A38 Derby Junctions

TR010022

Volume 6

6.3 Environmental Statement Appendices

Appendix 13.3A: Kingsway Water Framework Directive Assessment

Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

April 2019

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

A38 Derby Junctions Development Consent Order 202[ ]

6.3 Environmental Statement Appendices
Appendix 13.3A: Kingsway Water Framework Directive Assessment

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A38 Derby Junctions

Kingsway Junction: Water Framework Directive Assessment Report

Report Number: HE514503-ACM-EWE-Z1_ZZ_ZZ_ZZ-RP-HD-0001 P03 S4
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EXECUTIVE SUMMARY

Scheme Details

AECOM Infrastructure & Environment UK Ltd (AECOM) has been commissioned by Highways England to provide design services regarding the development of the A38 Derby Junctions Scheme (referred to as "the Scheme" herein). The Scheme concerns the grade separation of three junctions on the A38 in Derby as follows:

- A38/ A5111 Kingsway junction
- A38/ A52 Markeaton junction
- A38/ A61 Little Eaton junction

At Kingsway junction, the Scheme would involve improving the existing road network and the realignment of Bramble Brook which is culverted under the existing junction. Bramble Brook is considered to be part of Markeaton Brook (from Mackworth Brook to Derwent) under the Water Framework Directive (WFD), and would be the only WFD waterbody affected at Kingsway junction.

This WFD assessment comprises one of a number of documents supporting the environmental assessment of the Scheme to be reported within an Environmental Statement.

WFD Assessment

The WFD (EC Directive 2000/60/EC) aims to protect and enhance the quality of the water environment across all European Union (EU) member states. This WFD assessment has, therefore, been undertaken to determine whether the Scheme at Kingsway junction has the potential to:

- Cause deterioration of any waterbodies from their current status or potential, or
- Prevent future attainment of good status or potential where not already achieved.

The main aim of this WFD assessment is to demonstrate that WFD objectives can be met at Kingsway junction, and that any risks to the water environment can be avoided or mitigated.

Outcome of the WFD Assessment

The focus of this WFD assessment has been to assess whether the Scheme at Kingsway junction would result in any deterioration from the existing 'moderate' ecological conditions of Markeaton Brook, prevent or compromise the waterbody from meeting its WFD objectives of 'good' potential by 2027, or prevent connecting waterbodies from meeting their objectives.

This WFD assessment has established that the Scheme at Kingsway junction would require the realignment and culverting of Bramble Brook through the junction which would cause (without mitigation) local deterioration to WFD quality elements.

The report acknowledges the deterioration risk and proposes appropriate and proportionate mitigation measures to manage this risk and enhance existing riparian and in-channel habitats. The habitat within this section of the Bramble Brook is poor, with the channel being heavily modified, including a weir and bank reinforcement. In-channel macrophytes are also sparse due to heavy shading and the bed of the watercourse is dominated by silt within a section of channel with limited to no perceptible flow in places.

The mitigation measures proposed would enhance the riparian zone of Bramble Brook through the provision of formal flood storage areas which would remain wet and provide wetland habitat. The Bramble Brook channel within the junction would also be enhanced through the creation of alternate inset berms which would provide improved flow variation, reduce fine sediment deposition and provide habitat for bankside and emergent vegetation.

With the implementation of the mitigation measures defined herein, the Scheme at Kingsway junction would not have an adverse effect on the WFD status of the Markeaton Brook waterbody.

1 INTRODUCTION

1.1 Commission

1.1.1 AECOM Infrastructure & Environment UK Ltd (AECOM) has been commissioned by Highways England to provide design services regarding the development of the A38 Derby Junctions Scheme (referred to as "the Scheme" herein). The Scheme concerns the grade separation of three junctions on the A38 in Derby as follows:

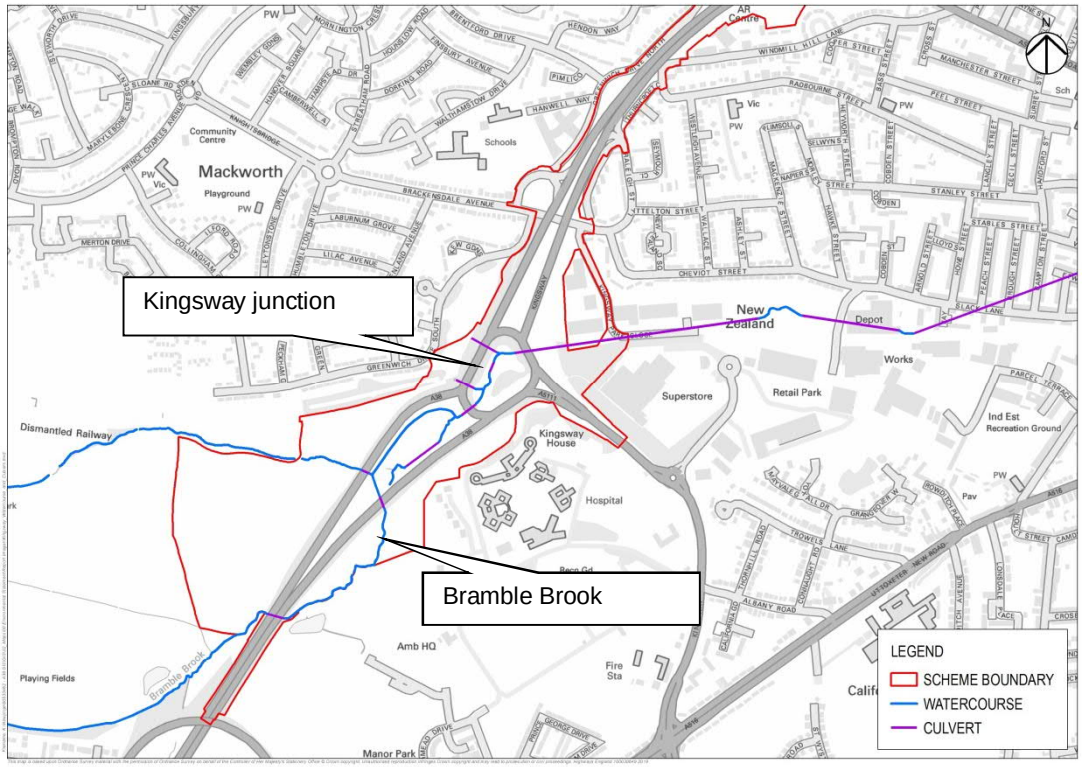
- A38/ A5111 Kingsway junction
- A38/ A52 Markeaton junction
- A38/ A61 Little Eaton junction

1.1.2 In order to inform the assessment of potential impacts of the Scheme on the water environment, AECOM has carried out a Water Framework Directive (WFD) assessment for the Scheme works at Kingsway junction. As such, this report focuses upon Scheme works at Kingsway junction only – a separate WFD assessment has been prepared for Scheme works at Little Eaton junction. A WFD assessment was screened out for Markeaton junction as the Scheme would not require any physical changes to watercourses at this junction.

1.2 The Scheme

1.2.1 Kingsway junction is currently an at-grade, three-armed roundabout located on the A38 in Derby, providing a connection between the A38 and A5111 (Kingsway) – see Figure 1.1.

Figure 1.1: Kingsway junction site location and water features

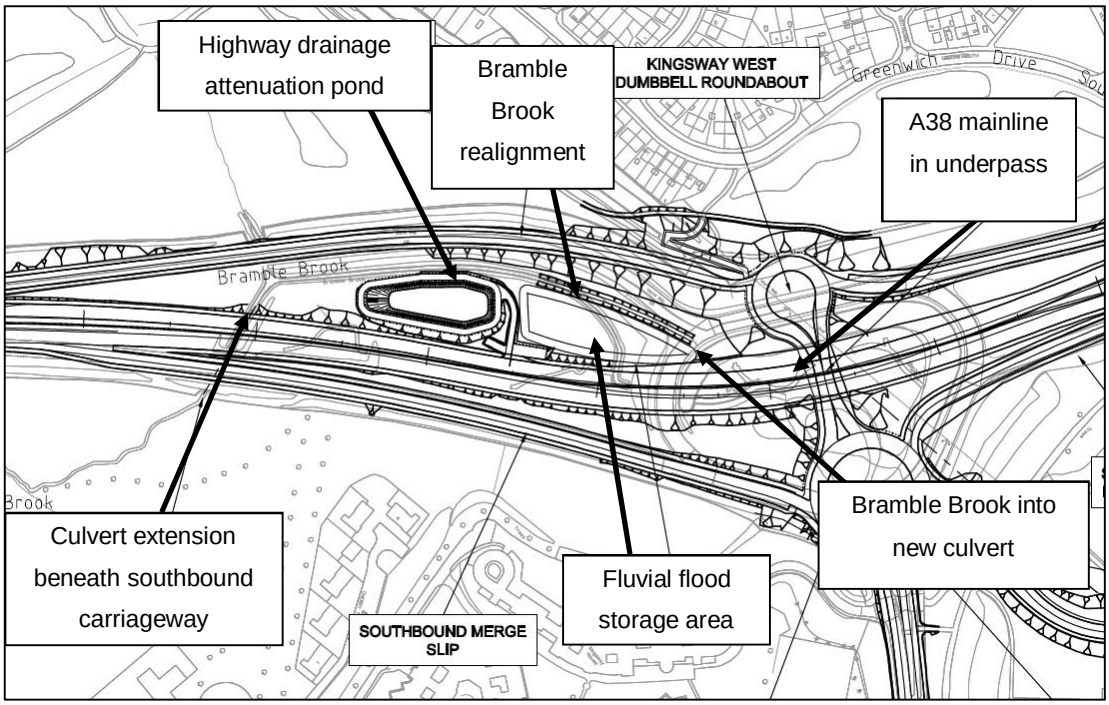


1.2.2 Bramble Brook flows through the middle of the existing Kingsway junction, where it is known locally as the “Grand Canyon” due to the presence of the steep sided wooded valley. Bramble Brook is a tributary of Markeaton Brook and thus under the WFD it is considered to be part of the Markeaton Brook from Mackworth Brook to Derwent (GB104028052830) WFD Waterbody (the Markeaton Brook).

