Appendix 12.2:
Water Framework Directive Assessment: Detailed Design Stage

Water Framework Directive Assessment - Detailed Design Stage

Brent Cross Cricklewood Development Partners

BXCR-ACM-RB-26-RP-HD-00002

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Quality information

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Revision History

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1. Introduction

This Water Framework Directive (WFD) assessment has been prepared for the River Brent Realignment scheme, which forms part of the Brent Cross Cricklewood (BXC) development in the London Borough of Barnet. The proposed development received planning permission following a successful Section 73 planning revision in 2014.

This report forms an update to the initial WFD assessment prepared in October 2013, following the detailed design of the river realignment. This WFD assessment has been completed to satisfy Section 44.10 of the planning conditions linked to the consented 2014 scheme. The River Brent realignment is central to the wider development scheme.

The river realignment elements of the wider BXC scheme are briefly summarised with respect to WFD objectives. The design documents that justify river restoration decisions, and provide technical details on general arrangements, channel geometry, flows, sediment transport, scour, water quality and ecology are referenced for further information.

1.1 Background to the River Brent Realignment

The River Brent realignment (currently at detailed design stage) will divert the route of the existing artificially straightened (circa 1930s) channel, further south, to flow around the extension of the Brent Cross shopping centre, and back towards its natural course. The route is heavily constrained by the land available, the need to manage flood risks, highways and infrastructure, and contaminated land and groundwater. A balanced approach has been taken throughout the detailed design evolution to incorporate ‘river naturalisation’ and maximise the ecological potential of the new channel. Figure 1.1 shows the existing heavily modified river at the site, and the more natural channel upstream at Brent Park, which is one of several proxy sites assessed in detail for design targets.

Figure 1.1 Comparison of Brent Cross existing channel with the more natural channel upstream at Brent Park

1.2 Brent Cross Cricklewood Site Masterplan

Planning Permission was originally granted in October 2010 for an earlier version of the scheme; however changes necessitated a revised S.73 proposal, mainly with respect to commercial and infrastructure (especially highways) alignments, and the constraints those impose on fluvial flood risks. The S.73 planning update for the proposed revised BXC regeneration received planning permission in July 2014 from the Local Planning Authority (LPA), London Borough of Barnet.

Overall, the revised consented master plan includes greater connectivity to transport interchanges including Brent Cross London Underground Station, Cricklewood Railway Station, the Brent Cross Shopping Centre Bus Station, and a new railway station in the western area of the site. Set within a new area layout are residential developments, civic spaces, leisure and office developments, together with a focus on green spaces and parks.

The River Brent has been a central focus of the site masterplan, with ambitions to restore the river for biodiversity and amenity value, and the need to manage flood risks and the structural integrity of near-channel assets in an intensively developed area.

Further details of the Brent Cross site masterplan can be found in the previous WFD Assessment[1].

1.3 Water Environment Site Monitoring and Appraisal

Detailed groundwater and surface water monitoring, geomorphological appraisals, flood risk modelling, and environmental and ecological assessments have underpinned the Brent Cross 'Basis of Design' report[2], which was subsequently used to guide the detailed civils elements of the channel design. Detailed design is nearing completion ready for the tendering process to appoint a contractor in late summer 2017.

This document provides an update to the WFD Assessment completed in 2013:

- Brent Cross Cricklewood. Water Framework Directive Assessment. October 2013. URS. (47065005-RH-RPT-002).

Design details are available from:

- Brent Cross Cricklewood. Stage 1 and 2 Channel Design. March 2017. AECOM (in production).
- Brent Cross Monitoring Water Level Summary – August 2016. AECOM.
- Brent Cross Cricklewood. River Brent Diversion. Maintenance Manual. *Draft for discussion*. September 2016. AECOM.
- Brent Cross Cricklewood. Factual Groundwater Monitoring Report. AECOM. February 2016. (BXCR-URS-RB-XX-RP-HY-00018 FINAL).
- Brent Cross Cricklewood. Basis of Design Report – River Brent. August 2015. Revision 4. URS. (BXCR-URS-RB-XX-RP-HY-00001).
- Brent Cross/Cricklewood Regeneration. Water Monitoring Plan. September 2014. URS. (47067191).
- Brent Cross Cricklewood. Technical Advice Note 11 – River Naturalisation Options Appraisal. AECOM. January 2014. (BXCR-URS-RB-XX-RP-HY-00011).
- Assessment of the macroinvertebrate community of the Clitterhouse Ditch (Tributary of the Brent) London. Borough of Barnet. Thames Water. Ahern Ecology. 2014.
- Ground Investigation and Remedial Strategy Report – River Brent Diversion. Revision 1. URS. 2014. (47065005-GERPT-009).
- Brent Cross Cricklewood – Flood Risk Assessment (BXC 16). URS October 2013. (470605005-RH-RPT-001).
- Brent Cross Cricklewood – Flood Risk Assessment. Appendix E. Hydraulic Modelling Technical Note. URS October 2013. (47065005-RH-RPT-002-APPE).
- Brent Cross Cricklewood Section 73 Planning Application. BXC15 — Supplementary Section 73 Drainage Strategy. URS. 2013. (47065005-DR-RPT-01).

1.4 Overview of the Water Framework Directive

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] Brent Cross Cricklewood. Water Framework Directive Assessment. October 2013. URS. (47065005-RH-RPT-002).
[2] Brent Cross Cricklewood. Basis of Design Report – River Brent. August 2015. Revision 4. URS. (BXCR-URS-RB-XX-RP-HY-00001).

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; and/ or
- Prevent future attainment of good status or potential where not already achieved.

