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-

Proof of Evidence

Richard Graham, BSc (Hons), MSc, FGS

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 In 1993 I gained a BSc with Honours in Geophysical Sciences from the University of Southampton. This was followed in 1994 with an MSc in Exploration Geophysics from the University of Leeds. Following 5 years professional employment as a Geophysicist within the offshore energy and communications sectors, I returned to further education and gained an MSc in Hydrogeology from the University of Birmingham in 2000 after which I have been employed by RPS.

1.3 During my 15 years employment with RPS, I have worked predominantly on the assessment of potential impact on the water environment from proposed development as part of planning submissions. Many of these projects required Environmental Impact Assessment of the likely significant effects as part of an Environmental Statement. These have included highways, energy, waste and utilities related infrastructure projects some of which I have also acted in the capacity of Expert Witness at Inquiry.

1.4 I have previously been appointed to act as an expert witness on hydrogeological matters for the following proposed developments:

a) Preparation and presentation of evidence in 2009 relating to the potential impacts to groundwater resources from a proposed 300,000 tonne per annum domestic landfill at Lusk, Co. Dublin, Ireland. My evidence related to assessments of risk from escaping pollutants formed within landfill leachate migrating via vertical pathways within Quaternary till deposits into underlying Carboniferous limestone aquifers to impact highly sensitivity

groundwater resources. Planning permission was granted following a Bord Pleanála hearing, which ruled that the development would not injure local amenities or property in the vicinity.

b) Preparation and presentation of evidence relating to the risk to groundwater from impacts associated with surface water drainage and foul sewerage for a proposed new Motorway Service Area (MSA) for the A1(M) in North Yorkshire. A Regulation 19 Inquiry was held in 2012 following a request from the Secretary of State for further information on alternative sites submitted by the respective appellants appealing an earlier decision to grant planning permission against them. Following the inquiry, the Secretary of State was not moved in his original decision, which was not on grounds of drainage or hydrogeology.

c) Preparation of evidence relating to the hydrogeological impacts associated with the proposed Energy Recovery Facility at the Former Rufford Colliery site in Nottinghamshire. In May 2011, the proposal was refused planning permission by the Secretary of State however hydrogeological matters were not a basis for the refusal of the application.

d) Project review and expert witness at a Planning Inquiry for proposals to construct and operate a Coal Bed Methane production facility with ancillary infrastructure at Letham Moss near Falkirk, Scotland. Dealing with complex hydrogeological matters related to multiple production well impact on overlying groundwater resources and associated groundwater dependant terrestrial ecosystems to defend the proposals from technical and nontechnical challenges made by academic, professional and local residents' objections. The inquiry has been concluded but no determination was made by the Reporter (Scottish equivalent of a Planning Inspector) due to the moratorium on unconventional gas development introduced in Scotland at that time.

1.5 My role within the project is that of Water Environment Lead with particular responsibility for water quality. As part of my role I have attended design meetings to identify and discuss matters of significance to the water environment for both the construction and operational phases of the Scheme. 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. I have also directed and collaborated on aspects of the Environmental Statement Chapter 11 Geology and Soils that relate to the surface water or groundwater.

1.6 In preparing the evidence I have been supported by a team of hydrogeologists and environmental consultants. They have worked to my instruction and I adopt their work as my own and opinions I express are my own.

1.7 The evidence which I have prepared and provide in this Proof of Evidence is true and has been prepared and is given in accordance with the guidance of my professional institution and I confirm that the opinions expressed are my true and professional opinions.

2. Scope of Proof of Evidence

2.1 The objective of this evidence is to demonstrate that due regard has been taken of the physical characteristics and constraints imposed by the water environment – that is surface water and groundwater quality - and that the proposed alignment accords with the relevant standards and meets and exceeds the objectives of the proposed Scheme. In addition it will demonstrate that the environmental issues and proposed mitigation as detailed in the Environmental Statement 2016 (REF) are appropriate and have been taken into account in the engineering design.

2.2 The remainder of my evidence is structured under the following headings:

3. Context

4. Scoping and Meetings

5. Establishment of Baseline Conditions;

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

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

8. Adequacy of the proposed provision of routine operational highway drainage to avoid unacceptable impacts to surface water quality;

9. Adequacy of the standard of protection provided to the SSSI from pollution resulting from operational accidents on the new section of motorway;

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

11. Specific objections

12. Conclusions.

2.3 Matters relating to the water environment associated with fluvial flood risk – that is surface water conveyance and storage, and related flood defences - are considered separately in the evidence provided by Mr Michael Vaughan. Additionally, matters relating to pluvial flood risk – that is the effects of rainfall on and resultant and drainage from the Scheme and associated land, and related flooding and flood attenuation matters – are considered separately in the evidence provided by Mr Michael Vaughan (WG 1.17.1)

2.4 .Matters relating to the water environment associated with tidal flood risk – that is protection of the Scheme and associated land from flooding by the sea and related flood defences - are considered separately in the evidence provided by Dr Paul Canning (WG 1.16.1).

2.5 Matters relating to the water environment associated with highway drainage engineering details – that is locations of drainage infrastructure, including attenuation ponds, relative to existing topography and ground features and engineering layout of attenuation lagoons and reed beds - is considered separately in the evidence provided by Mr Ben Sibert (WG 1.5.1). Matters relating to construction are considered separately in the evidence of Mr Barry Woodman (WG 1.6.1).

2.6 Matters relating to the water environment associated with land quality and materials – that is the chemical condition of both of soils, geology or fills, and any required related remediation –are considered separately in the evidence provided by Mr Andy Clifton (WG 1.11.1).

2.7 Dr Peter Ireland's evidence (WG 1.7.1) discusses the Register of Commitments which I also refer to within my evidence.

3. Context

3.1 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'.

3.2 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. A WFD Compliance Assessment is therefore required by the Statutory Authorities (i.e. NRW) to assess whether the proposed new section of motorway is compliant with WFD legislation.

3.3 Under the Water Framework Directive, surface water bodies are evaluated according to their ecological and chemical status. Run-off from roads contain pollutants that when discharged to water bodies can lead to a lowering of water quality. It is a requirement of the WFD that such discharges do not lead to the deterioration in the classification status of the receiving water body as determined in the relevant River Basin Management Plan. Furthermore, such discharges must not prevent the receiving water body from attaining good overall status within an allocated timeframe.

3.4 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.

3.5 The Groundwater Protection: Policy and Practice (GP3) sets out the policy framework to groundwater protection and management in England and Wales. These policies set out the principles expected of regulators

to protect groundwater and specifically water intended for human consumption, as well as the discharge of liquid effluents to the ground. Potable abstractions are afforded protection from pollution through the delineation of concentric Source Protection Zones. No discharges of road drainage are permitted within the innermost zone (SPZ1) of a protected abstraction.

3.6 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. These include surface waterbodies (e.g. rivers, streams, lakes, ponds) and groundwater. Welsh Government also has duties under Section 28G of the Wildlife and Countryside Act 1981 and Section 40(1) of the Natural Environment and Rural Communities (NERC) Act 2006.

3.7 Matters relating to policy are considered separately in the evidence provided by Mr John Davies (WG.1.23.1).

4. Scoping and Meetings

4.1 Prior to the commencement of work on the collection and collation of baseline data, a Scoping Report (Document 4.3.18) regarding the ES was issued to statutory consultees.

4.2 Given the environmental sensitivity of the proposed route corridor close to or within the Gwent Levels SSSI, particular attention was given to scoping the approach to be taken for the assessment of potential impacts on the water environment.

4.3 The key consultee for the water environment was Natural Resources Wales (NRW), which includes the former Caldicot and Wentlooge Levels Internal Drainage Board, the functions of which were transferred to NRW in April 2015. NRW have statutory oversight of surface and groundwater quality, abstractions and discharges, water resources and flood risk management. NRW is responsible for selecting and notifying SSSIs in Wales.

4.4 Additional important consultees were the Local Authorities who have statutory oversight of private water supplies.

4.5 The drainage design philosophy was based on early design work undertaken to minimise impact to the water environment through considered capture, conveyance, storage, treatment and release of highway run-off via a number of bespoke Water Treatment Areas. This design was provided as part of the scoping on the water environment undertaken.

4.6 The following key deliverables for the assessment of impacts to the water environment were identified

a) Baseline monitoring to characterise the general variability of water quality within the reen and surface water system, including in the vicinity of key contaminated land sites identified on or near the Scheme;
b) An assessment of effects relating to highway construction and highway operation;
c) A DMRB compliant assessment of impacts from routine runoff on the water environment (using the Highways Agency Water Risk Assessment Tool (HAWRAT) and other bespoke approaches should these be required;
d) A Water Framework Directive assessment;
e) A Construction Environment Management Plan incorporating an Outline Pollution Control and Prevention Plan and an Outline Ground and Surface Water Management Plan; and
f) A Buildability Report.

4.7 In addition to the above, due to the quantity of ditches and reens proposed to be bifurcated and infilled by the new section of motorway requiring replacement and/or reconnection, it was also recognised and proposed that a Reen Mitigation Strategy would be required in addition to water environment monitoring during and following construction of the Scheme.

