	<p>Largely improved agricultural landscape with a high proportion of semi-improved neutral and marshy grasslands supporting notable species, particularly the Marsh Fritillary butterfly. The area is also characterised by fields of generally small size with infrequently managed boundaries often supporting mature trees and frequently associated with small woodlands or areas of scrub.</p> <p>The aspect area is considered of high value, due to the high proportion of neutral and marshy grasslands within the agricultural field pattern, although this habitat is most concentrated in association with land around the SSSI.</p>

Table 4-W Landmap Classification Cultural Landscape

Landmap classification	Cultural Landscape
Aspect Area Name	Gwendraeth Valley & Limestone Belt
Aspect Area Classification	Minerals & mining
Aspect Area Code	CRMRTCL027
Description	<p>Categorised under "Other urban", Cross Hands is a cross roads settlement standing largely north and south of the A48 extension of the M4 and the A476 road from Laugharne to Llandeilo. It also stands at the point where the limestone belt to the north morphs into the anthracite coalfield to the south and south-west. It appears to owe its present cultural character to the result both of improved east-west transport links and to the characteristic nodal regenerative development at significant junctions. There are, for example, business parks containing low-cost food supermarkets, retail warehouses, a small hotel and a small (but expanding) light industrial area. It is a place of limited distinction visually or culturally.</p> <p>The aspect area is considered of moderate cultural value, due to its former coal mining and quarrying heritage. New developments such as the economic link road, would provide inward investment that would be an improving trend, although it must not erode the existing cultural essence.</p>

Table 4-X Landmap Classification Geology

Landmap classification	Geology
Aspect Area Name	Cross Hands / Llyn Lech / Pen-y-groes
Aspect Area Classification	Lowland hills and valleys
Aspect Area Code	CRMRTGL262 / CRMRTGL277 / CRMRTGL278
Description	<p>Lower valley slopes and depressions with glacial clay cover or infill (Quaternary: Pleistocene). Active peat development in basins is widespread.</p> <p>The aspect area is considered of moderate value, with no regionally geological significant sites or landforms within the study area.</p>

Table 4-Y Landmap Classification Historical Landscape

Landmap classification	Historical Landscape
Aspect Area Name	Waun Henllan
Aspect Area Classification	Rural environmental / Agricultural / Irregular Fieldscapes
Aspect Area Code	CRMRTL39563
Description	<p>Categorised using key patterns and elements that include irregular fieldscapes and hedgerow boundaries, exhibiting elements of character from Prehistoric, Medieval (to 1536) and Post Medieval (1536 +) times.</p> <p>The aspect area is considered of outstanding value, due to it being a good example of Carmarthenshire agricultural landscape associated with ancient documentation.</p>
Aspect Area Name	Mynydd Mawr - DE
Aspect Area Classification	Rural environmental / Agricultural / Regular Fieldscapes
Aspect Area Code	CRMRTL39550
Description	<p>This is an area of regularly laid out field enclosures with opencast mining in the northeast corner and a settlement pattern of urban ribbon development along roads through the area. The most significant archaeological elements include coal mining and post medieval settlement.</p> <p>The aspect area is considered of high value, due to it being a good example of Carmarthenshire agricultural landscape associated with ancient documentation.</p>

(i) Townscape Character

The study area is traversed from north to south and east to west by existing road corridors, which are fringed with residential properties and linear ribbon development in Cross Hands and Gorslas. This is consistent with urban growth along transport routes, giving much of the study area settlements a suburban edge character. The style and appearance of properties consists of detached, semi-detached and terraced one or two storey properties, in many different styles including red brick and plain/ painted render with pitched roofs and red brick chimneys. Many residential areas have views out to agricultural fields and scrubland. The properties generally have off street parking, with the exception of terraced housing. There is a mix of different aged housing stock, with some new residential properties along Gate Road and Black Lion Road in particular.

Overhead power lines and street lighting are dominant clutter within the street scene, but hedgerows and existing mature trees are also present in sections along these corridors and occasional vistas or woodland blocks interrupt the built infrastructure.

Listed buildings within the study area are described in more detail within Section 4.7 Heritage.

4.4.5 Zone of Visual Influence

The Zone of Visual Influence (ZVI or visual envelope) is the geographical extent from which the scheme would be visible. In order to determine the Stage 2 ZVI, the Stage 1 ZVI boundary was analysed, which was based on OS data and observations from a preliminary site visit in October 2012. This boundary was adapted to create a ZVI for the three route options (Orange, Green and Pink) being assessed at this stage. This was achieved firstly using OS and aerial photo data and then confirmed during a site visit undertaken in August 2013.

The combined ZVI for the three options is shown on Figure 3.2, which is similar to the one identified at Stage 1.

The ZVI of all three route options covers the same geographic area to the south (between Black Lion Road and Penygroes Road). This geographic area is relatively small as built form, vegetation and falling topography serve to enclose views. Short distance views would be possible from the rear of properties on Black Lion Road with medium distance, filtered views from the rear of properties on Gors Ddu Road.

Further north, (between Penygroes Road and Llandeilo Road) the ZVI of the three route options is slightly different as the routes follow different alignments.

The differing ZVI descriptions for the three routes are described below:

- *Orange Route - The ZVI is largely constrained by rolling topography and existing vegetation, which filter and screen the route corridor. Medium distance views would be possible from the rear of properties along Penygroes Road, with shorter distance (more pronounced) views possible from the rear of properties along Gate Road and from those around the junction with Llandeilo Road. There would also be longer distance views from properties on the B4297.*

- *Green Route - The ZVI is largely constrained by rolling topography and existing vegetation, which filter and screen the route corridor. Medium distance views would be possible from the rear of properties along Penygroes Road, with shorter distance views possible from the rear of properties along Gate Road, particularly where the route joins Gate Road. There would also be longer distance views from properties on the B4297.*
- *Pink Route – Between Penygroes Road and Gate Road, the ZVI would be similar to the Green Route, in that it would be largely constrained by rolling topography and existing vegetation. Beyond Gate Road, the route would become visible over a larger area as it rises towards Llandeilo Road. There would be views from the rear of properties on Gate Road and from properties on Llandeilo Road. There would also be longer distance, filtered views from properties in the village of Carmel and longer distance views from properties on the B4297.*

For all three options, there is also likely to be long distance views from an area of rising topography to the south east of Cross Hands at Pentwyn (Upper Tumble). However, this area is approximately 2km from the study area, therefore, any views of the options would be barely perceptible in the surrounding landscape. The location of this area is shown on Figure 3.2.

4.4.6 Visual Receptors

Visual receptors have been identified based on the ZVI boundary and by field survey work. A list of receptors has been provided below. Locations of the receptors are shown on Figure 3.2 and photos of views from a selection of receptors are provided on Figures 3.3 to 3.4. Not all of the receptors listed below would be affected by all three options. A detailed assessment for the receptors for each option is provided in Appendix E:

- *Greengrove Farm, adjacent properties and Greengrove Cottage;*
- *Properties south of Black Lion Road;*
- *Properties north of Black Lion Road;*
- *Properties on Heol Derwen;*
- *Properties on Gors Ddu Road;*
- *Properties on Norton Road;*
- *Properties south of Penygroes Road;*
- *Properties north of Penygroes Road;*
- *Properties on Gate Road, north of 53-63 Gate Road;*
- *53-63 Gate Road;*
- *65 Gate Road;*
- *67 Gate Road;*
- *Properties to the south west of Gate Road;*
- *Nythfa and adjacent properties;*
- *Properties to the north east of Gate Road;*
- *Castell-y-Rhingyll;*
- *Properties on Llandeilo Road, south of Gate Road;*
- *Properties on Llandeilo Road, around junction with Gate Road;*
- *Properties on Llandeilo Road, north of Gate Road;*
- *Properties on the B4297;*
- *Llwynyrynn;*
- *Cardinen;*

- *Properties in Carmel village;*
- *51/55A/1 Footpath between Black Lion Road and Norton Road;*
- *51/117/1 Footpath between Gors Ddu Road and Norton Road;*
- *31/22A/1 & 50/1/2 & 50/1/1 Footpath between Penygroes Road and Gate Road;*
- *51/50/1 & 51/49/1 & 50/2/2 & 50/3/1 Footpath between Gate Road and Llandeilo Road; and,*
- *50/2/1 & 50/7/2 Footpath north of Llandeilo Road.*

4.4.7 Value

Individual landscape elements, landscape character and townscape character of the study area have been assessed to determine their value. This is based on a consideration of quality, a judgement on the landscape as a whole, how it is perceived and its current condition. Value has been categorised as high, good, ordinary, poor or damaged, the definitions of which are set out in Appendix C.

(a) Value of Landscape Elements

- *Topography – the value of the topography has been assessed as being **good**, as although the surrounding landscape is of varied and attractive topography, the study area itself is gently undulating, which is often disguised by built form and vegetation;*
- *Hydrology - the value of hydrological features has been assessed as being **ordinary**, as the study area contains few features except small ditches and streams, which are often not highly visible in the landscape due to vegetation cover;*
- *Land cover and vegetation – the value of land cover and vegetation has been assessed as being **good**, as although vegetation cover is dense and is a strong characteristic of the landscape, there is evidence that it is relatively unmanaged, particularly the overgrown hedgerows;*
- *Landscape pattern – the value of landscape pattern has been assessed as being **high**, as there is a strong, historical field pattern in the study area;*

(b) Value of Landscape Character

Key characteristics of the landscape, including designations, have been identified from the LANDMAP data:

- *Strong landscape pattern of hedge and tree field boundaries, with associated wet grassland/meadow habitat and historic associations;*
- *Areas designated as SSSI;*
- *Scattered woodland blocks and trees;*
- *Middle distance views across rolling lowland countryside to hills beyond; and*
- *Linear urban developments along existing route corridors.*

Value classifications within the LANDMAP data range between moderate and outstanding. The value of landscape character has, therefore, been assessed as being **good**. There are highly valued characteristics such as the strong field pattern, which is a good heritage example of the Carmarthenshire landscape, and important habitats, such as the neutral and marshy grasslands. However, the topography and hydrology of the study area is often disguised by built form and vegetation, and there is evidence that the landscape could be better managed.

(c) Value of Townscape Character

The value of townscape character has been assessed as being **ordinary**. There is little unity or structure to the townscape, due to properties developing along linear road corridors in a mismatch of housing types, styles, colours and materials. However, there are often attractive views across the countryside with few visual detractors.

4.4.8 Sensitivity

The sensitivity of individual landscape elements, landscape character, townscape character and visual receptors has been assessed as being high, moderate or low according to the criteria and descriptions in Appendix C.

Sensitivity is determined through consideration of landscape quality, proximity of designated landscapes, perceived value and the ability of the landscape to accommodate change. The sensitivity of the study area has been assessed as follows:

- Topography – the topography has been assessed as being of **moderate sensitivity**, as the rolling topography is of good value and contributes to the rolling and hilly nature of the surrounding countryside. It is partly able to accommodate change, as the proposals would follow the more undulating parts of the study area where the introduction of man-made earthworks are likely to blend in with the surrounding landscape more easily;
- Hydrology – hydrological features have been assessed as being of **low sensitivity**, as there are few hydrological features within the study area, and those that are present do not significantly contribute to the landscape character;
- Land cover and vegetation – land cover and vegetation have been assessed as being of **moderate sensitivity**, as although the study area is well vegetated with the potential for large amounts of vegetation loss, the majority of land cover is in the form of hedgerows, which would be relatively easily replaced;
- Landscape pattern – landscape pattern has been assessed as being of **high sensitivity**, as there is a strong historical field pattern with well defined hedgerow boundaries within much of the study area, which would be unable to accommodate significant change;
- Landscape Character – landscape character has been assessed as being of **moderate sensitivity**, as although it is of good value and contains areas of important grassland and a strong field pattern, the landscape is partly able to accommodate change. This is because many landscape elements in the study area are relatively common features that would be relatively easily replaced.
- Townscape Character – townscape character has been assessed as being of **low sensitivity**, as the townscape is made up of linear development along local roads, which would not be too dissimilar to the proposals, therefore, it is likely the townscape would be able to accommodate change.
- Visual Receptors: Residential – Twenty three residential receptors, or groups of receptors, (R1 – R23) have been identified. These have been assessed as being of **high** or **moderate sensitivity** depending on the openness of views towards the proposed scheme¹². Residential receptors are used as

¹² Appendix A provides detailed definitions of the different sensitivity categories for visual receptors.

permanent accommodation, and views from these are assumed to be highly valued and considered to be important to quality of life. The sensitivity of individual or groups of receptors is provided in Appendix E.

