Welsh Government

# M4 Corridor around Newport

## Environmental Statement Volume 3: Appendix 16.3

## Water Treatment Area DMRB Risk Assessments

M4CaN-DJV-EWE-ZG_GEN-RP-EN-0005

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# Contents

# 1 Introduction

## 1.1 Background

**1.1.1** This Water Environment Risk Assessment (WERA) is designed to meet the requirements of the Design Manual for Roads and Bridges (DMRB) standards prescribed in Volume 11 Section 3 Part 10 (HD45/09) titled 'Road Drainage and the Water Environment' ('the Standard') (Highways Agency *et al.*, 2009).

**1.1.2** The Standard gives guidance on the assessment and management of the impacts that road projects may have on the water environment during operation. These include possible impacts on the quality of waterbodies and on the existing hydrology of the catchments through which roads pass.

**1.1.3** Possible impacts on the water environment resulting from construction of the Scheme and their monitoring and mitigation are reported within the Environmental Statement (ES) and Pre-Construction Environment Management Plan (Pre-CEMP) in accordance with the obligations and requirements of environmental legislation policy.

**1.1.4** This report supports Chapter 16 of the ES for the M4 Corridor around Newport (hereafter referred to as the Scheme).

## 1.2 Objectives

**1.2.1** In accordance with the Standard, the objective of the WERA is to provide a surface water dataset that shall enable the characterisation of baseline water conditions (in terms of quality, level and flow) in sufficient detail to allow:

- effects of routine runoff on surface waters;
- effects of routine runoff on groundwater; and
- pollution impacts from spillages.

**1.2.2** Flood impacts arising from the Scheme are assessed and reported separately within the Flood Consequences Assessment (FCA) forming Appendix 16.1 of the ES.

## 1.3 General Approach

**1.3.1** The Standard specifies procedures for the assessment of pollution impacts from routine runoff on surface waters, groundwater and from accidental spills, known as Method A, Method C and Method D respectively.

**1.3.2** Only Methods A and D have been used as all proposed road drainage outfalls have been designed to discharge to surface waters, therefore there would be no pollution impact on groundwater from routine runoff.

**1.3.3** The Method A assessment comprises two separate elements - the Highways Agency Water Risk Assessment Tool (HAWRAT) (Highways Agency Drainage Data Management System (HADDMS), 2009) and the Environmental Quality Standards (EQS) assessments.

**1.3.4** HAWRAT is an application designed to assess the short term risks related to the intermittent nature of road runoff. It assesses the acute and chronic pollution impacts on aquatic ecology associated with soluble and sediment bound pollutants respectively. It is used to help highways designers decide whether pollution mitigation measures are needed in specific circumstances.

**1.3.5** Full details on the development and use of HAWRAT can be found in the Standards and in the HAWRAT User's Manual (HADDMS, 2009), which includes background information on the research programme behind the tool, derivation of the toxicity thresholds used and explanation of the background calculations.

**1.3.6** EQS are the maximum permissible annual average concentrations of potentially hazardous chemicals, as defined under the Water Framework Directive (WFD). The long term risks over the period of one year are assessed through comparison of the annual average concentration of pollutants discharged with the published EQS for those pollutants.

**1.3.7** The Method D assessment is an empirical methodology utilising look up tables for probabilities of accidents and risk from pollution. Mitigation can be considered in the form of risk reduction factors associated with up to two complementary drainage treatment types.

## 1.4 Supporting Reports

**1.4.1** The routine runoff drainage design for the new section of motorway is reported within the Drainage Strategy Report forming Appendix 2.2 of the ES.

**1.4.2** Mitigation of existing watercourses severed by the Scheme is reported in the Reen Mitigation Strategy forming Appendix 2.3 of the ES.

**1.4.3** The findings of an ongoing programme of baseline monitoring of surface watercourses and groundwater is reported within the Baseline Water Environment Report forming Appendix 16.2 of the ES.

# 2 Drainage Design

## 2.1 Design Principles

### Overview

**2.1.1** For the majority of its length, the proposed new section of motorway is located within the Caldicot and Wentlooge Levels (collectively known as the Gwent Levels), which comprise soft ground with a very high water table. In order to minimise settlement, impact upon the ground water level and visual intrusion, it is proposed to maintain a low level embankment on which the motorway is constructed.

### Surface Water Setting

**2.1.2** The surface water setting of the proposed new section of motorway drainage design is described within the Baseline Water Environment Report (Appendix 16.2 of the ES). The proposed alignment would cross three distinct topographic zones:

- high elevation, Devonian hills in the west around Castleton (Junction 29) (elevation of up to approximately 60 metres Above Ordnance Datum (AOD));
- low-lying, flat coastal plain of Gwent Levels (elevation of below 10 metres AOD); and
- high elevation Carboniferous hills in the east around Magor (Junction 23A) (elevation of up to approximately 60 metres AOD).

**2.1.3** In its mid-section, the route would cross the River Ebbw and River Usk which discharge into the Severn Estuary, to the south of Newport. The proposed alignment would also cross the Alexandra Docks, between the Usk and Ebbw. To the west and east are the Wentlooge Levels and Caldicot Levels respectively. Only in the vicinity of Newport and Llanwern are the Gwent Levels extensively developed.

**2.1.4** The Gwent Levels are dissected by an extensive network of tide locked freshwater drains, locally known as reens, that drain a complex array of smaller internal field drains. The Gwent Levels are almost entirely designated as Sites of Special Scientific Interest (SSSIs).

**2.1.5** Natural Resource Wales (NRW) maintain agreed summer and winter “penning levels” within the system as described in their Water Level Management Plan (CWLDB, 1995). The change to low winter penning levels occurs in October, with water levels raised to the high summer penning levels in July. In addition to maintaining water levels through the system of sluice gates, NRW also undertake an annual programme of dredging and clearance of the main reens.

**2.1.6** Field observations during water quality monitoring in 2015 demonstrate that during the summer penning months the reen system is characterised by extremely low flow with apparently stagnant areas. During the winter penning, lower levels are maintained to facilitate elevated flows to convey flood waters to the Severn Estuary.

### Reen and Ditch Mitigation

**2.1.7** New reens are generally provided on one side of the proposed new section of motorway to provide improved connectivity, by connecting existing reens severed by the alignment to culverts located through the embankment. These reens would be excavated to a depth of 2 metres with 1 in 1 side slopes, a 0.7 metre berm and approximately 5.7 metres wide at the surface. The total length of replacement reens and field ditches would be equal to or greater than the reens and field ditches to be infilled.

**2.1.8** On the other side of the proposed new section of motorway, smaller field ditches would be used to connect the existing field ditches to the nearest main reens. These would be 2.5 metres wide with 1 in 1 slopes and would be 1 metre deep.

### Routine Runoff Capture

**2.1.9** The very flat longitudinal gradients across the Levels would exclude the use of kerb and gully and a piped drainage system because the longitudinal falls necessary for this system could not be achieved in an efficient way.

**2.1.10** It is therefore proposed to intercept the runoff from the motorway into impermeably lined grassed channels in the verge (Inset 1). It is anticipated that they would be lined with a geo-synthetic clay liner below 50 mm of topsoil. This eliminates the risk of surface water runoff containing possible pollutants seeping into the underlying ground.

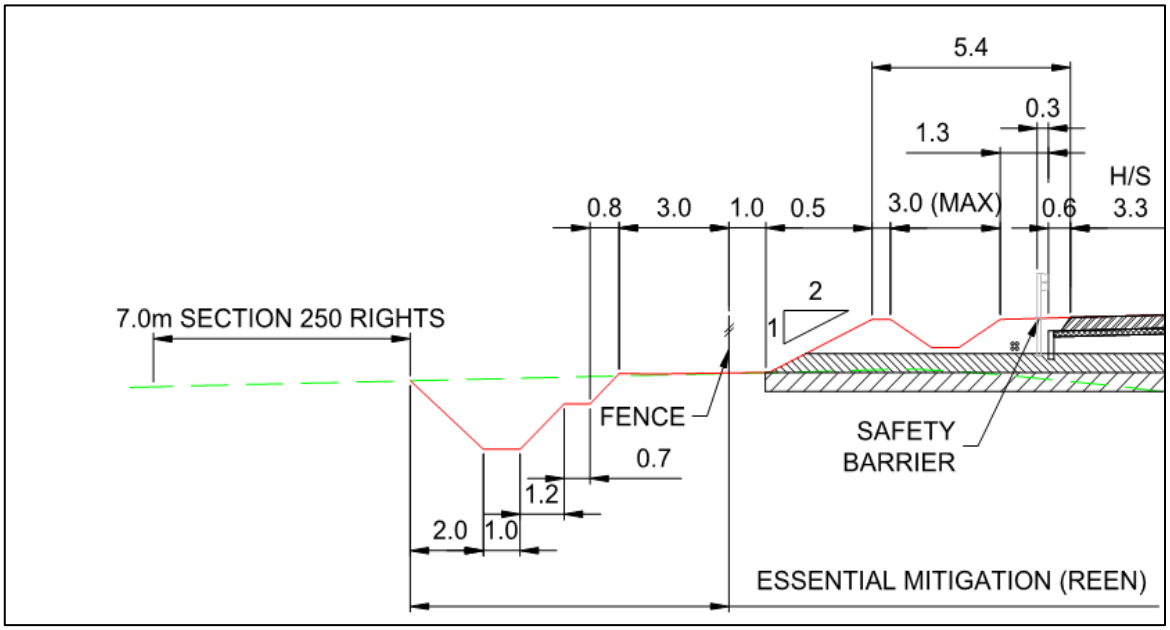
**2.1.11** The grass lined channels would be trapezoidal shaped typically 2.1 metres wide, widening to 3 metres wide and 0.8 metres deep near the outfall points,. Side slopes would be 1 in 1.5 side slopes. These channels would route surface water overland from the drained carriageway to the water treatment areas (WTA). The grassed channels would follow the gradient of the motorway, typically 1 in 7,000 through the Levels.

**2.1.12** Over some stretches of the proposed new section of motorway, the road would be super-elevated and drainage to the median channel would be required. The central reserve would be hardstanding, with a concrete vertical concrete barrier where a concrete channel would be used. The channel would be designed for a 1 in 5 year return period and outfalls are generally limited to locations which are close to the WTA, i.e. at the low points.

**2.1.13** The size of the channel would be limited by the amount of space available in the central reserve. Generally the central reserve would be 1.5 metres wide, however as a result of widening for visibility on some curved sections the size may vary. The depth of the channel would be limited to 0.15 metres as this is the largest allowable depth which is not required to have a barrier between the channel and the road edge.

**2.1.14** The South Wales Trunk Road Agency (SWTRA) have proposed that they would maintain the grassed channels using self-propelled or remote control mowers. These would require cutting 3 times a year in late spring and summer. Grass length should not be longer than 75 mm, in accordance with DMRB HA 119/06 (Highways Agency *et al*., 2006a).

**Inset 1: Typical section of highway across the Gwent Levels**




## Groundwater

**2.1.15** No routine runoff is designed to be discharged to soakaway or permeable channels that would present a risk to groundwater. The assessment of the effects of routine runoff on groundwater (DMRB Method C) is therefore not required.