4.8 In response to scoping, the following principal concerns were provided by NRW in their letter of 18th September 2015:

a) The possible discharge of contaminated surface water into the River Usk during the construction and operation of the road
b) The need to consider all materials required during construction, not just chemicals, to avoid potential adverse effects on the water quantity or quality of the Gwent Levels.
c) Need for evidence that the water entering the SSSIs system will be of appropriate quality and quantity, compatible with the features of interest, and also that contingency measures have been agreed if problems arise following implementation.
d) Need to be assured that reen mitigation works will provide the necessary level of connectivity, be capable of being managed and have an appropriate water quality and water quantity to enable them to support the SSSIs features of interest, and be viable in the long-term.

4.9 A number of meetings have been held with NRW water quality and conservation experts prior to and during the Environmental Statement reporting period. The following meetings were held with NRW where water quality issues were discussed.

a) 15/04/15 Drainage Design Strategy
b) 11/05/15 Environmental Liaison Group Meeting
c) 11/06/15 Llanwern Steelworks Remedial Strategy
d) 18/08/15 Reen Mitigation Strategy
e) 02/09/15 Permitting and Licensing Strategy
f) 04/11/15 Environmental Liaison Group Meeting
g) 14/12/15 Water Framework Directive Scoping
h) 06/09/16 Drainage and Reen Mitigation Strategy
i) 08/11/16 Revised Water Quality Objectives for Gwent Levels
j) 20/12/16 Water Quality Risk Assessment

5. Establishment of Baseline Conditions

5.1 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.

5.2 During scoping of the Environmental Statement, it was proposed that four consecutive rounds of quarterly monitoring was undertaken to delineate 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 SSSIs.

5.3 The surface water baseline characterisation of the Scheme focusses on the new section of motorway corridor with a nominal 250 metres radial width from the main highway alignment. A larger study area was assessed where effects were considered to have the potential to extend outside of this corridor, i.e. for continuous groundwater catchment areas that extend laterally outside of the study area, watercourses crossing potentially contaminated sites and/or major reens within the area of potential influence of the new section of motorway.

5.4 To simplify baseline characterisation of the study area, the new section of motorway was subdivided into five sections:

a) Castleton (Existing M4 Junction 29);
b) Wentlooge Levels;
c) New Bridged Section of Motorway (River Usk, River Ebbw and Alexandra Docks);
d) Caldicot Levels; and
e) Magor (Existing M4 Junction 23A).

5.5 Surface water quality monitoring data has been collected within the Gwent Levels in three phases, with the baseline characterisation and assessment of effects giving particular reliance on the third phase A total of 72 surface water monitoring locations have been sampled since 2007:

a) Titan Environmental Surveys Limited – 22 monitoring locations, typically over 4 rounds conducted between 2007 and 2008;
b) Supplementary ground investigation for the Welsh Government - 10 Monitoring Locations over 3 Rounds conducted in 2015;
c) Baseline water monitoring at 41monitoring locations typically over 7 quarterly rounds commenced in 2015. This quarterly monitoring is on-going to more accurately define pre-construction water quality baseline conditions.

5.6 The above baseline monitoring data set provided the principal evidence upon which to produce the Baseline Water Environment (BWE) Report. This report, forming Appendix 16.2 to Chapter 16 of the March 2016 ES, established the physical and chemical condition of the water environment with particular emphasis on the hydrology and hydrogeology of the aforementioned five sections of the proposed route corridor.

5.7 Surface water samples taken from each monitoring point have been subject to analysis for a wide variety of parameters as follows:

a) General parameters associated with defining water quality within surface water bodies, including Water Framework Directive parameters;
b) Parameters historically monitored by the former Countryside Commission for Wales (CCW) and subsequently adopted by NRW for which water quality trigger levels have been defined;
c) General contaminants of concern associated with routine highway run-off, that include heavy metals and hydrocarbons; and

d) Site-specific contaminants of concern defined for contaminated land sites that have plausible or previously evidenced pollutant linkages with the surrounding watercourses.

5.8 Groundwater quality data has been obtained for approximately 98 monitoring locations installed along the route corridor. This includes a total of c. 120 sample points, as many locations comprise a dual installation (i.e. shallow and deep). Groundwater samples have been taken on multiple occasions from the 120 sample locations. Up to 284 analyses have been undertaken for individual parameters, although most parameters have been analysed less frequently.

5.9 Water quality was determined by comparison with appropriate screening concentrations, which include statutory Environmental Quality Standards (EQS), as defined under the WFD, Drinking Water Standards (DWS) as well as non-statutory NRW SSSI water quality trigger levels (NRWTL) and World Health Organisation (WHO) guideline values.

5.10 The key aspects of the baseline water environment have been summarised in the Baseline Water Environment Report forming Appendix 16.2 to Chapter 16 of the March 2016 ES summarised for each of the five subsections in the series of drawings Figure 5 to Figure 9. The Conceptual Hydrogeological Models for each subsection is provided in the Figure 5.4, Figure 6.4, Figure 7.4, Figures 8.4 to Figure 9.4 and summarised below.

Section 1: Castleton

5.11 Surface water quality is characterised by neutral to mildly alkaline pH and freshwater chemistry is characterised by moderate dissolved oxygen (DO) and presence of key nutrients. Dissolved metals are frequently present, most notably chromium, lead, nickel and zinc with exceedances of the relevant EQS observed for chromium and lead. Occasional occurrences of Total Petroleum Hydrocarbons (TPH) and Polynuclear Aromatic Hydrocarbons (PAH) are identified, generally occurring more

frequently and at higher concentrations than observed within the reen system of the Gwent Levels themselves. Exceedances of the relevant EQS are identified for PAH compounds in up to 44% of samples analysed. Exceedances of relevant EQS and NRWTL where applicable are observed for nutrient parameters including ammoniacal nitrogen, nitrate and orthophosphate.

5.12 Groundwater is located at depth, within bedrock, under high elevation areas. Lateral groundwater flow towards the Estuary, local surface water courses and/or springs / spring line associated with the inland-Tidal Flat Deposit (TFD) boundary is expected. Groundwater encountered in the bedrock and superficial deposits within this section is fresh in nature, of neutral / mildly alkaline pH and general absence of organic contaminants and relatively low concentration of ammoniacal nitrogen (with a mean of 1.4 mg/l). Groundwater is characterised by the routine presence of arsenic, boron, chromium, copper, nickel and zinc although respective DWSs and EQSs are only rarely exceeded for any parameter. Infrequent occurrence of lead, cadmium and mercury, with rare exceedance of the respective assessment criteria. The principal groundwater receptors are considered to be Brides Brook, any unidentified springs and/or spring-lines (principally at the inland boundary of the TFD) and groundwater within bedrock concealed beneath the TFD.

Section 2: Wentlooge Levels

5.13 Surface water quality is characterised by neutral to mildly alkaline pH and freshwater chemistry characterised by low to moderate dissolved oxygen and presence of key nutrients. Dissolved oxygen falls below the NRWTL of 5 mg/l in 23.5% of all samples. Dissolved metals are frequently present, notably arsenic, chromium, copper, lead, nickel, zinc and iron with the relevant EQS exceeded occasionally for chromium, lead, nickel and iron. Occasional occurrences of TPH and PAH are identified and exceedances of the relevant EQS are identified for PAH compounds in up to 17% of samples analysed. Exceedances of relevant

EQS and NRWTL where applicable are observed for nutrient parameters including ammoniacal nitrogen, nitrate and orthophosphate.

5.14 The TFD hydraulically separate the Gwent Levels surface water system from the underlying groundwater in bedrock / Glacio Fluvio Deposits (GFD). Groundwater in the bedrock and GFD is typically fresh, but becomes increasingly saline (and non-potable) toward the River Ebbw in the east. Groundwater encountered in the bedrock and superficial deposits within this section is fresh in nature, of neutral / mildly alkaline pH and characterised by the presence of metals and general absence of organic contaminants.

5.15 Groundwater quality data for bedrock is limited but indicates the presence of the metals arsenic, boron, chromium, nickel and selenium. Metals concentrations only exceed their respective DWS within a single analysis, although the EQS for nickel was exceeded in three of five analyses. Typically there is an absence of organic contamination in groundwater. Porewater within the TFD in the Wentlooge Levels has a routine presence of arsenic, boron and nickel, the less frequent occurrence of chromium, copper and zinc and rare occurrence of cadmium, lead and mercury. Only occasional exceedances of DWS are observed, most notably for arsenic.

5.16 Groundwater in the shallow Made Ground is perched upon the underlying TFD. There is evidence to suggest that groundwater levels within the GFD are lower than the water groundwater levels in the underlying bedrock, which implies a downward potential for vertical flow and/or discharge from the GFD. There is evidence for declining water levels in GFD and bedrock in the vicinity of the River Ebbw. This suggests the potential for a degree of hydraulic continuity and interchange between the watercourse and adjacent groundwater bodies.