1.2.3 The Scheme design at Kingsway junction would require the realignment of the Bramble Brook within the junction against the A38 northbound diverge slip, the creation of flood storage areas and some culverting of the currently open channels.

1.2.4 The following Scheme elements have been assessed in terms of potential impacts on local waterbodies at Kingsway junction (see Figure 1.2):

- Proposed extension of the existing culvert under the southbound carriageway to the west of the junction.
- Setting the mainline A38 carriageway below its existing level.
- Extension of existing culverts through sections of the junction (thus replacing sections of existing Bramble Brook open channel) and reduction in culvert diameter to 1,200mm (see Figure 1.2).
- Creation of realigned open channel upstream of the junction for the Bramble Brook against the proposed northbound diverge slip road.



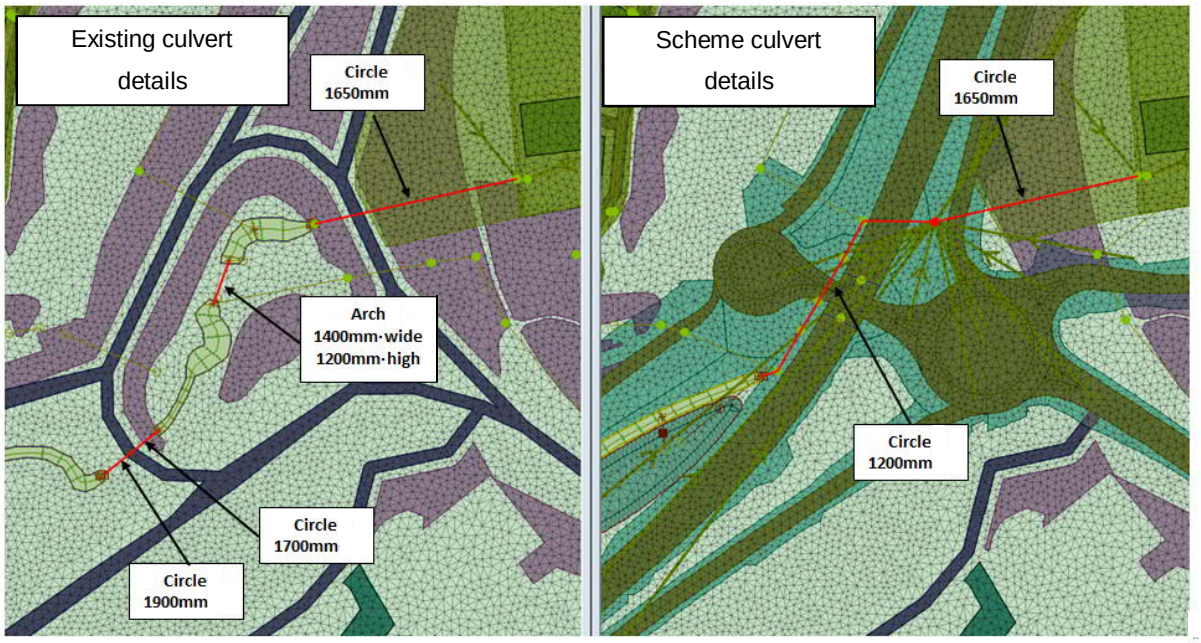


Figure 1.2: Kingsway junction Scheme design

1.3 Water Framework Directive (WFD)

1.3.1 The WFD (EC Directive 2000/60/EC) aims to protect and enhance the quality of the water environment across all European Union (EU) member states. It takes a holistic approach to the sustainable management of water by considering the interactions between surface water (including transitional and coastal waters, rivers, streams and lakes), groundwater and water-dependent ecosystems. This includes interactions between sediment and water.

1.3.2 Under the WFD, 'waterbodies' are the basic management units and are defined as all or part of a river system or aquifer. Waterbodies form part of a larger 'river basin districts' (RBD), for which River Basin Management Plans (RBMPs) are developed and environmental objectives are set. RBMPs are produced every six years, in accordance with the river basin management planning cycle. Cycle 2 plans were published in February 2016.

1.3.3 The WFD requires all EU member states to classify the current condition (i.e. the 'Status' or 'Potential') of surface and groundwater bodies and to set a series of objectives for maintaining or improving conditions so that waterbodies maintain or reach Good Status or Potential. The Environment Agency is the competent authority for implementing the WFD in England. As part of its role, the Environment Agency must consider whether proposals for new developments have the potential to:

- Cause deterioration of a waterbody from its current status or potential, or
- Prevent future attainment of good status or potential where not already achieved.

1.3.4 As a result, new developments that have the potential to impact on current or predicted WFD status are required to assess their compliance against the WFD objectives of the potentially affected waterbodies.

2 METHODOLOGY

2.1 Background to Surface Water Body Status

2.1.1 Under the WFD, surface water body status is classified on the basis of chemical and ecological status or potential. “Ecological status” is assigned to surface water bodies that are natural and considered by the Environment Agency not to have been significantly modified for anthropogenic purposes. “Ecological potential” is assigned to artificial and man-made water bodies (such as canals), or natural water bodies that have undergone significant modification; these are termed Heavily Modified Water Bodies (HMWBs), and this classification applies to the Markeaton Brook system in the vicinity of Kingsway junction.

2.1.2 The term ecological potential is used as it may be impossible to achieve good ecological status because of modification for a specific use, such as navigation or flood protection, which needs to be maintained. Ecological potential represents the degree to which the quality of the water body approaches the maximum it could achieve. Overall status or potential is comprised of elements describing waterbody morphology, biology and water quality. The worst case element classification is assigned as the overall surface waterbody status/ potential, in a ‘one-out all-out’ system - this system is summarised in Figure 2.1, whilst Figure 2.2 provides a definition of High, Good, Moderate, Poor and Bad surface water status as related to the WFD.

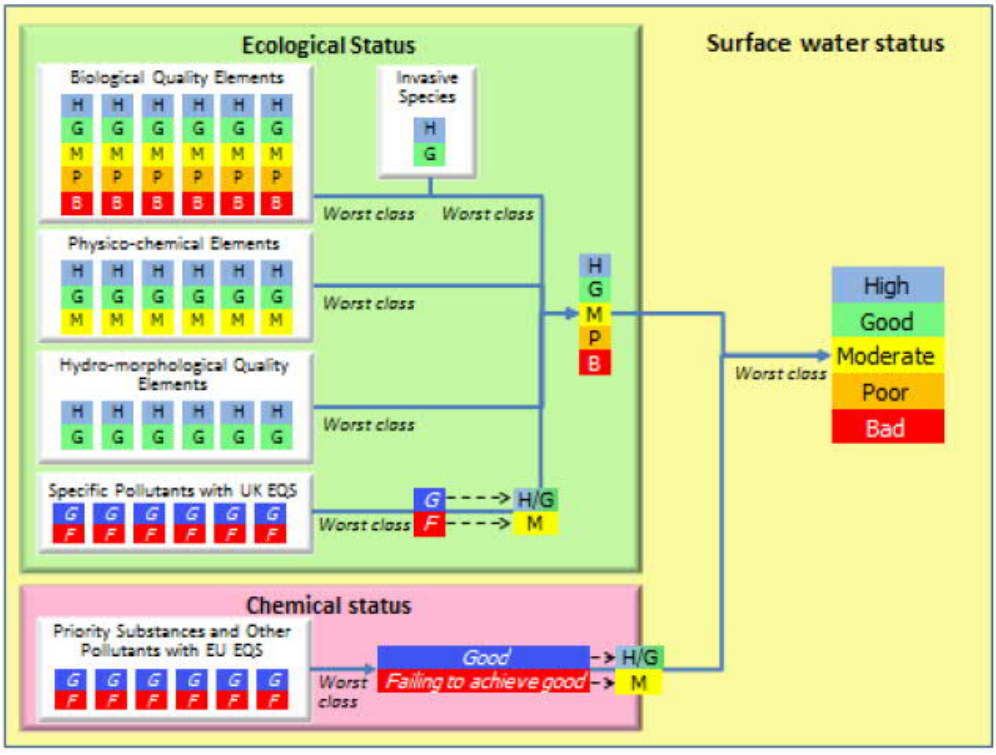


Figure 2.1: WFD classification elements for surface water body status (Environment Agency, 2015[1])

[1] Environment Agency (2015) Rules for Assessing Surface Water Body Status and Potential. Version 2.0 (October 2015).

Status	Definition
High	Near natural conditions. No restriction on the beneficial uses of the water body. No impacts on amenity, wildlife or fisheries.
Good	Slight change from natural conditions as a result of human activity. No restriction on the beneficial uses of the water body. No impact on amenity or fisheries. Protects all but the most sensitive wildlife.
Moderate	Moderate change from natural conditions as a result of human activity. Some restriction on the beneficial uses of the water body. No impact on amenity. Some impact on wildlife and fisheries.
Poor	Major change from natural conditions as a result of human activity. Some restrictions on the beneficial uses of the water body. Some impact on amenity. Moderate impact on wildlife and fisheries.
Bad	Severe change from natural conditions as a result of human activity. Significant restriction on the beneficial uses of the water body. Major impact on amenity. Major impact on wildlife and fisheries with many species not present.