## Flood Risk

**2.1.16** The grassed channels within the SSSI designated areas of the Gwent Levels are currently proposed to cater for a 1 in 100 year storm event with a 30% allowance for climate change. Substantial storms in excess of this return period event would overflow over the highway embankment into the adjacent field reens, but it is considered that a storm intensity of this magnitude would dilute any pollutants to acceptable levels, and that the statistical probability of the storm occurring is very low.

**2.1.17** The culverts beneath the proposed new section of motorway embankment with discernible catchments would be designed to cater for the 1 in 100 year plus climate change storm events.

**2.1.18** Each attenuation lagoon would be designed to cater for a 1 in 100 year storm event with an allowance for climate change. Historically, the greenfield runoff rate has been restricted to 3.5 litres/second/hectare (l/s/ha) as set by NRW. Through consultation during the EIA process, NRW have stated that this value is appropriate for the design.

**2.1.19** Flood risk impacts have been reported within the Flood Consequence Assessment forming Appendix 16.1 of the ES. The modelling concludes the impact from flooding is of neutral significance in DMRB terms, i.e. change in peak flood level within +/- 10 mm at 1% annual probability, as a consequence of the construction of the new section of motorway. It is judged that local exceedances

of this criteria can be mitigated through management of sluices incorporated into the drainage design.

### Water Treatment Areas

**2.1.20** Bespoke WTA are proposed for the routine highways drainage. These are typically located at low points along the alignment. The runoff in the grassed channels would discharge to desilting catchpits through a series of gully gratings.

**2.1.21** The desilting catchpit would be constructed within the width of the grassed channel or the median channel and would be maintained from the motorway. From the catchpits the water would flow into the water treatment and attenuation areas. They would include the provision to capture hydrocarbons and grits prior to flows entering the main attenuation lagoons.

### Treated Water Discharges

**2.1.22** Surface water runoff, after attenuation and treatment, would discharge to the major reens draining the Gwent Levels. This would either be directly by pipe or by the addition of engineered field ditches, which would discharge to the main reens. Table 2.1 summarises the drained areas flowing to each proposed outfall.

**Table 2.1: Drainage Outfall Characteristics**

| Outfall | Contributing Impermeable Area (Ha) | Chainage | | Drain Channel Type | Notes |
|---|---|---|---|---|---|
| | | Start | End | | |
| 1 | 9.3 | 1+350 | 3+000 | Concrete | A48M / Existing M4 Junction |
| 2 | 11.5 | 3+000 | 4+300 | Concrete | M4CaN / Existing M4 Junction |
| 4a | 4.3 | 4+300 | 6+500 | Grass | Embankment in SSSI |
| 4b | 4.2 | 4+300 | 6+500 | Grass | Embankment in SSSI |
| 5 | 7.3 | 6+500 | 8+150 | Grass | Embankment in SSSI |
| Ebbw West | 1.3 | 8+150 | 8+400 | Concrete | Embankment in SSSI |
| Ebbw East inc. SDR link | 11.0 | 8+600 | 10+150 | Concrete | Docks Junction and Usk Crossing (west) |
| Usk | 2.9 | 10+150 | 11+100 | Concrete | Usk Crossing (east) |
| 6 | 4.8 | 11+100 | 12+400 | Concrete/ Grass | Super Elevated |
| Meadows Road (north) | 0.34 | na | | Concrete | Side Road |
| Meadows Road (south) | 0.34 | na | | Concrete | Side Road |
| 7 | 4.1 | 12+400 | 13+300 | Grass | Embankment in SSSI |
| 8 | 9.0 | 13+300 | 15+500 | Grass | Embankment in SSSI |
| 8a | 1.0 | na | | Concrete | Glan Llyn Junction |
| North Row (north) | 0.31 | na | | Concrete | Side Road |
| North Row (south) | 0.34 | na | | Concrete | Side Road |
| 9 | 15.8 | 15+500 | 19+100 | Grass | Embankment in SSSI |
| 10 | 3.3 | 19+100 | 20+250 | Concrete | Embankment in SSSI |
| 11b | 6.0 | 20+250 | 21+250 | Concrete | D2AP/M4CaN Junction |
| 11c | 5.0 | 21+250 | 22+050 | Concrete | D2AP/Existing M4 |
| 12a | 14.4 | 22+050 | J23 | Concrete | Existing M4 |
| 12b | 0.73 | J23 | | Concrete | D2AP/M48/Existing M4 Gyratory |

# 3 Water Treatment Area Stages

## 3.1 Introduction

**3.1.1** Each WTA is proposed to provide bespoke runoff capture, bypass interception, settlement, flow attenuation, treatment and controlled discharge back to the water environment. This is achieved by a number of individual elements that when considered together represent a water treatment train.

**3.1.2** The components making up the treatment train are described in this section and comprise the following:

- stage 1 – grass lined or concrete channels;
- stage 2 – bypass oil separator / pollution control lagoon;
- stage 3 – wet balancing pond; and
- stage 4 – sub surface flow (SSF) reed bed.

## 3.2 Stage 1: Grass Lined Channels

**3.2.1** CIRIA C609 (CIRIA, 2004) summarises that grass lined channels should be designed to:

- treat the water quality volume to remove pollution;
- provide storage as necessary to achieve other design criteria;
- half empty within 24 hours so that storage and treatment is available for following events and vegetation is not damaged by saturated conditions (unless it is a wet swale); and
- convey runoff from extreme events through the swale without causing erosion.

**3.2.2** Additionally, the principal pollutant removal mechanisms are summarised as:

- settling and trapping of sediment in vegetation;
- adhesion of sediment and pollutants to plants;
- filtering and adsorption in the underlying soils (dry swales only); and
- nutrient uptake by plants.

**3.2.3** For the purposes of assessment, a number of key contaminants are identified within these broad groups of pollutants, as discussed in Section 4 of this report.

**3.2.4** Swales generally remove pollutants for frequent small storm events (Ellis, 2003). For larger, less frequent storms of between a 50 and 10 per cent annual probability (1 in 2 and 1 in 10 year return period), they can act as a storage and conveyance mechanism.

**3.2.5** For larger storms with an annual probability of less than 10 per cent (return periods greater than 1 in 10 years), providing storage in swales may become impractical as catchment size increases and they are often used in conjunction with other techniques.

**3.2.6** The use of grassed channels has been identified as a means of reducing pollution and promoting a more sustainable drainage system compared to conventional drainage systems. The proposed grassed channels would be dry during dry weather, enhancing their pollutant removal capability, but during a rainfall event the water would flow into them from the carriageway and move slowly to the outfall point. The flow of water would be retarded and filtered by the grass. Sediment would be deposited and oily residues and organic matter retained and broken down in the top layer of soil and vegetation.

**3.2.7** Additionally, during a rainfall event, a proportion of the runoff may be lost due to evaporation and transpiration. The grass lined channels would have maximum dimensions of 3 metres across the top and 0.6 metres at the base with a depth of 0.8 metres. This equates to an in channel storage volume of up to 1.44 $m^3$ per linear metre. Within the Levels embankment sections, the proposed new section of motorway would incorporate grass-lined channels on both carriageways. Given the length of embankment present, a significant additional storage volume is present within these channels totalling up to 2,880 $m^3$ of storage for every kilometre of embankment.

**3.2.8** Generally, the performance data show that well-designed and well-maintained swales are good at removing potential pollutants associated with routine runoff, particularly total suspended solids (TSS), metals and hydrocarbons. However, swales are less effective at removing dissolved pollutants and very low removal rates (of less than 10 per cent) can be expected.

**3.2.9** Studies reported in CIRIA C609 concluded that confidence in removal efficiency fell with lower residence times and that the distance water travelled along a swale had a strong influence on pollutant removal and increased travel along the swale improved removal of total suspended solids. Similarly, water depth also affected removal rates. A greater depth resulted in less effective removal of total suspended solids, because the water flowed over the vegetation rather than being filtered through it. The same effect was noted for metals, as would be expected, since metals in runoff are generally attached to sediment.

**3.2.10** The very long (> 1 kilometre), low fall (1 in 7,000) grass lined channel lengths proposed within the drainage strategy are considered to be highly effective attenuation pathways for highways runoff providing long residence times and low flows for the substantial majority of storm events. These are the most favoured conditions for maintaining high pollutant attenuation efficiencies.

## 3.3 Stage 2: Bypass Oil Separator / Pollution Control Lagoon

**3.3.1** The first stage of treatment within the WTA would be a Pollution Control Lagoon designed with a storage capacity of 50 $m^3$ capable of separating oil via a baffle plate. In addition to acting as a bypass oil separator, this lagoon would also function as a grit and sediment trap as well as a means of containing a major spill on the carriageway which is capable of flowing into a WTA. A Pollution Control Valve would permit this volume to be isolated and bypassed to allow pollutant recovery.

## 3.4 Stage 3: Wet Balancing Pond

**3.4.1** Each WTA would incorporate a permanently wet balancing pond providing a bunded volume of up to 1.1 metre above existing ground level to retain the 1 in 100 year plus 30% climate change rainfall event. The balancing pond would have a nominal depth of 2 metres to benefit from limited groundwater recharge from the Tidal Flat Deposits within which it would be constructed.

**3.4.2** The outfall from the balancing pond would pass through a flow control device to maintain an appropriately attenuated discharge into the adjacent reed bed.

**3.4.3** The size of the permanent volume would be several times larger than the runoff generated by a 6 hour, 5 mm/hour rain event as summarised in Table 3.1. This storm magnitude is used as a large rainfall event that can be used to represent a worst case volume of runoff from the highway as 95% of rainfall events within the UK are likely to be of lower intensity. The runoff from this event, prescribed by HAWRAT to be 50% of total rainfall for impervious surfaces, is used to determine balancing pond capability to provide attenuation by dilution within the permanent wet volume.

**3.4.4** Dilution is an important attenuation process for inorganic pollutants within routine runoff, principally comprising chloride and sulphate. Indicative dilution efficiencies are provided in Table 3.1 based on a ten-fold runoff to lagoon concentration difference, i.e. a winter storm flushing applied road salt (chloride) from the carriageway at a mean concentration of 500 milligrams / litre (mg/l) for 6 hours arriving in each WTA lagoon with a baseline concentration of 50 mg/l.

**Table 3.1: Wet Balancing Pond Attributes**

| WTA | Contributing Impermeable Area (Ha) | Wet Volume ($m^3$) | Wet Area ($m^2$) | Additional 1 in 100 yr Rainfall Volume ($m^3$) | 6 hr 5mm/hr Volume 50% runoff ($m^3$) | Lagoon / storm volume ratio | Indicative dilution efficiency |
|---|---|---|---|---|---|---|---|
| 1 | 9.3 | 6,680 | 4,940 | 9,000 | 2,790 | 5 | 74% |
| 2 | 11.5 | 13,050 | 6,540 | 10,500 | 3,270 | 7 | 79% |
| 4a | 4.3 | 8,964 | 5,580 | 4,200 | 1,290 | 13 | 83% |
| 4b | 4.2 | 5,940 | 4,225 | 4,200 | 1,260 | 10 | 82% |
| 5 | 7.3 | 23,079 | 12,239 | 7,000 | 2,190 | 21 | 86% |
| 6 | 4.8 | 6,465 | 4,303 | 4,000 | 1,440 | 9 | 81% |
| 7 | 4.1 | 3,725 | 2,971 | 3,600 | 1,230 | 6 | 77% |
| 8 | 9.0 | 8,261 | 5,341 | 8,400 | 2,700 | 6 | 77% |
| 8a | 1.0 | 3,590 | 2,438 | 3,500 | 300 | 24 | 86% |
| 9 | 15.8 | 27,255 | 16,299 | 13,000 | 4,740 | 12 | 83% |
| 10 | 3.3 | 20,439 | 10,898 | 2,700 | 990 | 41 | 88% |
| 11b | 6.0 | 4,034 | 4,870 | 7,950 | 1,800 | 9 | 81% |
| 11c | 5.0 | 2,255 | 2,130 | 5,100 | 1,500 | 3 | 68% |
| 12a | 14.4 | 20,775 | 11,085 | 18,000 | 4,320 | 10 | 82% |
| 12b | 0.73 | 354 | 571 | 675 | 439 | 2 | 56% |

**3.4.5** The WTA wet balancing ponds would provide a 2-fold minimum, 41-fold maximum and a 12-fold mean volume dilution for the design rainfall event.