5.17 The principal receptor for groundwater in the bedrock and GFD underlying the TFD is likely to be the Severn Estuary to the south or River Ebbw in west. The low permeability expected for the TFD suggests

limited potential for vertical exchange of water (between the surface and groundwater at depth) and little lateral flow within the unit towards either the Sever Estuary or River Ebbw.

Section 3: New Bridged Section of Motorway

5.18 Water quality in the River Usk is monitored by the NRW and is characterised by a high salinity, neutral pH and the presence of heavy metals most commonly nickel, lead and zinc. No parameters measured exceed either EQS or former-CCW trigger levels, with the exception of zinc.

5.19 Groundwater in Made Ground has been shown to be perched on the TFD with little vertical exchange with underlying units. This positioning is evident from the recent additional ground investigation, during drilling surrounding the River Usk.

5.20 Groundwater contained in the bedrock and GFD have an elevated chloride concentration and are non-potable (with a mean concentration in excess of 2,200 mg/l), with elevated ammoniacal nitrogen concentrations. This is consistent with their proximity to the estuaries of the River Usk and River Ebbw.

5.21 Groundwater in the bedrock is characterised by the routine presence of metals, most notably arsenic, boron, chromium, copper, nickel, selenium and zinc and occasional occurrence of petroleum hydrocarbons although other organic compounds are largely absent.

5.22 Similarly, groundwater in the GFD is characterised by elevated chloride and ammoniacal nitrogen, with routine presence of heavy metals arsenic boron, chromium, copper, nickel, selenium and zinc although it is the DWS for arsenic, boron and selenium which is commonly exceeded.

5.23 Arsenic, boron and selenium also exceed their respective DWS limits within the bedrock and GFD in excess of c. 70% of samples analysed.

The concentration of copper, nickel and mercury exceed their relevant EQS. Mercury is present in groundwater.

5.24 Baseline quality indicates that groundwater in the bedrock and GFD is of little resource potential.

5.25 Porewater quality in the TFD is characterised by high chloride concentration (mean c. 2,000 mg/l), routine presence of metals and occasional presence of organic contaminants. Metals include arsenic, boron, chromium, copper, nickel and selenium (i.e. in more than 80% of samples analysed). Lead, cadmium and mercury occur less frequently. The DWS for arsenic, boron and selenium are exceeded.

5.26 Groundwater levels in the confined bedrock appear to be typically lower than the confined groundwater levels in the GFD. This implies a downward vertical gradient between these units. There is evidence of declining water levels in the GFD and TFD as the main water courses are approached suggesting a degree of hydraulic continuity with these water levels.

5.27 The principal receptor of groundwater within this subsection is the estuary of the River Usk and River Ebbw, although the degree of hydraulic continuity with these units is not known.

Section 4: Caldicot Levels

5.28 Water quality is characterised by neutral to mildly alkaline pH, freshwater chemistry (with the exception of one reading from location 17.3, south of Green Moore Landfill (CL-27) with a chloride concentration of 785 mg/l). DO is low to moderate, falling below the NRWTL of 5 mg/l in 56% of all samples. Key nutrients are routinely present with exceedances of relevant EQS and NRWTL observed for ammoniacal nitrogen, nitrate and orthophosphate. Dissolved metals are frequently present, notably arsenic, chromium, lead, mercury, nickel, zinc and iron with the relevant EQS occasionally exceeded for cadmium, chromium, lead, mercury, nickel and iron. Rare occurrences of TPH and PAH are identified and

exceedances of the relevant EQS are identified for PAH compounds in up to 3% of samples analysed.

5.29 The water quality in Monks Ditch has also been monitored by NRW and is characterised by freshwater with similar concentrations of nitrogen compounds, copper and zinc as seen in the reens, although DO is typically high and orthophosphate typically lower than the reens. No parameters exceed either EQS or NRWTL, with the exception of nitrogen compounds and zinc (in 4% of samples).

5.30 Groundwater has been identified in the Made Ground and bedrock with variable quality that relates to historical land-use. The water quality in the Made Ground is considered in the Contaminated Land Assessment report forming Appendix 11.1 of the March 2016 ES.

5.31 Groundwater potentiometric levels in the bedrock and TFD are typically similar, suggesting limited and/or variable potential for vertical groundwater flow. The bedrock is confined by the TFD deposits and Made Ground perched above the TFD, confirming the low permeability of this unit and limited potential for vertical transfer of groundwater between the surface and bedrock.

5.32 Groundwater identified in the TFD and underlying bedrock are commonly characterised by elevated chloride concentrations, commonly exceeding 1,500 mg/l. Taken with the observed groundwater levels, this implies there is limited potential for the vertical transfer of water between the surface and deeper bedrock.

5.33 Groundwater in the bedrock and TFD is characterised by the routine presence of some metals (most notably arsenic, boron, chromium and nickel) and occasional occurrence of petroleum hydrocarbons although other organic compounds are largely absent.

5.34 Bedrock is characterised by the presence of arsenic, boron, chromium, copper, nickel, selenium and zinc in almost all samples, with respective DWS exceeded for arsenic, boron, chromium and selenium. Measured

concentrations of copper and nickel routinely exceed their respective EQS. There is an elevated concentration of ammoniacal nitrogen with a mean concentration of 11.5 mg/l. Petroleum hydrocarbons typically occur in around 10% of samples analysed,.

5.35 Owing to their low permeability, little lateral flow is expected in the TFD. Vertical flows are also considered likely to be quantitatively trivial.

5.36 There is the potential for localised lateral flow of perched water within the Made Ground towards surface water receptors, although the significance of such flow will be dependent on the extent and lateral continuity of these deposits.

5.37 The principal receptor for groundwater in the bedrock that underlies the TFD is likely to be the Severn Estuary in the south and/or the River Usk in the west. The low permeability of the TFD units and limited potential for vertical recharge, suggest that lateral flows to these receptors will be small. Groundwater in the bedrock at this location can be susceptible to tidal influence.

Section 5: Magor

5.38 Surface water quality is characterised by neutral to mildly alkaline pH and freshwater chemistry, with moderate dissolved oxygen. Key nutrients are routinely present albeit at lower concentrations than observed in the other subdivisions described previously. Exceedance of the relevant EQS for orthophosphate was observed in 22% of samples. Dissolved metals are present in surface water, notably chromium, lead, nickel, zinc and iron with exceedances of the relevant EQS observed for iron only. A single occurrence of TPH was observed and PAH compounds are identified, with exceedances of the relevant EQS.

5.39 Fresh groundwater is encountered within all bedrock, most notably the sandstones of the Tintern Sandstone Group (TSG) and limestone of the Carboniferous Limestone Series.

5.40 Groundwater encountered in the bedrock and superficial deposits within this section is fresh in nature, of neutral / mildly alkaline pH, presence of metals and general absence of organic contaminants.

5.41 Lateral groundwater flow in the bedrock that is orientated towards the Caldicot Levels and St Brides Brook is expected. The potential for lateral flow to the bedrock concealed beneath the TFD is also expected.

5.42 Despite the limestone and sandstone geology of the inland catchment, there is a general absence of groundwater utilisation in the corridor of the new section of motorway and/or spring resurgences recorded in the general area.

5.43 The principal groundwater receptors are considered to be Brides Brook, any unidentified springs and/or spring-lines (principally associated with the limestone and/or at upland boundary with the TFD of the Caldicot Levels) and groundwater within bedrock concealed beneath the TFD.

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

6.1 The Gwent Levels SSSIs are designated primarily because of their reen and ditch habitats, the aquatic vegetation, insect, invertebrate species those habitats support. Water quality within the reens and ditches is therefore considered an important underlying supporting element of the SSSIs features.

6.2 The importance of water quality to the Gwent Levels was recognised from the outset within the project team as a critical design requirement. The nature of the proposed alignment on low lying earth embankments through the Gwent Levels imposed drainage design challenges which have been overcome to provide a functional drainage regime capable of capturing, conveying, storing, treating and discharging run-off whilst safeguarding the motorway and surrounding land from significant

increases in pluvial flood risk and the water quality of reens and ditches from significant impact from pollution. A key element of this drainage design is the provision of 12 bespoke Water Treatment Areas (WTA). The engineering design of the road drainage scheme for the new section of motorway is considered in the evidence of Mr Ben Sibert (WG 1.5.1) although the following design elements are crucial to the protection of water quality within the Gwent Levels SSSI which I will describe within my own evidence as follows.

6.3 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. In his evidence, Mr Mike Vaughan (WG 1.17.1) states that the national guidelines on flood risk require that, “the development meets an acceptable standard of flood defence for the design life of the development.” 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. Storm events of lower AEP (i.e greater than 1 in 100 years) would potentially result in overtopping of the grass lined channels permitting flood waters from the carriageway to enter the reen in closest proximity to the toe of the highway embankment. Under such storm conditions road pollution will be minimal due to complete washing of the road surface and increased dilution more generally within flood waters beyond the carriageway.