Figure 2.2: Definition of status or potential in the WFD (Environment Agency, 2015)

2.2 Ecological Status or Potential

2.2.1 Ecological status or potential is defined by the overall health or condition of the watercourse. The waterbody affected by the Scheme at Kingsway junction is designated as a HMWB, therefore, its condition and objectives are referred to in terms of Potential rather than Status. Potential is assigned on a scale of High, Good, Moderate, Poor or Bad (see Figure 2.1), and on the basis of four classification elements or 'tests' (Environment Agency, 2013), as follows:

- **Biological**: This test is designed to assess the status indicated by a biological quality element such as the abundance of fish, invertebrates or algae and by the presence of invasive species. The biological quality elements can influence an overall water body status from Bad through to High.
- **Physico-chemical**: This test is designed to assess compliance with environmental standards for supporting physicochemical conditions, such as dissolved oxygen, phosphorus and ammonia. The physicochemical elements can only influence an overall water body status from Moderate through to High.
- **Specific pollutants**: This test is designed to assess compliance with environmental standards for concentrations of specific pollutants, such as zinc, cypermethrin or arsenic. As with the physico-chemical test, the specific pollutant assessment can only influence an overall water body status from Moderate through to High.
- **Hydromorphology**: For natural, non-HMWBs, this test is undertaken when the biological and physico-chemical tests indicate that a water body may be of High status. It specifically assesses elements such as water flow, sediment composition and movement, continuity, and structure of the habitat against reference or 'largely undisturbed' conditions. If the hydromorphological elements do not support High status, then the status of the water body is limited to Good overall status. For artificial or HMWBs, hydromorphological elements are

assessed initially to determine which of the biological and physico-chemical elements should be used in the classification of ecological potential. In all cases, assessment of baseline hydromorphological conditions are an important factor in determining possible reasons for classifying biological and physico-chemical elements of a water body as less than Good, and hence in determining what mitigation measures may be required to address these failing water bodies.

2.3 Chemical Status

2.3.1 Chemical status is defined by compliance with environmental standards for chemicals that are priority substances and/ or priority hazardous substances, in accordance with the Environmental Quality Standards Directive (EQSD) (2008/105/EC). This is assigned on a scale of good or fail. Surface water bodies are only monitored for priority substances where there are known discharges of these pollutants; otherwise surface water bodies are reported as being at good chemical status.

2.4 Changes between Cycle 1 (2009 RBMP) and Cycle 2 (2015 RBMP) New Building Blocks

2.4.1 Cycle 1 (inaugural release of 2009 RBMP) comprised a set of building blocks for water environmental improvements (highlighted above), in order to establish:

- Waterbody and monitoring networks.
- The designation of artificial and heavily modified waterbodies.
- The standards and boundaries used in assessment.
- The tools used to derive classification results for individual elements from monitoring data.

2.4.2 Cycle 2 of River Basin Management Planning commenced in early 2016. A number of significant changes to these building blocks have been introduced for the second cycle of River Basin Management Planning[2]. These are:

- Updated standards are being used to determine good status for nutrients and some chemical substances. These new standards were developed as part of a UK-wide collaboration and were widely consulted upon.
- New chemical standards have been introduced as a result of the 2013 EQSD amendments.
- A second generation of biological classification tools to ensure biological classifications are better at reflecting local conditions.
- The size and shape of some waterbodies have changed so that they become more logical management units.
- The process to designate heavily modified water bodies has been improved.

2.4.3 The new building blocks set the baseline for the updated RBMPs released in early 2016, and help to inform future investigations and help determine appropriate measures and objectives.

[2] Available at: https://www.gov.uk/government/collections/river-basin-management-plans-2015 Last reviewed November 2018

2.5 Assessment Methodology

2.5.1 The assessment of WFD compliance for new activities and schemes that may affect the water environment consists of a 4-step process (summarised in Figure 2.3). This document is designed to support key steps 1 - 3 of the assessment process including data collection (Step 1.1), screening for risk of WFD deterioration and risk to waterbody potential (Step 1.3), determining whether the activity would prevent achievement of good potential at the waterbody scale, (Step 2.5) and details of proposed mitigation measures to ensure there is no local deterioration, maximises opportunities for enhancement and that the Scheme is compliant with WFD legislation.

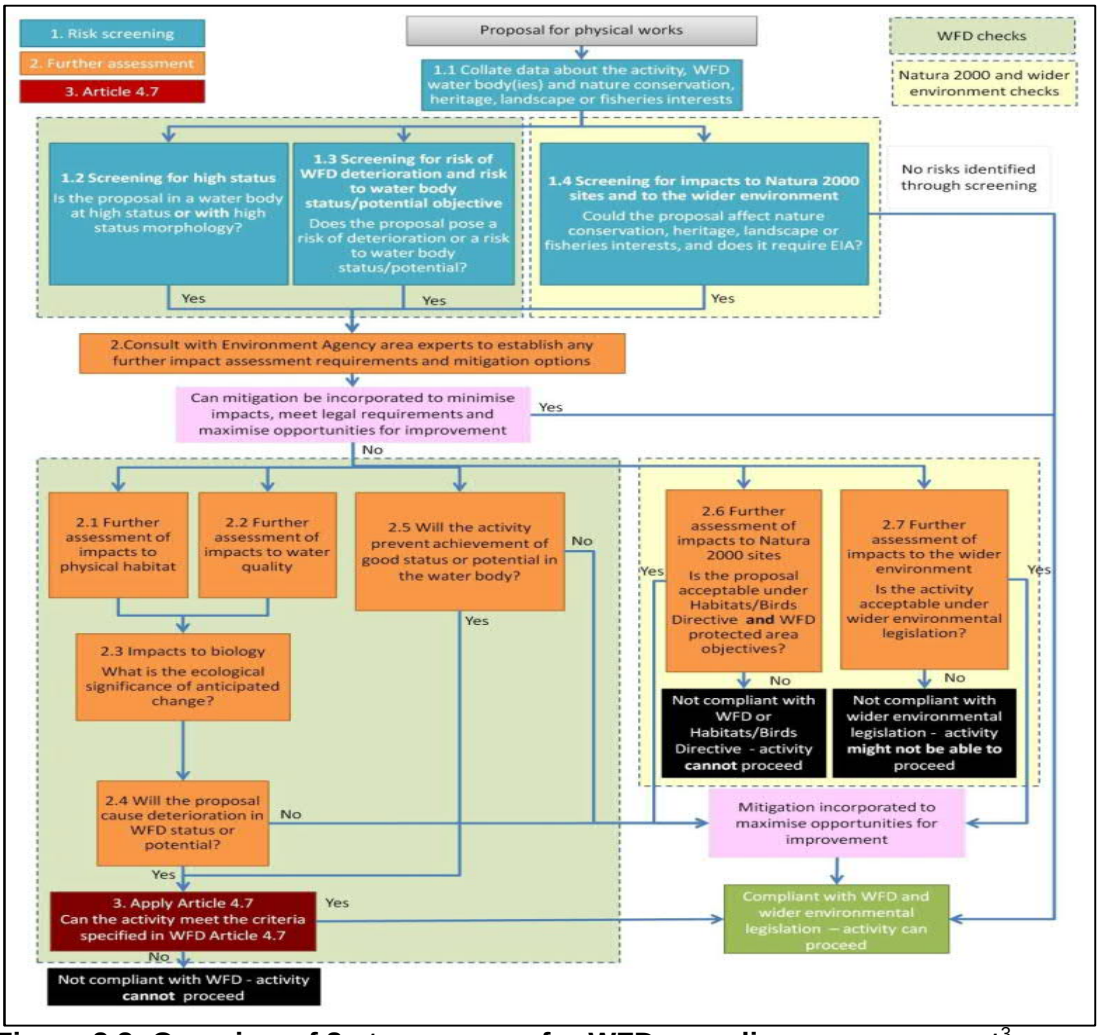


Figure 2.3: Overview of 8-step process for WFD compliance assessment[3]

[3] Environment Agency (2016) Protecting and improving the water environment Water Framework Directive compliance of physical works in rivers position 488_10 (Public Facing)

3 BASELINE DATA

3.1 Relevant Waterbodies

3.1.1 The Scheme at Kingsway junction crosses Bramble Brook which does not have an independent waterbody classification. In WFD terms it is, therefore, considered as part of its receiving waterbody, Markeaton Brook from Mackworth Brook to the River Derwent (GB104028052830) (hereafter referred to as Markeaton Brook).

3.1.2 Additionally the Scheme at Kingsway junction would require a deep cutting, therefore the Derwent-Secondary Combined Ground waterbody (GB40402G990400) is also considered potentially at risk and is screened into the assessment.

3.1.3 The potential for the Scheme to affect other local and connecting waterbodies has also been assessed. The following waterbodies have been screened out on the grounds that they are outside of the Scheme's zone of influence:

- Mackworth Brook Catchment (tributary of Markeaton Brook) (GB104028052840) is screened out because it is approximately 2km upstream of the proposed waterbody crossing and would not be affected by the Scheme at Kingsway junction.
- Markeaton Brook from source to Mackworth Brook (GB104028052850) is screened out because it is approximately 2km upstream of the proposed waterbody crossing and would not be affected by the Scheme at Kingsway junction.

3.2 Ecological Potential and Objectives

3.2.1 Baseline WFD data for Markeaton Brook are summarised below from the Environment Agency's Catchment Data Explorer, the Humber RBMP[4], the Kingsway Junction Flood Risk Assessment (Highways England, 2019[5]) and data presented within the Environmental Statement.

3.2.2 Markeaton Brook (Mackworth Brook to River Derwent) is a HMWB that according to the 2015 Humber RBMP, has an overall Moderate ecological potential. Further details of its WFD status are presented in Table 3.1. Other available details for the different WFD elements are provided in Tables 3.2 and 3.3.

[4] Environment Agency (2015) Part 1: Humber River Basin District - River Basin Management Plan. Updated: December 2015.
[5] Highways England (2019) A38 Derby Junctions – A38 Kingsway Junction Flood Risk Assessment.

Table 3.1: Surface waterbody classification details

RBMP Parameter	Classification
Waterbody Name, ID, and Category	GB104028052830 Markeaton Brook from Mackworth Brook to River Derwent
Size (Area, Length)	Length 3.951km, Area 9.776km^2
Current Overall Ecological Quality	Moderate
Current Hydromorphological Condition	HMWB
Reasons for Designation	Flood Protection, Nitrates Directive
Ecological Status	Moderate
Current Chemical Status	Good
Supporting Elements	Moderate
Future Overall Ecological Potential	Good by 2027
Protected Area Designation	Nitrates Directive

3.2.3 The chemical and physico-chemical conditions described in the 2015 Humber RBMP are reproduced in Table 3.2.

Table 3.2: Overall physico-chemical supporting elements as assessed in 2016

Element	Current status (and certainty of probable)	Predicted status by 2027
Ammonia (Phys-Chem)	High	High
Dissolved oxygen	High	High
pH	High	High
Phosphate	Moderate	Good
Temperature	Good	High
Copper	High	High
Zinc	High	High
Ammonia (Annex 8)	High	High

3.2.4 The biological conditions described in the 2015 Humber RBMP are reproduced in Table 3.3.

Table 3.3: Biological elements assessed in 2016

Element	Current status (and certainty of probable)	Predicted status by 2027
Macrophytes and phytobenthos combined	Moderate	Good
Fish	Good	Good
Invertebrates	Good	Good

3.2.5 The Markeaton Brook is designated as a HMWB with hydromorphology element assessed as supporting good biological potential.