- *Visual Receptors: Public Rights of Way* - Five recreational routes (RR1 – RR5) have been identified, which have been assessed as either **high or moderate sensitivity**. The routes are all public footpaths. Those of high sensitivity have open views of the proposed scheme from all or part of the route. Those of moderate sensitivity have relatively more restricted views of the proposed scheme. The sensitivity of individual public rights of way is provided in Appendix E.

4.4.9 Summary of Potential Impacts

The potential impacts have been differentiated as follows:

- *Landscape/ townscape impacts are changes that would physically alter the character of the landscape/ townscape; and,*
- *Visual impacts are changes in the view experienced by the visual receptors located within the ZVI of each of the proposed corridors as described previously.*

Impacts have been considered for the Construction Period¹³ and the Opening Year¹⁴ in order to reflect the differences in the nature of the impact. Timescales are discussed further in Appendix C. Route specific impacts have been identified using the following codes; (ALL) applicable to all routes, (O) orange route, (G) green route, (P) pink route.

(a) Construction Period Impacts

- *Construction of man-made earthwork and cutting features along the new road alignment (ALL);*
- *Existing small streams and ditches diverted or culverted (ALL);*
- *Bisection of hedgerow field boundaries and loss of hedgerow trees and small woodland blocks between Black Lion Road and Gate Road (ALL);*
- *Bisection of hedgerow field boundaries and loss of hedgerow trees and small woodland blocks between Gate Road and Llandeilo Road (P);*
- *Loss of pastoral agricultural land and rough grassland (ALL);*
- *Bisection and fragmentation of existing field pattern (ALL);*
- *Bisection of local road pattern; Black Lion Road and Norton Road (ALL), Llandeilo Road (O & P), Gate Road (G & P);*
- *Reduction in visual amenity and tranquillity due to construction works for the road, material storage mounds, bare earth, site compounds and site vehicle movements (ALL); and,*
- *Indirect impacts on visual amenity and tranquillity from associated traffic control (ALL).*

¹³ Period when construction works would be taking place. Considers construction activities, temporary works and construction traffic

¹⁴ On completion of construction when the scheme is operational.

(b) Opening Year Impacts

- *Continued presence of man-made earthwork and cutting features into the landscape (ALL);*
- *Existing small streams and ditches diverted or culverted (ALL);*
- *Continued reduction in hedgerow, hedgerow tree and woodland cover between Black Lion Road and Gate Road (ALL);*
- *Continued reduction in hedgerow, hedgerow tree and woodland cover between Gate Road and Llandeilo Road (P);*
- *Continued reduction in pastoral agricultural land and rough grassland, although some land used for temporary construction works would be returned (ALL);*
- *Continued bisection and fragmentation of existing field pattern and associated reduction in field size (ALL);*
- *Continued bisection of local road pattern; Black Lion Road and Norton Road (ALL), Llandeilo Road (O & P), Gate Road (G & P); and,*
- *Reduction in visual amenity and tranquillity due to introduction of traffic and associated road signage and lighting, although visual and tranquillity would improve on completion of construction (ALL).*

4.4.10 Mitigation

Indicative mitigation proposals drawings have been developed for all three routes, which incorporate a range of measures to integrate the scheme into the surrounding landscape, thereby limiting effects on landscape character and visual receptors. The measures are shown on Figures 3.5 to 3.7 and have been taken into account in the corridor options appraisal.

At this stage the proposals are indicative only and highlight the principles and objectives to be followed during detailed design. The proposals would aim to achieve the following:

- *Minimal loss of existing vegetation and retention wherever possible;*
- *Reinstatement of existing woodland blocks, hedgerows and individual trees lost during the construction phase;*
- *Planting of native tree and shrub species in keeping with local landscape character;*
- *A variety of grassland, including species rich grassland, to increase local biodiversity;*
- *Design to include landscape areas that provide habitat links between existing and proposed vegetation;*
- *Screen planting around significant road embankments and around junctions to break up the scale of the road and screen structures, traffic and lighting;*
- *Lighting to be kept to a minimum to reflect the rural nature of the landscape and existing light levels;*
- *Retain views to local landmarks to help create a sense of place for drivers; and,*
- *Design of structures, walls and fences to reflect local landscape character and pattern.*

The key planting types shown on the indicative mitigation proposals drawings include:

- *Woodland planting, with a choice of species reflecting local conditions that, where possible, integrate into existing woodland areas and help to provide screening;*
- *Shrub planting with intermittent trees where an element of vertical interest is required but tall screen planting is not necessary or desirable; and,*
- *Hedgerows, with intermittent trees where required, where planting areas are limited or to mitigate hedgerow losses as a result of construction.*

4.4.11 Designations and Policy Background Appraisal

- *None of the options would result in an adverse landscape and visual impact on Llyn Llech Owain Country Park.*
- *Policy SP14 Protection and Enhancement of the Natural Environment – There are likely to be adverse impacts on the countryside and landscape due to all of the routes. There would, therefore, be a conflict with planning policy, although mitigation vegetation would reduce impacts as much as possible.*
- *Policy EQ1 Protection of Buildings, Landscapes and Features of Historic Importance - There are likely to be adverse impacts on landscape character due to all of the routes. There would, therefore, be a conflict with planning policy, although mitigation vegetation would reduce impacts as much as possible.*
- *Policy EQ6 Special Landscape Areas (SLA) – None of the routes would result in significant adverse landscape or visual impacts on Carmarthenshire Limestone Ridge SLA.*

4.4.12 Route Options Appraisal

The following section provides a summary of the effects from the three route corridor options on landscape elements, landscape character and visual receptors and a brief comparison of the options. A more detailed assessment has been provided in the Landscape Effects Schedule in Appendix D and the Visual Effects Schedule in Appendix E.

The assessment takes into account the sensitivity of the receptor to change and the degree or magnitude of change for that receptor due to the new road schemes. A score for significance of effect has been determined using the matrix set out in Appendix C for the Construction Period and Opening and Future Years¹⁵. The assessment predicts effects after the incorporation of the indicative mitigation proposals shown on Figures 3.5 to 3.7. Detailed methodology for the assessment is provided in Appendix C.

(a) Effects on Landscape and Townscape

(i) Topography

All three routes would result in a ***slight adverse effect*** on topography during the Construction Period and Opening Year. This would be due to the introduction of man-made cuttings and earthworks into the landscape. Effects would not be greater as all options would ultimately follow the rolling topography.

¹⁵ Fifteen years after the Opening Year, following establishment of mitigation vegetation

The largest changes would be north of Norton Road where the road would be in cutting. This cutting would be most significant on the green route. The pink route extends much further north than the green and orange route, therefore, topographical changes would occur over a larger geographical area.

Effects would reduce to **neutral** by the Future Year for all three routes, as mitigation vegetation would have established to help blend the road and its man-made earthwork features into the landscape.

(ii) Hydrology

All three routes would result in a **slight adverse effect** on hydrology during the Construction Period. This would be due to the bisection or diversion of ditches or streams. Effects would only be considered as slight adverse because the watercourses are not dominant features in the landscape, often hidden by vegetation, built form and topography.

The orange route would affect four streams or ditches, including the Gwendraeth Fawr. The green route would affect five ditches or streams, and the pink route five ditches or streams, including the Afon Lash. Effects would be similar for all three options, but the green route would affect fewer watercourses, and only more minor ones.

Effects would reduce to **neutral** by the Opening Year for all three options, as the modifications to the watercourses would be complete, and would not be significantly different to existing.

(iii) Land Cover and Vegetation

All three routes would result in a **moderate adverse effect** on land cover and vegetation during the Construction Period and Opening Year. This is due to the loss of pastoral fields and rough grassland, hedgerows, woodland and shrub vegetation. The landscape is well wooded, therefore, the route corridors would result in the loss of a significant amount of vegetation. The predicted vegetation loss for each route is summarised in Table 4-Z.

Table 4-Z Comparison of predicted vegetation loss between the routes

Route	Loss of hedgerow (m)	Loss of woodland/shrub blocks (m ²)
Orange	1,090	7,810
Green	1,100	2,360
Pink	1,140	5,410

The orange route would result in the largest amount of vegetation loss (both hedgerows and woodland blocks), and the green route the least.

Effects would improve to **slight beneficial** by the Future Year for all three options. Mitigation vegetation proposed along the new road (indicative at this stage) would result in an overall increase in the amount of vegetation as set out in Table 4-AA.

Table 4-AA Indicative mitigation vegetation for each route

Route	Hedgerow (approximate m)	Woodland (approximate m ²)	Shrub (approximate m ²)
Orange	3,900	8,600	7,140
Green	3,290	5,040	7,300
Pink	4,560	8,330	9,780

Therefore, in terms of overall vegetation gain the green route would result in the greatest beneficial effect, and the orange route the least, when compared to the amount of vegetation lost.

(iv) Landscape Pattern

All three routes would result in a **large adverse effect** on landscape pattern in the Construction Period and Opening Year. This would be due to the road crossing small, semi regular agricultural fields in a curving alignment, which would break up the field pattern and reduce field size. This pattern is an important, historical feature in the landscape.

The largest changes would be between Black Lion Road and Llandeilo Road/ Gate Road where the field pattern is strongest. All three options would cross this area, although the green and pink routes would intersect less of the field pattern. The pink route would also extend further north than the orange and green options. The field pattern is not as strong here but it would still result in the bisection of field boundaries and a reduction in field size.

Effects would continue to be **large adverse** in the Future Year for all three routes, because although mitigation vegetation would help to provide new linkages between hedgerow field boundaries and woodland blocks, the change in field pattern and reduction in field size is permanent.

(v) Landscape Character

All three routes would result in a **moderate adverse effect** on landscape character in the Construction Period and Opening Year. This would predominantly be as a result of vegetation loss and the intersection of the strong field pattern, as well as the introduction of man-made cuttings and earthworks and a decrease in visual amenity and tranquillity from construction works and traffic. The strong field pattern and well wooded feel of the landscape are important characteristics, which help to give the landscape a sense of place.

Changes in landscape character would be similar for all three options. The green option would result in the least amount of vegetation removal and would disturb fewer field boundaries, therefore, it would have a less significant effect on landscape character when compared to the other routes. The orange route would result in the greatest amount of vegetation loss and would intersect more of the strong field pattern between Black Lion Road and Llandeilo Road/ Gate Road. However, the pink route would extend further north into the landscape, so effects would be noticed over a larger geographic area.

Effects would reduce to **slight adverse** by the Future Year for all three options. This is because the mitigation vegetation reconnecting field boundaries and woodland blocks reduces the impact on the landscape pattern. It also visually blends the man-made cuttings and earthworks into the landscape. Adverse effects would remain, as the curving road would continue to intersect the field pattern, which is an important characteristic of the landscape.

(vi) Townscape Character

All three routes would result in a **slight adverse effect** during the Construction Period. The townscape would remain relatively unaffected by the works except for the intersection of local roads. The orange route would cross or join Black Lion Road, Norton Road and Llandeilo Road, the green route would cross or join Black Lion Road, Norton Road and Gate Road, and the pink route would cross or join Black Lion Road, Norton Road, Gate Road and Llandeilo Road.

Effects would reduce to **neutral** by the Opening Year as none of the local roads would be stopped up and would be provided with access points onto the new road. This would maintain connectivity and result in the local road system being similar to the existing.

(b) Effects on Visual Receptors

The assessment of significance of effect for visual receptors has been described below in four sections. All three options would follow a similar route between Black Lion Road and Norton Road so the assessment would be the same for all options. Beyond Norton Road the three options have been assessed separately. Some visual receptors have been assessed in groups, therefore, in isolated cases there may be some receptors that would experience a more significant or less significant effect than that described below, depending on their proximity to the scheme.

(i) Black Lion Road to Norton Road

All three route options would result in similar effects on receptors to the south around Black Lion Road and Norton Road, as they share the same route corridor.