6.4 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 as shown on Figure 1 of this evidence and described as follows:

a) The use of impermeably lined grass lined channels rather than conventional concrete channels. It is proposed to intercept the run-off from the new section of motorway into grassed channels in the verge. These are trapezoidal shaped are typically 2.1m wide, widening to 3.0m wide x 0.8m deep near outfall points. Side slopes would be 1 in 1.5. Imperviously lined grass lined channels provide a high degree of pollutant attenuation. Due to the storage and retention properties of the grass lined channels, spillages on the carriageway forming run-off would not be conveyed quickly and in far lower volumes to the WTA, particularly in dry weather.

b) A Pollution Control Lagoon would intercept the “first flush” volume and be capable of capturing gross contamination that has flowed to a WTA. Baffles would prevent the onward flow of any floating hydrocarbons further into the WTA. The fore bay is sized to contain the volume of spill that could be expected to be associated with a large road tanker and can be hydraulically isolated with Penstock valves (manually controlled sluices capable of stopping flow) following such a spill to reduce the risk of contamination being transferred into the main attenuation lagoon.

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. Outfall from the Attenuation Lagoon would be restricted to the equivalent ‘greenfield runoff’ within the Gwent Levels, i.e. 3.5 l/sec for every hectare of carriageway. This rate of run-off has been agreed with NRW and has been recommended by the former Internal Drainage Board for assessment of developments within the area of the Gwent Levels for many years. The lagoon provides dilution, settlement and attenuation potential for contaminants entrained in run-off water leaving the fore bay. Manually operated penstocks would be provided on the discharge points from lagoon to provide additional

pollution control if this is appropriate during the management of an emergency.

d) Reed beds have been provided to filter water and remove pollutants within a growing medium prior to discharge to reens. Reed beds are recognised as highly effective at filtering and cleaning polluted water particularly when utilised down stream of attenuation ponds where flows are controlled and not subject to large variation. Penstocks will be provided on the discharge points from reed bed to provide additional pollution control if this is appropriate during the management of an emergency.

6.5 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 in accordance with requirements as set out in Design Manual for Roads and Bridges, Volume 4 Section 2 Part 1: (HA103/06) 'Vegetated Drainage Systems for Highways Runoff'. Such maintenance has been included in the Register of Commitments (Commitment Ref. 174) for the Scheme as provided within the December 2016 ESS.

6.6 In recognition of the high sensitivity of the River Usk SAC, tender design requirements to avoid the River Usk from the proposed bridged motorway crossing were fully adopted. Early design for the crossing identified, following liaison with NRW, the limits of the tidally wetted channel within which the features of the River Usk SAC are deemed to reside. Proposed bridge piers have been located outside of the wetted channel to avoid direct impact to water quality within the River Usk during construction.

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

7.1 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.

7.2 The construction of linear projects have inherent challenges regarding site drainage, principally as a consequence of limited space within the construction corridor and the likelihood of such projects to cross water courses and occupy land within multiple surface water catchments.

7.3 The Gwent Levels SSSIs, 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 requires a high level of protection to avoid significant impact. The project team has therefore considered the potential for impacts on the water environment from the outset and promoted approaches to construction that would be protective of the water quality, especially within the Gwent Levels SSSIs.

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

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.

7.5 To better inform the likely required level of protection of the water environment, and particularly the highly sensitive environment of the Gwent Levels SSSIs, from construction of the new section of motorway, a construction drainage design was produced.

7.6 This design 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 is presented within the Buildability Report forming Appendix SR3.1 to the December 2016 ESS.

7.7 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 and are to be provided as part of the construction drainage design.

7.8 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.

7.9 This design would comply with best practice as described in CIRIA C648 'Control of water pollution from linear construction projects' (CIRIA, 2006). Drainage control would be achieved by use of a site specific, hydraulically isolated construction drainage design comprising lateral bunds sized to allow capture and sufficient attenuation of rainfall for a 10 year return storm of two day duration.

7.10 The scheme would also allow for the temporary storage of this water to achieve adequate settlement of 7 hours prior to controlled discharge to the water environment via reens under consent from NRW. Settlement would take place within the water treatment areas specifically designed for this purpose during the construction period.

7.11 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. This provision is included in the Register of Commitments for the Scheme (Reference No. 4) as provided within the December 2016 ESS to ensure surface water runoff will meet Water Framework Directive (WFD) and SSSI requirements prior to entering the SSSI reen network.

7.12 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.

7.13 The construction phase water management design proposed would be capable of the following.

a) Retaining the volume of water from a 1 in 10 year intense (six hour) storm within the lateral lagoons without discharge to the existing reen network.
b) Settlement of fine silt transported by runoff from a 1 in 10 year long duration (48 hour) storm using water treatment area footprints

without the incoming flow rate exceeding the minimum settlement duration.

7.14 Achieving this standard would mitigate uncontrolled releases of potentially polluting drainage water and protect ambient high surface water quality within reens and ditches in close proximity to the construction corridor.

7.15 This assessment showed that construction water volumes could be stored to allow suspended solids to settle sufficiently by gravity for water to be returned to reens without detriment. Sampling of water would take place to ensure water was suitable prior to discharge as included in the Register of Commitments (Reference Nos. 102 and 103) forming Appendix SR18.1 to the December ESS.

7.16 NRW have stated however that whilst they recognise that a water sampling regime would be implemented to confirm that the settled water achieves required parameters and can be discharged into the network of reens, a concern remains as to what would occur if the water quality did not meet the required standards.

7.17 It is stated in the Pre-Construction Environmental Management Plan (Pre-CEMP (Appendix 3.2 to the March 2016 ES)) that other techniques other than settlement by gravity could, if necessary be employed to reach an acceptable discharge quality including mechanical separators or use of environmentally appropriate flocculent. The Pre-CEMP also identified tankering of water to water treatment centres as an option if necessary. These steps would be implemented if required to ensure required standards are met.

7.18 It is my opinion that these approaches would be adequate and follow the required guidance to control surface water during construction to avoid impact to the water environment from potential soluble and suspended pollutants.

7.19 The proposed re-use of site won material is proposed for the Scheme and described within Section 12.7 of Chapter 12 of the March 2016 ES. Additionally the proposed scheme would be built on or adjacent to a number of formerly developed land, some of which is currently within land regulated by NRW under the Environmental Permitting Regulations. Such materials may require remediation prior to being considered acceptable for use within the permanent works or land take.

7.20 An Outline Remediation Strategy Report and Land Contamination Management Strategy (Appendices 11.2 and 11.3 respectively to the March 2016 ES) set out an outline remediation implementation plan that includes procedures for excavation of materials, handling arrangements, dealing with unexpected contamination and monitoring. This includes an outline remediation verification plan which describes requirements to ensure that adequate records and information will be gathered during construction to provide 'lines of evidence' to demonstrate the remediation was successful. The Outline Remediation Strategy Report also sets out the need for surface water and groundwater assurance monitoring during and after construction. Further evidence on remediation is provided by Mr Andy Clifton (WG 1.11.1).

7.21 NRW have agreed that during construction, provided the principles of the Outline Remediation Strategy Report are carried through to its implementation, any adverse effects on the water environment from the re-use of site won materials can be avoided.

7.22 I conclude 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.

7.23 In my opinion, such mitigation measures and contingencies are adequate, follow appropriate guidance and would afford the necessary protection of water quality within surface water crossed or adjacent to the proposed works.

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

8.1 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).

8.2 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.

8.3 The Water Framework Directive (WFD) aims to protect and enhance water quality through the protection of designated water bodies within the European Union. Developers must ensure that new highways projects or improvement projects which will cause discharges to receiving water bodies do not lead to deterioration in its classification status. Specifically the WFD aims to:

a) Prevent deterioration, enhance and restore bodies of surface water, achieve good chemical and ecological status of such water and reduce pollution from discharges and emissions of hazardous substances
b) Protect, enhance and restore all bodies of groundwater, achieve good chemical and quantitative status of groundwater, prevent the pollution and deterioration of groundwater, and ensure a balance between groundwater abstraction and replenishment

c) Preserve Protected Areas.

8.4 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.

8.5 It is an important consideration that due to the fact that the Gwent Levels, both within and beyond the SSSIs, are highly modified environments, only a small number of WFD water bodies are present in proximity to the proposed Scheme with potential for direct impact. These are:

a) Broadway Reen
b) Usk (transitional)
c) Monks Ditch - source to Wainbridge
d) Monks Ditch - Wainbridge to mouth
e) Mill Reen - source to the R Severn Estuary

8.6 WFD water bodies present with potential for indirect impact from the proposed Scheme are:

a) River Ebbw – conference River Ebbw Fach to Maes-glas
b) Severn Lower (transitional)

8.7 The current status of the mitigation measures which have been identified for each water body based on the 2009 Severn RBMP has not been updated within the currently available updated RBMP published in December 2015. Therefore, where mitigation measures are assessed in Section 5.3 of Appendix 16.1 to the March 2016 ES, this has been based on the 2009 mitigation measure status.

