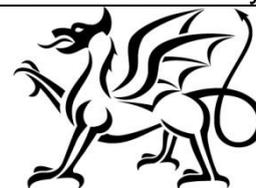


Adran yr Economi a'r Seilwaith
Department for Economy and Infrastructure



Llywodraeth Cymru
Welsh Government

The M4 Motorway (Junction 23 (East of Magor) to West of Junction 29 (Castleton) and Connecting Roads) and The M48 Motorway (Junction 23 (East of Magor) Connecting Road) Scheme 201-

The M4 Motorway (Junction 23 (East of Magor) to West of Junction 29 (Castleton) and Connecting Roads) and The M48 Motorway (Junction 23 (East of Magor) Connecting Road) (Amendment) Scheme 201-

The London to Fishguard Trunk Road (East of Magor to Castleton) Order 201-

The M4 Motorway (West of Magor to East of Castleton) and the A48(M) Motorway (West of Castleton to St Mellons)(Variation of Various Schemes) Scheme 201-

The M4 Motorway (Junction 23 (East of Magor) to West of Junction 29 (Castleton) and Connecting Roads) and the M48 Motorway (Junction 23 (East of Magor) Connecting Road) and The London to Fishguard Trunk Road (east of Magor to Castleton) (Side Roads) Order 201-

The Welsh Ministers (The M4 Motorway (Junction 23 (East of Magor) to West of Junction 29 (Castleton) and Connecting Roads) and the M48 Motorway (Junction 23 (East of Magor) Connecting Road) and the London to Fishguard Trunk Road (East of Magor to Castleton)) Compulsory Purchase Order 201-

The M4 Motorway (Junction 23 (East Of Magor) to West of Junction 29 (Castleton) and Connecting Roads) and The M48 Motorway (Junction 23 (East Of Magor) Connecting Road) (Supplementary) Scheme 201-

The Welsh Ministers (The M4 Motorway (Junction 23 (East Of Magor) to West of Junction 29 (Castleton) and Connecting Roads) and The M48 Motorway (Junction 23 (East Of Magor) Connecting Road) and The London to Fishguard Trunk Road (East of Magor to Castleton)) Supplementary Compulsory Purchase Order 201-

Summary Proof of Evidence

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Welsh Government, Water Quality

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1. Personal Statement

- 1.1 My name is Richard Graham. I am an Associate Director of Hydrogeology at RPS, responsible for the delivery of Water Sciences within the Environment Team based in Bristol. I am a Fellow of the Geological Society. I have worked professionally in the field of Earth Sciences for approximately twenty years.
- 1.2 My role within the project is that of Water Environment Lead with particular responsibility for water quality. I was responsible for the directing and production of the Environmental Statement Chapter 16 Road Drainage and the Water Environment and the supporting appendices, including the field work undertaken to acquire additional baseline data.

2. Context

- 2.1 The assessment of potential effects on the water environment is underpinned by the methodology outlined in guidance provided in the Design Manual for Roads and Bridges (DMRB) HD 45/09 (Highways Agency et al., 2009) 'Road Drainage and the Water Environment'.
- 2.2 The DMRB guidance lists the European (EU) Water Framework Directive (WFD) (2000/60/EC) as one of the key pieces of environmental legislation regarding water resource management and all discharges to water from roads projects must comply with the standards and classifications of the WFD.
- 2.3 The Groundwater Regulations (1998) provide the legislative framework for the protection of groundwater quality to prevent entry of certain hazardous polluting substances and to limit the entry of certain non-hazardous polluting substances. They also seek to prevent the deterioration of classification of the receiving groundwater body as determined in the relevant River Basin Management Plan.
- 2.4 The Groundwater Protection: Policy and Practice (GP3) sets out the policy framework to groundwater protection and management in England and Wales.

- 2.5 With respect to the water environment, Planning Policy Wales (Welsh Government, 2016) sets out to protect both public health and the environment by maintaining and improving the quality of natural waters.