During the Construction Period, there would be a **large adverse effect** on 67 properties and a **moderate adverse effect** on 10 properties, as there would be open or filtered views of construction works, particularly where the road crosses Black Lion Road and Norton Road in close proximity to properties. There would also be a **slight adverse effect** on 43 properties, where views would be more restricted by vegetation and built form.

On completion of construction views from properties would improve as construction works would no longer be a dominant and disruptive feature in the view. In the Opening Year there would be a **moderate adverse effect** on 67 properties and a **slight adverse effect** on 53 properties. There would be close range views of traffic and the new road embankments from properties on Black Lion Road and Norton Road, as well as more filtered views of the new road cutting north of Norton Road from properties on Norton Road and Penygroes Road.

By the Future Year, mitigation vegetation would have established to help improve views for some properties, with 42 properties experiencing a **slight adverse effect** and 37 properties a **neutral effect**. For example, once woodland vegetation

establishes around the new road cutting north of Norton Road, views from Penygroes Road would improve as it would help to screen traffic. However, there would continue to be a **moderate adverse effect** on 41 properties. This is because hedgerow mitigation, proposed in some locations due to minimal space being available, would not fully screen traffic, which would continue to be visible for many properties.

(ii) Orange Route – Norton Road to Llandeilo Road

On the whole, the orange route would have the least significant effect on visual receptors. This is because views of the route would be relatively well contained by existing vegetation along field boundaries, Llandeilo Road and Gate Road.

During the Construction Period, there would be a **large adverse effect** on 17 properties on Llandeilo Road where the new road would tie in directly opposite the properties and there would be no existing vegetation to screen views of construction works. Otherwise there would be a **slight adverse effect** on 82 properties and a **neutral effect** on 36 properties, as views towards the construction works would be restricted by existing vegetation or built form, or the works would not be visible at all.

The route crosses footpath 31/22A/1 & 50/1/2 & 50/1/1 between Penygroes Road and Gate Road and there would be open, close range views towards construction works, resulting in a **large adverse effect**. This would be the same for all options as all three would cross this footpath.

On completion of construction views from properties would improve as construction works would no longer be a dominant and disruptive feature in the view. In the Opening Year there would be a **slight adverse effect** on 53 properties and a **neutral effect** on 82 properties. For some properties, effects would reduce to neutral as the traffic on the road would barely be perceptible through existing vegetation.

By the Future Year, mitigation vegetation would have established to help improve views for the majority of properties, as there would be a **neutral effect** on 118 properties. Vegetation would help to blend the road into the landscape and screen views of traffic. However, there would remain a **slight adverse effect** on views from 17 properties on Llandeilo Road, as there would be open views towards a slightly wider road corridor, which would be more dominant in the view than the existing road.

(iii) Green Route – Norton Road to Gate Road

On the whole, the green route would have a more significant effect on visual receptors than the orange route. This is because the route would be visible to a greater number of properties where it meets Gate Road, and it is likely traffic levels would increase along Gate Road between the new road and Llandeilo Road, reducing visual amenity for some properties.

During the Construction Period, there would be a **large adverse effect** on 26 properties located on Gate Road in close proximity to construction works for the new route where it joins Gate Road. In addition, there would be a **moderate adverse effect** for seven other properties on Gate Road, which would have similar views of these construction works, but they would be located further away so that construction works would be less dominant in the view.

There would be a **slight adverse effect** on 20 properties and a **neutral effect** on 82 properties that would have views towards the construction works restricted by vegetation or built form, or the works would not be visible at all.

On completion of construction views from properties would improve as construction works would no longer be a dominant and disruptive feature in the view. There would continue to be a **moderate adverse effect** on the 26 properties on Gate Road due to the proximity of traffic and the new road embankments and their dominance in the view. Otherwise, there would be a **slight adverse effect** on 45 properties, and a **neutral effect** on 64 properties. The number of properties with a neutral effect would reduce, as it is likely traffic levels would increase along Gate Road, reducing visual amenity for properties located along it.

By the Future Year, mitigation vegetation would have established to help improve views for some properties, although 17 properties would continue to experience a **moderate adverse effect**. These are the properties closest to the tie in with Gate Road, where mitigation vegetation would not completely screen traffic and the new road feature would continue to be a dominant feature in the view. There would be a **slight adverse effect** on 47 properties where glimpses of traffic would still be possible through mitigation vegetation, and a **neutral effect** on 71 properties where views would return to similar to existing.

(iv) Pink Route – Norton Road to Llandeilo Road

On the whole, the pink route would have a more significant effect on visual receptors than the orange and green routes, as it crosses Gate Road in close proximity to properties and extends further north so that additional properties would experience an adverse change in views.

During the Construction Period, there would be a **large adverse effect** on 36 properties located on Gate Road, which would be in close proximity to construction works for the new route where it crosses Gate Road. There would also be a large adverse effect on properties located on Llandeilo Road and the property Llwynrynn, as they would be in close proximity to construction works between Gate Road and Llandeilo Road.

There would be a **moderate adverse effect** on 21 properties on Gate Road, which would have views towards construction works but at a greater distance, and Castell-y-Rhyngyll, which would have close, open views towards construction works between Gate Road and Llandeilo Road.

There would be a **slight adverse effect** on 47 properties and a **neutral effect** on 31 properties that would have views towards the construction works restricted by vegetation or built form, or the works would not be visible at all.

On completion of construction views from properties would improve as construction works would no longer be a dominant and disruptive feature in the view. There would continue to be a **moderate adverse effect** on the 36 properties on Gate Road and Llandeilo Road and the property Llwynrynn due to the proximity of traffic and the new road embankments and their dominance in the view. There would be little existing vegetation to screen views. Otherwise, there would be a **slight adverse effect** on 65 properties where traffic would still be visible through existing vegetation, and a **neutral effect** on 34 properties.

By the Future Year, mitigation vegetation would have established to help improve views for some properties, although 13 properties would continue to experience a **moderate adverse effect**. These are the properties closest to the tie in with Gate Road, where mitigation vegetation would not completely screen traffic and the new road feature would continue to be a dominant feature in the view. In addition, the property Llwynrynn would also continue to experience a moderate adverse effect due to the proximity of traffic on the road between Gate Road and Llandeilo Road, and mitigation vegetation not fully screening views of traffic. There would be a **slight adverse effect** on 44 properties where glimpses of traffic would still be possible through mitigation vegetation, and a **neutral effect** on 78 properties where views would return to similar to existing.

4.4.13 Summary of Appraisal

Table 4-BB Summary of effects on landscape and townscape

	Route	Effect		
		Construction Year	Opening Year	Future Year
Topography	All	Slight adverse	Slight adverse	Neutral
Hydrology	All	Slight adverse	Neutral	Neutral
Land cover and vegetation	All	Moderate adverse	Moderate adverse	Slight beneficial
Landscape pattern	All	Large adverse	Large adverse	Large adverse
Landscape character	All	Moderate adverse	Moderate adverse	Slight adverse
Townscape character	All	Slight adverse	Neutral	Neutral

Table 4-CC Summary of effects on visual receptors

Area	Route	Effect / No. of properties		
		Construction Year	Opening Year	Future Year
Footpath 31/22A/1 & 50/1/2 & 51/1/1	All	Large adverse		
Black Lion Road to Norton Road	All	Large adverse / 67 Moderate adverse / 10 Slight adverse / 43	Moderate adverse / 67 Slight adverse / 53	Moderate adverse / 41 Slight adverse / 42 Neutral / 37
Norton Road to Llandeilo Road	Orange	Large adverse / 17 Slight adverse / 82 Neutral / 36	Slight adverse / 53 Neutral / 82	Slight adverse / 17 Neutral / 118
Norton Road to Gate Road	Green	Large adverse / 26 Moderate adverse / 7 Slight adverse / 20 Neutral / 82	Moderate adverse / 26 Slight adverse 45 Neutral / 64	Moderate adverse / 17 Slight adverse / 47 Neutral / 71
Norton Road to Llandeilo Road	Pink	Large adverse / 36 Moderate adverse / 21 Slight adverse / 47 Neutral / 31	Moderate adverse / 36 Slight adverse / 65 Neutral / 34	Moderate adverse / 13 Slight adverse / 44 Neutral / 78

4.5 Biodiversity

4.5.1 Baseline Conditions

Figure 4.1 illustrates the biodiversity baseline of the study area.

Table 4-DD sets out the nature conservation designations within the study area and the surrounding 1km. Within the study area are two Sites of Special Scientific Interest (SSSIs): Caeau Blaen-yr-Orfa SSSI and Gorslas Bog pSSSI, which are designated for floral diversity and habitat importance. Within 1km of the study area there were two Special Areas of Conservation (SACs) and four SSSIs recorded.

Table 4-DD: Nature Conservation Sites within 1km of the Study Area

Designation Name	Reason	Approximate distance from study area
Caeau Mynydd Mawr SAC	Designated for both the Purple moor grass <i>Molinion caeruleae</i> on calcareous, peaty or clayey-silt-laden soils <i>habitat</i> and the Marsh fritillary butterfly <i>Euphydryas aurina</i> .	450m south
Cernydd Carmel SAC	Designated for important habitat types including active raised bogs, mixed woodland on base rich soil, turloughs, dry heaths and wet heathland with cross-leaved heath <i>Erica tetralix</i> .	450m north
Caeau Blaen-yr-Orfa SSSI	Designated for unimproved grassland and whorled caraway	Within study area
Gorslas Bog pSSSI	Designated for peat habitats	Within study area
Caeau Ffos Fach SSSI	Part of the Caeau Mynydd Mawr SAC. It is an important site due to its abundance of devil's-bit scabious <i>Succisa pratensis</i> , the food plant of the larva of the marsh fritillary butterfly <i>Eurodryas aurinia</i> .	450m south
Cernydd Carmel SSSI	Part of the Cernydd Carmel SAC. Designated for a diverse range of habitat types including wet heath, mire systems and an ephemeral lake at Pant-y-llyn, known as a turlough, is the only known example occurring in mainland Britain.	450m north
Broad Oak and Thornhill Meadows SSSI	Part of the Caeau Mynydd Mawr SAC and is designated for unimproved grasslands containing an abundance of the umbelliferous plant, whorled caraway <i>Carum verticillatum</i> .	550m south east
Llyn Llech Owain SSSI	A shallow lake which exhibits features that are more typical of the upland oligotrophic (deficient in plant nutrients) lakes of the mountainous massifs of mid and north Wales. Such lakes are rare in the county of Carmarthenshire.	750m north east

The study area largely comprises a network of fields of marshy grassland bordered by hedgerows featuring semi-mature broadleaved trees. A number of the fields are grazed semi-improved grassland habitat. The majority of the fields are unmanaged and feature marshy grassland habitat. In addition to the field boundaries there are a small number of broadleaved woodland pockets and areas of scrub.

The south east part of the study area is dominated by a significant sized area of manmade ground (former Emlyn Brickworks and proposed Parc Emlyn development site) featuring a mosaic of dry grassland, marshy grassland, bare ground, dense and

scattered scrub, and tall ruderal vegetation. Due to the generally wet nature of the study area there are numerous ditches and areas of standing water.

The study area includes habitat used by the marsh fritillary butterfly *Euphydryas aurina*. The individuals present within the study area are considered to be part of the metapopulation associated with the Caeau Mynydd Mawr SAC. Figure 4.1 shows areas of suitable and good condition habitat for marsh fritillary from survey work carried out by CCC. In the fields that were not surveyed by the CCC study, anecdotal evidence of devil's bit scabious *Succisa pratensis* presence has been confirmed during other Jacobs visits to the study area in 2013, although a full habitat mapping exercise has not been carried out at this stage.

The study area also offers suitable habitat for and has records of other internationally and nationally protected species including, badger *Meles meles*, hazel dormouse *Muscardinus avellanarius* and native reptile and amphibian species. The site visit in August 2013 recorded dormouse nests in the area between Norton Road and Llandeilo Road.

The study area contains variable depths of peat, which has scientific value in itself and supports important habitats and species.

4.5.2 Value of the receptors in the study area

The SSSIs Caeau Blaen-yr-Orfa SSSI and Gorslas Bog pSSSI represent the most valuable habitats within the study area and are designated due to their national importance.

The study area is within the boundary of the marsh fritillary metapopulation that is associated with the Caeau Mynydd Mawr SAC. The areas of suitable marsh fritillary habitat within the study area are therefore considered to be of importance at a European scale in terms of their value to the SAC metapopulation.