8.8 A number of existing Surface Water Management Issues (SWMI) are defined within the relevant RBMP for these water bodies. Typically these reflect poor water quality – typically low dissolved oxygen and high

nutrient - as a consequence of modified land drainage caused by agriculture and land management.

8.9 Based on the WFD Compliance Assessment undertaken for the relevant construction impacts described above, 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 of the Surface Water Supporting Elements component.

8.10 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. These criteria are expressed as alkalinity specific Run-off Specific Thresholds (RST) for both a 6 hour and a 24 hour period for the dissolved pollutant and Threshold Effect and Probable Effect Levels (TEL/PEL) for the sediment bound pollutant.

8.11 RST concentrations were developed by collaborative research undertaken by the Environment Agency and the Highways Agency. This utilised short term toxicity studies for 13 algal, invertebrate and fish species along with literature data for other relevant species all chosen as representative of UK resident species with a representative range of sensitivities to significant pollutants found in road run-off. In this way the RST concentrations are protective against possible short term effects on tested and untested but sensitive species. This approach is consistent with that adopted for the derivation of Environmental Quality Standards (EQS) under the Water Framework Directive (WFD).

8.12 The NRW trigger levels (NRWTL) are comparable only to the dissolved pollutants. The NRWTL are based on WFD requirements for achieving good status with respect to water quality.

8.13 A HAWRAT assessment was carried out to inform the March 2016 ES for each proposed WTA discharge (see Appendix 16.3 and S16.3 to the

March 2016 ES and December 2016 ESS respectively). HAWRAT is to help highway designers decide whether or not pollution mitigation measures are needed in specific circumstances.

8.14 HAWRAT assessments take into account the predicted traffic density and regionally specific rainfall statistics. The runoff quality for each rainfall event and each pollutant is predicted using statistical models developed during the project 'Improved determination of pollutants in highway runoff' (Dempsey et al, 2007). These models predict the EMCs and EMSCs for all the events from a chosen rainfall series applied to a highway of a specified AADT in a specified climatic region. Rainfall characteristics (maximum hourly intensity, preceding 10 days' rain, preceding 20 days' rain, and antecedent dry weather period), AADT and climatic region were the factors that were found to account for the wide variability in the runoff concentrations measured in the project.

8.15 For soluble (acute) impacts the number of events for which the EMCs exceed the toxicity thresholds are calculated and compared with the exceedance frequency thresholds. For sediment (chronic) impacts, the number of events for which the EMSCs exceed the toxicity thresholds are calculated and compared with exceedance frequency thresholds.

8.16 Where WTA are proposed, HAWRAT adjusts the predicted discharge concentrations by a user defined factor. These factors were defined within the DMRB Assessment Report (Appendix 16.3 and S16.3 to the March 2016 ES and December 2016 ESS respectively) based on literature derived expected reduction efficiencies of individual elements contributing to overall WTA performance. For the Scheme, these include grass lined channels, a pollution prevention lagoon, an attenuation lagoon and a reed bed. There is thus a 4 element treatment train designed to treat water in this order.

8.17 To assess these elements in combination, a conservative approach of significantly underestimating performance for all elements other than the first was adopted, following guidance (CIRIA C609). In this way, pollutant

removal efficiencies for a number of principal pollutant groups were derived for four, three, two and single train WTA.

8.18 The cumulative pollutant reduction efficiencies for these WTA are documented in Appendix 16.3 of the March 2016 ES. I consider these factors to be conservative for the purposes of defining likely impact from WTA discharges. A principal reason for my view is the substantial length of grass lined channels proposed for the Scheme, especially within the Gwent Levels SSSIs, where approximately 80% of drainage channels comprise Grass Lined Channels). The length of grass lined channels totalling approximately 14km kilometres, constituting a Sustainable Drainage System (SuDS), would have a notable effect on the attenuation of pollutants within highways drainage. Firstly, studies have been shown that much shorter lengths of grass lined channels are capable of reducing pollutants in road run-off (TRL, 2006).

8.19 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 from volatilisation, hydrolysis and bio-attention, that is the breakdown and destruction of pollutants into less harmful substances and gases. Furthermore, 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.

8.20 It is also a significant aspect of the conservative approach undertaken that no account for the large lengths of grass lined channels, i.e. approximately 14 km on each carriageway, that would result in an increase in performance of pollutant reduction efficiency for the WTA treatment trains containing them.

8.21 Additionally, the preliminary 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. Such criteria optimised for the individual reed bed areas within WTA include the recommended residence time for water within the wetland prior to discharge and the recommended hydraulic loading rates that is the ratio of the flow through a wetland to its total area. 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.

8.22 However, whilst no empirical formulas exist with which to predict pollutant reduction performance efficiencies of WTA, a reasonable risk adverse approach based on well documented guidance literature is, in my opinion, an acceptable basis on which to assess the significance of potential impacts to the water environment. It is upon this basis that the WTA performance efficiencies have been evaluated to inform my evidence.

8.23 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 within water emerging from the wet sedimentation pond of the WTA, prior to discharge to a receiving watercourse.

8.24 The HAWRAT software then determines whether breach of RST and TEL/PEL is likely within the proposed watercourse by accounting for the likelihood and expected degree of soluble metal dilution and polluting sediment accumulation within a receiving watercourse based on anticipated low-flow velocities.

8.25 All of the HAWRAT assessments for each of the proposed WTA discharges met the DMRB criteria for dissolved (RST) and sediment bound (TEL/PEL) impact.

8.26 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.

8.27 For the dissolved metals of concern, copper and zinc, the TLs are actually PNECs calculated for each discharge point based on prevailing pH, water hardness and dissolved organic carbon (DOC) concentrations.

8.28 Additionally, as ABCs are lower than the HAWRAT assessment criteria for the pollutants of concern (i.e. RST concentrations) and PNECs, such an approach is the most conservative of all. WTA discharges that have no theoretical impact on existing water quality would be assessed as having insignificant impact to the Gwent Levels SSSIs.

8.29 This assessment was undertaken, firstly as reported in Appendix 16.3 of the March 2016 ES, based on averaged water quality conditions derived from all baseline monitoring data acquired from across the Gwent Levels SSSIs, and secondly following NRW's comments, based on reen specific conditions as reported in Appendix SS16.3 of the December 2016 ES. In these assessments the existing water quality is referred to as Ambient Background Concentrations (ABC).

8.30 Attenuation factors (AF) have been calculated to describe the pollutant reduction percentage required to achieve the stated compliance concentrations. Where these percentages are lower than the treatment efficiency percentages calculated for each WTA it can be reasonably concluded that the WTA is capable of treating highway run off to achieve compliance. Conversely, where the required AF if higher than a calculated WTA treatment efficiency percentage, risk of non-compliance is indicated.

8.31 Comparison of the WTA specific mean EMC to PNEC AF values for both copper and zinc show that with the exception of a minor deficiency at WTA1 of 3.6% and 0.1% for copper and zinc respectively, all discharges are attenuated to below the PNEC. A residual value has been shown, that is the difference where positive between the required and the available AF at each WTA as shown under solubles removal efficiency.

8.32 This assessment approach was also undertaken to determine an AF for each WTA to reduce the mean EMC 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 described in Appendix 16.3 to the March 2016 ES, being far larger than comparable systems in existence currently operating on the Highways estate within the UK.

8.33 Furthermore, the calculations presented in Annex 1 are based on 'event' impacted drainage entering the grass lined channels and WTA. Such events as described previously, follow a duration of dry weather - the antecedent dry weather period (ADWP) - of at least 24 hours and are therefore representative of 'first flush' road drainage. This 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 occurs within the first 10 mm of a rainfall event.

8.34 It is the case that the majority of weather events in the UK are of short duration and limited rain depth. It has been estimated that around 50% of rainfall events (probably in excess of 70 events a year in most areas), are less than 5mm (Environment Agency, 2013). HAWRAT predicts an average of 95 ADWP events of any rain depth per year occurring in the

Cardiff area, being the nearest to Newport. The Met Office long term daily rainfall data for Usk weather station (being the nearest to Newport) gives an average number of 135 days a year seeing rain of which 25 to 40 days see rainfall in excess of 10 mm.

8.35 It can therefore be appreciated that a sizeable proportion of rainfall will fall after the first flush has been generated, i.e. during first 10 mm of rainfall. Such non-event rainfall, i.e. rainfall following the first 10 mm, received at the WTA via the grass lined channels will be relatively unpolluted and dilute water stored within the grass lined channels, pollution control and attenuation lagoons, and reed bed. Treated water discharged by the WTA will be of a higher quality and require lower attenuation factors than those calculated within the tables at Annex 1.

8.36 In conclusion, based on the HAWRAT assessment's conservative assumptions on pollutant reduction performance of the WTA, i.e. utilising only half the literature recommended median performance for each subsequent treatment train within a WTA, and in particular the presence of large lengths of grass lined channels for the reasons previously stated, and no account having being made of dilution effects particularly following rainfall within reens, I believe that any measurable impact on reen water quality above the ABC would be unlikely. On this basis I am confident that WTA discharges would have an insignificant impact on reen ABC and hence not lead to deterioration of water quality within the Gwent Levels SSSIs.