## 3.5 Stage 4: Reed Bed

**3.5.1** Given the high ambient water quality present within the Gwent Levels, a high standard of water treatment is required in order to mitigate risks of pollution from routine runoff from the proposed new section of motorway.

**3.5.2** Captured and treated routine runoff is typically discharged to surface watercourses where some level of dilution can be relied upon even under low flow conditions. However, within the Gwent Levels, penning of reens is undertaken where natural flows are significantly restricted to preserve water levels within the interconnected field drains. Under periods of low rainfall, particularly during summer penning, it is anticipated that the reens proposed to accept routine runoff would not exhibiting extremely low flow and would effectively offer no in channel dilution. This is a conservative approach as drainage of the Gwent Levels takes place via ditches and ultimately reens. The presence of penning, however, may result in water being temporarily held without significant flow, particularly during the summer months.

**3.5.3** It has therefore been necessary to include within each Water Treatment Area a dedicated wetland area comprising reed beds to provide the necessary treatment of residual soluble and suspended pollutants. Reed beds are widely acknowledged to provide a relatively high level of treatment. Thus is particularly true where the reed bed forms part of a wider hierarchy of complementary stages and flows are attenuated to provide a low energy environment with adequate residence times for pollutant uptake and attenuation to occur.

**3.5.4** Owing to the episodic and statically variable nature of runoff events, there are no absolute design criteria available for reed bed sizing. However there are a number of empirical relationships established to assist in providing an effective design based on a number of both site specific and generic criteria, as follows:

- flow rate – each WTA discharges at the greenfield run-off rate based on the contributing impermeable area;
- depth – a nominal depth of 1 m is assumed within the Drainage Design Strategy;
- gradient - between 0.5% and 1% recommended;
- down gradient fall – maximum 0.2 m stipulated within the Drainage Design Strategy;
- substrate / root zone porosity – between 20% and 40% recommended;
- hydraulic retention time (HRT) – between 10 and 15 hours recommended;
- hydraulic loading rate (HLR) – below 1 $m^3/m^2$/day recommended with an optimum value of 0.2; and
- aspect ratio – some evidence supporting minimum of width/length ratio of 4.

**3.5.5** Reed bed areas have been calculated utilising the volume required to provide a 15 hour resident time for flows at each WTA greenfield discharge rate. Reed bed depth and porosity are used to derive an indicative surface area based on the flow volume associated with the desirable residence time, i.e.

Area = through flow volume / ( depth x porosity )

**3.5.6** Such empirical approaches aim to provide a volume of reed bed considered to be of sufficient size and performance standard to ensure the treatment efficiencies previously summarised. To calculate reed bed areas, mid values were taken from any recommended ranges to produce an indicative design area. Table 3.2 summarises the parameters utilised to calculate the optimum sized reed bed for each WTA and the proposed size given. In all cases the proposed reed bed areas are within the range encompassed by the stated recommended input parameter distributions.

## 3.6 Assessment of Treatment Train Efficiency

**3.6.1** A number of research references are available providing prescriptive guidance on the evaluation of runoff attenuation efficiency for various types of drainage infrastructure and treatment techniques. Table 3.3 summarises the principal treatment stages commonly utilised to mitigate highway runoff and the process responsible for reductions in pollution loadings for the principal groups of contaminants.

**Table 3.2: WTA Reed Bed Attributes**

| WTA | Contributing Impermeable Area (Ha) | Discharge rate (l/s) | HRT Volume ($m^3$) | HRT Area ($m^2$) | Proposed Area ($m^2$) | Difference |
|---|---|---|---|---|---|---|
| 1 | 9.3 | 32.6 | 4,395 | 6,510 | 7,100 | +9% |
| 2 | 11.5 | 38.2 | 5,150 | 7,630 | 7,210 | -6% |
| 4a | 4.3 | 15.1 | 2,032 | 3,010 | 3,890 | +29% |
| 4b | 4.2 | 14.7 | 1,985 | 2,940 | 3,750 | +28% |
| 5 | 7.3 | 25.6 | 3,449 | 4,599 | 6,329 | +24% |
| 6 | 4.8 | 16.8 | 2,268 | 3,360 | 3,336 | -1% |
| 7 | 4.1 | 14.4 | 1,937 | 2,870 | 2,859 | -0.4% |
| 8 | 9.0 | 31.5 | 4,253 | 6,300 | 6,379 | +1% |
| 8a | 1.0 | 3.5 | 473 | 700 | 3,373 | +382% |
| 9 | 15.8 | 55.3 | 7,466 | 11,060 | 10,299 | -7% |
| 10 | 3.3 | 11.6 | 1,559 | 2,310 | 8,062 | +249% |
| 11b | 6.0 | 21.0 | 2,835 | 4,200 | 2,770 | -34% |
| 11c | 5.0 | 17.5 | 2,363 | 3,500 | 3,200 | -9% |
| 12a | 14.4 | 50.4 | 6,804 | 10,080 | 11,595 | +15% |
| 12b | 0.73 | 5.1 | 691 | 1,023 | 450 | -56% |
| **Totals** | | | | **71,534** | **80,602** | **+13%** |

**Table 3.3: Typical Pollutant Removal Efficiencies (HA 103/06)**

| Pollutant Group | Swales | Infiltration Basins | SF Wetlands | SSF Wetlands | Balancing Ponds | Sed. Ponds |
|---|---|---|---|---|---|---|
| TSS and associated heavy metals | **Filtering** | **Filtering**<br>Settlement | **Filtering**<br>Settlement | **Filtering** | **Settlement** | **Settlement** |
| Heavy metals (particulate and soluble) | **Filtering**<br>Adsorption | **Filtering**<br>Plant uptake<br>Settlement<br>Adsorption<br>Precipitation | **Filtering**<br>Settlement<br>Adsorption<br>Plant uptake | **Adsorption**<br>**Filtering**<br>Plant uptake | **Settlement**<br>Adsorption | **Settlement**<br>Plant uptake<br>Adsorption<br>Precipitation |

| Pollutant Group | Swales | Infiltration Basins | SF Wetlands | SSF Wetlands | Balancing Ponds | Sed. Ponds |
|---|---|---|---|---|---|---|
| Organic compounds (particulate and soluble) | **Filtering** Adsorption | **Filtering** Settlement Adsorption Biodeg. Volatilisation | **Filtering** Settlement Adsorption Biodeg. Volatilisation | **Adsorption Biodeg. Filtering** | **Settlement** Adsorption Biodeg. Volatilisation | **Settlement Adsorption** Biodeg. Volatilisation |
| Oil and grease | **Filtering** Adsorption | **Filtering** Adsorption Settlement Biodeg. | **Filtering** Adsorption Settlement Biodeg. | **Filtering Adsorption** Biodeg. | **Settlement** Adsorption Biodeg. | Adsorption Settlement Biodeg. |
| Nutrients | Plant uptake | Plant uptake | **Plant uptake** | **Plant uptake** | Plant uptake | Plant uptake |

Note: bold type indicates dominant processes. Biodeg. = biodegradation.

**3.6.2** Tables 3.4a and 3.4b provides a summary of typical attenuation efficiency factors associated with the above treatment stages derived from HA103/06 (Highways Agency *et al*., 2006b) and CIRIA C609 (Wilson *et al.*, 2004), respectively. The values represent the typical overall performance that could be expected to be achieved given the high variability and site specific performance constraints that may be present.

**Table 3.4a: Typical Pollutant Removal Efficiencies (HA 103/06)**

| Pollutant | Swales | Infiltration Basins | SF Wetlands | SSF Wetlands | Balancing Ponds | Sedimentation Ponds |
|---|---|---|---|---|---|---|
| TSS and associated heavy metals | 60-100% **80%** | 60-100% **80%** | 60-100% **80%** | 60-100% **80%** | 30-60% **45%** | 60-100% **80%** |
| Heavy metals in solution | 30-100% **65%** | 30-100% **65%** | 30-100% **65%** | 60-100% **80%** | 0-30% **15%** | 0-60% **30%** |
| Oil and grease | 60-100% **80%** | 30-100% **65%** | 60-100% **80%** | 60-100% **80%** | 30-60% **45%** | 30-60% **45%** |
| Nutrients | 0-30% **15%** | 0-30% **15%** | 30-100% **65%** | 60-100% **80%** | 0-30% **15%** | 0-60% **30%** |

Median values added in bold.

**Table 3.4b: Typical Pollutant Removal Efficiencies (CIRIA C609)**

| Pollutant | Dry Grassed Swales | Infiltration Basins | Oil Separator | Stormwater Wetlands | Balancing Ponds | Extended Detention Basin |
|---|---|---|---|---|---|---|
| TSS | 70-90% **80%** | 45-75% **60%** | 0-40% **20%** | 80-90% **85%** | 75-90% **82.5%** | 65-90% **77.5%** |
| Heavy metals | 80-90% **85%** | 85-90% **87.5%** | ID | 50-60% **55%** | 50-80% **65%** | 40-90% **65%** |
| Hydrocarbons (inc. PAH) | 70-90% **80%** | ID | 40-90% **65%** | 50-80% **65%** | 30-60% **45%** | 30-60% **45%** |
| Total phosphorus | 30-80% **55%** | 60-70% **65%** | 0-5% **2.5%** | 30-40% **35%** | 30-50% **40%** | 20-50% **35%** |
| Total nitrogen | 50-90% **70%** | 55-60% **57.5%** | 0-5% **2.5%** | 30-60% **45%** | 30-50% **40%** | 20-30% **25%** |

Median values added in bold. ID=insufficient data to quote removal rate.

**3.6.3** The efficiencies cited in this assessment are subject to the drainage systems being properly installed and maintained. Standards expected to be maintained

are set out within DMRB report HA 103/06 Vegetated Drainage Systems for Highway Runoff (Chapter 6 Maintenance and Management of Vegetated Drainage Systems) (Highways Agency *et al*., 2006b).

**3.6.4** The key treatment stage for highway runoff from the embankments within the Gwent Levels would be the road side grass lined, dry channels. Such channels are widely reported to provide high treatment efficiencies particularly of suspended solids and associated pollutants as well as of treatment of metals within the grass root zone. Grass lined channels are typically quoted for being effective over relatively short distances of the order of tens of metres. The proposal to install thousands of metres of grass lined channels is therefore considered to have the potential to present very high pollutant attenuation of routine highway run off and of potential spillages resulting from accidents.