3.3 Protected Habitats

3.3.1 Reference to online natural environment mapping available at MAGIC[6] shows that there are Priority Habitats (protected floodplain grazing marsh and woodland) close to the Scheme at Kingsway junction. Floodplain grazing marsh could be directly dependent on the hydromorphology of the local Markeaton Brook, and this is assessed below. Further details of protected habitats at Kingsway junction are detailed in the Environmental Statement - also refer to para. 6.4.5.

3.4 RBMP Mitigation Measures

3.4.1 The 2015 Humber RBMP includes a single mitigation measure that would serve to improve the ecological potential of Markeaton Brook, namely additional treatment at Kirk Langley Sewage Treatment Works to reduce concentrations of phosphate (Environment Agency 2018[7]). Whilst Markeaton Brook is not connected to Bramble Brook, it would benefit the overall WFD waterbody.

[6] Available at: http://www.magic.gov.uk/. Last accessed November 2018.
[7] Environment Agency 2018 https://environment.data.gov.uk/catchment-planning/OperationalCatchment/3134/Action [accessed November 2018]

4 SCREENING ASSESSMENT

4.1 Risk

4.1.1 According to Environment Agency Guidance (Environment Agency, 2016[8]) the following works listed in Table 4.1 would be considered low risk and would not require detailed WFD assessment.

Table 4.1: WFD low risk activities list

Activity	Type of modification
Low impact maintenance activities (encourage removal of obstructions to fish/ eel passage)	Re-pointing (block work structures)
	Void filling ('solid' structures)
	Re-positioning (rock or rubble or block work structures)
	Replacing elements (not whole structure)
	Re-facing
	Maintenance, repair or replacement of minor structures
	Cleaning and/ or painting of a structure
	Maintenance of pumps at pumping station (including pumps that operate outside of 'normal' parameters)
	Blockage/ obstruction removal at a structure (or within 10m upstream or downstream of a structure)
	Removal of young trees, shrubs and grass that may affect the structural stability/ integrity of the structure (including the use of herbicides where permission has been obtained). Only applicable to very localised vegetation growing directly on or immediately adjacent (for example 10 m) to a structure that risks impacting structural integrity.
	Vermin control
Temporary works	Temporary scaffolding to enable bridge re-pointing
	Temporary flood defences
	Temporary clear span bridge with abutments set-back from bank top
	Temporary coffer dam (if eel/ fish passage not impeded)
	Temporary flow diversion (if fish/ eel passage not impeded) such as flumes and porta-dams
	Repair works to bridge or culvert which do not extend the structure, reduce the cross-section of the river or affect the banks or bed of the river, or reduce conveyance
	Temporary Excavation of trial pits of boreholes in byelaw margin
	Structural investigation works of a bridge/ culvert/ flood defence such as intrusive tests, non-intrusive surveys
Bridges	Permanent clear span bridge, with abutments set-back from bank top
	Bridge deck/ parapet replacement/ repair works
	Replacing surfacing on a bridge
Service crossing	Service crossing over a river. This includes those attached to the parapets of a bridge or encapsulated within the bridge's footpath or road

[8] Environment Agency (2016) Protecting and improving the water environment Water Framework Directive compliance of physical works in rivers Position 488_10 (Public Facing)

Activity	Type of modification
	Replacement or dismantling of any pipes, cables or service crossings over a water course. This does not include crossings that require the installation of in-channel supports building a new in-channel structure to support the crossing or any new bed or bank reinforcement.
Other structures	Fishing platforms
	Fish/ eel pass on existing structure (where <2% water body length is impacted)
	Cattle drinks
	Mink rafts
	Fencing (if open panel/ chicken wire) in byelaw margin
	Removal of urban trash from channel and banks. This does not include the removal of gravel or woody debris.

4.1.2 The Scheme at Kingsway junction involves non-temporary channel realignment and culverting which, according to Environment Agency guidance, are not listed on the low risk activity register and are thus considered to be high risk activities from a WFD compliance perspective (Environment Agency, 2016[9]). The Scheme, therefore, has the potential to affect waterbody potential and objectives, and is screened in for WFD assessment.

[9] Environment Agency (2016) Protecting and improving the water environment Water Framework Directive compliance of physical works in rivers Position 488_10 (Public Facing)

5 PRELIMINARY ASSESSMENT

5.1 Methodology Overview

5.1.1 For high risk WFD activities, a WFD Preliminary Assessment is used to rationalise Further Assessments, by screening out waterbody elements and development elements that would not be impacted by the proposals.

5.2 Possible Impacts on Ecological Potential and Objectives

5.2.1 The outcomes of the Preliminary Assessment are presented as an assessment matrix in Appendix A. This includes temporary and non-temporary effects associated with the construction phase and operational phases of the Scheme (at Kingsway junction). The assessment matrix in Appendix A is colour coded to help visualise potentially positive, neutral and negative impacts associated with the Scheme, as shown in Table 5.1.

5.2.2 For the Preliminary Assessment, the main focus is identifying those Scheme/ WFD elements that are not applicable i.e. particular WFD elements that would not be impacted by particular Scheme elements. For ease of presentation, elements that do have the potential to be impacted, and therefore require Further Assessment, are also summarised in Appendix A.

5.2.3 The scale of Scheme works associated with the Scheme at Kingsway junction means that there are a number of potential waterbody impacts that cannot be ruled out at this stage, and that these require Further Assessment.

Table56.1: WFD impact colour coding used in Appendix A

Not applicable
Major beneficial effect that could result in improved overall status of the waterbody
Minor beneficial effect that would have local benefits but would not contribute to status change at waterbody scale
Neutral effect, i.e. no effect or an overall balance of minor beneficial and adverse effects
Localised and/or temporary adverse effect that needs to be acknowledged but would not have an impact on WFD objectives
Major adverse effect on one WFD element at waterbody scale
Major adverse effect that could result in deteriorated overall status of waterbody

6 FURTHER ASSESSMENT

6.1 Methodology Overview

6.1.1 Further WFD assessment involves all at-risk biological, chemical, hydrological and physico-chemical elements, and consideration of whether they could potentially cause deterioration in WFD status/ potential or prevent a waterbody from meeting its ecological objectives. Further Assessment provides more in-depth analysis of Scheme elements that have been screened in for assessment through the Preliminary Assessment matrix.

6.2 Hydromorphological Impacts

6.2.1 Bramble Brook flows through the middle of the existing Kingsway junction. It is heavily modified throughout its length and depleted of natural habitats. The brook flows from the south-west as an open channel that has been realigned against the A38 embankments, and passes beneath the A38 within a culvert that extends approximately 500m east. Prior to modification, its natural typology would have been a sinuous, single thread gravel bed river with riffles and bars providing substrate and hydraulic habitat diversity.

6.2.2 During the River Habitat Survey (RHS) survey undertaken in May 2018 for the Scheme (Highways England, 2018[10]), it was noted that the northern and central channel marked on maps were completely dry (refer to Figure 1.1), while the former railway cutting to the north-west of the junction contained standing and flowing water. This was discussed with Derby City Council (DCiC) in December 2014 who confirmed that all sections of the brook operate when the catchment is saturated.

6.2.3 The Scheme has the potential to significantly impact upon the hydromorphology relative to existing conditions.

6.2.4 To facilitate the construction of Kingsway junction, the Scheme would realign a section of Bramble Brook against the proposed northbound slip road, whilst it would also require an extension of the existing culvert under the southbound carriageway to the west of the junction and an extension of existing culverts through sections of the junction which would replace sections of open channel.

Bramble Brook Hydromorphology Assessment

6.2.5 A RHS was undertaken along Bramble Brook in 2018, the findings of which are summarised below to inform the WFD assessment.

6.2.6 The surveyed section of Bramble Brook extended from the northern end of the Kingsway roundabout downstream, to approximately 60m west of the A38 northbound carriageway at the upstream end. The brook was culverted beneath the A38 carriageways in three sections and a major weir was present in a reinforced section of channel downstream of the central culvert.

6.2.7 Valley form was considered asymmetrical due to the steep sided valley being situated closer to the northbound carriageway of the A38.

[10] Highways England (2018) A38 Derby Junctions - River Habitat Survey Report.

6.2.8 Natural sections of bank were composed of earth, and generally covered with broad-leaved plantation woodland, scrub and associated ground flora. Culverted sections and the four upstream spot checks consisted of reinforced banks of laid concrete blocks, or solid concrete in the case of culverts. These sections were obviously re-sectioned and straightened.

6.2.9 Channel substrate was generally silt or artificial, with some gravel present in the form of side bars. Some urban trash was also present in the channel. Several point bars were also present, along with both vegetated and unvegetated mid-channel bars, largely composed of accumulated silt deposits.

6.2.10 Channel vegetation was sparse due to the heavily shaded nature of the watercourse. Only bryophytes/ lichens, emergent broad-leaved herbs such as willowherb (*Epilobium* sp.), emergent reeds/ sedges and filamentous algae were present, however, these were very localised.

6.2.11 Although largely contiguous with the bank profile, the A38 embankment was considered to represent a set-back embankment as it had clearly been constructed above the existing floodplain of the watercourse.

6.2.12 Trees were semi-continuous throughout the survey section, with extensive shading and overhanging boughs. Exposed bankside roots, underwater tree roots, fallen trees and large woody debris were also present.

6.2.13 Flow appeared lower than normal, with rippled flow being the extensive flow type, and smooth flow with areas of no flow also present. Evidence of high flows was observed, with debris accumulated in culvert entrances and trapped in bankside vegetation.