8.37 Regarding the previously reported theoretical potential for WTA discharges to be above reen ABC, I must stress that this is not an absolute prediction of certainty but the findings of the assessment based on pessimistic assumptions to inform a risk assessment. The most significant and overly simplified assumption is that WTA will receive drainage with pollutants continuously at mean event concentrations. In reality, run-off events occur infrequently, typically following a period of antecedent dry weather and requiring a minimum rain depth to generate a significant run-off volume and flow to the WTA. So called first flush

events where washing of the highway occurs generating the most significant run-off events are likely to occur following the first 10 mm of a rainfall event. A large number of rainy days following the first flush of 10mm, will produce relatively little pollutant.

8.38 For this reason, the HAWRAT software uses a formula to predict EMC/EMSC that utilises statistics on the length of the antecedent dry weather period. Therefore it is self-evident that EMC/EMSC values are not attributable to perennial discharges from WTA but ephemeral events from the carriageway. Similarly, pollutant washed from the highway is limited to that deposited since the last rainfall event, i.e. of two similar, closely spaced, run-off generating rainfall events following a period of dry weather, the first will contain more pollutant than the second due to the latter rain event falling on a previously washed road surface. The rainfall patterns of the Gwent Levels, comprising many sporadic rainfall events, many of which will be prolonged, i.e. longer than a few hours, will mean fewer and lower pollution generating first flush events will be realised than that represented by a continuous discharge.

8.39 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.

8.40 I therefore conclude that the WTA are capable of preserving ambient reen water quality in the long term 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.

8.41 Given the use of large areas of grass lined, low gradient channels, I am confident that a large number of run-off events from the new section of

motorway will not generate significant run-off events at the WTA and accordingly the discharges from the WTA are overstated where grass lined channels are present.

8.42 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.

8.43 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. To aid delineation of natural variations unattributable to the new section of motorway, monitoring sites would also be chosen as representative of reen aquatic biology not considered to be in direct or indirect impact from the new section of motorway.

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

9.1 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.

9.2 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. These are described in the Drainage Strategy Report (Appendix 2.2. to the March 2016 ES) and would comprise trapezoidal shaped typically 2.1m wide

with 1 in 1.5 side slopes, widening to 3.0m wide x 0.8m deep near outfall points. Channels would be present on both carriageways where low lying embankments are proposed including the Gwent Levels.

9.3 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.

9.4 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 contains systems which are designed to retain a minimum of 50 cubic metres of oil/hydrocarbon. This capacity - a volume in excess of the capacity of two large articulated oil tankers - is sufficient to capture and retain gross pollution of highway drainage resulting from an accident on the motorway. Any oil/hydrocarbon which is not retained within the pollution control lagoon will pass into the main attenuation lagoon. The discharge out of the lagoon also contains systems to prevent oil/hydrocarbon entering the reed bed. The lagoons 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.

9.5 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.

9.6 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.

9.7 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.

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

10.1 Groundwater abstraction sources, that include boreholes, well, springs and spring fed streams, situated within the corridor of the new section of motorway have been identified from the following data sources:

a) NRW Licensed Abstraction Database (QGIS)
b) Data request to Local Authority (Newport City Council and Monmouthshire County Council)
c) Site Walkover Surveys
d) Arup Hydrogeological Assessment (Arup, 2008).

10.2 The location of all groundwater abstraction sources are identified in Figure 5.4 and Figure 9.4 and are summarised in Table 5.2 of Appendix 16.2 to the March 2016 ES.

10.3 Groundwater utilisation is largely restricted to bedrock and/or spring sources located on high ground around Castleton and Magor in the west and east respectively. There are no documented abstractions taken from the GFD or bedrock beneath the TDF of the Gwent Levels within the corridor of the new section of motorway.

10.4 It is notable that the majority of private water sources correspond with the area of groundwater emergence on the flanks of the local high

ground situated around Pen-y-lan, approximately 1 km north of Castleton.

10.5 Abstraction sources are typically for small domestic or agricultural supplies. A number of larger licensed abstractions have been identified, most notably Green Farm (Source 15) which is situated on carboniferous limestone.

10.6 Source Protection Zones are designated around important groundwater supplies for the purpose of groundwater protection. No source protection zones have been defined within the study area. This reflects the limited resource potential of the groundwater bearing units in the area.

10.7 An appraisal of potential impact to private water users is undertaken at paragraphs 16.7.42-44 of Chapter 16 of the March 2016 ES. Existing groundwater users may be affected by the following activities undertaken during the construction phase.

a) Groundwater dewatering associated with new or extended areas of highway cut, most notably around the existing Castleton Interchange.
b) Groundwater dewatering associated with the borrow pits at the eastern and western ends of the new section of motorway.

10.8 New or extended road cuttings that intercept groundwater represent a potential long term risk to the reliability of groundwater abstraction sources in terms of yield reliability. In contrast, the temporary dewatering of borrow pits represents a short term risk to yield reliability for any groundwater abstraction located in close proximity, but could represent a long term risk with respect to water quality depending on the material used to backfill the excavation. Water quality issues would, however, only represent a risk to groundwater abstraction sources situated down hydraulic gradient of borrow pits.

10.9 A qualitative evaluation of the potential risk to known groundwater abstraction sources identifies those sources at greatest risk of possible

effects from supply derogation. At the existing Castleton Interchange a single spring source is identified as being potentially at high risk and four sources at moderate risk of being affected by the proposed excavations. Three sources, principally around Knollbury, have been identified as being at moderate or high risk at the Magor end of the existing motorway.

10.10 Potential effects on private groundwater abstractors considered to be at moderate or high risk as identified would be mitigated through measures outlined in the Groundwater and Surface Water Management Plan, most notably the following.

a) Preconstruction baseline monitoring (quality and flow)
b) Construction and post construction monitoring with agreed contingency measures.

10.11 Contingency measures would include the provision of an emergency source of water should the reliability of supply and/or water quality be affected during construction phase. For two highest risk sources identified in Table 16.15 of Chapter 16 of the March 2016 ES and/or sources shown to be impacted during the construction and operation of the Scheme an alternative source of water supply shall be provided.

10.12 It is my opinion that such measures are appropriate and provide the necessary level of mitigation should such impacts be forthcoming.

11. Specific objections

11.1 This section of my evidence will water environment related matters for the Scheme in relation to objections received from statutory stakeholders and organisations, private individuals or businesses with interests in the land, such as freehold, leasehold or tenants in the draft Compulsory Purchase Order (CPO).

Natural Resources Wales

11.2 In response to the Water Treatment Area DMRB Risk Assessment (Appendix 16.3 to the March 2016 ES) that considered likely impacts based on a ranges of ambient background concentrations (ABC) recorded within the Gwent Levels SSSIs, NRW commented that rather than averaged conditions, assessments should be made on a watercourse specific basis using only data acquired over the last rounds undertaken since 2015. Notwithstanding this, NRW have stated that they have interpreted the findings of the DMRB risk assessment (Appendix 16.3 to the March ES) to mean that it is theoretically possible for WTA drainage water to enter the Gwent Levels above the recorded ABC and that this would have significant adverse effects on the integrity of the Gwent Levels SSSIs.

11.3 In this connection, NRW have commented that a key concern of theirs is that the pollutant reduction efficiency figures provided in the assessment within the Environmental Statement are still only theoretical and not based on any real testing. Additionally, NRW state that they have practical experience of advising on and witnessing the significant problems which other, much smaller, developments have produced when seeking to meet their requirements for water quality discharges to the Gwent Levels, although the type of development in question was not stated.

11.4 Following a meeting with NRW water environment and conservation specialists on 8th November 2016, NRW suggested that HAWRAT assessments should be reviewed with caution, i.e. as producing overly optimistic results, given the very low flows within the Gwent Levels and the reliance of HAWRAT to some extent on the presence of flow to dilute and disperse pollutants from proposed discharge outfalls to reens.

11.5 We therefore undertook a revised WTA risk assessment to review the assumptions regarding flow within reens and to identify areas where the assessments on soluble and sediment risk could be made more

representative and/or less optimistic than those originally undertaken for the Environment Statement.

11.6 This revised assessment, (Appendix SR16.3 to the December 2016 ESS) identified a number of areas where additional conservatism was introduced. These included

a) Reduction in modelled reen widths from generic to site estimated values.
b) Reduction of the assumed theoretical Q95 flow of reens from 0.0005 to 0.0001 m^3/s.
c) Use of the Flood Consequence Assessment (Appendix 16.1 to the Environmental Statement) to verify assigned Q95 are not likely to be over optimistic.
d) Sensitivity analysis on HAWRAT assessment results undertaken without reliance on in reen dilution for soluble pollutants.

11.7 The results of this assessment showed that the proposed discharges, under pessimistic assumptions of low flow conditions, were highly likely to meet NRW requested Trigger Levels prior to discharge to reens but also likely to maintain existing Ambient Background Concentrations (ABC). This showed that the original proposed assessment objective for the WTA, i.e. that existing water quality in reens should be preserved, would be realised.