**3.6.5** The treatment train proposed for the proposed new section of motorway is summarised in Table 3.5 together with indicative design treatment efficiencies and the resultant in train cumulative efficiency that can be relied upon for drainage mitigation.

**Table 3.5a: Efficiencies of Proposed 4 Element Scheme Treatment Train**

| Pollutant | Stage 1 Grass Lined Channel | Stage 2 Interceptor/ Detention Basin | Stage 3 Sedimentation Pond | Stage 4 Reed Bed |
|---|---|---|---|---|
| TSS / suspended heavy metals | 80% | 77.5% | 80% | 80% |
| Heavy metals – dissolved | 75% | 65% | 30% | 80% |
| PAHs* | 80% | 65% | 45% | 80% |

* Figures for oil interceptor component

**Table 3.5b: Efficiencies of Proposed 3 Element Scheme Treatment Train**

| Pollutant | Stage 1 Interceptor/ Detention Basin | Stage 2 Sedimentation Pond | Stage 3 Reed Bed |
|---|---|---|---|
| TSS / suspended heavy metals | 77.5% | 80% | 80% |
| Heavy metals - dissolved | 65% | 30% | 80% |
| PAHs | 65% | 45% | 80% |

**Table 3.5c: Efficiencies of Proposed 2 Element Scheme Treatment Train**

| Pollutant | Stage 1 Balancing Pond | Stage 2 Oil Interceptor |
|---|---|---|
| TSS / suspended heavy metals | 80% | 20% |
| Heavy metals - dissolved | 30% | 0% |
| PAHs | 45% | 65% |

**3.6.6** CIRIA C609 provides guidance on assessing the pollutant removal efficiencies of treatment trains comprising the in series connection of a number of separate treatment systems located downstream of each other. It is recommended that 50% of the quoted removal efficiency is utilised for each subsequent treatment component.

**3.6.7** Given some sections of the proposed new section of motorway are drained via kerb and gully with or without a lagoon, rather than grass lined channels, three treatment train efficiencies are calculated both with and without a grass lined channel and lagoon stage. Tables 3.6a and 3.6b summarises the cumulative efficiency of these proposed treatment trains following the conservative assessment methodology within CIRIA C609.

**3.6.8** The overall cumulative efficiency figures in red of 95.6% and 91.4% for the four element treatment train and 91.9% and 82.2% for the three element treatment train are used in the HAWRAT assessments as mitigation for the treatment of suspended and soluble pollutants respectively.

**3.6.9** For the Water Treatment Areas located within the Gwent Level's SSSIs, grass lined channels present on both sides of the carriageway, comprise very high lengths of drainage runs of between 1,800 and 7,200 metres.

**Table 3.6a: Cumulative Treatment Efficiencies of Proposed 4 Element Drainage System**

| Pollutant | Initial Runoff | STAGE 1 100% Grass Lined Channel | | STAGE 2 50% Bypass Interceptor | | STAGE 3 50% Wet Sedimentation Pond | | STAGE 4 50% Wetland | | Cumul. |
|---|---|---|---|---|---|---|---|---|---|---|
| | WTA IN % | Stage %eff | OUT % | Stage %eff | OUT % | Stage 50% | OUT% | Stage %eff | OUT % | TOTAL eff% |
| TSS / suspended heavy metals | 100 | 80 | 20.0 | 77.5 | 12.3 | 80 | 7.4 | 80 | 4.4 | **95.6** |
| Heavy metals - dissolved | 100 | 75 | 25.0 | 65 | 16.9 | 30 | 14.3 | 80 | 8.6 | **91.4** |
| Hydrocarbons / PAH | 100 | 80 | 20.0 | 65 | 13.5 | 45 | 10.5 | 80 | 6.3 | 93.7 |
| Nutrients | 100 | 15 | 85.0 | 2.5 | 83.9 | 30 | 71.3 | 80 | 42.8 | 57.2 |

**Table 3.6b: Cumulative Treatment Efficiencies of Proposed 3 Element Drainage System**

| Pollutant | Initial Runoff | STAGE 1 100% Bypass Interceptor | | STAGE 2 50% Wet Sedimentation Pond | | STAGE 3 50% Wetland | | Cumul. |
|---|---|---|---|---|---|---|---|---|
| | WTA IN % | Stage %eff | OUT % | Stage eff% | OUT % | Stage 50% | OUT % | TOTAL eff% |
| TSS / suspended heavy metals | 100 | 77.5 | 22.5 | 80 | 13.5 | 80 | 8.1 | **91.9** |
| Heavy metals - dissolved | 100 | 65 | 35.0 | 30 | 29.8 | 80 | 17.9 | **82.2** |
| Hydrocarbons / PAH | 100 | 65 | 35.0 | 45 | 27.1 | 80 | 16.3 | 83.7 |
| Nutrients | 100 | 2.5 | 97.5 | 30 | 82.9 | 80 | 49.7 | 50.3 |

## Table 3.6c: Cumulative Treatment Efficiencies of Proposed 2 Element Drainage System

| Pollutant | Initial Runoff | STAGE 1 100% Wet Balancing Pond | | STAGE 2 50% Oil Interceptor | | Cumul. |
|---|---|---|---|---|---|---|
| | WTA IN % | Stage %eff | OUT% | Stage 50% | OUT% | TOTAL eff% |
| TSS / suspended heavy metals | 100 | 80 | 20.0 | 20 | 18.0 | 82.0 |
| Heavy metals - dissolved | 100 | 30 | 70.0 | 0 | 70.0 | 30.0 |
| Hydrocarbons / PAH | 100 | 45 | 55.0 | 65 | 37.1 | 62.9 |
| Nutrients | 100 | 2.5 | 97.5 | 15 | 90.2 | 9.8 |

%eff=% removal efficiency. OUT%= output to following stage. Cumul. = cumulative.

# 4 Risk Assessment

## 4.1 Contaminants of Concern

**4.1.1** The main pollutants present in highways run-off can be grouped in the following categories.

- Sediment – on its own or as a colloid site for metal and organic pollutants.
- Metals – vehicles and fuel combustion, metal corrosion.
- Hydrocarbons – lubricating oils, fuel, exhaust emissions and herbicides.
- Salts and nutrients – de-icing operations and fertilisers.
- Microbial – decay of organic matter / litter in verges.

**4.1.2** For the assessment of routine runoff, the following key contaminants are modelled to represent the above pollutant groups, those considered within DMRB HAWRAT methodology are marked with an asterisk.

- Total suspended solids (TSS).
- Copper (total* and filtered*).
- Zinc (total* and filtered*).
- Cadmium (total)*.
- Pyrene*.
- Fluoranthene*.
- Anthracene*.
- Phenanthrene*.
- Total PAH (total)*.
- Chloride.

## 4.2 Compliance Criteria

**4.2.1** NRW have been consulted on appropriate assessment methodologies for the assessment of impact to the Gwent Levels SSSIs water quality. Specific queries were raised to understand the relevance of several water quality compliance regimes which may require adherence. The following compliance regimes were identified:

1. Former Countryside Council for Wales (CCW) 'trigger levels' for developments across the Gwent Levels SSSIs;
2. Water Framework Directive standards both existing and emerging to protect the water environment;
3. DMRB thresholds for the assessment of short term, acute and chronic impacts to surface water; and

4. Preservation of ambient baseline concentrations (ABC) within main reens determined by on-going baseline monitoring.

**4.2.2** NRW provided the following comment:

'*The Gwent Levels SSSIs are designated because they support a range of qualifying features (wetland plants and freshwater invertebrates) which are able to survive and/or thrive in the prevalent eutrophic conditions. Water quality trigger levels have been derived, historically by CCW but now used by NRW, to assist developers in designing their projects and in undertaking their water quality monitoring. The trigger levels indicate the concentration above which we become concerned that damage could be occurring to the SSSI features and which therefore needs to trigger follow up monitoring and potential remedial action. These levels have been derived locally but have come from expert knowledge of the Gwent Levels environment as well as evidence and lessons learnt from major developments in the area over the past 25 years.*

*From a WFD perspective, the Gwent Levels waterbodies are defined as artificial, heavily modified waterbodies. In practice this means that water quality criteria are not used as part of the routine classification of these waterbodies. In addition, environmental quality standards specific to an environment such as the Gwent Levels (a lowland, grazing marsh, drainage system) have not been drawn up*

*Regular water quality monitoring across the Gwent Levels undertaken by NRW occurs primarily to detect any gross pollution events. However, aspects of the WFD water quality standards are relevant; including the Environmental Quality Standards (EQSs) for Priority Substances, as set out in Table 1 of Part 3 of the WFD Directions 2015– of relevance to this project are cadmium and lead - as well as standards for specific pollutants which could have eco-toxicity, as set out in Table 1 of Part 2 of the same Directions – those substances of relevance here include copper and zinc.*

*However, results of pre-construction phase monitoring are vital to these discussions as these provide an indication of baseline conditions and therefore what is reasonably achievable both during and following any construction phase.'*

**4.2.3** The Gwent Levels baseline water environment status has been determined through four quarterly rounds of surface water monitoring conducted during 2005 and January 2016 capturing both summer and winter penning levels.

## 4.3 Runoff Source

**4.3.1** The HAWRAT assessment tool deals with soluble (acute) and sediment related (chronic) pollutants associated with routine highways runoff. Acute pollution impacts are expressed as Event Mean Concentrations (EMCs in µg/l) for dissolved copper and zinc. Chronic pollution impacts are expressed as Event Mean Sediment Concentrations (EMSCs in mg/kg) for total copper, zinc, cadmium, and (in µg/kg) for pyrene, fluoranthene, anthracene, phenanthrene and total PAH (Polycyclic Aromatic Hydrocarbons).

**4.3.2** The assessment tool uses statistically-based models for predicting the runoff quality for each pollutant based on data collected during the "Improved Determination of Pollutants in Highway Runoff Phase 2 project" (Dempsey *&* Song, 2007) and the "Long term monitoring of pollution from highway runoff" (Moy *et al*., 2002).

**4.3.3** The models use traffic density, climatic region and event rainfall characteristics to predict runoff quality in terms of EMCs and EMSCs. Using long term rainfall event data the models generate distributions of runoff quality that reflect the likely distributions of runoff quality that could be observed in practice.

**4.3.4** The assessment tool also incorporates models for predicting the impact of the runoff on receiving rivers and streams. For the soluble pollutants that cause acute impact the model involves a simple mass balance approach taking account of river flows.

**4.3.5** For the sediment related pollutants that cause chronic impact, the impact models consider both the likelihood and extent of sediment accumulation based broadly on the chronic impact assessment procedure developed by University of Sheffield (Gaskell *et al*., 2007).

**4.3.6** The assessment tool incorporates a number of ecologically-based pollutant thresholds. The tool compares the predicted impacts with these thresholds to evaluate toxicity risks (Johnson *et al*., 2007, Gaskell *et al*., 2007).

**4.3.7** Much of the pollution in runoff is attached to the finer sediments known as total suspended solids. If the fine sediment is removed then a significant proportion of pollutants such as hydrocarbons and metals can also be removed. For the sediment related pollutants that cause chronic impact, the impact models include additional thresholds to judge the likelihood of sediment accumulation and whether the extent of accumulation is excessive.