The other habitats within the study area that exist outside of the SSSIs are also of importance in terms of providing breeding and foraging habitat for protected species of fauna. Many of the marshy grassland, bog, woodland and hedgerow areas are also local Biodiversity Action Plan (LBAP) habitats and as such are considered important at the county level.

The presence of dormouse within the study area is considered to be important at the county level.

Peat deposits and wet modified bog are considered to be of county level importance.

4.5.3 Potential Impacts

Any new road scheme, independent of the exact location of the route corridor has the potential to affect biodiversity through a number of key impacts and these are set out in Table 4-EE.

Table 4-EE: Potential impacts on biodiversity

Potential Impact	Description
Land take resulting in habitat loss	The permanent loss of the habitat present beneath the footprint of the road and the degradation of habitats present within the construction footprint including temporary access routes and site compound areas.
Land take resulting in severance and fragmentation	The placement of one or more barriers (e.g. a road) within an area of continuous habitat, which effectively prevents or reduces natural movements of faunal species and essentially results in a number of smaller areas of habitat which are of less ecological value and potentially insufficient to support viable populations of protected species.
Land take and/or changes in air and water quality resulting in habitat degradation	Reduction in the quality of retained habitat resulting from loss of key features (e.g. veteran trees and old buildings) from surrounding areas, pollution (e.g. road run off and vehicle exhausts), changes to hydrology.
Direct mortality during construction	Death or mortal injury of important species as a direct result of the road development, primarily during the construction phase.
Direct mortality during operation	Death or mortal injury of important species resulting from a collision with a vehicle or an acute pollution incident.
Noise, vibration and lighting resulting in disturbance	Direct impact on faunal species reducing their ability to forage or breed.

4.5.4 Potential Effects of Proposed Routes

The impact significance described in the following text is based on the significant criteria set out in Appendix A.

(a) All Routes

The routes cross a number of fields that support good condition and suitable marsh fritillary habitat in both the south west and north of the study area. The land take of any scheme through this area would result in habitat loss, fragmentation and habitat degradation which would affect the amount of breeding habitat available to the butterfly. This would be considered to be, at worst, a large adverse effect on this internationally valuable receptor. However, the CCC Local Development Plan includes Supplementary Planning Guidance (SPG) on impacts on marsh fritillary butterfly habitat associated with the SAC, which includes acceptable mitigation (in the form of a mechanism for provision of compensatory habitat within the metapopulation area) to ensure development within the area does not result in adverse effects on the integrity of the SAC. Direct and facilitated habitat enhancement should reduce the significance of the impact to slight adverse.

Areas including woodland, grassland, bog and hedgerows will be directly affected resulting in loss of habitat and severance of important wildlife corridors. This level of loss and severance may affect protected and local biodiversity action plan (LBAP) species and habitats and could be of slight to moderate adverse significance. Scheme and construction design, habitat enhancement and planting should reduce this impact to neutral or slight adverse.

(b) Orange Route

This route does not directly affect Caeau Blaen-yr-Orfa SSSI and Gorslas Bog pSSSI. The Caeau Blaen-yr-Orfa SSSI is within 20m of the proposed route centre line and may be affected by changes in air quality and hydrology.

This option will require a number of watercourse/field ditch crossings including the Gwendraeth Fawr. There is a slight possibility that any of these watercourses could be used by otter *Lutra lutra* and if present, the effect could be of moderate significance. Scheme and construction design, habitat enhancement and planting should reduce this impact to neutral or slight adverse.

This option should not require disturbance of any substantial peat deposits.

(c) Green Route

This option does not directly affect any of the SSSIs and is approximately 350m east of the Caeau Blaen-yr-Orfa SSSI so is highly unlikely to indirectly affect this SSSI through changes in air quality or hydrology.

The proposed corridor passes through an area to the east of the study area that is thought by NRW (CCW 1994 data) to be wet modified bog. However, initial ground investigations have not identified any deep deposits of peat in this area. Further study will be required to identify whether this area is wet modified bog. There may be negative effects on this habitat through habitat loss or degradation, which at worst could be moderate adverse significance. If required, mitigation could include enhancement of other suitable habitat in the area.

The option lies in close proximity to a British Bryological Society survey point, which indicates the importance of the local area for bryophytes (mosses & liverworts). There may be negative effects to this area through changes in hydrology and air quality which at worst could be of moderate adverse significance. No suitable mitigation has yet been developed and further study would be required to enable the impact to be reduced.

This corridor option will cross a tributary of the Afon Lash (to the east). There is a slight possibility that any of these watercourses could be used by otter *Lutra lutra* and if present, the effect could be of moderate significance. Scheme and construction design, habitat enhancement and planting should reduce this impact to neutral or slight adverse.

This option may require removal or modification of peat deposits. NRW consider the area to the west of the study area to contain deep peat deposits (CCW 1994 data), although initial ground investigations have not identified any. Further study will be required to identify whether deep peat is present. There may be negative effects on peat deposits through habitat loss or degradation, which at worst could be moderate adverse significance. If required, mitigation could include enhancement of other suitable habitat in the area.

(d) Pink Route

This option does not directly affect any of the SSSIs and is approximately 350m east of the Caeau Blaen-yr-Orfa SSSI so is highly unlikely to indirectly affect this SSSI through changes in air quality or hydrology.

The proposed corridor passes through an area to the east of the study area that is thought by NRW (CCW 1994 data) to be wet modified bog. However, initial ground investigations have not identified any deep deposits of peat in this area. Further study will be required to identify whether this area is wet modified bog. There may

be negative effects on this habitat through habitat loss or degradation, which at worst could be moderate adverse significance. If required, mitigation could include enhancement of other suitable habitat in the area.

The option lies in close proximity to a British Bryological Society survey point, which indicates the importance of the local area for bryophytes (mosses & liverworts). There may be negative effects to this area through changes in hydrology and air quality which at worst could be of moderate adverse significance. No suitable mitigation has yet been developed and further study would be required to enable the impact to be reduced.

This option may require removal or modification of peat deposits. NRW consider the area to the west of the study area to contain deep peat deposits (CCW 1994 data), although initial ground investigations have not identified any. Further study will be required to identify whether deep peat is present. There may be negative effects on peat deposits through habitat loss or degradation, which at worst could be moderate adverse significance. If required, mitigation could include enhancement of other suitable habitat in the area.

4.5.5 Summary

The route options are broadly similar in terms of the ecological features affected, such as watercourse, woodland, grassland, and hedgerows and their associated protected species (including dormouse, bats and otters).

All routes have the potential (in the absence of mitigation) to have an effect of large adverse significance on marsh fritillary and the Caeau Mynydd Mawr SAC. In purely quantitative terms, the pink corridor option (being the longest route) would have the largest direct habitat loss impact of the three routes, and would have the slightly longer construction period. However, when other impacts are taken into account, such as severance, overall, there is little to distinguish between any of the three route options in terms of impact significance. Therefore, it is considered that all three would have broadly similar levels of impact so it is not possible to provide a ranking as to which has the lowest to highest impact on the marsh fritillary butterfly.

The Green and Pink routes possibly cross an area of peat deposits and wet modified bog, which may contain bryophytes of interest. This receptor, although valuable, is likely (in the absence of mitigation) to be affected less significantly than the SAC.

There is potential for mitigation of impacts on most of the ecological features present using best practice design and construction methods and provision of habitat enhancement and planting. In particular, habitat enhancement in line with the provisions of the draft CCC Caeau Mynydd Mawr SAC SPG for loss and severance of marsh fritillary butterfly breeding habitat should reduce the significance of the options to slight adverse.

It is difficult at this stage to assess the potential for mitigation for the impacts on peat deposits and wet modified bog habitat (Pink and Green routes). The presence of these habitats is still uncertain and it is not yet known if it is possible to mitigate any effects through enhancement of other nearby habitat patches.

4.6 Soil

4.6.1 Existing Conditions

(a) Geology

The study area lies on the solid geology of the Upper and Lower Westphalian series (formerly known as the Carboniferous, Lower, Middle and Upper Coal measures). The Lower Westphalian series includes productive coal measures comprising a sequence of mudstones and siltstones with coal seams and beds of sandstone. Due to folding of the strata in the area sequences are complex. There is a north east to south west trending thrust and monoclonal fold complex adjacent to the northern section of the study area.

The superficial drift deposits are head, clay-with-flints, and brickearth, and include peat in the northern part of the study area and glacial boulder clay deposits. There are some alluvial deposits associated with watercourses.

There has been extensive working of the coal deposits in the area and this is described in more detail within the engineering section of the Arup's Cross Hands Economic Link Road Phase 2 WeITAG Stage 2 Appraisal report.

(b) Agricultural Land Classification

Consultation with the Welsh Government's Rural Affairs office in Carmarthen has confirmed that the land in the study area lies within a 'Less Favoured Area' (LFA) and is classified as either 'a Disadvantaged Area' or a 'Severely Disadvantaged Area'

(c) Designated Sites in the Study Area

There are no geological SSSI's within or adjoining the Route Options.

(d) Potentially Contaminated Land

Areas of potentially contaminated land were identified for the WeITAG 1 report (Jacobs March 2013) on the basis the historic land use within the study area. This information has been gathered from a review of the available historic Ordnance Survey maps at scales of 1:10,560, 1:10,000 and 1:2500. No update to this assessment has been undertaken as the historic baseline will be as previously reported.

Consultation with Carmarthenshire County Council's Contaminated Land Officer has confirmed that there are no sites in the study area which have been designated as "Contaminated Land" as defined in Part IIA of the Environment Act 1990 and that the area is included as part of the contaminated land inspection strategy required by Part 2A of the Act. The land was previously used for coal mining and quarrying, with associated spoil heaps of unknown constituents in the area.

4.6.2 Summary

There are a limited number of potentially contaminative uses within the route corridors under consideration. They are as follows:

(a) Orange Route

- *Disused railway and tramways, especially sections where which were on embankment and where embankments remain;*
- *Restored opencast coal workings;*
- *Former coal workings (pits, levels and shafts);*
- *Former colliery sites;*
- *Colliery spoil heaps, and*
- *Filled quarries*

(b) Green and Pink Route

- *Disused railway and tramways, especially sections where which were on embankment and where embankments remain;*
- *Restored opencast coal workings;*
- *Former coal workings (pits, levels and shafts);*
- *Former colliery sites;*
- *Colliery spoil heaps;*
- *Filled quarries;*
- *Former abattoir; and*
- *Pumping station.*

For all of the routes there is potentially a Slight Beneficial impact as earthworks are likely to lead to the removal or capping of any contaminated material encountered.

4.7 Heritage

4.7.1 Geological and Topographical Background

The industrial village of Cross Hands is the focus point of two modern main roads: the A476 from Llandeilo to Llanelli and the A48 linking Fishguard and Milford Haven with Swansea and Cardiff. The proposed development site is located at around 150m AOD and is centred on grid reference SN 5610 1330, to the northeast of Cross Hands.

The solid stratum of the area consists of 'boulder clay' which is underlain by the Lower and Middle Coal Measures of Carboniferous age. Ironstone is common in the area as are mudstones and sandstones (BGS, 1977).

The wider setting of the site is dominated by a gently rolling agricultural landscape of semi-improved grassland, marshy grassland and broadleaf woodland. The fields are typically relatively small in size and bound by hedgerows often with hedgebanks formed as the result of enclosure in the 19th century.

4.7.2 Existing Conditions

(a) Introduction

There are no cultural heritage assets which have a statutory designation (such as a Scheduled Monuments, Listed Buildings or Conservation Areas), within the study areas. In addition there are no non-statutory designations such as World Heritage Sites, Registered Landscapes or Registered Parks and Gardens recorded.

No historic landscape character areas have currently been defined within the study area by Dyfed Archaeological Trust. However, LANDMAP data for the study area does provide a limited assessment of the study areas Cultural and Historic aspects of the landscape.

The baseline assessment of the cultural heritage assets within 200m of the centre of each route option identified a total of 22 sites of cultural heritage interest (Figures 5.1 to 5.3) which are listed in Table 4-FF. Further information about these assets is provided in the gazetteer presented at Appendix G.