6.2.14 The upstream section of Bramble Brook to the west of the A38 northbound carriageway was dry at the time of the survey and it is likely that normal flows are being intercepted by the Mickleover Cutting channel, though the point at which the flows have been intercepted has not been identified.

Bramble Brook Hydromorphology Impacts

6.2.15 The total land take for the Scheme at Kingsway junction is approximately 10ha, which predominantly comprises land within the existing highway boundary (approximately 1.35ha of land outside the existing highway boundary would be required at Kingsway junction). The total area of the Markeaton Brook catchment (from Mackworth Brook to Derwent) is 9.776km^2 (approximately 977.6ha). Therefore, the Scheme at Kingsway junction would impact approximately 1.0% of the total catchment area. The area of the proposed junction (i.e. the new impact beyond the existing highway footprint) would be far less (approximately 0.14% of the total catchment area).

6.2.16 The current Bramble Brook open channel length within the junction is approximately 423m long. In order to facilitate Scheme development at the junction, the open channel length would reduce to approximately 292m (i.e. a loss of approximately 131m of open channel). This equates to approximately 3.3% of the Bramble Brook watercourse length of 3.951km measured from source (SK 31023 35881) to discharge (SK 34734 36559) with significant lengths of channel already in culvert (approximately 2.1km, 53% of the total channel length). This loss of open channel would, therefore, be unlikely to affect the ecological potential of the Markeaton Brook at the catchment scale, however, local effects to Bramble Brook would need to be mitigated.

6.2.17 The proposed extension of the existing culvert under the southbound carriageway to the west of the junction is likely to have a minor detrimental hydromorphological impact to the Bramble Brook watercourse. Culverts typically result in homogenised boundary conditions and flow patterns and can impede substrate continuity, although an approximate 30m extension to the existing culvert would be a less significant impact than construction of a new culvert.

6.2.18 Replacing sections of the existing open watercourse through the new junction within a culvert would have a detrimental impact to the Bramble Brook amounting to loss of a significant proportion of the short distance of existing open channel. However, the existing open watercourse is of low morphological quality in terms of being disproportionately deep and heavily shaded, with little in-channel vegetation and any substrate forms having been scoured out due to the lack of floodplain connectivity and peak flow energy dissipation. However, culverts would still be detrimental due to the loss of open channel and would also prevent any possible future improvements to the channel.

6.2.19 Whilst the paragraph above indicates that it would be preferable in WFD terms to have an open watercourse (which would allow restoration/ naturalisation of the existing degraded brook), flood risk concerns mean that the Bramble Brook channel within the junction needs to be realigned and part placed in culvert to accommodate the fluvial flood storage and sustainable drainage systems (SuDS) highway run off attenuation pond. The diameter of the main culvert through the junction would be reduced to 1,200mm in order to facilitate flood storage. Mitigation measures to offset the loss of open channel are detailed in Section 6.5.

6.2.20 Given the existing heavily modified nature and poor habitat quality of Bramble Brook upstream of Kingsway junction, between the southbound and northbound carriageways, the realignment and culverting sections of the channel would have a negligible impact on the Markeaton Brook waterbody at the catchment scale. Local detrimental effects to the Bramble Brook channel are likely to occur, however, these would be mitigated as detailed in Section 6.5.

6.2.21 Setting the A38 carriageway in a new cutting is likely to only have minor impacts on surface water and groundwater connectivity at the waterbody scale. The site is underlain by low permeability Mercia Mudstone Group and the Tarporley Siltstone Formation (Siltstone, Mudstone and Sandstone). Environment Agency mapping shows that the underlying bedrock is classified as a 'Secondary A' Aquifer, which is defined as "*permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers*".

Impact Summary

6.2.22 Overall, it is considered that the Scheme could potentially result in detrimental impacts or constraints to future improvement of the Bramble Brook within the Markeaton Brook waterbody due to the lengths of culvert within the design of the Scheme and the realignment of the Bramble Brook channel within the new junction. Measures to mitigate this detrimental impact are detailed in Section 6.5.

6.3 Chemistry and Physico-Chemistry Impacts

6.3.1 The Scheme at Kingsway junction could have temporary construction phase impacts on the physico-chemical status of local waterbodies due to the effects of residual contaminants, sediment mobilisation and the introduction of new contaminants through construction activities. It could also have non-temporary impacts in terms of the potential to create new chemical pathways from road runoff and automobile-related contaminants.

6.3.2 Temporary (construction) and non-temporary impacts associated with increased local traffic and associated road runoff could result in the introduction of priority substances such as automobile related contaminants including polycyclic hydrocarbons (PAHs) or heavy metals. However, construction works would be temporary and any potential effects would be mitigated through the adoption of standard environmental construction best practices – such management practices would be specified within a Construction Environmental Management Plan (CEMP) which would be prepared and implemented by the construction contractor.

6.3.3 Construction of the junction could interact with groundwater, through the construction of the culverts, brook diversion and the proposed A38 underpass. All excavation works would be governed by methodologies within the CEMP in order to protect groundwater from spillage and/ or leaks, such that groundwater quality impacts would be negligible.

6.3.4 The Scheme would direct highway runoff into a highway drainage system[11] that incorporates SuDS to control runoff quantity and quality from the Scheme. The drainage system at Kingsway junction includes an attenuation pond, underground tanks, petrol interceptors and separators which would limit polluted drainage and sediments entering Bramble Brook or Markeaton Brook, and could improve drainage quality relative to existing conditions.

[11] Highways England (2018) A38 Derby Junctions Improvement – Drainage Strategy.

Impact Summary

6.3.5 In summary, it is considered that the Scheme would have negligible impacts on the physico-chemical potential of Markeaton Brook, given that appropriate construction and operational mitigation measures would be put in place. Details of such mitigation measures are further discussed within the Environmental Statement.

6.4 Biology Assessment and Impacts

6.4.1 Detailed biological and ecological surveys were undertaken in 2015[12] and 2018[13] at select locations of Bramble Brook as part of invertebrate surveys in spring (April 2015 and May 2018), summer (August 2015) and autumn (October 2015 and September 2018). The latest 2018 macroinvertebrate survey suggests Bramble Brook is of "Moderate" to "Good" biological water quality in the stretch sampled, and of "Low" to "Moderate" conservation value. The brook supports a community that is likely to be relatively tolerant of changes in water quality.

6.4.2 Macrophytes are sparse due to the shaded nature of the channel and the 2018 RHS identified a lack of suitable habitat to support fish populations in Bramble Brook. Large coarse fish are not anticipated to be present due to the extensive, habitat-disconnecting culvert between the existing junction and Markeaton Brook. However, some minor fish species such as three-spined stickleback *Gasterosteus aculeatus* may be present within sections of channel with running water.

6.4.3 Construction works tend to result in temporary noise and vibration which can cause fish mortality or injury at high levels and behavioural responses at low levels. The scale of in-channel works and existing limited biodiversity within the brook means that significant effects are not anticipated following adherence to best practice construction methods.

6.4.4 New culverts can have significant adverse impacts on plants and invertebrates due to shading and homogenised channel conditions. The upstream culvert under the southbound carriageway would be designed to match existing diameters and cross-sections within the junction to ensure existing flow conveyance is maintained and that a natural bed can be maintained throughout. The main culvert which conveys Bramble Brook away from Kingsway junction would, however, be reduced in diameter in order to provide flood relief benefit (see Figure 1.2). This would alter existing flow conveyance downstream, however, the culvert would be designed to maintain a natural bed. Whilst the existing brook habitat and biodiversity is moderate to good and of moderate conservation value, it would be degraded by new culverts, which would constrain the potential for future improvements.

6.4.5 There are several sensitive habitats and non-statutory designated sites within close proximity to Kingsway junction as follows:

- A38 Roundabout Local Wildlife Sites (LWS) (Site Code DE010) is located within the island of Kingsway junction and designated for its semi-improved neutral grassland.

[12] Highways England (2015) A38 Derby Junctions. Aquatic Macroinvertebrate Survey Report.
[13] Highways England (2018) A38 Derby Junctions. Aquatic Macroinvertebrate Survey Report.

- Bramble Brook and Margins LWS (Site Code DE014) is located adjacent to Kingsway junction and is designated for its secondary broad-leaved woodland.
- Mickleover Railway Cutting LWS (Site Code DE004) is located within approximately 50m of the site boundary at Kingsway junction and designated for its habitat mosaic. The LWS appears to have hydrological links to the site.
- Markeaton Park LWS (Site Code DE074) is located directly adjacent to the northern site boundary at Markeaton junction. The LWS is designated for its wood pasture and parks including veteran trees.
- Markeaton Brook System LWS (Site Code DE003) is located within 50m of the site boundary at Markeaton junction. The LWS is designated for its invertebrate assemblage (including white-clawed crayfish *Austropotamobius pallipes*). Markeaton Brook is also a Water Framework Directive (WFD) waterbody.

6.4.6 The Scheme would have a significant effect on the A38 Roundabout LWS, although Scheme impacts on the Markeaton Brook System LWS would be negligible (details are provided within the Environmental Statement (ES) – refer to ES Chapter 8: Biodiversity).

6.4.7 Overall, it is considered that the Scheme would have negligible impact on the Markeaton Brook biological potential at a waterbody scale. Some local deterioration could potentially occur due to land take, and the southern culvert extension, but such impacts would be mitigated (see Section 6.5).

6.5 Mitigation Measures

Construction Management

6.5.1 During the Scheme construction phase, best practices would be applied in accordance with a CEMP to be prepared and implemented by the selected construction contractor. Such measures would ensure that significant effects upon local waterbodies in the vicinity of the Scheme at Kingsway junction would be avoided.

Operational Highway Runoff

6.5.2 The Scheme would direct highway runoff into a highway drainage system that includes a highway runoff attenuation ponds as well as underground tanks, oversized pipes, narrow filter drains, combined kerb drainage units, trapped gully pots/ road-side linear drains, petrol interceptors at outfalls and connections to existing public sewers, and by-pass separators. The outfall from the highway runoff storage tank within Mackworth Park would discharge via a swale into a tributary of Bramble Brook which is periodically dry. The highway drainage system would thus appropriately manage both water runoff and quality and avoid adverse effects upon Bramble Brook.