**4.3.8** The HAWRAT software is designed to replicate a large number of statistically possible rainfall events and compute event statistics for key pollutants by using a database of measured road drainage data for a number of sites within the England and Wales falling within four climatic regions and various representative sub catchments and within 3 defined Annual Average Daily Traffic (AADT) volume ranges.

**4.3.9** The HAWRAT generated EMC figures have been calculated based on the projected AADT figures for the design year 2038. In all cases for the proposed new section of motorway, this falls within the HAWRAT 50,000-100,000 AADT bracket.

## 4.4 Screening

**4.4.1** EMC statistics provided within HD45/09 (Highways Agency *et al.*, 2009) and Crabtree *et al*. (2008) for the WTA are summarised in Table 4.1. Monitored reen ABC and the respective pollutant EQS or Probable No Effect Concentration (PNEC) are also shown for comparison with EMC concentrations. As PNECs are monitoring location specific, the range of values calculated from ten proposed WTA discharge locations using the Metal Bioavailability Assessment Tool (M-BAT, 2104) have been shown.

## 4.5 Runoff Receptors

**4.5.1** The drainage design proposes to discharge all captured highway runoff to reens via water treatment areas (WTA). No discharges are proposed to groundwater.

**1.1.1** Each proposed WTA has an identified reen into which the discharge would connect. Baseline surface water monitoring of these reen locations is ongoing with two of four quarterly monitoring rounds processed for inclusion within this report, which will be updated on completion of subsequent monitoring rounds. Further details are presented within the Baseline Water Environment Report (Appendix 16.2 of the ES).

**4.5.2** The ABCs range of the key runoff pollutants for all reens are summarised in Table 4.1 together with the EMC statistics generated by HAWRAT.

**Table 4.1: Runoff pollutant EMC, ABC and EQS/PNEC concentrations**

| Pollutant | Units | EMC min | EMC mean | EMC median | EMC max | ABC range | EQS/PNEC |
|---|---|---|---|---|---|---|---|
| Copper (dissolved) | ug/l | 2.15 | 31.31 | 23.3 | 304 | <LOD - 5.08 | 2.86 – 60.45 |
| Zinc (dissolved) | ug/l | 5.0 | 111.1 | 58.3 | 1,360 | <LOD – 30.7 | 16.76 – 57.14 |
| Cadmium (total) | ug/l | <0.01 | 0.63 | 0.29 | 5.4 | <LOD | 0.15* |
| Total PAH | ug/l | <0.01 | 7.52 | 3.33 | 62.18 | <LOD – 17.2 | ns |
| Pyrene | ug/l | <0.01 | 1.03 | 0.31 | 12.5 | <LOD – 1.88 | ns |
| Fluoranthene | ug/l | <0.01 | 1.02 | 0.30 | 12.5 | <LOD – 2.24 | 0.0063 |
| Anthracene | ug/l | <0.01 | 0.08 | 0.03 | 0.81 | <LOD – 0.13 | 0.1 |
| Phenanthrene | ug/l | <0.01 | 0.35 | 0.13 | 3.63 | <LOD – 0.95 | ns |
| Chloride | mg/l | 5 | 350 | 66 | 9,760 | 3 - 785 | 250 |

*dissolved Class 4 hardness.

ns = no standard.

**4.5.3** The DMRB HAWRAT methodology utilises Runoff Specific Thresholds (RST) over both 6 and 24 hour periods for both dissolved copper and zinc based on statistical rainfall and runoff relationships. Table 4.2 compares these RST with the other compliance criteria – EQS and PNEC for these and other key pollutants within routine road runoff together with the ABC recorded within reens near each proposed WTA outfall point.

**4.5.4** From inspection of Tables 4.1 and 4.2, it is apparent that reen baseline concentrations for key heavy metal and organic pollutants are significantly below EQS/PNEC and DMRB RST compliance criteria where prescribed. In addition to the minimal in-reen dilution that can be expected at each WTA outfall for treated runoff, it can be reasonably concluded that departures from existing baseline quality can be expected. Table 4.3 summarises the attenuation factors required to mitigate mean EMC to EQS, 50% EQS and ABC values.

**4.5.5** The most appropriate previously calculated four, three and two stage treatment train Attenuation Factors (AF) efficiencies are included in Table 4.3 for comparison with the calculated AFs for preservation of the indicated compliance criteria.

**4.5.6** It can be seen that the proposed WTA treatment train, whilst not achieving reen ABCs within discharge waters, is likely to maintain reen conditions within the EQS/PNEC at the point of discharge. Further dilution within reens due to runoff during rain events, whilst not included, represents further potential attenuation.

## Table 4.2: WTA outfall reen ABC and RST concentrations

| WTA ID | Reen ID | Water sample ID | Mean copper (dissolved) ug/l RST6=42 RST24=21 | | Mean zinc* (dissolved) ug/l RST6=184 RST24=92 | | Mean cadmium (total) ug/l | Mean PAH (total) ug/l | Mean chloride mg/l |
|---|---|---|---|---|---|---|---|---|---|
| | | | ABC | PNEC | ABC | PNEC | EQS=0.15* | No EQS | EQS=250 |
| 1 | Pwll Bargoed Reen | 1.1 | 0.99 | 2.86 | 2.46 | 16.76 **** | <LOD | <LOD | 35.30 |
| 2 | Tyn-y-Brwyn Reen | 2.2 | 1.29 | 21.75 | 1.50 | 27.14 | <LOD | 1.55 | 43.95 |
| 4a/4b | Percoed Branch East | 5.2 | 1.12 | 35.59 | 5.29 | 33.42 | <LOD | <LOD | 42.85 |
| 5 | Morfa Gronw Reen | 7.1 | 1.16 | 54.62 | 5.27 | 49.91 | <LOD | <LOD | 29.43 |
| 6 | Lakes Reen | 12.2 | 0.96 | 57.48 *** | 3.49 | 50.38 | <LOD | <LOD | 34.73 |
| 7 | Julians Reen | 13.1 | 0.69 | 52.96 | 1.75 | 43.16 | <LOD | <LOD | 34.1 |
| 8 | Ellen Reen | 14.1 | <LOD | 52.57 | 1.43 | 44.55 | <LOD | <LOD | 25.00 |
| 8a | Black Wall Reen | 15.1 | <LOD | 47.31 | 1.44 | 45.82 | <LOD | <LOD | 22.90 |
| 9 | Middle Road Reen Diversion | 17.1 | 2.96 | 34.64 | 2.05 | 33.39 | <LOD | <LOD | 30.30 |
| 10 | Rush Wall South Reen | 18.1 | 0.96 | 60.45 *** | 1.15 | 57.14 | <LOD | <LOD | 29.90 |
| 11b/c | St Bride's Brook | MR WTA | <LOD | 8.79 | 1.20 | 22.01 **** | <LOD | 1.20 | 14.63 |
| 12a | Prat Reen | 20.1** | <LOD | 44.99 | 0.63 | 38.77 | <LOD | <LOD | 47.10 |
| 12b | Vurlong Reen | nd | nd | nd | nd | nd | nd | nd | nd |

<LOD = below laboratory limit of detection

Mean concentration assumes any analyses <LOD are equivalent to a concentration of zero

*Medium hardness

**Data only available for monitoring rounds Q1 and Q2

***Measured DOC is above the validated range. PNEC calculated using DOC of 15 mg/l

****Measured pH is above the validated range. PNEC calculated using a pH of 8

nd = no data for WTA12b currently available due to dry reen conditions

**Table 4.3: Runoff Attenuation Factors (AF) for ABC, 50 / 100% EQS/PNEC**

| Pollutant | Mean EMC ug/L | ABC ug/L | ABC AF | EQS / PNEC ug/L | 50% EQS / PNEC AF | 100% EQS / PNEC AF | 4/3/2 Stage Treatment Train AF |
|---|---|---|---|---|---|---|---|
| Copper (dissolved) | 31.31 | <LOD - 5.08 | >97.3% - 83.8% | 2.86 – 60.45 | 95.4 – 3.5% | 90.9 – 0% | 92/82/30% |
| Zinc (dissolved) | 111.1 | <LOD – 30.7 | >99.6% - 72.4% | 16.76 – 57.14 | 92.5 – 74.3% | 84.9 – 48.6 % | 92/82/30% |
| Cadmium (total) | 0.63 | <LOD | >20.6% | 0.15* | 88.1% | 76.2% | 92/82/30% |
| Total PAH | 7.52 | <LOD – 17.2 | >95.4% - 0% | ns | - | - | 96/92/82% |
| Pyrene | 1.03 | <LOD – 1.88 | >98.5% - 0% | ns | - | - | 96/92/82% |
| Fluoranthene | 1.02 | <LOD – 2.24 | >98.3 – 0% | 0.0063 | 99.7% | 99.4% | 96/92/82% |
| Anthracene | 0.08 | <LOD – 0.13 | >81.25 - 0% | 0.1 | 37.5% | 0% | 96/92/82% |
| Phenanthrene | 0.35 | <LOD – 0.95 | >93.7 – 0% | ns | - | - | 96/92/82% |
| Chloride | 350 | 3 - 785 | 99.1% – 0% | 250 | 64% | 29% | 67.5%** |

ns = no standard. *Medium hardness. ** Lowest AF value taken from Table 3.7. PNEC used if available, if not EQS.

## 4.6 DMRB Method A: Simple Assessment

**4.6.1** For the purposes of this risk assessment, ambient background concentrations currently identified and EQS/PNEC concentrations will be summarised at each of the proposed WTA discharges. Additionally, a conventional HAWRAT assessment which determines compliance against predefined 6 hour and 24 hour Runoff Specific Thresholds (RSTs) has been conducted for WTA discharges. These assessments include acute impacts arising from dissolved loads and both Threshold Effect Levels (TELs) and Probable Effect Levels (PELs) for chronic impacts arising from sediment loads.

**4.6.2** Given the very low flows expected within reens accepting WTA discharges, a nominal flow of 0.5 litres/second (l/s) is applied to the HAWRAT assessment to provide compliance assessments in the absence of in channel dilution. This figure compares with the greenfield runoff rates to reens from WTA, which are dependent on catchment sizes, ranging between 1.0 and 55.3 l/s with an average of approximately 20 l/s. Rainfall events generating flows from the WTA would in any case also stimulate flows within reens due to the anticipated pronounced runoff from well drained land within the Gwent Levels. Similarly, no base flow to reens is accounted for within the model to remove any dilution that may occur as a result of recharge from groundwater. It is therefore considered a highly conservative approach.