11.8 A further meeting, requested by NRW, was held on the 20th December 2016 to discuss potential water quality impacts arising from WTA discharges. Although NRW had not reviewed Appendix SR16.3 at the time of the meeting, discussions were positive.

11.9 A concern over chloride pollution of surface water as a result of winter road treatment from rock salt gritting was discussed. Whilst precise application rates of rock salt could not be predicted day to day during severe winter weather, it was recognized that as a theoretically worst case scenario, short term salinisation of reens could occur and that this

impact might extend into early spring, which would pose greater risk to aquatic ecology than during winter months.

11.10 NRW also stated that proposed monitoring of reens, whilst capable of capturing long term or seasonal water quality trends, would not necessarily record short term high chloride concentrations following a prolonged period of gritting with rock salt. NRW consider this risk to be unacceptable given potential high sensitivity of aquatic biology to elevated chloride concentrations.

11.11 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 winter treatment strategy. This strategy may take longer than 5 years to finalise should consecutive mild winters prevent collection of suitably robust data sets to determine with certainty the magnitude of risk presented to water quality from rock salt gritting. An agreement will therefore be required to be reached with NRW and Welsh Government on the effective management of road treatment during severe winters to prevent unacceptable impact on the water quality from chloride.

11.12 Welsh Government is procuring specialist equipment capable of spreading CMA on the road network and so will have the ability to use CMA if necessary on the new section of motorway. The operational use of CMA as an option for road treatment during extreme winters will continue to be discussed between Welsh Government and NRW.

11.13 In summary there is a high degree of confidence in the proposed highway drainage design having negligible impact on the water quality within the Gwent Levels SSSI. This reinforces the conclusion made within the Environmental Statement .

11.14 NRW have also commented on the drainage proposals that whilst welcoming the use of sediment sumps, catchpits and bypass separators as proposed, the information provided in the ES does not demonstrate how these various control measures will be monitored to ensure only water of appropriate quality will be discharged at greenfield rates to the watercourses of the Gwent Levels SSSIs.

11.15 In response to this query, it is intended to monitor the outfall of the WTAs both upstream and downstream of the discharge point to ensure water quality of receiving reens is not adversely impacted. The Statement of Commitments includes this monitoring.

11.16 NRW have also recommend that reference is made to the specific threshold limits or 'trigger levels' for the key determinants and that suitable remedial action should be identified should these thresholds be exceeded, and a full reporting mechanism be put in place.

11.17 In response to this requirement, the project team want to agree performance criteria with NRW for each of the WTA discharges. To this end, a meeting was held with NRW water quality and conservation experts where new compliance criteria for the Gwent Levels SSSIs were discussed.

11.18 Trigger levels are useful data management approaches to provide better understanding of WTA performance and to draw the attention of operators and regulators to the development of adverse, or unexpected, trends in the monitoring data.

11.19 Control levels are additional specific concentrations defined as criteria below which a WTA can be considered to be operating within expected an acceptable pollutant reduction efficiency. Additionally, control levels can be set to allow for variation in natural water quality from baseline conditions as well as giving sufficient time to take corrective or remedial action before trigger levels are breached.

11.20 As a result of this discussion, it is therefore proposed to maintain quarterly monitoring during the 5 year aftercare period to demonstrate compliance with the NRW trigger levels but also to identify baseline conditions and trends so that any statistically relevant deviations can be identified and contingencies put into practice before a trigger level is potentially breached. Accordingly a control level will be defined for each pollutant at the 95th%ile of the baseline data set or similar in agreement with NRW. In this way, the range of natural variation of baseline conditions can be accounted for. A significant control level breach will be considered to have occurred following 3 consecutive exceedances of the control level or other number in agreement with NRW. Such an approach allows for sporadic, non-repeating fluctuations to be observed but discounted as not in themselves considered as significant or warranting immediate corrective actions.

11.21 Following the identification of a significant control level breach following consecutive exceedances of a control level, corrective action would be started. This would be agreed with NRW within the Surface Water Management Plan but would typically involve the communication of the event to concerned parties, the instigation of further monitoring to verify conditions and further investigations of the drainage catchment to identify likely causes and to propose mitigation. In the first instance, this would likely be the inspection of the grass lined channels and WTA for possible causes potentially leading to the removal of silts from grass lined channels or WTA lagoons or partial regeneration of reed beds.

11.22 I consider that this methodology will provide the necessary understanding of drainage treatment functionality and provide evidence to NRW of adequate levels of WTA performance and hence protection of surface water quality, whilst allowing for timely identification and intervention should significant deficiencies in WTA performance occur.

Gwent Wildlife Trust

11.23 The Gwent Wildlife Trust (GWT) have objected to the scheme on grounds that newly constructed reens and ditches – some of which are 'aligned at the base of the motorway embankments – would be at a much higher risk of pollution incidents into the future thereby jeopardising the whole reen system.

11.24 GWT further state that there is no evidence given to support the view that pollutants would always be diluted to acceptable levels. Clearly there is also the risk of an accident on the motorway whereby a vehicle might fall onto the embankment resulting in direct pollution into an adjacent reen. As the proposal is to link these reens beside the embankment with the main system across the Levels any resultant pollution could spread a considerable distance along the reens threatening the unique wildlife found there.

11.25 Risks of pollution of the water environment from accidents have been assessed according to DMRB guidelines. This shows that the new section of motorway, according to the acceptable risk factors provided by the DMRB methodology for new sections of motorway, exceeds these standards and accordingly can be confidently expected to limit pollution risk to acceptable levels. Furthermore, the design of the motorway drainage within the Gwent Levels is such that protection of the SSSI will be afforded by the grass lined channels present beyond the hard shoulder on both carriageways. The grass lined channels are capable of capturing and curtailing spills and major pollution events within the road corridor thus preventing discharge to the SSSI.

OBJ0035, OBJ061, OBJ0064, OBJ0087, OBJ106, OBJ109, OBJ111, OBJ119, OBJ183

11.26 These objections concern pollution seeping off the road surfaces into and causing harm to the surrounding waterways of the SSSIs.

11.27 As described in Chapter 16 of the Environmental Statement and evidenced above, the proposed new section of motorway has been designed to capture all surface water run-off via naturally cleansing grass lined channels or conventional concrete channels where this is not feasible.

11.28 Captured water would then be conveyed by gravity into twelve dedicated water treatment areas (WTA) located at regular intervals along the alignment. Only once water had been passed through a sequence of treatment processes including sediment and oil traps, an open water lagoon and a large reed bed would water return to the SSSIs via a discharge to a main reen. The quality of water at each proposed discharge point has would meet water quality requirements for the Gwent Levels SSSIs.

11.29 A risk assessment has also been undertaken (Appendix 16.3 to the Environmental Statement) for the likelihood of serious pollution resulting from potential accidents on the new section of motorway. This assessment showed that the Scheme exceeds the DMRB design standards for limiting the risk of pollution prevention from accidents.

11.30 The presence of grass lined channels within the verges of the new section of motorway within the Gwent Levels will prevent spills and pollution events that may occur on the carriage way from leaving the embankment and entering the SSSIs. Furthermore, the presence of pollution control lagoon areas within each WTA will allow significant pollutant flows to be captured and prevented from flowing through the open water lagoon and reed bed thus avoiding pollution of the reen receiving the treated water discharge.

OBJ0077

11.31 This objection concerns the risk of pollution and reduced water quality to the Gwent Levels especially during periods of heavy rainfall.

11.32 As described in Chapter 16 of the Environmental Statement, the proposed new section of motorway has been designed to capture all surface water run-off via naturally cleansing grass lined channels or conventional concrete channels where this isn't practically feasible.

11.33 Captured water would then be conveyed by gravity into twelve dedicated water treatment areas located at regular intervals along the alignment. Only once water has been passed through a sequence of treatment processes including sediment and oil traps, an open water lagoon and a large reed bed does water return to the SSSIs via a discharge to a main reen. The quality of water at each proposed discharge point has been assessed as meeting water quality requirements for the Gwent Levels.

11.34 It was recognised at an early stage that the ability of the drainage and pollution control systems to function during all weather conditions was essential to manage water quality and flood risk within the Gwent Levels.

11.35 The normal design standards for trunk roads and motorways are that drainage systems are designed to accommodate a 1 year return period storm within the pipework and ensure that a 5 year return period storm does not result in surface flooding. On the M4CaN project this was recognised as being an inappropriate standard due to the risk of potentially contaminated surface water finding its way into the reen system on the Gwent Levels.

11.36 For the project the highway drainage systems have been designed to contain all flows up to a 100 year return period storm including a 30% increase in precipitation to account for climate change. This will ensure that the drainage systems are capable of conveying all this flow to the Water Treatment Areas (WTA) for attenuation and treatment.