3. Establishment of Baseline Conditions

- 3.1 In order to predict the likely impact on water quality as a consequence of construction and operation of the Scheme, it is necessary to determine the current condition of the water environment potentially within hydraulic influence of the Scheme.
- 3.2 Quarterly monitoring was considered appropriate allowing for potential seasonal variations in water quality. This is particularly of importance within the Gwent Levels where artificial drainage controls – termed penning – are utilised, the corresponding water levels of which differ between summer and winter. This approach also followed guidance provided by NRW for the monitoring of physical developments within the Gwent Levels SSSI. Quarterly monitoring commenced in May 2015 and is continuing. A total of 7 quarterly rounds have currently been undertaken.

4. Consideration afforded to the protection of water quality within the Gwent Levels SSSI and River Usk (Lower Usk) SSSI and SAC

- 4.1 The Gwent Levels SSSIs are designated primarily because of their reed and ditch habitats, the aquatic vegetation, insect, invertebrate species those habitats support. Water quality within the reeds and ditches is therefore considered an important underlying supporting element of the SSSIs features.
- 4.2 The importance of water quality to the Gwent Levels was recognised from the outset within the project team as a critical design requirement. A key element of this drainage design is the provision of 12 bespoke Water Treatment Areas (WTA) which are considered crucial to the protection of water quality within the Gwent Levels SSSI.

- 4.3 The normal design standards for trunk roads and motorways are that drainage systems are designed to accommodate a 1 year return period or 100% Annual Event Probability (AEP) storm within the pipework and ensuring that a 5 year return period (20% AEP) storm does not result in surface flooding. The flood risk design life of the Scheme is 100 years and accordingly, the highway drainage systems have been designed to contain all flows up to a 100 year return period (1% AEP) storm including a 30% increase in precipitation to account for climate change. This would ensure that the drainage systems are capable of conveying all this flow to the WTA for attenuation and treatment. .
- 4.4 The designs of the drainage infrastructure and WTA include specifically designed elements to capture, settle, filter and biodegrade pollutants from road run-off water prior to discharge to reens. This is achieved by four independent pollution reduction measures
- a) The use of impermeably lined grass lined channels rather than conventional concrete channels.
 - b) A Pollution Control Lagoon would intercept the “first flush” volume and be capable of capturing gross contamination that has flowed to a WTA.
 - c) The main Attenuation Lagoon has a permanent wet volume and sufficient surcharged storage capacity to attenuate flows from a 100 year return period storm including a 30% increase in precipitation due to climate change.
 - d) Reed beds have been provided to filter water and remove pollutants within a growing medium prior to discharge to reens.
- 4.5 I conclude that the design of the highway drainage and WTA provides a very high standard of protection from flooding and impacts on water quality. Appropriate management and maintenance of these features will be required to ensure these functions are maintained. A drainage inspection and maintenance schedule of all grass lined channels and water treatment areas, to be agreed with NRW, will be undertaken.

4.6 In recognition of the high sensitivity of the River Usk SAC, the proposed bridge piers have been located outside of the wetted channel to avoid direct impact to water quality within the River Usk during construction.

5. Adequacy of proposed safeguards to avoid unacceptable impacts of the water environment during construction

5.1 Within my evidence I identify the following areas of potential impact on water quality arising from construction of the Scheme

- a) Run-off from the working areas
- b) Accidental spills of fuels and chemicals
- c) Re-use within the temporary and permanent works of site won fill including cement stabilised material sourced from the Llanwern steelworks
- d) Effects of the new section of motorway on pre-existing contamination and associated risks to the water environment.

5.2 The Gwent Levels SSSI comprising a complex, artificial network of managed reens, ditches and field grips to control drainage as well as promote conservation objectives is also a highly sensitive water environment, which will require a high level of protection to avoid significant impact.