**4.6.3** The input parameters utilised for the HAWRAT assessments are summarised in Table 4.4.

### Table 4.4: HAWRAT Method A Input Parameters

| Parameter | Units | Value(s) | Justification |
|---|---|---|---|
| Climatic region | - | Warm wet | One of 4 HAWRAT default option for south west UK |
| Rainfall site | - | Cardiff | SAAR 1,111.7 mm. One of 5 HAWRAT default options. Newport (850mm) + 30% climate change = 1,105 mm |
| Annual average daily traffic (AADT) | Vehicles / day | >=50,000 and <100,000 | One of 3 HAWRAT default options based on Traffic Model predicted vehicle for design year 2038 |
| Reen surface water hardness | mg/L as $CaCO_3$ | Medium 50-250 | Baseline Water Environment Report |
| Width | m | 4.2<br>25<br>100 | Drainage Strategy Report for Replacement Reen<br>Low Tide Ebbw<br>Low Tide Usk |
| Reen annual 95th flow | $m^3/s$ | 0.0005 | 0.5 l/s. Professionally judged very low flow |
| Base flow | [1] | 0 | Assume no base flow from Tidal Flat Deposits |
| Treatment for solubles | % | 91.4 / 82.2 | Table 3.6a and 3.6b. Cumulative Treatment Efficiencies of Drainage System with / without grass lined channels |
| Treatment of sediments | % | 95.6 / 91.9 | Table 3.6a and 3.6b. Cumulative Treatment Efficiencies of Drainage System with / without grass lined channels |
| Restricted discharge rate | l/s | varied | Individual WTA outfall discharges defined in Table 1 of Drainage Strategy Report |
| Impermeable road area drained | Ha | varied | Individual WTA contributing impermeable areas defined in Table 1 of Drainage Strategy Report |
| Permeable area draining to outfall | Ha | 0 | Only road surface considered |

**4.6.4** The HAWRAT assessments for the proposed new section of motorway have utilised rainfall statistics for Cardiff within a 'warm and wet' region owing to the absence of rainfall data for Newport. Although Cardiff receives standard annual average rainfall (SAAR) of 1117.2 mm, higher than that for Newport of 850 mm, it is considered representative when a 30% increase for climate change is allowed for.

### HAWRAT Method A Results

**4.6.5** Individual HAWRAT assessment sheets for each WTA are presented in Annex A. The results are summarised in Table 4.5.

**4.6.6** All WTA discharges have been assessed as likely to present acceptable discharges to the reens within DMRB compliance criteria.

### Side Road Discharges

A number of existing side roads would be provided with new outfalls for sections crossed by the new section of motorway or reconnected to relocated junctions. Owing to the low traffic anticipated on these side roads which serve the rural road network within the Levels south of the new section of motorway, only a flood attenuation basin and petrol interceptor are proposed. This represents an improvement on the baseline standard. Details of the new side road discharges are summarised in Table 4.6.

### Table 4.5: HAWRAT Method A Results

| WTA ID | Receiving Reen | Soluble – acute impact | | Significance | Sediment – chronic impact | Significance |
|---|---|---|---|---|---|---|
| | | Copper | Zinc | | | |
| 1 | Pwll Bargoed Reen | Pass | Pass | Neutral | Pass | Neutral |
| 2 | Tyn-y-Brwyn Reen | Pass | Pass | Neutral | Pass | Neutral |
| 4a/4b | Percoed Branch East | Pass | Pass | Neutral | Pass | Neutral |
| 5 | Morfa Gronw Reen | Pass | Pass | Neutral | Pass | Neutral |
| 6 | Lakes Reen | Pass | Pass | Neutral | Pass | Neutral |
| 7 | Julians Reen | Pass | Pass | Neutral | Pass | Neutral |
| 8 | Ellen Reen | Pass | Pass | Neutral | Pass | Neutral |
| 8a | Black Wall Reen | Pass | Pass | Neutral | Pass | Neutral |
| 9 | Middle Road Reen Diversion | Pass | Pass | Neutral | Pass | Neutral |
| 10 | Rush Wall South Reen | Pass | Pass | Neutral | Pass | Neutral |
| 11b/c | St Bride's Brook | Pass | Pass | Neutral | Pass | Neutral |
| 12a | Prat Reen | Pass | Pass | Neutral | Pass | Neutral |
| 12b | Vurlong Reen | Pass | Pass | Neutral | Pass | Neutral |

### Table 4.6: Proposed Side Road Discharges

| Outfall | Attenuated Discharge Rate (l/s) | Impermeable Area (Ha) | Estimated runoff lagoon storage ($m^3$) | Receiving watercourse |
|---|---|---|---|---|
| Meadows Road North | 1.2 | 0.34 | 350 | Ditch to Julians Reen |
| Meadows Road South | 1.2 | 0.34 | 350 | Julians Reen |
| North Row North | 1.1 | 0.31 | 350 | Middle Row Reen |
| North Row South | 1.2 | 0.34 | 350 | Middle Row Reen |

## Estuary Discharges

**4.6.7** Three highway sections of the new section of motorway are proposed to be discharged to the tidal River Ebbw and one section to the tidal River Usk as summarised in Table 4.7.

### Table 4.7: Proposed Estuary Discharges

| Outfall | Drained Length (m) | Impermeable Area (Ha) |
|---|---|---|
| Ebbw West | 250 | 1.3 |
| Ebbw East | 1,550 | 11.0 |
| Usk | 950 | 2.9 |

**4.6.8** The Ebbw outfalls would not be flow attenuated and would be untreated. The Usk outfall would not be flow attenuated but has the provision of a Pollution Control Lagoon to capture and retain significant pollution resulting from road accidents that may otherwise flow uncontrolled to the River Usk Special Area of

Conservation (SAC). No impacts would arise from chloride within road runoff due to the Rivers Usk and Ebbw being tidal and therefore brackish or saline.

**4.6.9** The attenuation of these discharges is not required due to the receiving water bodies being tidal and not subject to flood volume compensation requirements.

**4.6.10** Daily pollutant loads present within these discharge flows are considered to be insignificant following mixing within diurnal tidal volumes within both the Rivers Ebbw and Usk estuaries. Impacts from these discharges are therefore based on the criteria outlined in Chapter 16 of the ES, considered to have negligible magnitude of impact and neutral significance of effect.

### Complementary Measures

**4.6.11** Any reduction in the projected growth in traffic (AADT) utilising the reclassified M4 as a consequence of the Scheme operation would have a beneficial impact arising from reduced pollution loads associated with routine runoff entering the water environment via current drainage network.

**4.6.12** This section of the existing M4 became operational in 1967 and as such there remains limited information about the existing motorway kerb and gully drainage system. Contemporary practice would have seen the surface water flows discharged directly to receiving watercourses almost certainly without any form of attenuation or pollution control. For the greater part, this is believed to be the situation along the existing M4 corridor in South Wales. An exception to the above is believed to be a localised stretch in the vicinity of Magor (J23 – J23A) where infiltration via attenuation basins connecting flows to boreholes is understood to be used to discharge surface water flows. Two attenuation basins are to be found adjacent to the existing motorway, accessed from St. Brides Road and Rockfield Road.

**4.6.13** The DMRB assessment methodology HAWRAT utilises three calibrated AADT bandings within which to assess routine runoff impacts – 11,000-50,000 (Band 1), 50,000-100,000 (Band 2) and 100,000-159,000 (Band 3) vehicles. Only impacts arising from AADT vehicle numbers within different bands would be expressed differently by HAWRAT.

**4.6.14** Traffic modelling predicts that the design year 2037 would generate junction averaged AADT of 121,000 vehicles for J23A to J29 without the Scheme compared to 74,000 vehicles with the Scheme. This is a reduction of 39% and represents a change in HAWRAT AADT Band 3 to Band 2 for the reclassified M4.

**4.6.15** Table 4.8 shows the change in EMC concentration predicted for copper and zinc for the two bands.

**Table 4.8: HAWRAT AADT Band vs EMC statistics for copper and zinc**

| Statistic | HAWRAT Band 2 | | HAWRAT Band 3 | | % increase | % increase |
|---|---|---|---|---|---|---|
| AADT | 50,000-100,000 | | 100,000-159,000 | | | |
| Pollutant | Copper | Zinc | Copper | Zinc | | |
| Mean | 32.28 | 107.22 | 55.92 | 266.37 | 73.2% | 148.4% |
| 90%ile | 62.08 | 215.82 | 107.53 | 536.16 | 73.2% | 148.4% |
| 95%ile | 84.02 | 325.64 | 145.53 | 808.99 | 73.2% | 148.4% |
| 99%ile | 146.64 | 561.77 | 254 | 1395.58 | 73.2% | 148.4% |

Concentrations in ug/l/.

**4.6.16** Table 4.8 shows that HAWRAT utilises a multiplier of approximately 1.7 and 2.5 for copper and zinc respectively and shows the relationship between AADT and EMC to be non-linear and pollutant specific. As built detailed drainage design is unavailable for the existing M4 having been built in the 1960s and 1970s. Nevertheless, based on AADT alone, a DMRB assessment for the reclassified M4 would predict a significantly lower impact to the water environment at each of the exiting discharge points. This is concluded to generate a beneficial impact of minor magnitude and moderate significance of effect.

## 4.7 Method D: Assessment of Pollution Impacts from Spillages

**4.7.1** Input parameters for the Method D assessment are summarised in Table 4.9.

### Table 4.9: HAWRAT Method D Input Parameters

| Parameter | Units | Value | Justification |
|---|---|---|---|
| RL – road length | km | 3.6 | Longest length of motorway draining to WTA |
| SS – spillage rates | [1] | 0.36-3.09 | Range for motorway taken from HD45/09 Table D1.1 |
| $P_{SPL}$ – spillage probability | % | variable | RL x SS x (AADT x 365 x $10^{-9}$) x (%HGV/100) |
| $P_{POL}$ – spillage pollution risk | [1] | 0.45 | HD45/09 Table D1.2 Surface Water for fast urban response time |
| $P_{INC}$ – pollution occurring risk | [1] | <0.5 | To achieve negligible magnitude under DMRB |
| Annual Average Daily Traffic (AADT) | vehicles/day | 71,000 | Maximum modelled AADT for design year 2037 |
| % Heavy Goods Vehicles (%HGV) | % | 11 | Maximum predicted %HGV from traffic model |

**4.7.2** HD45/09 provides optimum risk reduction factors to be considered for determining whether pollution risk will be mitigated by the standard or highway drainage treatment proposed (Highways Agency *et al.*, 2009). These are summarised in Table 4.10.

### Table 4.10: Optimum Pollution Risk Reduction Factors (HD45/09)

| Grass Lined Channel $R_{F1}$ | Oil Separator $R_{F2}$ | Sediment Trap $R_{F3}$ | Wet Balancing Pond $R_{F4}$ | Wetland $R_{F5}$ | Cumulative $R_{F2x}R_{F4}$ |
|---|---|---|---|---|---|
| 40% | 50% | 40% | 50% | 50% | 75% |

**4.7.3** Of all the above risk reduction factors both an oil separator and balancing pond are components of the proposed runoff treatment trains proposed for the Scheme. A cumulative risk reduction factor of 75% using only these two complementary forms as prescribed by HD45/09 has been calculated. This equates to a reduction in risk by a factor of 4, i.e. 1 / 0.25.

### HAWRAT Method D Results

**4.7.4** The DMRB prescribes an acceptable annual probability of a spillage with the potential to cause a serious pollution incident ($P_{INC}$) of 0.5% (HD45/09)

(Highways Agency *et al.,* 2009). The calculated cumulative 4-fold risk reduction factor increases this acceptable risk to 2% (0.02).

**4.7.5** The equation for deriving $P_{INC}$ as defined by DMRB is as follows:

$$P_{INC} = RL \times SS \times ( AADT \times 365 \times 10^{-9} ) \times ( \%HGV / 100 ) \times P_{POL}$$

**4.7.6** Taking a mitigated $P_{INC}$ value of 0.02 and re-arranging to solve SS utilising the worst case figures from Table 4.7 gives to yield an acceptable spillage rate:

$$SS = P_{INC} / \{ ( RL \times AADT \times 365 \times 10^{-9} ) \times ( \%HGV / 100 ) \times P_{POL} \} = 4.33$$

**4.7.7** The calculated acceptable spillage rate, SS, for the longest section of the motorway draining to a single WTA of 4.33 is above the maximum theoretical risk motorways of 3.09 prescribed for motorway sections terminating at roundabouts, with motorway sections having slip road junctions (being typical of the proposed new length of motorway) prescribed a risk rate of 0.43, being 10 times lower.