11.37 When flows enter the WTA they first pass through a pollution control lagoon before entering the main attenuation lagoon. The pollution

control lagoon contains systems which are designed to retain a minimum of 50 cubic metres of oil/hydrocarbon. Any oil/hydrocarbon which is not retained within the pollution control lagoon will pass into the main attenuation lagoon. The discharge out of the lagoon also contains systems to prevent oil/hydrocarbon entering the reed bed. The lagoons have the capacity to retain very large volumes of oil/hydrocarbon.

11.38 The attenuated flow is then trickle fed through the reed bed for final polishing and treatment.

11.39 Penstocks will be provided on the discharge points from the pollution control lagoon and reed bed to provide additional pollution control if this is appropriate during the management of an emergency.

11.40 The main attenuation lagoon has been designed to restrict flow to the equivalent ‘greenfield runoff’ within the Gwent Levels. The attenuation lagoons have sufficient storage capacity to attenuate flows from a 100 year return period storm including a 30% increase in precipitation, (climate change). Discharge rates from the attenuation lagoon are restricted to a flow equivalent to 3.5 l/sec for every hectare of carriageway. This rate of run-off has been agreed with NRW and has been used by the Internal Drainage Board for developments within the area of the Gwent Levels for many years.

11.41 Filter drains will be introduced at the base of the cuttings to control ground water where appropriate.

11.42 The appropriateness and resilience of the WTA design under conditions of flooding is provided within the evidence of Mr Mike Vaughan.

12. Conclusions

12.1 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. The use of four independent, robust and scientifically studied and sustainable drainage systems (SuDS) in the majority of the proposed Water Treatment Areas - comprising impervious grass lined channels, pollution prevention lagoon, attenuation lagoon and reed bed – provide substantial potential spare capacity in the proposed treatment of road drainage. Additionally, the inclusion of a pollution control lagoon in each WTA, provides a capability to capture large highway spills to prevent them from reaching the water environment.

12.2 Similarly, in recognition of the high sensitivity of the River Usk SAC, the Welsh Government specified tender design requirements to avoid the River Usk SAC from the proposed bridged motorway crossing. The design team adopted these standards. Following early liaison with NRW, the Usk bridge design team identified the sensitive limits of the tidally wetted channel within which the features of the SAC reside. Proposed bridge piers have been located outside the wetted channel to avoid direct impact to water quality within the River Usk during construction.

12.3 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. Extensive surface water monitoring is proposed during construction to identify and manage run-off that could lead to unacceptable impact to

water quality and to demonstrate compliance with water quality criteria to be agreed with NRW during the works.

12.4 The team undertook an operational motorway drainage quantitative risk assessment following DMRB methodology which is scientifically validated for the protection of aquatic biology. This methodology pays specific attention among other things to protecting water quality within Protected Sites so is appropriate for assessment of potential impact to the Gwent Levels SSSIs from soluble and suspended pollutants. This methodology also includes a quantitative assessment methodology for the assessment of risk of pollution occurring as a consequence of spills arising from road traffic accidents.

12.5 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. The modelling justifies the conclusion that operational drainage will not lead to exceedances of NRW trigger levels for the SSSI based on Water Framework Directive Environmental Quality Standards.

12.6 Existing baseline water quality has been and continues to be monitored at reens which are proposed to receive treated highways drainage. Here too, the modelling justifies the conclusion that operational drainage will not lead to exceedances of long term ambient background reen water quality identified within the SSSI for the pollutants.

12.7 Contingency measures have been identified to provide further guarantees of long term performance of the WTA including 5 years of operational water quality and ecological monitoring of reens. This monitoring would check baseline conditions are being preserved within historical ranges to demonstrate the absence of a measurable impact on the water quality of the Gwent Levels SSSI in proximity to the proposed discharges. WTA would be subjected to a programme of review and

maintenance according to guidance to ensure future functionality and water treatment performance.

12.8 Additionally, options have been identified to mitigate water quality concerns through the adjustment of flows through reens receiving discharges at certain times of the year should water quality trends be judged to be seasonally unacceptable. Finally, reen sediment chemical monitoring would be undertaken as part of the reen dredging programme to identify any likely accumulations of motorway derived polluted sediments.

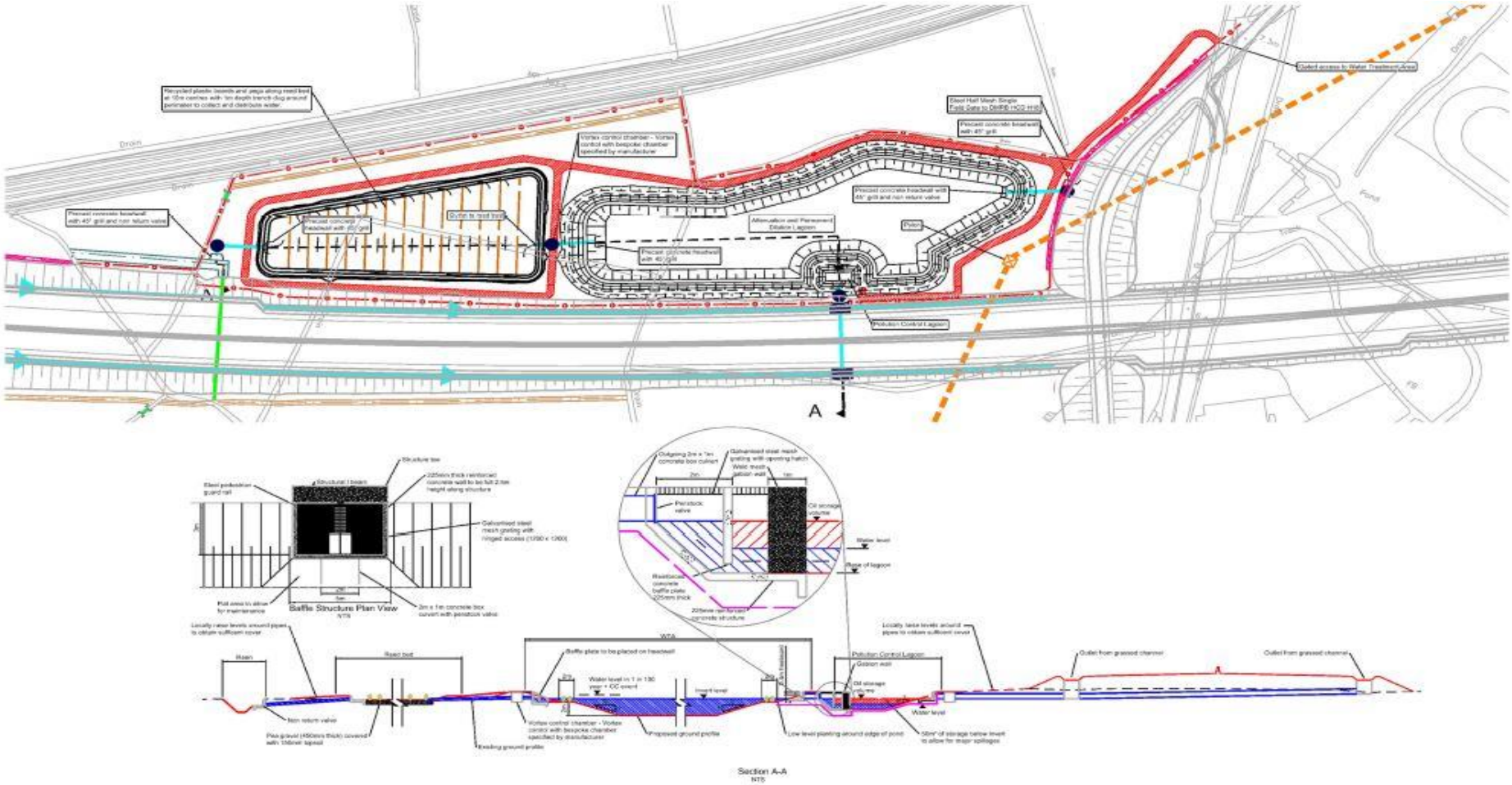
12.9 An Outline Remediation and Land Contamination Management Strategy have been agreed with NRW. These would ensure protection of the water environment during and following construction.

12.10 Private Water Abstraction users have been identified and those at risk will be monitored for potential interruption or denigration of supply. Temporary water supplies would be provided to replace any resources considered to have been made unreliable or unpotable as a consequence of the construction works. In the unlikely event of permanent unacceptable impact, alternative permanent water supplies would be provided.

12.11 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.

13. Appendices

Appendix 1: Indicative plan and cross section of a proposed Water Treatment Area (WTA)


Drain
Vortex control chamber - Vortex control with bespoke chamber specified by manufacturer
Precast concrete headwall with 45° grill and non return valve
Attenuation and Permanent Dilution Lagoon
Pump
Pollution Control Lagoon
A
Baffle Structure Plan View
N.T.S
Section A-A
N.T.S
Baffle plate to be placed on headwall
Vortex control chamber - Vortex control with bespoke chamber specified by manufacturer
Pollution Control Lagoon
Outlet from grassed channel
Legend
Access Track
Grassed channel
Culvert
Headwall
Manhole
Replacement rens
Replacement field ditch
Cut off ditch