WFD Mitigation Measures

6.5.3 Additional lengths of culvert would be installed on Bramble Brook through the junction and between the southbound merge slip and the northbound diverge slip roads. Bramble Brook would also be realigned to accommodate the new fluvial flood storage area and highway runoff attenuation pond within the junction. Whilst the existing brook channel habitat is poor and heavily modified, the Scheme would cause local deterioration to WFD quality elements as discussed above.

6.5.4 In order to mitigate this risk, the following mitigation measures have been integrated into the Scheme design which would be proportionate to the scale of the impact:

- The upstream southbound carriageway culvert extension would be designed to match existing diameters and cross-sections within the junction to ensure existing flow conveyance is maintained and that there would be no impediment to sediment transport downstream of the junction.
- The main culvert through the junction would, however, be reduced in diameter through the installation of a 1,200mm culvert, altering existing flow conveyance during high flow events (see Figure 1.2). Considering the lengths of culvert downstream of the junction, changes in flow regime are unlikely to have any significant effects. To manage changes to the sediment regime, the culvert would be installed to maintain a natural bed through the culvert such that there would be no impediment to sediment transport.
- The flood risk design for the Scheme at Kingsway junction includes the provision of four flood storage areas, namely three storage areas located adjacent to Bramble Brook within the Kingsway hospital site (see Figure 6.1) and a single large storage area located adjacent to the realigned Bramble Brook within the junction (see Figure 2.2). It was the original intention that these flood storage areas would be predominantly dry, and only contain water under extreme flooding events. However, specifically to mitigate WFD effects as identified herein and to improve riparian habitat, it is proposed that the base of these flood storage areas would be kept wet (to a depth of approximately 100mm) in order to provide valuable wetland habitat within the riparian corridor. Water would be delivered into the storage areas from Bramble Brook using low level piping at bed level. The system would be designed in a manner that would not cause Bramble Brook to dry out during low flow periods and prevent fauna (i.e. fish) from becoming trapped in the wetland areas.

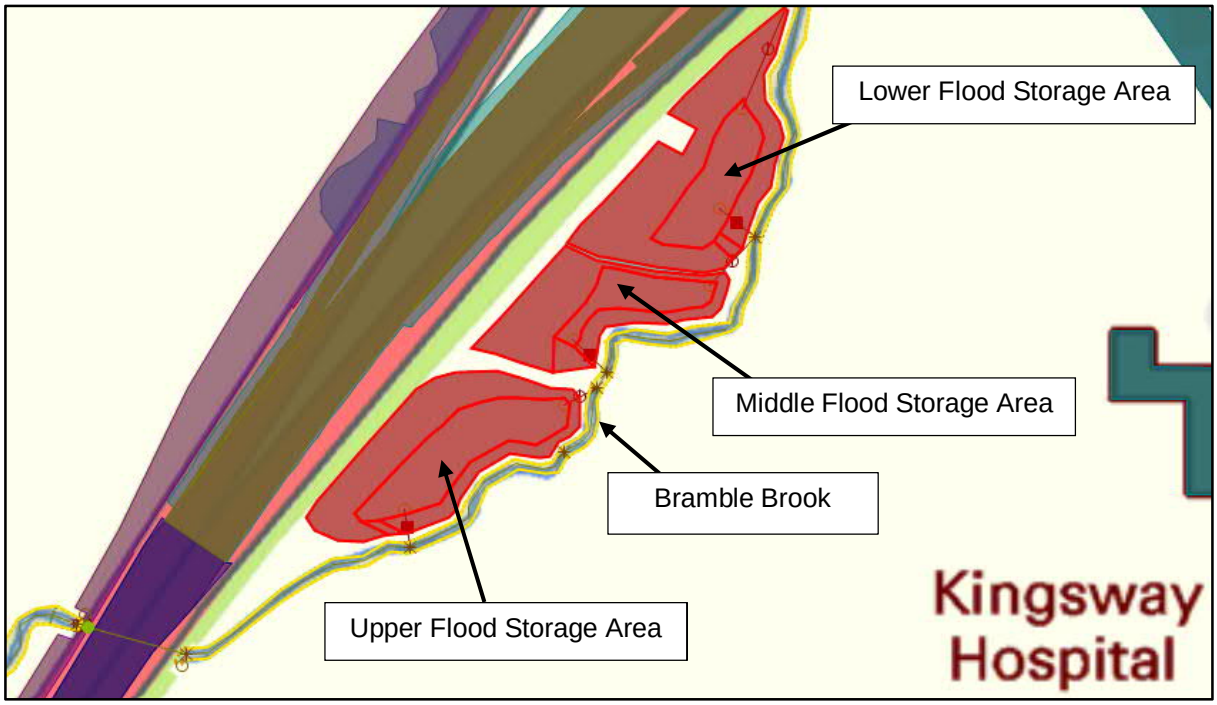


Figure 6.1: Flood storage areas adjacent to Bramble Brook

- The design of the realigned Bramble Brook channel has been amended for WFD mitigation purposes to include inset alternate berms. Such berms would improve flow variation, help to reduce fine sediment deposition and provide suitable available habitat for in-channel macrophytes.
- The outfall from the highway runoff storage tank within Mackworth Park to the tributary of Bramble Brook (which is periodically dry) was initially proposed to be pipes. However, it is now proposed to transfer this water via a 20m swale.

7 CONCLUSIONS

7.1.1 The Scheme at Kingsway junction would expand the existing road network, as well as culvert and divert sections of Bramble Brook.

7.1.2 This WFD assessment has been undertaken to identify the potential impacts of the Scheme at Kingsway junction and its compliance with EC Directive 2000/60/EC, which aims to protect and enhance the quality of the water environment. This report has been produced to help inform the development of the Scheme design in terms of WFD objectives.

7.1.3 The Scheme design includes culverts on the Bramble Brook through sections of the junction and extends an existing culvert on the southbound merge slip road resulting in the loss of approximately 131m of open channel which would result in local deterioration to this stretch of Bramble Brook. There would also be an approximate 30m extension to the existing culvert under the southbound carriageway to the west of the junction.

7.1.4 The habitat within this section of the Bramble Brook is poor, with the channel being heavily modified, including a weir and bank reinforcement. In-channel macrophytes are also sparse and the bed of the watercourse is dominated by silt within a section of channel with limited to no perceptible flow.

7.1.5 In order to mitigate for the loss of open channel at Kingsway junction, the Scheme design has been amended to include:

- Southbound carriageway culverts designed to match existing diameters and cross-sections to ensure existing flow conveyance is maintained and no impediment to sediment transport downstream of the junction.
- Main culvert would be installed to have a natural bed that could be maintained through the structure and that there would be no impediment to sediment transport downstream, maintaining some habitat connectivity.
- Low level piping of water from Bramble Brook into flood storage areas such that they would be kept wet (to a depth of approximately 100mm).
- The realigned Bramble Brook channel would include inset alternate berms to improve flow variation, help to reduce fine sediment deposition and provide suitable available habitat for in-channel macrophytes.
- The outfall from the highway runoff storage tank within Mackworth Park would discharge via a swale into a tributary of Bramble Brook.

7.1.6 The measures proposed to mitigate for loss of open channel would enhance the riparian zone of Bramble Brook through the provision of formal flood storage areas which would remain wet and provide wetland habitat within the riparian corridor. The realigned Bramble Brook channel would also be enhanced through the creation of inset alternate berms which would provide improved flow variation, reduce fine sediment deposition and provide habitat for bankside and emergent vegetation.

7.1.7 In addition to the above, construction works would be undertaken in accordance with a CEMP that would be prepared and implemented by the selected construction contractor. The Scheme would also be provided with an appropriate highway drainage system that would control the quantity and quality of runoff from the new road network.

7.1.8 With the implementation of the mitigation measures defined herein, the Scheme at Kingsway junction would not have an adverse effect on the WFD status of the Markeaton Brook.