5.3 The potential likely significant effects on water quality within the Gwent Levels SSSI arising through construction have been identified as the follows:

- a) Crossing of watercourses comprising reens, River Usk and River Ebbw
- b) Infilling, replacement and reconnection of reens and ditches bifurcated by the new section of motorway
- c) Uncontrolled releases of suspended silts or contaminants from run-off from the construction corridor to surface water
- d) Uncontrolled releases of contaminants from re-used soils or cement stabilised materials to surface water
- e) Uncontrolled releases of contaminants from re-used soils or cement stabilised materials to groundwater via piles or band drains

- f) Temporary or permanent effects on certainty, quantity or quality of supply from existing private water abstractions.
- 5.4 A construction drainage design has been undertaken that incorporates measures to ensure separation of the construction corridor from the surrounding water environment as well as convey, store and treat run-off prior to discharge. This forms part of the Buildability Report submitted as an Appendix to Chapter 2 of the Environmental Statement.
- 5.5 Within the Buildability Report and as summarised at paragraph 16.11.16 of the Environmental Statement, a construction drainage assessment was undertaken to quantify likely worst case run-off volumes from the construction corridor resulting from storm events. To provide necessary compliance with quality criteria on suspended solids prior to discharge to the SSSI, adequate run-off storage volumes and settlement durations were calculated to be provided as part of the construction drainage design.
- 5.6 Surface drainage would be managed during construction to control runoff, together with any groundwater from surcharging and the use of band drains to avoid uncontrolled discharges to the water environment and to avoid flooding.
- 5.7 Additional mitigation that may be required periodically to achieve acceptable discharge quality includes the use of pumps, flocculation devices, filtration media, other specialist treatment equipment or off-site disposal as a worst case contingency.
- 5.8 Prior to discharge, treated surface water would be tested to ensure compliance criteria are met for chemical and physical parameters including pH and total suspended solids, to be agreed with NRW.
- 5.9 It is my opinion that these approaches are adequate and follow the required guidance to control surface water during construction to avoid impact to the water environment to avoid unacceptable long term impact from potential soluble and suspended pollutants.

5.10 An Outline Remediation Strategy Report and Land Contamination Management Strategy (Appendices 11.2 and 11.3 respectively to the Environmental Statement) set out an outline remediation implementation plan that includes procedures for excavation of materials, handling arrangements, dealing with unexpected contamination and monitoring.

5.11 NRW have agreed that provided the principles of the Outline Remediation Strategy Report are carried through to its implementation, any adverse effects on the water environment can be avoided.

5.12 It is my opinion that the Outline Remediation Strategy and Land Contamination Management Strategy is adequate to prevent unacceptable impact to the water environment and that appropriate contingency monitoring has been identified.

6. Adequacy of the proposed highway drainage to avoid unacceptable impacts on the water environment during operation

6.1 The potential likely significant effects on water quality within the Gwent Levels SSSIs have been identified as arising during operation from:

- a) Uncontrolled releases of contaminants in routine highway drainage to surface water
- b) Uncontrolled releases of contaminants in highway drainage to surface water following accidents
- c) Reduction in uncontrolled releases of contaminants in routine highway drainage to surface water from the existing M4 motorway between junctions 23 and 29 as a consequence of a predicted reduction in traffic, particularly Heavy Goods Vehicles (HGV).

6.2 Water quality objectives for the water environment within the Gwent Levels SSSI were considered both during the scoping of the ES and subsequent consultation with NRW.

- 6.3 As the proposed new section of motorway would be located within and in close proximity to a number of WFD water bodies, a WFD Compliance Assessment (Appendix 16.4 to the March 2016 ES) has been undertaken for the Scheme. This concluded the new section of motorway would not prevent any of the mitigation measures listed above from being implemented and would not result in a status deterioration.
- 6.4 Water quality criteria are provided by the DMRB Highways Agency Water Risk Assessment Tool (HAWRAT) methodology for a number of key pollutants associated with highways drainage defined for both dissolved pollutant – copper and zinc – and sediment bound pollutant – copper, zinc, cadmium and PAH.
- 6.5 Additionally, NRW have provided trigger levels for a wider range of dissolved pollutants. These trigger levels are largely based on WFD requirements for achieving good status with respect to water quality.
- 6.6 The cumulative pollutant reduction efficiencies for each WTA were conservatively estimated as documented in Appendix 16.3 of the March 2016 ES and Appendix SS16.1 of the December 2016 ESS.
- 6.7 I consider these factors to be conservative for 3 reasons. Firstly due to approximately 14km kilometres of grass lined channels proposed for the Scheme, especially within the Gwent Levels SSSIs, where approximately 80% of drainage channels comprise Grass Lined Channels. Secondly, given the very low design gradient of the embankments within the SSSIs of 0.05% (a fall of 1 in 2,000), highway run-off can be expected to reside for far longer periods with resultant reduction in pollutants. Thirdly, the slowing and storage of run-off water would act to dilute pollutants arriving following so called ‘first flush’ of the road surface whereby maximum pollutants are associated with the washing of the highway pavement following the build-up of pollutants during antecedent periods of dry weather, typically within the first 10 mm of a rainfall event.