Table 4-FF Heritage Assets within the study area

Asset Number	Asset Name	Value
1	Cwn y nant Colliery	Low
2	Pen-y-Waun Cottage Outbuildings	Medium
3	Llwyn-yr-yn Farm	Medium
4	Bryn-Melyn Tramway	Low
5	Carreg Calch Standing Stone/ Boundary Stone	Medium
6	Emlyn Colliery Tramway	Low
7	Emlyn Colliery Earthwork	Low
8	Emlyn Colliery Spoil Heap	Negligible
9	Emlyn Colliery Field Boundary	Negligible
10	Emlyn Colliery Structure	Medium
11	Emlyn Colliery Structure	Medium

Asset Number	Asset Name	Value
12	Emlyn Colliery Structure	Medium
13	Emlyn Colliery Road	Negligible
14	Emlyn Colliery Quarry	Low
15	Emlyn Colliery Field Boundary	Negligible
16	Penygroes Tile Factory Tile Works	Low
17	Glaspant Quarry	Low
18	Glaspant Tramway	Low
19	Banc-Twlc Gwili Cottage	Low
20	Ty-Newydd Cottage	Low
21	Mynydd Mawr Railway colliery branch line	Medium
22	Castellrhingyll Chapel Sunday-School	Low

(b) Archaeological and Historic Background

The only potential prehistoric activity in the study area is represented by the Carreg Calch standing stone (Asset 5). This site may have been Bronze Age in origin, but may equally be one of the many medieval or post-medieval boundary stones which are common in Carmarthenshire. The location of the standing stone was identified on 19th century maps but is no longer visible on site (PRN14492).

There are no further identified assets representing the period between the Bronze Age and the post-medieval period within the study area. The remaining assets consist of sites related to the post-medieval and modern industrial development of Cross Hands. The village grew as a settlement located at a noted cross-roads on the route from Carmarthen to Swansea which was an important staging post for travellers during the era of coach travel (James, 1991).

During the 18th and 19th centuries the landscape was transformed from an agricultural one to a mining landscape by the opening of a succession of coal mines developed along the Gwendraeth Valley from Cross Hands to Carway. The presence of the exploitable coal measures led to immense industrialisation of the area and an influx of labour from different areas. However, unlike the coal mining valleys of south eastern Wales, historically the Gwendraeth Valley retained a mix of farming alongside the coal mines, thus making coal mining a seasonal occupation. The temperate climate of cool summers and mild winters as well as the high rainfall in the area combined to enable mixed farming to remain a profitable occupation. It is due to the surviving agricultural traditions and the relative isolation that, despite the presence of coal mining and other outside influences, the area retained its rural traditions and majority of the population retained the Welsh language.

Rich seams of high quality anthracite coal were found in the Gwendraeth Fawr valley and the Mynydd Mawr, which led to the growth of a coal industry and large villages around the coal mines such as Cross Hands, Tumble, Penygroes, Cwmmawr, Pontyberem, Ponthenry and Trimsaran. The study area is associated with the former California Colliery, later superseded by the Emlyn colliery, as well as the remains of associated mining structures (Assets 10 and 11), tramways (Asset 6), quarries (Asset 14) and colliery waste tips (Asset 7 and 8).

The landscape within the study area retains a number of regularly laid-out hedgerows which originate from the enclosure of pasture by Parliamentary enclosure in the 19th century.

4.7.1 Value of Heritage Assets

(a) Assets of High Value

There are no heritage assets of high value within the study area.

(b) Assets of Medium Value

There are seven heritage assets of high value within the study area. These consist of the following:

- *Asset 2, Pen-y-Waun cottage outbuildings which are a series of surviving outbuildings shown on the OS maps from the First Edition onwards;*
- *Asset 3, the Llwyn-yr-yn Farm, which is a stone built farm shown on OS maps from the First Edition onwards and surviving in its original layout;*
- *Asset 5 the site of Carreg Calch standing stone or boundary stone which is recorded from the 19th century onwards on maps but has now been lost and may be either Bronze Age, medieval or post-medieval in origin;*
- *Assets 10, 11 and 12 which are three Emlyn Colliery Structures interpreted as roofed loading bays for Emlyn Quarry (Asset 14); and,*
- *Asset 21 which is the route of the former Mynydd Mawr Railway colliery branch line, shown on the First Edition (1889) OS map, linking Cross Hands to the Gors-goch Colliery and brickworks then California Colliery and Emlyn Colliery and brickworks.*

(c) Assets of Low Value

There are eleven heritage assets of Low Value. These consist of the following:

- *Asset 1, the former Cwn y nant Colliery to the north of the study area, which is a small colliery and shaft shown on the OS 1889 map but for which there are no visible remains;*
- *Asset 4 Bryn-Melyn tramway, the site of tramway recorded on the HER, it is probably mislocated and is a duplicate of Asset 18, the Glaspant tramway;*
- *Asset 6 the Emlyn Colliery tramway recorded on the HER as a tramline to and from a quarry which led to small processing sheds but with no visible surface remains;*
- *Asset 7 is an earthwork at Emlyn Colliery which formed an area of spoil from a 1924 drift mine which is no longer present;*
- *Asset 14 the Emlyn Colliery Quarry was a small quarry shown on the OS 1st Edition maps associated with a tramway and three related roofed structures (Assets 10, 11 and 12);*
- *Asset 16 the former Penygroes Tile Factory Works which opened in the 1920s but is no longer visible;*
- *Asset 17, the Glaspant Quarry which was built before 1906 and was linked to the main-line railway by the Glaspant tramway (Asset 18);*
- *Assets 19 and 20, the former site of Banc-Twlc Gwili Cottage and Ty-Newydd Cottage, which no longer survive but were shown on the First Edition OS mapping; and,*
- *Asset 22, the former Castellrhingyll Chapel Sunday-School which was shown on the OS Second Edition map but no longer survives.*

(d) Assets of Negligible Value

The following four assets are all considered to be of Negligible Value:

- Asset 8, Emlyn Colliery spoil heap;
- Asset 9 a field boundary at Emlyn Colliery;
- Asset 13, Emlyn Colliery road; and,
- Asset 15, a field boundary at Emlyn Colliery.

(e) Summary of heritage assets per route option

Table 4-GG Heritage Assets – Orange Option

Asset Number	Asset Name	Value
2	Pen-y-Waun Cottage Outbuildings	Medium
4	Bryn-Melyn Tramway	Low
5	Carreg Calch Standing Stone/ Boundary Stone	Medium
6	Emlyn Colliery Tramway	Low
7	Emlyn Colliery Earthwork	Low
8	Emlyn Colliery Spoil Heap	Negligible
9	Emlyn Colliery Field Boundary	Negligible
10	Emlyn Colliery Structure	Medium
11	Emlyn Colliery Structure	Medium
12	Emlyn Colliery Structure	Medium
13	Emlyn Colliery Road	Negligible
14	Emlyn Colliery Quarry	Low
15	Emlyn Colliery Field Boundary	Negligible
16	Penygroes Tile Factory Tile Works	Low
17	Glas pant Quarry	Low
18	Glas pant Tramway	Low
19	Banc-Twlc Gwili Cottage	Low
20	Ty-Newydd Cottage	Low
21	Mynydd Mawr Railway colliery branch line	Medium
22	Castellrhingyll Chapel Sunday-School	Low

Table 4-HH Heritage Assets – Green Option

Asset Number	Asset Name	Value
1	Cwn y nant Colliery	Low
2	Pen-y-Waun Cottage Outbuildings	Medium
6	Emlyn Colliery Tramway	Low
7	Emlyn Colliery Earthwork	Low
8	Emlyn Colliery Spoil Heap	Negligible
9	Emlyn Colliery Field Boundary	Negligible
10	Emlyn Colliery Structure	Medium
11	Emlyn Colliery Structure	Medium
12	Emlyn Colliery Structure	Medium
13	Emlyn Colliery Road	Negligible
14	Emlyn Colliery Quarry	Low
15	Emlyn Colliery Field Boundary	Negligible

16	Penygroes Tile Factory Tile Works	Low
18	Glas pant Tramway	Low
19	Banc-Twlc Gwili Cottage	Low
20	Ty-Newydd Cottage	Low
21	Mynydd Mawr Railway colliery branch line	Medium
22	Castellrhingyll Chapel Sunday-School	Low

Table 4-II Heritage Assets – Pink Option

Asset Number	Asset Name	Value
1	Cwn y nant Colliery	Low
2	Pen-y-Waun Cottage Outbuildings	Medium
3	Llwyn-yr-yn Farm	Medium
5	Carreg Calch Standing Stone/ Boundary Stone	Medium
6	Emlyn Colliery Tramway	Low
7	Emlyn Colliery Earthwork	Low
8	Emlyn Colliery Spoil Heap	Negligible
9	Emlyn Colliery Field Boundary	Negligible
10	Emlyn Colliery Structure	Medium
11	Emlyn Colliery Structure	Medium
12	Emlyn Colliery Structure	Medium
13	Emlyn Colliery Road	Negligible
14	Emlyn Colliery Quarry	Low
15	Emlyn Colliery Field Boundary	Negligible
16	Penygroes Tile Factory Tile Works	Low
18	Glas pant Tramway	Low
19	Banc-Twlc Gwili Cottage	Low
20	Ty-Newydd Cottage	Low
21	Mynydd Mawr Railway colliery branch line	Medium

4.7.2 Historic Landscape: Characteristics of the Area

No historic landscape character areas have been defined for the Cross Hands area by Dyfed Archaeological Trust. However LANDMAP (maintained by the former Countryside Commission for Wales (CCW), now part of Natural Resources Wales (NRW)) does include limited assessment of the historic character of the area and this has been used to aid this assessment of the impact on the present-day landscape and the historic processes that have shaped it.

LANDMAP describes Cross Hands' (LANDMAP Aspect Area Code: CRMRTCL059) *Cultural Landscape* as being a cross roads settlement standing largely north and south of the A48 extension of the M4 and the A476 road from Laugharne to Llandeilo. It also stands at the point where the limestone belt to the north morphs into the anthracite coalfield to the south and south-west. It appears to owe its present cultural character to the result both of improved east-west transport links and to the characteristic nodal regenerative development at significant junctions.

LANDMAP describes Cross Hands' (LANDMAP Aspect Area Code: CRMRTHL39544) *Historic Landscape* as being defined by having regular fieldscapes, extractive industries, communications links, processing and

manufacturing industries with recreational areas. Its historic landscape includes relict-stone monuments, buildings and structures and industrial archaeology.

The overall Historic Landscape Character was assessed as having a Low Value as the proposed development area contains remains of post-medieval field systems with the former mining industry remnants and historic farm buildings remaining in pockets.

4.7.3 Options Appraisal

This section deals with the assessment of Value for the identified heritage assets as well as the predicted Magnitude of Impact and the Significance of Impact from the construction impacts of the proposed development.

The baseline assessment of the proposed three routes identified 22 cultural heritage assets within the combined three study areas.

There would be no physical impact on any features with statutory or non-statutory designations from the proposed route options. However, there would potentially be direct impacts on a number of heritage assets recorded on the Historic Environment Record and by Royal Commission on the Ancient and Historical Monuments of Wales database (RCAHMW).

(a) Potential for impacts on Unknown Archaeological Remains

There is considered to be moderate to high potential across all three options for undiscovered features dating from the industrial era. However, due to the heavily industrialised nature of the area the potential for unknown archaeological features pre-dating the Industrial Revolution is considered to be low.

(b) Orange Route - Assessment of Impacts

A total of 20 sites of cultural heritage interest were recorded within 200m of the Orange Route (Figure 5.1).

Physical effects of the Orange Route are the following:

- *It directly crosses the former site of Ty-Newydd cottage (Asset 20), which is assessed as an asset of Low Value (PRN24101); this would have a Major adverse impact on the site.*
- *It directly crosses the former site of Banc-Twlc Gwili cottage (Asset 19), an asset of Low Value (PRN24128) and would have a Major adverse impact on it.*
- *It skirts the site of the former Glaspant quarry site, an asset of Low Value (PRN27741), having a Minor impact on the site.*
- *It severs the course of the former colliery Glaspant tramway (Asset 18) (PRN 27740), which is of Low Value, having a Minor impact on it.*
- *It severs the course of the former line of the Mynydd Mawr Railway colliery branch line (Asset 21), which survives as an access road and is assessed as of Medium Value, having a Minor impact on it.*

Setting effects of Orange Route are the following:

- *It passes close to the former site of the Penygroes Tile Factory site (Asset 16) which is assessed as of Low Value (PRN30726) and would have a Minor impact on its setting.*

- *It passes within circa 90m to the east of the site of Asset 5, a former site of a possible prehistoric boundary stone, Carreg Calch, an asset assessed to be of Medium Value (PRN14429). The route option would have an impact on setting of this site which, as the stone is no longer standing, is assessed as Slight.*

The overall Significance of Impact for this route was assessed as Slight Adverse.