**4.7.8** Following consideration of the above risk reduction factors it is concluded that the risk associated with pollution impacts from spillages is mitigated to below 0.5% as prescribed by DMRB and as such can be considered to have negligible magnitude impact and neutral significance of effect.

### Complementary Measures

**4.7.9** The predicted reduction of AADT numbers for the reclassified M4 would have a pro rata reduction in baseline $P_{INC.}$ Furthermore, predicted reductions in the percentage of HGVs on the existing M4 will have a benefit through risk reduction of polluting accidents. To conservatively assess potential benefit as a consequence of the new section of motorway operation, AADT and HGV% figures for the existing M4 with and without the new section of motorway in place predict a minimum of 31% and 59% reduction in AADT and HGV% respectively.

**4.7.10** These predicted reductions will directly reduce the theoretical pollution occurring risk, $P_{INC}$. Whilst not directly quantifiable, this can be assessed as a minor benefit to water environment as a consequence of the Scheme operation.

# 5 Conclusions

## Table 5.1: Summary of Scheme Significance of Potential Effects

| Potential Impact | Feature | Attribute | Quality | Importance | Mitigation | Magnitude | Significance |
|---|---|---|---|---|---|---|---|
| Water Quality | Pwll Bargoed Reen | SSSI Biodiversity | High | Very High | WTA1 | Negligible | Neutral |
| Water Quality | Tyn-y-Brwyn Reen | SSSI Biodiversity | High | Very High | WTA2 | Negligible | Neutral |
| Water Quality | Percoed Branch East | SSSI Biodiversity | High | Very High | WTA4a/4b | Negligible | Neutral |
| Water Quality | Morfa Gronw Reen | SSSI Biodiversity | High | Very High | WTA5 | Negligible | Neutral |
| Water Quality | Lakes Reen | SSSI Biodiversity | High | Very High | WTA6 | Negligible | Neutral |
| Water Quality | Julians Reen | SSSI Biodiversity | High | Very High | WTA7 | Negligible | Neutral |
| Water Quality | Ellen  Reen | SSSI Biodiversity | High | Very High | WTA8 | Negligible | Neutral |
| Water Quality | Black Wall Reen | SSSI Biodiversity | High | Very High | WTA8a | Negligible | Neutral |
| Water Quality | Middle Road Reen Diversion | SSSI Biodiversity | High | Very High | WTA9 | Negligible | Neutral |
| Water Quality | Rush Wall South Reen | SSSI Biodiversity | High | Very High | WTA10 | Negligible | Neutral |
| Water Quality | St Bride's Brook | SSSI Biodiversity | High | Very High | WTA11b/11c | Negligible | Neutral |
| Water Quality | Prat Reen | SSSI Biodiversity | High | Very High | WTA12a | Negligible | Neutral |
| Water Quality | Vurlong Reen | SSSI Biodiversity | High | Very High | WTA12b | Negligible | Neutral |
| Water Quality | River USk | SAC Biodiversity | Good | Very High | Spill Lagoon | Negligible | Neutral |
| Water Quality | River Ebbw | Biodiversity | Good | High | Interceptor | Negligible | Neutral |
| Flooding from runoff | Pwll Bargoed Reen | Flow | High | Very High | WTA1 | Negligible | Neutral |
| Flooding from runoff | Tyn-y-Brwyn Reen | Flow | High | Very High | WTA2 | Negligible | Neutral |
| Flooding from runoff | Percoed Branch East | Flow | High | Very High | WTA4a/4b | Negligible | Neutral |
| Flooding from runoff | Morfa Gronw Reen | Flow | High | Very High | WTA5 | Negligible | Neutral |
| Flooding from runoff | Lakes Reen | Flow | High | Very High | WTA6 | Negligible | Neutral |
| Flooding from runoff | Julians Reen | Flow | High | Very High | WTA7 | Negligible | Neutral |
| Flooding from runoff | Ellen  Reen | Flow | High | Very High | WTA8 | Negligible | Neutral |
| Flooding from runoff | Black Wall Reen | Flow | High | Very High | WTA8a | Negligible | Neutral |
| Flooding from runoff | Middle Road Reen Diversion | Flow | High | Very High | WTA9 | Negligible | Neutral |
| Flooding from runoff | Rush Wall South Reen | Flow | High | Very High | WTA10 | Negligible | Neutral |
| Flooding from runoff | St Bride's Brook | Flow | High | Very High | WTA11b/11c | Negligible | Neutral |
| Flooding from runoff | Prat Reen | Flow | High | Very High | WTA12a | Negligible | Neutral |
| Flooding from runoff | Vurlong Reen | Flow | High | Very High | WTA12b | Negligible | Neutral |
| Floodplain loss | Gwent Levels SSSIs | Flood water storage | High | Very High | New reens | Negligible | Neutral |
| Water Quality | Secondary Aquifer | Water Supply | Poor | Low | - | Negligible | Neutral |

## Table 5.2 Summary of Complimentary Measures Significance of Potential Effects

| Potential Impact | Feature | Attribute | Quality | Importance | Mitigation | Magnitude | Significance |
|---|---|---|---|---|---|---|---|
| Water Quality | Mill Reen | SSSI Biodiversity | High | Very High | Reduced AADT | Minor Beneficial | Moderate |
| Water Quality | River Usk | SAC Biodiversity | High | Very High | Reduced AADT | Negligible | Neutral |
| Water Quality | Secondary Aquifers | Water Supply | Medium | Medium | Reduced AADT | Minor Beneficial | Slight |

# References

Caldicot and Wentlooge Levels Drainage Board – its history, functions and water level management plan, July 1995.

CIRIA (2004) C609 Sustainable drainage systems. Hydraulic, structural and water quality advice.

Crabtree, R.W., Dempsey, P. Moy, F., Brown, C. and Song, M (2008) Improved Determination of Pollutants in Highway Runoff – Phase 2: Final Report, WRc Plc, Report No.: UC 7697, UK

Defra / Welsh Government (2014) Water Framework Directive implementation in England and Wales: new and updated standards to protect the water environment, May 2014.

Dempsey, P. and Song, M. (2007) Improved Determination of Pollutants in Highway Runoff Phase 2 project.

Highways Agency, Transport Scotland, Welsh Assembly Government & The Department for Regional Development Northern Ireland (2006a) Design Manual for Roads and Bridges, Volume 4, Section 2, Part 9: Grassed surface water channels for highway runoff, (HA119/06) (May 2006).

Highways Agency, Transport Scotland, Welsh Assembly Government & The Department for Regional Development Northern Ireland (2006b) Design Manual for Roads and Bridges, Volume 4 Section 2 Part 1: (HA103/06) Vegetated drainage systems for highways runoff, (HA103/06) (May 2006).

Highways Agency, Transport Scotland, Welsh Assembly Government & The Department for Regional Development Northern Ireland (2009) Design Manual for Roads and Bridges, Volume 11, Section 2, Part 10: Road Drainage and the Water Environment (HD45/09)(November 2009).

Highways Agency Drainage Data Management System (HADDMS) (2009) Highways Agency Water Risk Assessment Tool (HAWRAT), Technical Manual, November 2009. Available at: www.haddms.com

Ellis, J.B., Shutes, R.B., & Revitt, D.M. (2003) Guidance manual for constructed wetlands, R&D Technical Report P2-159/TR2. Environment Agency, 2003.

Gaskell, P.N., Guymer, L. and Maltby, L., (2007) Accumulation and Dispersal of Suspended Solids in Watercourses, ECUS, University of Sheffield, University of Warwick, Report No.: HA3/368, UK Highways Agency.

Johnson, I., Harman, M. and Crabtree, R. (2007) Effects of Soluble Pollutants on the Ecology of Receiving Waters, WRc Plc, Report No.: UC 7486/1, UK Highways Agency.

Moy, F., Crabtree, R., and Simms, T. (2002) Long term monitoring of pollution from highway runoff. Environment Agency Technical Report P2-038/TR1.

UKTAG River & Lake Assessment Method, Metal Bioavailability Assessment Tool (M-BAT), 2104.

Welsh Government (2015) M4 Corridor around Newport, Drainage Strategy, October 2015.

Wilson, S., Bray, R. and Cooper, P. (2004) Sustainable Drainage Systems – Hydraulic, Structural and Water Quality Advice, Environment Agency R&D Report P2-261/20/TR (CIRIA C609)

# Annexes

# Annex A - HAWRAT calculation sheets

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 3.86 | 14.31 | ug/l |
| Step 3 | 0.69 | 2.56 | ug/l |

Copper: Pass

Zinc: Pass

## Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 59 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | WTA1 | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | Pwll Bargoed Reen | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 9.3

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

Tier 1 — Estimated river width (m): 4.2

Tier 2 — Bed width (m): 3; Manning's n: 0.07; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles (%) | | Attenuation for solubles - restricted discharge rate (l/s) | | Settlement of sediments (%) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 3 stage treatment train | 82.2 | | 32.5 | | 91.9 | |

Predict Impact

Show Detailed Results

Exit Tool

HIGHWAYS AGENCY

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version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 4.17 | 15.47 | ug/l |
| Step 3 | 0.74 | 2.77 | ug/l |

Copper: Pass

Zinc: Pass

## Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 73 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | WTA2 | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | Tyn-y-Brwyn Reen | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 11.5

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

Tier 1 — Estimated river width (m): 4.2

Tier 2 — Bed width (m): 3; Manning's n: 0.07; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles (%) | | Attenuation for solubles - restricted discharge rate (l/s) | | Settlement of sediments (%) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 3 stage treatment train | 82.2 | | 40.1 | | 91.9 | |

Predict Impact

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# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 3.73 | 13.82 | ug/l |
| Step 3 | 0.32 | 1.20 | ug/l |

Copper: Pass

Zinc: Pass

## Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 29 | Deposition Index |

## Location Details

| | | | |
|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | |
| Assessment type | Non-cumulative assessment (single outfall) | | |
| OS grid reference of assessment point (m) | Easting | Northing | |
| OS grid reference of outfall structure (m) | Easting | Northing | |
| Outfall number | WTA4a+4b | List of outfalls in cumulative assessment | |
| Receiving watercourse | Percoed Branch East | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | |
| Date of assessment | 01/11/2015 | Version of assessment | |
| Notes | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 8.5

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

Tier 1 Estimated river width (m): 4.2

Tier 2 Bed width (m): 3 Manning's n: 0.07 D Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles ( %) | | Attenuation for solubles - restricted discharge rate ( l/s ) | | Settlement of sediments ( %) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 4 stage treatment train | 91.4 | | 30 | | 95.6 | |

Predict Impact

Show Detailed Results

Exit Tool

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 3.51 | 13.00 | ug/l |
| Step 3 | 0.30 | 1.12 | ug/l |

Copper: **Pass**

Zinc: **Pass**

## Sediment - Chronic Impact

**Alert. Protected Area.**

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 25 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | WTA5 | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | Morfa Gronw Reen | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 7.3