APPENDIX A

WFD Assessment Matrix

A. Risk screening of potential for Scheme to cause deterioration of current WFD ecological status

Surface water body	Current status	Status objective	Scheme Elements	Expanded road network and increased impervious surface area drainage	Bramble Brook - Culvert extension through existing centre of the Kingsway Junction				Bramble Brook - Culvert extension				Bramble Brook - A38 mainline in cutting		Bramble Brook - Brook realignment	OVERALL effect on element	Additional Proposed Mitigation Measures		RESIDUAL effect on element (following any additional mitigation measures)
GB104028053240	Moderate	Good ecological status by 2027	Description of Scheme element impact		Culvert of the existing open watercourse beneath the junction (loss of approximately 131m of open channel).				Proposed culvert extension of approximately 30m underneath the A38 southbound merge slip. Proposed Kingsway junction would comprise a dumbbell roundabout with the A38 carriageway passing through the centre of the junction with an additional culvert length of approximately 131m.				The new A38 mainline would be in cutting and its low point would be high enough above the inlet chamber level to the long outfall culvert to allow drainage connection.		Bramble Brook would require diversion due to new road alignments between the westbound slip road and the A38 mainline.		Construction	Operation	
Markeaton Brook			Identified biological impacts	Drainage	Noise and Vibration	Land take	Shading	Changes to water body hydromorphology leading to changes in river processes and habitats upstream and downstream.	Noise and Vibration	Land take (embankments)	Shading	Changes to water body hydromorphology leading to changes in river processes and habitats upstream and downstream.	Changes (i.e. either decrease due to de-watering/damming of groundwater flows or increase due to re-charge) in flow velocity and volume due to de-watering	Change in water quality due to discharge of groundwater to a surface water body.	Creation of new, morphological and ecologically designed habitats.				
Biological Potential																			
WFD classification elements			Predicted change to status elements (green = none, amber = possibly, red = likely)																
1.Macrophytes and phytobenthos - diatoms				N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2. Macrophytes and phytobenthos - macrophytes	-	-		Expansion of an existing road network has the potential to increase road polluted sediment mobilisation. Proposed sustainable drainage systems should effectively manage any effects and could improve runoff quantity and quality with a beneficial impact on biodiversity.	Receptor is insensitive to impact.	Land take would lead to direct loss of macrophytes and reduce the availability of macrophyte habitats within culverts. Extension of the existing culvert through the junction would cause local deterioration from the perspective of the WFD.	Shading of the channel from the proposed culverts has the potential to reduce photosynthetic activity and therefore affect macrophyte communities present. Extension of the existing culvert through the junction would cause local deterioration from the perspective of the WFD.	Changes in flow dynamics may result in changes to macrophyte communities within the immediate vicinity of the culvert, through the removal of natural materials (i.e. gravels, alluvium). Extension of the existing culvert through the junction would cause local deterioration from the perspective of the WFD.	Receptor is insensitive to impact.	Land take would lead to direct loss of macrophytes and reduce the availability of macrophyte habitats within the culvert. Only a limited length of a minor tributary would be affected. Opportunities for improved habitat downstream of culvert within realigned channel through creation of inset berms.	Shading of the channel from the culvert has the potential to reduce photosynthetic activity and therefore affect macrophyte communities present. Only a limited length of a minor tributary would be affected. Opportunities for improved habitat downstream of culvert within realigned channel through creation of inset berms.	Localised changes in flow dynamics may result in changes to macrophyte communities within the immediate vicinity of the culvert. This would only affect a small distance and potential effects are considered to be minor and localised.	Possible minor and localised effects on flows in minor tributary, but no overall adverse effect on flows in the main watercourse itself. Possible minor and localised effects.	Possible minor and localised effects on water quality in minor tributary, but no overall adverse effect on water quality in the main watercourse itself.	Bramble Brook is of moderate (autumn) to good (spring/ summer) biological quality within the area surveyed upstream of the proposed diversion. The diversion offers the opportunity to provide beneficial habitat - the potential benefits of the diversion could act as compensation for the culvert extensions upstream and downstream.			Appropriate design of culverts through junction. Channel realignment to include in-set alternate berms designed to improve channel habitats in order to allow for colonisation by the range of taxa that currently characterise the reach.	
3. Macroinvertebrates	Moderate	-		Expansion of an existing road network has the potential to increase road polluted sediment mobilisation. Proposed sustainable drainage systems should effectively manage any effects and could improve runoff quantity and quality with a beneficial impact on biodiversity.	Localised and temporary adverse effects possible during Scheme construction, with no effect anticipated at the scale of the waterbody - mitigation via appropriate construction management.	Land take would lead to direct loss of macrophytes and reduce the availability of macroinvertebrate habitats within the culvert. Extension of the existing culvert through the junction would cause local deterioration from the perspective of the WFD.	Shading of the channel from the culvert has the potential to reduce photosynthetic activity and therefore affect macrophyte communities present reducing available macroinvertebrate habitat. Extension of the existing culvert through the junction would cause local deterioration from the perspective of the WFD.	Changes in flow dynamics may result in changes to macrophyte communities within the immediate vicinity of the culvert, through the removal of natural materials (i.e. gravels, alluvium) impacting macroinvertebrate species. Extension of the existing culvert through the junction would cause local deterioration from the perspective of the WFD.	Localised and temporary adverse effects possible during construction, with no effect anticipated at the scale of the water body - adoption of best construction practices in accordance with CEMP.	Land take would reduce the availability of macroinvertebrate habitats within the culvert. There is also the potential for impacts during Scheme construction (e.g. release of suspended solids) - thus adoption of best construction practices in accordance with CEMP. Only a limited length of a minor tributary would be affected. Opportunities for improved habitat downstream of culvert within realigned channel through creation of inset berms.	Loss of habitat. Only a limited length of the Bramble Brook would be affected . Anticipated that this would have a minor impact, not affecting the WFD status for this element. Opportunities for improved habitat downstream of culvert within realigned channel through creation of inset berms.	Localised changes in flow dynamics may result in changes to macrophyte communities and macroinvertebrate habitat within the immediate vicinity of the culvert. This would only affect a small distance and potential effects are considered to be minor and localised.	Possible minor and localised effects on flows in minor tributary, but no overall adverse effect on flows in the main watercourse itself. Possible minor and localised effects.	Possible minor and localised effects on water quality in minor tributary, but no overall adverse effect on water quality in the main watercourse itself.	Bramble Brook is of moderate (autumn) to good (spring/ summer) biological quality within the area surveyed upstream of the proposed diversion. The diversion offers the opportunity to provide beneficial habitat - the potential benefits of the diversion could act as compensation for the culvert extensions upstream and downstream.	Scheme elements identified as having potential for temporary and/ or localised minor adverse effects (culverting), but would be mitigated through adherence to construction best practices and channel design. Without mitigation the extension of the existing culvert through the junction could cause deterioration from the perspective of the WFD.	Implement best construction practices to provide sediment controls, limiting sediment from entering watercourses. Culvert under southbound slip would maintain existing diameter to ensure bed and flow continuity. The new 1,200mm culvert would be set to ensure development of a natural bed.	Appropriate design of culverts through junction. Channel realignment to include in-set alternate berms designed to improve channel habitats in order to allow for colonisation by the range of taxa that currently characterise the reach.	Minor localised and temporary effects during construction, possible non-temporary benefits with appropriate Scheme design.
4. Fish	=	-		Expansion of an existing road network has the potential to increase road polluted sediment mobilisation. Proposed sustainable drainage systems should effectively manage any effects and could improve runoff quantity and quality with a beneficial impact on biodiversity.	Localised and temporary adverse effects possible during Scheme construction, with no effect anticipated at the scale of the waterbody - mitigation via appropriate construction management.	Land take would reduce the availability of fish habitats within the culvert, though this is limited. There is also the potential for impacts during Scheme construction (e.g. release of suspended solids). A long length of a minor tributary would be affected (a loss of approximately 131m of open channel), although it is unlikely to have an impact on Markeaton Brook, which is a WFD waterbody. Extension of the existing culverts through Kingsway junction would cause local deterioration from the perspective of the WFD.	Extensive loss of available habitat by culverting open watercourse. Extension of the existing culvert through the junction would cause local deterioration from the perspective of the WFD.	Changes in flow dynamics and the proposed culvert extensions would not impede upstream passage of any migratory fish provided the culvert is sized and designed appropriately. Fish movement is likely to be impeded by existing lengths of culvert on the Bramble Brook and on the Markeaton Brook downstream of the site. Extension of the existing culvert through the junction would cause local deterioration from the perspective of the WFD.	Localised and temporary adverse effects possible during Scheme construction, with no effect anticipated at the scale of the water body - adoption of best construction practices in accordance with CEMP.	Land take would reduce the availability of fish habitats within the culvert. There is also the potential for impacts during Scheme construction (e.g. release of suspended solids) - thus adoption of best construction practices in accordance with CEMP. Only a limited length of a minor tributary would be affected. Opportunities for improved habitat downstream of culvert within realigned channel through creation of inset berms.	Loss of habitat. Only a limited length of the Bramble Brook would be affected . Anticipated that this would have a minor impact, not affecting the WFD status for this element. Opportunities for improved habitat downstream of culvert within realigned channel through creation of inset berms.	Localised changes in flow dynamics and the presence of the culvert would not impede upstream passage of any migratory fish provided the culvert is sized and designed appropriately. This would only affect a small distance and potential effects are considered to be minor and localised.	Possible minor and localised effects on flows in minor tributary, but no overall adverse effect on flows in the main watercourse itself. Possible minor and localised effects.	Possible minor and localised effects on water quality in minor tributary, but no overall adverse effect on water quality in the main watercourse itself.	Large coarse fish are not anticipated, although some minor fish species may be present within sections of channel with running water. By default, localised and temporary beneficial impacts as a result of channel diversion, with no effect anticipated at the scale of the water body.			Appropriate design of culverts through junction. Channel realignment to include in-set alternate berms designed to improve channel habitats in order to allow for colonisation by the range of taxa that currently characterise the reach.	
Physico-Chemical Potential																			
WFD classification elements: Physico-Chemistry			Predicted change to status elements (green = none, amber = possibly, red = likely)																
5. Dissolved Oxygen	Good	-		Expansion of an existing road network has the potential to increase polluted sediment mobilisation, which can lead to decreased dissolved oxygen levels. However, proposed sustainable drainage systems should effectively manage any effects and could improve runoff quantity and quality.	N/A	N/A	A culvert could have a minor impact on dissolved oxygen due to altered flow dynamics and loss of photosynthesising flora - this impact is likely to have a minor/ local effect in relation to the waterbody. Therefore, no change in status is anticipated.	No impact anticipated.	N/A	N/A	Culvert could have a minor impact on dissolved oxygen due to altered flow dynamics and loss of photosynthesising flora. This impact is likely to have a minor/local effect in relation to the water body. Therefore, no change in status is anticipated.	No impact anticipated.	Water quality could be reduced in the depleted reaches, particularly the hyporheic zone, due to the reduced inflow of water or altered surface water - groundwater dynamics.	Water quality could be reduced in the depleted reaches, particularly the hyporheic zone, due to the reduced inflow of water or altered surface water - groundwater dynamics.	Likely short term increase in sediment and associated pollutants during Scheme construction phase, but this would be temporary. Adoption of best construction practices in accordance with CEMP.	Minor localised and temporary effects during Scheme construction, possible non-temporary benefits with appropriate Scheme design including low level inset berms.			