Table 4-JJ Summary of magnitude of impacts on heritage assets

Asset No.	Asset Name	Value	Magnitude of Impact
Asset 5	Carreg Calch, site of a prehistoric, boundary stone	Medium	Slight Adverse
Asset 16	Penygroes Tile Factory	Low	Minor Adverse
Asset 17	Glaspant quarry site	Low	Minor Adverse
Asset 18	Former colliery Glaspant tramway	Low	Minor Adverse
Asset 19	Banc-Twlc Gwili cottage	Low	Major Adverse
Asset 20	Ty-Newydd cottage	Low	Major Adverse
Asset 21	Mynydd Mawr Railway colliery branch line	Medium	Minor Adverse

4.7.4 Green Route - Assessment of Impacts

A total of 18 sites of cultural heritage interest were recorded within 200m of the Green Route (Figure 5.2).

Physical effects of Green Route are the following:

- *It passes directly through the former site of the Penygroes Tile Factory site (Asset 16) which is assessed as of Low Value (PRN30726) having a Major impact on it.*
- *It crosses directly through the former site of Ty-Newydd cottage (Asset 20), which is an asset of Low Value (PRN24101) having a Major impact on it.*
- *It severs the course of the former line of the Mynydd Mawr Railway colliery branch line (Asset 21), an asset of Medium Value, having a Minor impact on the course of line.*

Setting effects of Green Route are the following:

- *It passes close to the former Castellrhingyll Chapel Sunday School, (Asset 22) which is assessed as of Low Value (NPRN12713), having a Negligible effect on the setting.*

The overall Significance of Impact for this route was assessed as Slight Adverse.

Table 4-KK Summary of magnitude of impacts on heritage assets

Asset No.	Asset Name	Value	Magnitude of Impact
Asset 16	Penygroes Tile Factory	Low	Major Adverse
Asset 20	Ty-Newydd cottage	Low	Major Adverse
Asset 21	Mynydd Mawr Railway colliery branch line,	Medium	Minor Adverse
Asset 22	Castellrhingyll Chapel Sunday School	Low	Negligible Adverse

4.7.5 Pink Route - Assessment of Impacts

A total of 19 sites of cultural heritage interest were recorded within 200m of the Pink Route Option (Figure 5.3).

Physical effects of the Pink Route are the following:

- *It passes directly through the former site of the Penygroes Tile Factory site (Asset 16) which is assessed as of Low Value (PRN30726) having a Major impact on it.*
- *It directly impacts the site of the former Ty-Newydd cottage (Asset 20), which is an asset of Low Value (PRN24101) having a Major impact on it.*
- *It severs the former line of the Mynydd Mawr Railway colliery branch line (Asset 21), which is assessed as of Medium Value, having a Minor impact on its course.*

Setting effects of the Pink Route are the following:

- *It passes through the former extent of the Cwm-y-nant colliery (Asset 1). The colliery, which has no surviving remains and is of Low Value, would be subject to a Minor impact.*
- *It passes circa 60m to the south of Llwyn yr yn Farm (Asset 2), a surviving farm which is of Medium Value and would have a Minor impact on its setting.*

The overall Significance of Impact for this route was assessed as Slight Adverse.

Table 4-LL Summary of magnitude of impacts on heritage assets

Asset No.	Asset Name	Value	Magnitude of Impact
Asset 1	Cwm-y-nant colliery	Low	Minor Adverse
Asset 2	Llwyn yr yn Farm	Medium	Minor Adverse
Asset 16	Penygroes Tile Factory	Low	Moderate Adverse
Asset 21	Mynydd Mawr Railway colliery branch line	Medium	Minor Adverse
Asset 20	Ty-Newydd cottage	Low	Major Adverse

4.7.6 Overall Significance of Effects

In summary the assessment has identified a total of 22 heritage assets within the combined three route study areas which are all undesignated sites. Of the three proposed route options, the routes with the greatest potential impact on the cultural heritage resource would be the Orange and Pink routes. No beneficial effects from the three road options were identified.

The Orange route would have a physical impact on a total of five heritage assets with an adverse impact on the setting of two heritage assets. The overall unmitigated Significance of Effect for the Orange route was assessed as Slight Adverse.

The Green route was predicted as having a direct adverse impact on a total of three heritage assets with an adverse impact on the setting of one heritage asset. The overall unmitigated Significance of Effect for the Green route was assessed as Slight Adverse effect.

The Pink route would have a direct adverse impact four heritage assets and the setting of one heritage asset. The overall unmitigated Significance of Effect for the Pink route was assessed as Slight Adverse.

The route option with the lowest number of potential adverse impacts on the cultural heritage assets would be Green route which would have an overall unmitigated Slight Adverse Significance of Effect.

(a) Potential for impacts on Unknown Archaeological Remains

Due to the heavily industrialised nature of activity in the area over the last 200 years the potential for unknown archaeological features pre-dating the Industrial Revolution is considered to be low. However, the potential for undiscovered features dating from the industrial era is considered moderate to high across all three options.

4.7.7 Potential Further Works and Mitigation

No significant cultural heritage effects are predicted from the three proposed routes and all the impacts identified within the three route options are considered to be mitigatable in accordance with Welsh Office Circular 60/96 'Planning and the Historic Environment: Archaeology' and Welsh Office Circular 61/96 'Planning and the Historic Environment: Historic Buildings and Conservation Areas'. However, there remains the possibility that unidentified archaeological features may be discovered within the study area, particularly for those dating from the industrial era, although it is likely any potential impacts on such sites could be mitigated.

It is recommended that a detailed desk-based assessment is undertaken of the final preferred option in order to provide more detail of the extent and nature of the effects of the proposed scheme.

It is also recommended that a staged programme of archaeological evaluation is undertaken along the route of the preferred option to confirm the potential for the presence/absence of unknown archaeological remains. This could comprise:

- *Geophysical surveys of areas with suitable ground conditions.*
- *Based on the results of geophysical survey, archaeological trial trenching may be required.*

The results of the evaluation will be used in the design of detailed mitigation for the preferred route option in consultation with Dyfed Archaeological Trust. Possible options for archaeological mitigation can include the following:

- *Detailed archaeological excavation: where particularly significant, complex or densely-concentrated archaeological remains are expected to be present, then a detailed archaeological excavation in advance of construction would be undertaken;*
- *Strip, map and sample: where archaeological remains of relatively low significance and/or complexity are expected to be present, and particularly where they are expected to be spread over a large area at low density, then strip, map and sample works may be appropriate. The topsoil would be stripped over relatively large, defined areas using methods designed to maximize archaeological visibility, followed by inspection to define the scope of any archaeological recording works that might be required; and,*

- *Archaeological recording during construction ('watching brief'): where there is some potential for as yet unidentified archaeological remains to be present, but the risk is considered low, then archaeological monitoring of the main topsoil/overburden stripping operations, and other excavation works as appropriate, would be applied, followed by appropriate archaeological investigation and recording of any remains that are identified.*

4.7.8 Conclusions

In summary the baseline assessment of the proposed three routes identified 22 cultural heritage assets within the combined three study areas. None of the three proposed options would have a direct impact on any designated heritage assets or have any significant effects on any features of cultural heritage interest.

Of the three route options, the routes with the least significant impacts on the cultural heritage assets would be the Green route which would have an overall unmitigated Significance of Impact which is Slight Adverse. The preferred option from the cultural heritage perspective would, therefore, be the Green route based on the number of impacts on heritage assets and the unmitigated significance of those impacts.

Nevertheless, the Orange and Pink route would also have only an overall unmitigated Slight Adverse Significance of Impact on heritage assets in the study area. It is considered that it will be possible to mitigate all the potential impacts identified within all three route options.

The effects, of all the route options proposed, on features of cultural heritage importance are, therefore, considered be mitigatable and are in compliance with national policies outlined by the Welsh Government included in advice in Circular 60/96 and Circular 61/96 and Carmarthenshire County Council's policies for protecting the historic and archaeological environment in UDP Policies BE1, BE13 BE2 BE3 BE8 and LDP Policy Strategic Objective 13.

4.8 Water Environment

4.8.1 Existing Conditions

(a) Surface Water Features

The study area consists of small, regular pastoral fields. To the south the landform gradually rises from Black Lion Road (170m AOD) to a high point in the area around Gorslas (195m AOD), before dipping back gently across the agricultural fields and rising again up to Llandeilo Road in the north (190m AOD).

The land is characterised by numerous minor streams and ditches and more notably by the Gwendraeth Fawr which is sourced from springs within the study area and flows in a south-west direction eventually reaching the estuary near Kidwelly (See Figure 6.1). The Afon Lash, a tributary of the Loughor, is fed by springs east of Gate Road and flows in an easterly direction towards Ammanford.

(b) Groundwater

The Environment Agency's Aquifer Designation Maps identify the site as being underlain by Secondary A Aquifer (Superficial Deposits and Bedrock). This is defined as permeable layers capable of supporting water supplies at a local rather than strategic scale.

There is no designated Groundwater Protection Zone within the study area and Groundwater Vulnerability is designated as Minor Aquifer Low.

(c) Water Quality

The requirements of the Water Framework Directive have superseded previous water quality criteria used previously by the Environment Agency (now Natural Resources Wales).

The Gwendraeth Fawr is identified in the Western Wales River Basin Management Plan (RBMP) as having 'moderate' ecological quality and that it is predicted to have 'good' ecological status by 2015.

The Afon Lash is not identified in the RBMP but the Loughor confluence with the rivers Marlais and Aman, approximately 1.6km east of the Pink Corridor option is identified as having 'poor' ecological status and predicted to have 'poor' status by 2015.

The minor streams and ditches within the study area are not identified.

The current status of the Gwendraeth Fawr and the River Loughor as reported on the Environment Agency (now NRW) website are illustrated in Table 4-MM and Table 4-NN.

Table 4-MM Extract of the Status of the Gwendraeth Fawr

Gwendraeth Fawr - headwaters Afan Goch		
		View data
Waterbody ID	GB110060029061	
Waterbody Name	Gwendraeth Fawr - headwaters Afan Goch	
Management Catchment	Loughor to Taf	
River Basin District	Western Wales	
Typology Description	Low, Small, Calcareous	
Hydromorphological Status	Not Designated A/HMWB	
Current Ecological Quality	Moderate Status	
Current Chemical Quality	Does Not Require Assessment	
2015 Predicted Ecological Quality	Good Status	
2015 Predicted Chemical Quality	Does Not Require Assessment	
Overall Risk	Probably Not At Risk	
Protected Area	Yes	
Number of Measures Listed (waterbody level only)	-	

Table 4-NN Extract of the Status of the River Loughor

Loughor - conf with Marlais to conf with Aman		
		View data
Waterbody ID	GB110059032120	
Waterbody Name	Loughor - conf with Marlais to conf with Aman	
Management Catchment	Loughor to Taf	
River Basin District	Western Wales	
Typology Description	Low, Small, Calcareous	
Hydromorphological Status	Not Designated A/HMWB	
Current Ecological Quality	Poor Status	
Current Chemical Quality	Does Not Require Assessment	
2015 Predicted Ecological Quality	Poor Status	
2015 Predicted Chemical Quality	Does Not Require Assessment	
Overall Risk	At Risk	
Protected Area	Yes	
Number of Measures Listed (waterbody level only)	-	

(d) Flood Risk

The Welsh Assembly Government's Development Advice Map (DAM) indicates that the whole of the study area is located within Zone A (considered to be at little or no risk from fluvial or tidal/coastal flooding).

Immediately to the south west of the study area at the junction between Penygroes Road and the A476 Llandeilo Road the DAM shows an area of Zone B (areas known to have flooded in the past) and to the north east an area of Zone C2 (areas without significant flood defence infrastructure) is shown on the Afon Lash.