- 6.8 The design of reed bed sizes is based on literature guidance on critical performance criteria to ensure these features are capable of operating well within expected pollutant removal efficiencies. In this way I have reasonably accounted for potential performance variation of the WTA whilst maintaining high levels of protection for water quality within the Gwent Levels SSSIs. I consider that such an approach is a robust methodology from which to size reed beds to deliver the optimum performance for the removal of residual pollutants.
- 6.9 HAWRAT assessments were carried out for each proposed WTA discharge (see Appendix 16.3 and S16.3 to the March 2016 ES and December 2016 ESS respectively). All of the HAWRAT assessments for each of the proposed WTA discharges met the DMRB criteria for dissolved and sediment bound impact.
- 6.10 To provide further confidence in the environmental performance of the proposed WTAs, I have additionally assessed whether proposed drainage discharges from WTA to reens would be likely to meet both NRW imposed trigger levels (TL) concentrations and then to preserve existing water quality as measured by the baseline monitoring undertaken to date given ABC are typically lower than the TL concentrations for the pollutants of concern.
- 6.11 This assessment approach was undertaken to determine an attenuation factor (AF) for each WTA to reduce the HAWRAT predicted run off concentrations to the mean ABC and the 95th%ile ABC as monitored in each WTA specific reen. A residual value is again calculated for both where positive (as presented in Annex 1 of Appendix SS16.1). These residuals are less than 15% and accordingly it is considered that, given the solubles reduction efficiencies for the WTA used are based on a highly conservative approach, such residuals are within the likely performance envelope for the WTA treatment trains, particularly given the large scale and size of the individual treatments stages proposed being significantly larger than comparable systems in existence currently operating on the Highways estate within the UK.

- 6.12 Similarly, the HAWRAT assessments have demonstrated that suspended sediment concentrations, which constitute the principal source of insoluble metals and organic pollutants within WTA discharges, will not accumulate significantly within receiving watercourses to exceed associated toxicity thresholds for the protection of sensitive aquatic organisms.
- 6.13 I therefore conclude that the WTA are capable of preserving ambient ree water quality in the long term (and therefore also meeting higher NRW trigger levels), and that short term impacts are within the criteria used by HAWRAT to consider discharges to be acceptable for the protection of sensitive aquatic organisms for both 6 and 24 hour likely peaks in road both soluble and insoluble run off pollutant concentrations.
- 6.14 NRW have stated in their written response to the March 2016 ES that they are satisfied that discharges to the Rivers Usk and Ebbw have lesser requirements for attenuation and treatment and, provided these requirements are adequately covered to their satisfaction within the Statement of Commitments, they have advised that the proposals presented for discharges into these tidal waters are adequate.
- 6.15 NRW have raised a concern over chloride pollution of surface water as a result of winter road treatment from rock salt gritting leading to potentially unacceptable concentrations of chloride within reens developing during winter and early spring.
- 6.16 The M4 CaN team identified that alternatives to rock salt exist which do not contain chloride and have minimal environmental impact such as calcium magnesium acetate (CMA). It was agreed that CMA could be used as a substitute to rock salt should chloride concentrations be at risk of exceeding the NRW Tigger Level of 300 mg/L during prolonged, extreme winters. It was further agreed that an evidence based assessment of this issue was desirable to inform an appropriate strategy on the effective management of road treatment during severe winters to prevent unacceptable impact on the water quality from chloride.

6.17 A post construction period of 5 years contingency water quality and biological assurance monitoring of reens receiving WTA discharges is proposed. Upstream and downstream monitoring of reen chemical and ecological status would be recorded to allow any measurable impact from the proposed drainage on the SSSI features to be identified.