6. pH	High	-		Expansion of an existing road network has the potential to increase road polluted sediment mobilisation, although proposed sustainable drainage systems should effectively manage any effects and could improve runoff quantity and quality.	N/A	N/A	No impact anticipated.	No impact anticipated.	N/A	N/A	No impact anticipated.	No impact anticipated.	Water quality could be reduced in the depleted reaches, particularly the hyporheic zone, due to the reduced inflow of water or altered surface water - groundwater dynamics.	Water quality could be reduced in the depleted reaches, particularly the hyporheic zone, due to the reduced inflow of water or altered surface water - groundwater dynamics.	Likely short term increase in sediment and associated pollutants during Scheme construction phase, but this would only be temporary. Adoption of best construction practices in accordance with CEMP.	Minor localised and temporary effects during Scheme construction, possible non-temporary benefits with appropriate Scheme design including low level inset berms.			
7. Phosphate	Good	-		Expansion of an existing road network has the potential to increase road polluted sediment mobilisation, although proposed sustainable drainage systems should effectively manage any effects and could improve runoff quantity and quality.	N/A	N/A	No impact anticipated.	No impact anticipated.	N/A	N/A	No impact anticipated.	No impact anticipated.	Water quality could be reduced in the depleted reaches due to relatively increased concentrations of resident contaminants, including phosphate from source and diffuse pollution.	Possible minor and localised effects on water quality in minor tributary, but no overall adverse effect on water quality in the main watercourse itself.	Likely short term increase in sediment and associated pollutants during Scheme construction phase, but this would only be temporary. Adoption of best construction practices in accordance with CEMP.	Minor localised and temporary effects during Scheme construction, possible non-temporary benefits with appropriate Scheme design including low level inset berms.	Implement best construction practices to provide sediment controls, limiting sediment from entering watercourses.	Sustainable drainage systems to reduce sediment and sediment related contaminants from entering the watercourse.	Minor localised and temporary effects during Scheme construction, possible non-temporary benefits with appropriate Scheme design.
8. Ammonia	High	-		Expansion of an existing road network has the potential to increase road polluted sediment mobilisation, although proposed sustainable drainage systems should effectively manage any effects and could improve runoff quantity and quality.	N/A	N/A	No additional effect to this sub-element anticipated.	No impact anticipated.	N/A	N/A	No additional effect to this sub-element anticipated.	No impact anticipated.	Water quality could be reduced in the depleted reaches due to relatively increased concentrations of resident contaminants, the reduced inflow of water and reduced flow rates, turbulence and oxygenation, and other possible effects.	Possible minor and localised effects on water quality in minor tributary, but no overall adverse effect on water quality in the main watercourse itself.	Likely short term increase in sediment and associated pollutants during Scheme construction phase, but this would only be temporary. Adoption of best construction practices in accordance with CEMP.	Minor localised and temporary effects during Scheme construction, possible non-temporary benefits with appropriate Scheme design including low level inset berms.			
9. Temperature	-	-		Expansion of an existing road network has the potential to increase road polluted sediment mobilisation, although proposed sustainable drainage systems should effectively manage any effects and could improve runoff quantity and quality.	N/A	N/A	Extending the existing culvert through the junction could cause deterioration from the perspective of the WFD. A culvert could impact temperature due to shading - this impact is likely to have a minor/ local effect in relation to the waterbody. Therefore, no change in status is anticipated.	No impact anticipated.	N/A	N/A	Culvert could impact temperature due to shading - impact is likely to have a minor/local effect in relation to the water body. Therefore, no change in status is anticipated.	No impact anticipated.	Water quality could be reduced in the depleted reaches, particularly the hyporheic zone, due to the reduced inflow of water or altered surface water - groundwater dynamics.	Water quality could be reduced in the depleted reaches, particularly the hyporheic zone, due to the reduced inflow of water or altered surface water - groundwater dynamics.	Likely short term increase in sediment and associated pollutants during Scheme construction phase, but this would only be temporary. Adoption of best construction practices in accordance with CEMP.	Minor localised and temporary effects during Scheme construction, possible non-temporary benefits with appropriate Scheme design including low level inset berms.			
10. Specific Pollutants (Annex VIII)	-	-		Expansion of an existing road network has the potential to increase road polluted sediment mobilisation, although proposed sustainable drainage systems should effectively manage any effects and could improve runoff quantity and quality.	N/A	N/A	No impact anticipated.	Expansion of an existing road network has the potential to increase road polluted sediment mobilisation, although proposed sustainable drainage systems should effectively manage any effects and could improve runoff quantity and quality.	N/A	N/A	No impact anticipated.	Expansion of an existing road network has the potential to increase road polluted sediment mobilisation, although proposed sustainable drainage systems should effectively manage any effects and could improve runoff quantity and quality.	Water quality could be reduced in the depleted reaches due to relatively increased concentrations of resident contaminants, the reduced inflow of water and reduced flow rates, turbulence and oxygenation, and other possible effects.	Possible minor and localised effects on water quality in minor tributary, but no overall adverse effect on water quality in the main watercourse itself.	Likely short term increase in sediment and associated pollutants during Scheme construction phase, but this would only be temporary. Adoption of best construction practices in accordance with CEMP.	Minor localised and temporary effects during Scheme construction, possible non-temporary benefits with appropriate Scheme design including low level inset berms.			
Hydromorphological Potential																			
WFD classification elements: Hydromorphology			Predicted change to status elements (green = none, amber = possibly, red = likely)																
11. Quantity and dynamics of river flow	-	-			N/A	N/A	N/A	Bramble Brook is approximately 1.5m wide and hydromorphologically diverse, but appears to have been historically modified. The reach through Kingsway junction considered to be hydrodynamically degraded at present. Culverts typically mean that out of bank flows would be cut-off and culvert boundaries would be smooth compared to natural banks and vegetated riparian zones, which may result in homogenised flow patterns and increased flow velocities due to increased channel gradients and decreased roughness. Extension of the existing culvert through the junction could cause local deterioration from the perspective of the WFD.	N/A	N/A	N/A	Bramble Brook is approximately 1.5 m wide and hydromorphological diverse, but appears to have been historically modified. Culverts typically mean that out of bank flows would be cut-off and culvert boundaries would be smooth compared to natural banks and vegetated riparian zones, which may result in homogenised flow patterns and increased flow velocities due to increased channel gradients and decreased roughness. There would only be a small impact extent that could be mitigated elsewhere as part of the Scheme.	Possible effects, especially on dry weather flow.	N/A	A new channel offers the opportunity to create inset alternate berms to improve flow water diversity. The potential benefits of the realignment could act as compensation for the culvert extensions.				
12. Connection to Groundwater	-	-			N/A	N/A	N/A	No significant relationship with groundwater anticipated.	N/A	N/A	N/A	No significant relationship with groundwater.	Possible effects, especially on dry weather flow.	N/A	No significant relationship with groundwater.				
13. River continuity	-	-			N/A	N/A	N/A	The culvert would disconnect floodplains and out-of-bank flows, bank habitats and effectively sever existing flow and habitat continuity within and adjacent to both sides of the channel. Extension of the existing culvert through the junction could cause local deterioration from the perspective of the WFD.	N/A	N/A	N/A	The culvert would disconnect floodplains and out-of-bank flows, bank habitats and effectively sever existing flow and habitat continuity within and adjacent to both sides of the channel. However, at the waterbody scale, this is unlikely to have an impact on deterioration of the overall waterbody status.	Possible effects, especially on dry weather flow.	N/A	The realigned channel and the provision of flood storage areas would provide morphological habitat diversity. The potential benefits of the realignment including the inset alternate berms and adjacent flood storage areas would act as compensation for the culvert extensions upstream and downstream.				
14. River depth and width variation bed	-	-			N/A	N/A	N/A	Out-of bank flows would be severed by the culvert, and in-channel flows may become deeper than natural peak flows, and may even surcharge in extreme events. The culvert would homogenise channel morphology, although the channel appears to have been historically modified. Scour adjacent to the structure upstream and downstream could result in sharp changes in channel geometry and a stepped channel/ perched culvert base. Extension of the existing culvert through the junction could cause local deterioration from the perspective of the WFD.	N/A	N/A	N/A	Out-of bank flows would be severed by the culvert, and in-channel flows may become deeper than natural peak flows, and may even surcharge in extreme events. The culvert would homogenise channel morphology, although the channel appears to have been historically modified. Scour adjacent to the structure upstream and downstream could result in sharp changes in channel geometry and a stepped channel/ perched culvert base. There would only be a small impact extent that could be mitigated elsewhere as part of the Scheme.	Possible effects, especially on dry weather flow.	N/A	A new channel offers the opportunity improve morphological habitat diversity. The potential benefits of the channel realignment would act as compensation for the culvert extensions upstream and downstream.	Minor localised and temporary effects during Scheme construction, possible non-temporary benefits with appropriate Scheme design.	Incorporate hydromorphological mitigation measures into realigned channel design, including the provision of alternate inset berms and adjacent wetted flood storage areas. Culverts be designed to allow the development of natural bed.		Minor localised and temporary effects during construction, possible non-temporary benefits with appropriate Scheme design.
15. Structure and substrate of river bed	-	-			N/A	N/A	N/A	Culverts can interrupt downstream substrate transport, and can affect local scour and deposition of bed forms. The over deep reach is this area is likely to mean that bed diversity is poor due to concentrated flow energy where the floodplain has been disconnected. If the culvert base is set below the channel bed, the impacts on the bed can be minimised. Extension of the existing culvert through the junction could cause local deterioration from the perspective of the WFD.	N/A	N/A	N/A	Culverts can interrupt downstream substrate transport, and can affect local scour and deposition of bed forms. If the culvert base is set below the channel bed, the impacts on the bed can be minimised. There would only be a small impact extent that could be mitigated elsewhere as part of the Scheme.	Possible effects, especially on dry weather flow.	N/A	A new channel offers the opportunity improve morphological habitat diversity. The potential benefits of the channel realignment would act as compensation for the culvert extensions upstream and downstream.				
16. Structure of riparian zone	-	-			N/A	N/A	N/A	The culvert would disconnect the channel from the vegetated riparian zones and sever any existing riparian habitat continuity along the channel, although present riparian conditions are already likely to be degraded. Extension of the existing culvert through the junction could cause local deterioration from the perspective of the WFD.	N/A	N/A	N/A	The culvert would disconnect the channel from the vegetated riparian zones and sever any existing riparian habitat continuity along the channel. Not anticipated to have a significant effect at the waterbody scale.	Possible effects, especially on dry weather flow.	N/A	A new channel offers the opportunity to naturalise riparian zones and improve morphological habitat diversity. The potential benefits of the channel realignment and inset alternate berms would act as compensation for the culvert extensions upstream and downstream.				