4.8.2 Potential Impacts

(a) During construction

Potential impacts on the water environment during a road construction phase have been summarised in **Table 4-00** and are common to all of the route options being considered.

Table 4-00: Potential impacts on the water environment during construction

Receptor	Impact	Comment
Surface water quality	Construction activities can create the potential for accidental damage to surrounding water bodies as a result of spills, leaks and sedimentation	Industry standard measures to control the risk of pollution during construction can be mitigated by implementation of an appropriate Construction Environmental Management Plan
Groundwater	Although arising from the same sources as described above for surface water, impacts on groundwater can be longer lasting due to slow movement of water and slow rates of diffusion	As above
Flood risk	Debris and other construction material has the potential to block watercourses and drains thus increasing the risk of flooding	As above

(b) During operation

Potential impacts on the water environment during a road operation phase have been summarised in **Table 4-PP** and are common to all of the route options being considered.

Table 4-PP: Potential impacts on the water environment during operation

Receptor	Impact	Comment
Surface water quality	Carriageway surface water drains have the potential to introduce fuel oil and other contaminants into receiving watercourses. The impact of these discharges will depend upon the dilution achieved. This, in turn, will depend upon the volume and rate of discharge and also upon flows in the receiving watercourse.	The receiving watercourses for this scheme will be relatively small. Dilution levels are likely to be low and, therefore, consideration will need to be given to the potential need for treatment prior to discharge. This will apply to all corridor options under consideration.
Physical modification of waterbodies	The drainage ditches and water courses will need to be crossed by the scheme. This adversely impacts the natural functioning of wetland ecosystems, and can impede fish passage.	In general the ditches to be crossed are relatively minor. The Pink route option would be required to cross the Afon Lash, causing a modification to a slightly larger watercourse. The Green route option would have the fewest crossings and therefore the least modification of waterbodies.
Groundwater	There is potential for the options to impede groundwater flows. However further understanding of the groundwater regime from ground investigations is required to fully appraise the impacts.	Owing to the importance of maintaining marshy habitats within the study area, it has been identified that groundwater flows may need to be maintained for example through the use of rock blankets to ensure permeability of flows.
Flood risk	Without mitigation, flood risk could be increased as a result of increased flow from impermeable areas.	Flood risk can be satisfactorily managed by incorporating appropriate attenuation facilities within the scheme.

4.8.3 Corridor options Appraisal

The appraisal of the potential impacts from each of the proposed route options on the water environment is set out in **Table 4-QQ**.

Table 4-QQ: The effects on the water environment for each of the corridor options

Assessment	Significance
Orange	
Route incorporates cut off drain along approx 40% of its eastern boundary with outfall at new 1200mm dia culvert crossings. This may impact upon the drainage pattern along its western boundary and increase flow in the receiving watercourse/ditch with an associated flood risk.	Slight to Moderate Adverse
Attenuation of surface water flows provided at two locations. All surface water flows from carriageway outfall via attenuation ponds. The design of the attenuation ponds will need to consider the potentially low dilution afforded by minor watercourses/ditches.	Slight Adverse
Potential spillage risk at at-grade junctions. This will require consideration of petrol/oil interceptors	Slight to Moderate Adverse
Culverting of a five watercourses	Slight to Moderate Adverse
Possible local drawdown of groundwater level in cuttings	Slight Adverse
Green	
Route incorporates cut off drain along short lengths of its eastern and western boundary with outfall at new 1200 dia culvert crossings and to ditch respectively. This may impact upon the drainage patterns and increase flow in the receiving watercourse/ditch with an associated flood risk.	Slight to Moderate Adverse
Attenuation of surface water flows provided at two locations. All surface water flows from carriageway outfall via attenuation ponds. The design of the attenuation ponds will need to consider the potentially low dilution afforded by minor watercourses/ditches.	Slight adverse
Potential spillage risk at at-grade junctions. This will require consideration of petrol/oil interceptors	Slight to Moderate Adverse
Culverting of three watercourses	Slight to Moderate Adverse
Possible local drawdown of groundwater level in cuttings	Slight Adverse
Pink	
Route incorporates cut off drain along short lengths of its eastern and western boundary with outfall at new 1200 dia culvert crossings and to ditch respectively. This may impact upon the drainage patterns and increase flow in the receiving watercourse/ditch with an associated flood risk.	Slight to Moderate Adverse
Attenuation of surface water flows provided at two locations. All surface water flows from carriageway outfall via attenuation ponds. The design of the attenuation ponds will need to consider the potentially low dilution afforded by minor watercourses/ditches.	Slight adverse
Potential spillage risk at at-grade junctions. This will require consideration of petrol/oil interceptors	Slight to Moderate Adverse
Culverting of five watercourses	Slight to Moderate Adverse
Possible local drawdown of groundwater level in cuttings	Slight Adverse

5 Appraisal Summary Tables

5.1 Orange Route

Table 5-A Summary Appraisal of the Orange Route

Environment Topic	Assessment	Distribution	Significance
Noise	<p>The greatest adverse impacts for this route option are at properties:</p> <ul style="list-style-type: none"> • Near to where the scheme connects to Black Lion Road; • At the rear of some properties on the west side of Gors Ddu Road; • Near to where the scheme connects to A476 Llandeilo Road; • Near to where it crosses Norton Road. <p>There are potential noise benefits to properties that are bypassed as a result of the route option, including some properties along:</p> <ul style="list-style-type: none"> • Gors Ddu Road; • Waterloo Road; • Gate Road; • Part of the A476 Llandeilo Road. <p>This route has a NPV (a positive value reflects a net benefit (i.e. noise reduction)) of £4,355,971. It also has a net noise annoyance change in 15th year after opening (positive value reflects an increase in people annoyed by noise) of -92.</p>	Greatest adverse impacts are where the options crosses the local roads; Black Lion Road, Norton Road and Llandeilo Road.	<p>Beneficial</p> <p>Based on the calculated values, this route option would result in the highest beneficial noise impact compared to the other two route options considered.</p>
Local Air Quality	Traffic on the proposed route option would be unlikely to cause exceedance of any Air Quality Objective. May have a slight adverse impact on the SSSI.	AQ effects <50m from affected roads. There will be winners and losers dependant on the locations of the re-routeing of traffic. Generally more adverse impacts closer to the route option.	Slight Adverse
Greenhouse Gas Emissions	Very small increase over Do Minimum Situation	N/A	Slight Adverse

Environment Topic	Assessment	Distribution	Significance
Landscape and Townscape	<p>One moderate adverse effect on landscape pattern due to interruption of field pattern and reduction in field size, which in turn would result in one slight adverse effect on landscape character.</p> <p>Three neutral effects on topography, hydrology and townscape character as conditions would return to similar to existing, or mitigation vegetation would help to blend the scheme into the landscape.</p> <p>One slight beneficial effect on vegetation due to mitigation vegetation.</p> <p>Least visible due to screening by existing field boundary and woodland vegetation. Changes would affect views from properties; 41 moderate adverse, 59 slight adverse, 155 neutral.</p>	<p>Most significant landscape effects between Black Lion Road and Gate Road. Most significant visual effects for properties on Black Lion Road, Norton Road and Llandeilo Road.</p>	Slight Adverse
Biodiversity	<p>Loss/fragmentation of Marsh Fritillary breeding habitat (Caeau Mynydd Mawr SAC)</p> <p>Potential indirect effects on Caeau Blaen-yr-Orfa SSSI.</p> <p>Loss of riparian habitat with potential effects on otter.</p> <p>Loss / severance of LBAP habitats including wildlife corridors (dormouse, bats and otter affected).</p>	<p>Potential for impacts along length of option</p>	<p>Potentially Large Adverse</p> <p>(Potentially still Moderate Adverse for peat after mitigation)</p>
Soil	<p>Earthworks are likely to lead to the removal or capping of any contaminated material encountered.</p>	<p>Issues are few in number and their distribution is a random result of historic activities in specific locations</p>	Slight Beneficial
Heritage	<p>A total of 20 sites of cultural heritage interest were recorded within 200m.</p> <p>Physical effects are the following:</p> <ul style="list-style-type: none"> Major impact on the site on the former site of Ty-Newydd cottage (Asset 20), which is assessed as an asset of Low Value; Major adverse impact on the former site of Banc-Twlc Gwili cottage (Asset 19), an asset of Low Value; Minor impact on it the former line of the Mynydd Mawr Railway colliery branch line (Asset 21) an asset of Medium Value. Minor impact on the site of the former Glaspant quarry site, an asset of Low Value; 	<p>Most significant heritage effects predicted to the immediate south of the crossing of Norton Road.</p>	Slight Adverse

Environment Topic	Assessment	Distribution	Significance
	<ul style="list-style-type: none"> Minor impact on the course of the former colliery Glaspant tramway (Asset 18) a site of Low Value ; <p>Setting effects are the following:</p> <ul style="list-style-type: none"> Minor impact on its setting of the former site of the Penygroes Tile Factory site (Asset 16); Slight impact on setting of former site of a possible prehistoric boundary stone, Carreg Calch, an asset assessed to be of Medium Value. 		
Water Environment	<p>May impact upon the drainage pattern in the area crossed by the road. Attenuation of surface water flows may be required. There is a potential spillage risk from the carriageway.</p> <p>There will be a culverting of five watercourses.</p>	Localised to specific watercourse crossings.	Slight to Moderate Adverse

5.2 Green Route

Table 5-B Summary Appraisal of the Green Route

Environment Topic	Assessment	Distribution	Significance
Noise	<p>The greatest adverse impacts for this route option are at properties:</p> <ul style="list-style-type: none"> Near to where the scheme connects to Black Lion Road; At the rear of some properties on the west side of Gors Ddu Road; Close to where the corridor option connects to part of Gate Road and part of Llandeilo Road; Near to where it crosses Norton Road. <p>There are potential noise benefits to properties that are bypassed as a result of the route option, including some properties along:</p> <ul style="list-style-type: none"> Gors Ddu Road; Waterloo Road; Part of Gate Road. 	Greatest adverse impacts are where the options crosses the local roads; Black Lion Road, Norton Road and Llandeilo Road	<p>Beneficial</p> <p>Based on the calculated values, this route option would result in the lowest beneficial noise impact compared to the other route options considered.</p>

Environment Topic	Assessment	Distribution	Significance
	This route has a NPV of £3,301,125. It also has a net noise annoyance change in 15th year after opening (no. of people) of -70.		
Local Air Quality	Traffic on the proposed route option would be unlikely to cause exceedance of any Air Quality Objective. May have a slight adverse impact on the SSSI.	AQ effects <50m from affected roads. There will be winners and losers dependant on the locations of the re-routeing of traffic. Generally more adverse impacts closer to the route option.	Slight Adverse
Greenhouse Gas Emissions	Very small increase over Do Minimum Situation	N/A	Slight Adverse
Landscape and Townscape	One moderate adverse effect on landscape pattern due to interruption of field pattern and reduction in field size, which in turn would result in one slight adverse effect on landscape character. Three neutral effects on topography, hydrology and townscape character as conditions would return to similar to existing, or mitigation vegetation would help to blend the scheme into the landscape. One slight beneficial effect on vegetation due to mitigation vegetation. More visible than orange option due to Gate Road tie in. Changes would affect views from properties; 58 moderate adverse, 89 slight adverse, 108 neutral.	Most significant landscape effects between Black Lion Road and Gate Road. Most significant visual effects for properties on Black Lion Road, Norton Road and Gate Road.	Moderate Adverse
Biodiversity	Loss/fragmentation of Marsh Fritillary breeding habitat (Caeau Mynydd Mawr SAC) Potential loss of peat deposit and wet modified bog habitat. Loss of riparian habitat with potential effects on otter. Loss/ severance of LBAP habitats including wildlife corridors (dormouse, bats and otter affected).	Potential for impacts along length of option	Potentially Large Adverse (Potentially still Moderate Adverse for peat after mitigation)
Soil	Earthworks are likely to lead to the removal or capping of any contaminated material encountered.	Issues are few in number and their distribution is a random result of historic activities in specific locations	Slight Beneficial
Heritage	A total of 18 sites of cultural heritage interest were recorded within 200m. Physical effects are the following:	Most significant heritage effects predicted to the immediate south of the	Slight Adverse