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

Tier 1 Estimated river width (m): 4.2

Tier 2 Bed width (m): 3 Manning's n: 0.07 Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles ( %) | | Attenuation for solubles - restricted discharge rate ( l/s ) | | Settlement of sediments ( %) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 4 stage treatment train | 91.4 | | 25.6 | | 95.6 | |

**Predict Impact**

**Show Detailed Results**

**Exit Tool**

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 2.93 | 10.82 | ug/l |
| Step 3 | 0.25 | 0.94 | ug/l |

Copper: Pass

Zinc: Pass

## Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 16 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | WTA6 | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | Lakes Reen | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 4.8

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

(•) Tier 1 Estimated river width (m): 4.2

( ) Tier 2 Bed width (m): 3 Manning's n: 0.07 Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles (%) | | Attenuation for solubles - restricted discharge rate (l/s) | | Settlement of sediments (%) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 4 stage treatment train | 91.4 | | 16.8 | | 95.6 | |

Predict Impact

Show Detailed Results

Exit Tool

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 2.72 | 10.04 | ug/l |
| Step 3 | 0.23 | 0.87 | ug/l |

Copper: **Pass**

Zinc: **Pass**

## Sediment - Chronic Impact

**Alert. Protected Area.**

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 14 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | WTA7 | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | Julians Reen | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 4.1

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

(•) Tier 1 Estimated river width (m): 4.2

( ) Tier 2 Bed width (m): 3 Manning's n: 0.07 Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles (%) | | Attenuation for solubles - restricted discharge rate (l/s) | | Settlement of sediments (%) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 4 stage treatment train | 91.4 | | 14.4 | | 95.6 | |

**Predict Impact**

**Show Detailed Results**

**Exit Tool**

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 3.81 | 14.13 | ug/l |
| Step 3 | 0.33 | 1.22 | ug/l |

Copper: **Pass**

Zinc: **Pass**

## Sediment - Chronic Impact

**Alert. Protected Area.**

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 31 | Deposition Index |

## Location Details

| | | | |
|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | |
| Assessment type | Non-cumulative assessment (single outfall) | | |
| OS grid reference of assessment point (m) | Easting | Northing | |
| OS grid reference of outfall structure (m) | Easting | Northing | |
| Outfall number | WTA8 | List of outfalls in cumulative assessment | |
| Receiving watercourse | Ellen Reen | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | |
| Date of assessment | 01/11/2015 | Version of assessment | |
| Notes | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 9.0

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

(•) Tier 1 Estimated river width (m): 4.2

( ) Tier 2 Bed width (m): 3 Manning's n: 0.07 D Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles (%) | | Attenuation for solubles - restricted discharge rate (l/s) | | Settlement of sediments (%) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 4 stage treatment train | 91.4 | | 31.5 | | 95.6 | |

**Predict Impact**

**Show Detailed Results**

**Exit Tool**

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 1.19 | 4.46 | ug/l |
| Step 3 | 0.21 | 0.80 | ug/l |

Copper: **Pass**

Zinc: **Pass**

## Sediment - Chronic Impact

**Alert. Protected Area.**

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 6 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | WTA8a | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | Black Wall Reen | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 1.0

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

- (•) Tier 1 — Estimated river width (m): 4.2
- ( ) Tier 2 — Bed width (m): 3; Manning's n: 0.07; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles (%) | | Attenuation for solubles - restricted discharge rate (l/s) | | Settlement of sediments (%) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 3 stage treatment train | 82.2 | | 3.5 | | 91.9 | |

**Predict Impact**

**Show Detailed Results**

**Exit Tool**

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 4.63 | 17.22 | ug/l |
| Step 3 | 0.40 | 1.49 | ug/l |

Copper: **Pass**

Zinc: **Pass**

## Sediment - Chronic Impact

**Alert. Protected Area.**

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 54 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | WTA9 | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | Middle Road Reen Diversion | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 15.8

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

Tier 1 — Estimated river width (m): 4.2

Tier 2 — Bed width (m): 3; Manning's n: 0.07; Side slope (m/m): 0.5; Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles ( %) | | Attenuation for solubles - restricted discharge rate ( l/s ) | | Settlement of sediments ( %) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 4 stage treatment train | 91.4 | | 55.3 | | 95.6 | |

**Predict Impact**

**Show Detailed Results**

**Exit Tool**

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 2.44 | 9.01 | ug/l |
| Step 3 | 0.43 | 1.62 | ug/l |

Copper: Pass

Zinc: Pass

## Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 21 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | WTA10 | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | Rush Wall South Reen | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 3.3

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

(•) Tier 1 Estimated river width (m): 4.2

( ) Tier 2 Bed width (m): 3 Manning's n: 0.07 Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles ( %) | | Attenuation for solubles - restricted discharge rate ( l/s ) | | Settlement of sediments ( %) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 3 stage treatment train | 82.2 | | 11.6 | | 91.9 | |

Predict Impact

Show Detailed Results

Exit Tool

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 4.11 | 15.23 | ug/l |
| Step 3 | 0.73 | 2.73 | ug/l |

Copper: Pass

Zinc: Pass

## Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 69 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | WTA11b + 11c | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | St Brides Brook | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 11.0

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

(•) Tier 1 Estimated river width (m): 4.2

( ) Tier 2 Bed width (m): 3 Manning's n: 0.07 D Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles ( %) | | Attenuation for solubles - restricted discharge rate ( l/s ) | | Settlement of sediments ( %) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 3 stage treatment train | 82.2 | | 35.3 | | 91.9 | |

Predict Impact

Show Detailed Results

Exit Tool

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 4.49 | 16.71 | ug/l |
| Step 3 | 0.80 | 2.99 | ug/l |

Copper: Pass

Zinc: Pass

## Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 91 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | WTA12a | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | Prat Reen | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 14.4

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

(•) Tier 1 Estimated river width (m): 4.2

( ) Tier 2 Bed width (m): 3 Manning's n: 0.07 D Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles ( %) | | Attenuation for solubles - restricted discharge rate ( l/s ) | | Settlement of sediments ( %) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 3 stage treatment train | 82.2 | | 50.5 | | 91.9 | |

Predict Impact

Show Detailed Results

Exit Tool

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.96 | 3.59 | ug/l |
| Step 3 | 0.17 | 0.65 | ug/l |

Copper: Pass

Zinc: Pass

## Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 5 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | WTA12b | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | Vurlong Reen | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 0.73

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

(•) Tier 1 Estimated river width (m): 4.2

( ) Tier 2 Bed width (m): 3 Manning's n: 0.07 D Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles ( %) | | Attenuation for solubles - restricted discharge rate ( l/s ) | | Settlement of sediments ( %) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 3 stage treatment train | 82.2 | | 2.6 | | 91.9 | |

Predict Impact

Show Detailed Results

Exit Tool

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.75 | 2.72 | ug/l |
| Step 3 | 0.52 | 1.94 | ug/l |

Copper: Pass

Zinc: Pass

## Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 10 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | Meadow Road | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | Juliens Reen | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >10,000 and <50,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 0.68

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No

(•) Tier 1 Estimated river width (m): 4.2

( ) Tier 2 Bed width (m): 3 Manning's n: 0.07 Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles ( %) | | Attenuation for solubles - restricted discharge rate ( l/s ) | | Settlement of sediments ( %) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 2 stage treatment train | 30 | | 2.4 | | 82 | |

Predict Impact

Show Detailed Results

Exit Tool

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.72 | 2.63 | ug/l |
| Step 3 | 0.51 | 1.88 | ug/l |

Copper: Pass

Zinc: Pass

## Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 9 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | North Row | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | Middle Road Reen | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >10,000 and <50,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.0005 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 0.65

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

(•) Tier 1 Estimated river width (m): 4.2

( ) Tier 2 Bed width (m): 3 Manning's n: 0.07 D Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles ( %) | | Attenuation for solubles - restricted discharge rate ( l/s ) | | Settlement of sediments ( %) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 2 stage treatment train | 30 | | 2.3 | | 82 | |

Predict Impact

Show Detailed Results

Exit Tool

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.48 | 1.67 | ug/l |
| Step 3 | 0.48 | 2.05 | ug/l |

Copper: Pass

Zinc: Pass

## Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 55 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | Ebbw west + Ebbw east | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | River Ebbw | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.01 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 5.3

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

Tier 1 Estimated river width (m): 25

Tier 2 Bed width (m): 3 Manning's n: 0.07 D Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles ( %) | | Attenuation for solubles - restricted discharge rate ( l/s ) | | Settlement of sediments ( %) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | Oil interceptor | 0 | D | 2.4 | | 20 | |

Predict Impact

Show Detailed Results

Exit Tool

HIGHWAYS AGENCY

# Highways Agency Water Risk Assessment Tool

version 1.0 November 2009

## Soluble - Acute Impact

Annual Average Concentration

| | Copper | Zinc | |
|---|---|---|---|
| Step 2 | 0.26 | 1.02 | ug/l |
| Step 3 | 0.18 | 0.71 | ug/l |

Copper: Pass

Zinc: Pass

## Sediment - Chronic Impact

Alert. Protected Area.

Sediment deposition for this site is judged as:

| | | | |
|---|---|---|---|
| Accumulating? | Yes | 0.00 | Low flow Vel m/s |
| Extensive? | No | 2 | Deposition Index |

## Location Details

| | | | | | |
|---|---|---|---|---|---|
| Road number | M4CaN | HA Area / DBFO number | | | |
| Assessment type | Non-cumulative assessment (single outfall) | | | | |
| OS grid reference of assessment point (m) | Easting | | Northing | | |
| OS grid reference of outfall structure (m) | Easting | | Northing | | |
| Outfall number | Usk | List of outfalls in cumulative assessment | | | |
| Receiving watercourse | River Usk | | | | |
| EA receiving water Detailed River Network ID | | Assessor and affiliation | | | |
| Date of assessment | 01/11/2015 | Version of assessment | | | |
| Notes | | | | | |

## Step 1 Runoff Quality

AADT: >=50,000 and <100,000

Climatic region: Warm Wet

Rainfall site: Cardiff (SAAR 1111.7mm)

## Step 2 River Impacts

Annual 95%ile river flow ($m^3/s$): 0.01 (Enter zero in Annual 95%ile river flow box to assess Step 1 runoff quality only)

Impermeable road area drained (ha): 2.9

Permeable area draining to outfall (ha): 0

Base Flow Index (BFI): 0

Is the discharge in or within 1 km upstream of a protected site for conservation? Yes

**For dissolved zinc only**

Water hardness: Medium = 50-200 CaCO3/l

**For sediment impact only**

Is there a downstream structure, lake, pond or canal that reduces the velocity within 100m of the point of discharge? No D

(•) Tier 1 Estimated river width (m): 100

( ) Tier 2 Bed width (m): 3 Manning's n: 0.07 D Side slope (m/m): 0.5 Long slope (m/m): 0.0001

## Step 3 Mitigation

| | Brief description | Estimated effectiveness: Treatment for solubles ( %) | | Attenuation for solubles - restricted discharge rate ( l/s ) | | Settlement of sediments ( %) | |
|---|---|---|---|---|---|---|---|
| Existing measures | | 0 | D | Unlimited | D | 0 | D |
| Proposed measures | 2 stage treatment train | 30 | | Unlimited | D | 82 | |

Predict Impact

Show Detailed Results

Exit Tool