7. Adequacy of the standard of protection from operational accidents on the new section of motorway

7.1 The drainage design provides very robust defences against any potential major pollution events resulting from accidents on the new section of motorway from entering the reen following uncontrolled discharges from WTA.

7.2 Firstly, the large majority of the new section of motorway within the Gwent Levels SSSIs utilises grass lined channels constructed at very low gradients (nominally 0.05%) designed to capture and initially store a 1 in 100 year storm event plus 30% climate change. The size of the channels would provide considerable storage for spills off the carriageway and could theoretically contain, for example, the contents of a fuel tanker within a limited length of the carriageway.

7.3 Secondly, when highway run-off flows enter a WTA, first it passes through a pollution control lagoon area before entering the main attenuation lagoon. The pollution control lagoon have the capacity to retain very large volumes of potential contamination as the top levels of storage within the main attenuation lagoons are above the flood levels with the Gwent Levels.

7.4 Finally, penstocks would be provided on the discharge points from the pollution prevention, lagoon and reed bed to provide additional pollution control if this is appropriate during the management of an emergency to allow recovery of heavily contaminated water that may have accumulated in the pollution prevention and/or attenuation lagoon.

7.5 I therefore conclude that the treatment areas would be able to contain all the oil/hydrocarbon from a multi vehicle accident including oil tankers during a

storm that on average would be exceeded only once in 120 years thus providing a very high level of protection to water quality, particularly within the Gwent Levels SSSIs.

- 7.6 The DMRB methodology for the environmental assessment of road drainage and the water environment (HD45/09) provides a set of formulae to quantify the risk presented to the water environment from accidents on the highway. Risk factors include the presence of junctions, the traffic volume including percentage of HGVs provided by the traffic model, the overall highway length and likely emergency response times provided by DMRB guidance. A set of standards are provided against which to determine whether the calculated risk is acceptable. Such an assessment was undertaken within Appendix 16.3 of the March 2016 ES and concluded that the risk was low and within accepted limits.

8. Adequacy of safeguards provided to avoid or mitigate unacceptable impact on existing water abstractions

- 8.1 An appraisal of potential impact to private water users is undertaken at paragraphs 16.7.42-44 of Chapter 16 of the Environmental Statement.
- 8.2 A qualitative evaluation of the potential risk to known groundwater abstraction sources identifies those sources at greatest risk of possible effects from supply derogation.
- 8.3 Potential effects on private groundwater abstractors would be mitigated through measures outlined in the Groundwater and Surface Water Management Plan.

9. Conclusion

- 9.1 I have demonstrated in this evidence that from the start of design considerations for the M4CaN, the importance of the water Environment and in particular the Gwent Levels SSSI has been a primary concern. In response to the very high environmental sensitivity of the Gwent Level SSSI, a drainage design has evolved to provide exceptionally high standards of water

treatment provision utilising high standards of protection of the reens proposed to receive treated road drainage.

- 9.2 Similarly, in recognition of the high sensitivity of the River Usk SAC, the proposed bridge piers have been located outside the wetted channel to avoid direct impact to water quality within the River Usk during construction.
- 9.3 Similarly, in developing the construction methodology, the team has responded to the requirements for capture, storage, treatment and discharge of run-off water to avoid pollution of reens. A site specific construction water management plan has been produced to achieve this supported by monitoring.
- 9.4 The team undertook an operational motorway drainage quantitative risk assessment following DMRB methodology. The risk assessment utilised conservative assumptions about likely WTA performance as well as avoiding reliance on reen flow for dilution and dispersion given the very low flows present during the summer months within the managed Gwent Levels. This concluded that water quality within the Gwent Levels SSSIs is unlikely to deteriorate as a consequence of proposed treated discharges from WTA.
- 9.5 An Outline Remediation and Land Contamination Management Strategy have been agreed with NRW. These would ensure protection of the water environment during and following construction.
- 9.6 Private Water Abstraction users have been identified and those at risk will be monitored for potential interruption or denigration of supply and alternative temporary or permanent water supplies would be provided if necessary.
- 9.7 I conclude that the proposed scheme whilst crossing a highly sensitive water environment can be constructed and operated to avoid significant impact to the quality of water courses, especially within the Gwent Levels SSSIs, or water resources.