Environment Topic	Assessment	Distribution	Significance
	<ul style="list-style-type: none"> Major impact on the Penygroes Tile Factory site (Asset 16) which is assessed as of Low Value; Major impact on the former site of Ty-Newydd cottage (Asset 20), which is an asset of Low Value; Minor impact on the course of the former line of the Mynydd Mawr Railway colliery branch line (Asset 21), an asset of Medium Value. <p>Setting effects are the following:</p> <ul style="list-style-type: none"> Negligible effect on the setting of the former Castellrhingyll Chapel Sunday School, (Asset 22) which is assessed as of Low Value. 	crossing of Norton Road and at the Junction of Gate Road and Llandeilo Road.	
Water Environment	<p>May impact upon the drainage pattern in the area crossed by the road. Attenuation of surface water flows may be required. There is a potential spillage risk from the carriageway.</p> <p>There will be a culverting of three watercourses.</p>	Localised to specific watercourse crossings.	Slight to Moderate Adverse

5.3 Pink Route

Table 5-C Summary Appraisal of the Pink Route Option

Environment Topic	Assessment	Distribution	Significance
Noise	<p>The greatest adverse impacts for this route option are at properties:</p> <ul style="list-style-type: none"> Near to where the scheme connects to Black Lion Road; At the rear of some properties on the west side of Gors Ddu Road; Near to where the scheme connects to A476 Llandeilo Road; Near to where it crosses both Norton Road and Gate Road. <p>There are potential noise benefits to properties that are bypassed as a result of the route option, including</p>	Greatest adverse impacts are where the options crosses the local roads; Black Lion Road, Norton Road and Llandeilo Road	<p>Beneficial</p> <p>Based on the calculated values, this route option would result in the second highest beneficial noise impact compared to the other route options considered.</p>

Environment Topic	Assessment	Distribution	Significance
	<p>some properties along:</p> <ul style="list-style-type: none"> • Gors Ddu Road; • Waterloo Road; • Gate Road; • Part of the A476 Llandeilo Road. <p>This route has a NPV of £4,284,388. It also has a net noise annoyance change in 15th year after opening (no. of people) of -90.</p>		
Local Air Quality	Traffic on the proposed route option would be unlikely to cause exceedance of any Air Quality Objective. May have a slight adverse impact on the SSSI.	AQ effects <50m from affected roads. There will be winners and losers dependant on the locations of the re-routeing of traffic. Generally more adverse impacts closer to the route option.	Slight Adverse
Greenhouse Gas Emissions	Very small increase over Do Minimum Situation	N/A	Slight Adverse
Landscape and Townscape	<p>One moderate adverse effect on landscape pattern due to interruption of field pattern and reduction in field size, which in turn would result in one slight adverse effect on landscape character.</p> <p>Three neutral effects on topography, hydrology and townscape character as conditions would return to similar to existing, or mitigation vegetation would help to blend the scheme into the landscape.</p> <p>One slight beneficial effect on vegetation due to mitigation vegetation.</p> <p>Similar visibility to green option then extends further north beyond Gate Road over wider geographical area.</p> <p>Changes would affect views from properties; 54 moderate adverse, 86 slight adverse, 115 neutral.</p>	Most significant landscape effects between Black Lion Road and Gate Road. Most significant visual effects for properties on Black Lion Road, Norton Road, Llandeilo Road and Gate Road.	Moderate Adverse
Biodiversity	<p>Loss/fragmentation of Marsh Fritillary breeding habitat (Caeau Mynydd Mawr SAC)</p> <p>Potential loss of peat deposit and wet modified bog habitat.</p> <p>Loss of riparian habitat with potential effects on otter.</p> <p>Loss/ severance of LBAP habitats including wildlife corridors (dormouse, bats and otter affected).</p>	Potential for impacts along length of option	<p>Potentially Large Adverse</p> <p>(Potentially still Moderate Adverse for peat after mitigation)</p>

Environment Topic	Assessment	Distribution	Significance
Soil	Earthworks are likely to lead to the removal or capping of any contaminated material encountered.	Issues are few in number and their distribution is a random result of historic activities in specific locations	Slight Beneficial
Heritage	<p>A total of 19 sites of cultural heritage interest were recorded within 200m.</p> <p>Physical effects are the following:</p> <ul style="list-style-type: none"> • Major impact on the former site of the Penygroes Tile Factory site (Asset 16) which is assessed as of Low Value; • Major impact on the site of the former Ty-Newydd cottage (Asset 20) which is an asset of Low Value; • Minor impact on the former line of the Mynydd Mawr Railway colliery branch line (Asset 21), which is assessed as of Medium Value. <p>Setting effects are the following:</p> <ul style="list-style-type: none"> • Minor impact on the former extent of the Cwm-y-nant colliery (Asset 1) which is of Low Value; • Minor impact on the Llwyn yr yn Farm (Asset 2) which is of Medium Value. 	Most significant heritage effects predicted to the immediate south of the crossing of Norton Road and between the crossing of Gate Road and the junction with Llandeilo Road.	Slight Adverse
Water Environment	<p>May impact upon the drainage pattern in the area crossed by the road. Attenuation of surface water flows may be required. There is a potential spillage risk from the carriageway.</p> <p>There will be a culverting of five watercourses.</p>	Localised to specific watercourse crossings.	Slight to Moderate Adverse

6.1 Overall summary of all corridor options

Table 6-A Overall comparison of all of the corridor options across the environmental topics

Environment Topic	Summary of Significance or other quantitative finding		
	Orange Option	Green option	Pink Option
Noise	<p>NPV: £4,355,971 Net Annoyance: -92</p> <p>Based on the calculated values, this route option would result in the highest beneficial noise impact compared to the other two route options considered.</p>	<p>NPV: £3,301,125 Net Annoyance: -70</p> <p>Based on the calculated values, this route option would result in the lowest beneficial noise impact compared to the other route options considered.</p>	<p>NPV: £4,284,388 Net Annoyance: -90</p> <p>Based on the calculated values, this route option would result in the second highest beneficial noise impact compared to the other route options considered.</p>
Local Air Quality	<p>The results show that there are no predicted exceedances of the annual mean AQOs for either NO₂ or PM₁₀ at the modelled worst case receptor locations. The magnitudes of change are considerably smaller for PM₁₀ concentration with a predicted improvement of 1.5 ug/m³ and a worsening of 1.8 ug/m³. However, because there are no exceedances of the AQOs at any receptor location, the scheme will have a neutral impact on local air quality.</p> <p>Overall impact on the SSSI is considered to be neutral.</p>	<p>The results show that there are no predicted exceedances of annual mean AQOs for either NO₂ or PM₁₀ at the modelled worst case receptor locations. The magnitudes of change are considerably smaller for PM₁₀ concentration with a predicted improvement of 1.4 ug/m³ and worsening of 1.7 ug/m³. However, because there are no exceedances of the AQOs at any receptor location, the scheme will have a neutral impact on local air quality.</p> <p>Overall impact on the SSSI is considered to be neutral.</p>	<p>The results show that there are no predicted exceedances of the annual mean AQOs for either NO₂ or PM₁₀ at the modelled worst case receptor locations. The magnitudes of change are considerably smaller for PM₁₀ concentration with a predicted improvement of 1.5 ug/m³ and worsening of 1.9 ug/m³. However, because there are no exceedances of the AQOs at any receptor location, the scheme will have a neutral impact on local air quality.</p>
Greenhouse Gas Emissions	Very small increase over Do Minimum Situation	Very small increase over Do Minimum Situation	Very small increase over Do Minimum Situation
Landscape and Townscape	<p>Most significant landscape effects between Black Lion Road and Gate Road. Most significant visual effects for properties on Black Lion Road, Norton Road and Llandeilo Road.</p> <p>Overall Slight Adverse Impact</p>	<p>Most significant landscape effects between Black Lion Road and Gate Road. Most significant visual effects for properties on Black Lion Road, Norton Road and Gate Road.</p> <p>Overall a Moderate Adverse Impact.</p>	<p>Most significant landscape effects between Black Lion Road and Gate Road. Most Significant visual effects for properties on Black Lion Road, Norton Road, Llandeilo Road and Gate Road.</p> <p>Overall a Moderate Adverse Impact.</p>

Environment Topic	Summary of Significance or other quantitative finding		
	Orange Option	Green option	Pink Option
Biodiversity	<p>Potentially large adverse on the Caeau Mynydd Mawr SAC (Slight adverse with mitigation)</p> <p>Moderate adverse effects on LBAP habitats and protected species (Slight adverse with mitigation)</p> <p>Slight adverse impact on the Caeau Blaen yr Orfa SSSI (reducing to neutral with mitigation)</p>	<p>Potentially large adverse on the Caeau Mynydd Mawr SAC (Slight adverse with mitigation)</p> <p>Moderate adverse effects on LBAP habitats and protected species (Slight adverse with mitigation)</p> <p>Potentially moderate adverse effects on peat deposits and wet modified bog (unknown if can be reduced by mitigation)</p>	<p>Potentially large adverse on the Caeau Mynydd Mawr SAC (Slight adverse with mitigation)</p> <p>Moderate adverse effects on LBAP habitats and protected species (Slight adverse with mitigation)</p> <p>Potentially moderate adverse effects on peat deposits and wet modified bog (unknown if can be reduced by mitigation)</p>
Soil	Potentially a Slight Beneficial impact as earthworks are likely to lead to the removal or capping of any contaminated material encountered.	Potentially a Slight Beneficial impact as earthworks are likely to lead to the removal or capping of any contaminated material encountered.	Potentially a Slight Beneficial impact as earthworks are likely to lead to the removal or capping of any contaminated material encountered.
Heritage	<p>A total of 20 sites of cultural heritage interest were recorded within 200m. Most significant heritage effects predicted to the immediate south of the crossing of Norton Road.</p> <p>Overall a Slight Adverse Impact.</p>	<p>A total of 18 sites of cultural heritage interest were recorded within 200m. Most significant heritage effects predicted to the immediate south of the crossing of Norton Road and at the Junction of Gate Road and Llandeilo Road.</p> <p>Overall a Slight Adverse Impact</p>	<p>A total of 19 sites of cultural heritage interest were recorded within 200m. Most significant heritage effects predicted to the immediate south of the crossing of Norton Road and between the crossing of Gate Road and the junction with Llandeilo Road.</p> <p>Overall a Slight Adverse Impact.</p>
Water Environment	Slight to Moderate impact due to impacts on the drainage pattern and the need to culvert some watercourses.	Slight to Moderate impact due to impacts on the drainage pattern and the need to culvert some watercourses.	Slight to Moderate impact due to impacts on the drainage pattern and the need to culvert some watercourses.

There are no easily differentiating factors given the overall assessment for each route option is similar for 6 out of the 8 WelTAG topics considered. The exceptions are the biodiversity and landscape/townscape topics.

The WelTAG Stage 2 assessment process concludes that, for the biodiversity topic, the key differentiating factor for the three route options is the potential for peat deposits and wet modified bog in the Green and Pink corridor options, as all other likely impacts on the identified ecological features in the study area are broadly similar. This results in the Orange option being the preferred route corridor from a pure biodiversity perspective. For the other remaining topic, landscape and townscape, the green and pink routes also perform less well than the orange route.

Therefore, based on the differentiation confirmed by the Biodiversity and Landscape/Townscape topic assessments, the Orange route emerges as the option

with least overall environmental impact and is recommended as the preferred route to be taken forward.

- Air Quality Standards Regulations 2007
- CADW Conservation Principles, Policies and Guidance
- Carmarthenshire County Council, 2006, Unitary Development Plan,
- Department for Transport 2003 Transport Appraisal Guidance (TAG) - Historic Resources Sub-Objective TAG Unit 3.3.9
- Environmental Protection UK (2010) Development Control: Planning For Air Quality (2010 Update) Updated guidance from Environmental Protection UK on dealing with air quality concerns within the development control process
- Highways Agency et al, (2008/07) Design Manual for Roads and Bridges (DMRB) Vol. 11, Section 3, Part 2, HA 208/07
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- Welsh Assembly Government, 2008a, Welsh Transport Planning and Appraisal Guidance (WelTAG)
- Welsh Assembly Government, 2008b, Welsh Transport Planning and Appraisal Guidance Appendices (WelTAG Appendices)