2. Baseline WFD Status

The River Brent at Brent Cross is classified as the “Dollis Brook and Upper Brent” waterbody within the “Brent Rivers and Lakes” operational catchment of the Thames River Basin Management Plan. The Clitterhouse Stream joins the River Brent from the south-east but does not have its own waterbody classification, and as such is considered part of Dollis Brook and Upper Brent waterbody.

2.1 WFD data

Baseline WFD data for the Dollis Brook and Upper Brent waterbody (GB106039022980) have been summarised from the Environment Agency’s Catchment Data Explorer[3] in Table 2.1.

Table 2.1 Summary of surface waterbody classification

RBMP Parameter	Classification	
Waterbody Name, ID, Category	Dollis Brook and Upper Brent, GB106039022980, River	
Size (Length, Area)	Length 16.99 km, Area 43.08 km^2	
Hydromorphological Designation	Heavily Modified Waterbody	
	Current (2015 Cycle 2)	**Objective (2027)**
Current Overall Potential	Moderate	Good
Biological quality elements	Poor	Good
Hydromorphological supporting elements	Supports good	Supports good
Physico-chemical quality elements	Moderate	Good
Specific pollutants	High	High
Supporting elements (surface water)	Moderate	Good
Chemical	Good	Good

The latest available data (2015, Cycle 2) show the waterbody to be at ‘Moderate’ potential, with the objective for 2027 targeted to achieve ‘Good Ecological Potential (GEP). Key components of the current WFD classification are that biological elements are currently at ‘Poor’ status due to the ‘Poor’ status of invertebrates. The hydromorphological supporting elements, including hydrological regime support ‘Good’ status. Both phosphate and dissolved oxygen have ‘Poor’ status with ammonia classified as ‘Moderate’. Surface water in the mitigation measures assessment is classified as having a ‘moderate or less’ status and the waterbody overall is classified as a ‘heavily modified’ waterbody (HMWB).

2.2 Connecting waterbodies

The Dollis Brook and Upper Brent waterbody flows into the Lower Brent waterbody (GB106039023590) at the Welsh Harp reservoir (GB30641690), which is formed from artificial impoundment of the River Brent. The Welsh Harp also receives flow from Wealdstone Brook (GB106039022940), but with the confluence being downstream of the Brent Cross development site, Wealdstone Brook will not be influenced by the scheme. Water level monitoring has determined that the level of the Welsh Harp reservoir (and therefore the Lower Brent) will have a significant backwater effect on the flows in the lower third of the realigned waterbody.

The Brent Cross development proposals will not have a significant influence on the Welsh Harp or Lower Brent waterbodies, other than ecological improvements achieved through the site design. As such the Welsh Harp and Lower Brent are screened out of this WFD assessment.

The site is underlain by groundwater, but this is within local aquifers, and there is no groundwater body listed for this area in the Thames RBMP.

[3] http://environment.data.gov.uk/catchment-planning/WaterBody/GB106039022980 Accessed February 2017

2.3 Protected habitats

Reference to the online natural mapping available at MAGIC[4] shows that the Brent Reservoir (Welsh Harp) is located approximately 200m south-west (downstream) of the development and is designated as a SSSI and Local Nature Reserve (LNR) for its wide range of breeding birds and lowland fen habitats across the site.

The Brent Cross scheme will not directly influence the condition of the SSSI and LNR, but there will be residual and cumulative benefits to the protected habitat, in terms of improved physico-chemical flow quality, and habitat connectivity along the river corridor. However, these are not discussed in detail for this assessment.

2.4 RBMP Mitigation Measures

The following mitigation measures detailed in Table 2.4 are listed in the Environment Agency's Catchment Data Explorer[5] as being relevant to the "Dollis Brook and Upper Brent" waterbody (GB106039022980). All mitigation measures are classified by the Environment Agency in this waterbody as 'affordable'.

Table 2.4 RBMP Mitigation Measures of specific relevance to the Dollis Brook and Upper Brent waterbody

Category general	Category detailed	Title	Lead organisation
Structural modification	Changes to locks	Remove weir at Brent Cross	Local authorities
Structural modification	Enhance ecology	Major river restoration and re-routing (875m) at Brent Cross	Local authorities
Reduce diffuse pollution at source	Restrict plumbing and drainage modifications/installations by unqualified people	Misconnections rectification for polluted surface water catchments	Waste water treatment
Working with physical form and function	Preserve or restore habitats	Major river restoration and re-routing (875m) at Brent Cross	Local authorities
Working with physical form and function	In-channel morph diversity	Major river restoration and re-routing (875m) at Brent Cross	Local authorities
Working with physical form and function	Remove or soften hard bank	Major river restoration and re-routing (875m) at Brent Cross	Local authorities
Structural modification	Fish passes	Remove weir at Brent Cross	Local authorities

4 http://www.magic.gov.uk Accessed February 2017
5 http://environment.data.gov.uk/catchment-planning/OperationalCatchment/3044/Action Accessed February 2017

3. WFD Opportunities and Constraints

The proposed channel design at Brent Cross has the opportunity to 'naturalise' the heavily modified channel, improve amenity value, water quality, biodiversity, and realign the route back towards its original course, prior to artificial channelisation.

The 900m Brent Cross river diversion project is probably the single greatest opportunity that exists to enhance the 17km waterbody environment towards GEP, given that the catchment is set in an intensively urbanised area of London. As such, the project will contribute to a number of RBMP objectives and mitigation measures (Table 2.4), but relative scales mean that the scheme is unlikely to change the potential of the waterbody as a whole.

The detailed design stage which has been carried out since April 2016 has followed the design principles that were set out in the Basis of Design Report[2] and the parameters set through the s.73 planning permission and the subsequent reserved matters applications.

Numerous constraints exist to achieving channel 'naturalisation'. Prior to urbanisation, the River Brent would naturally have been a low relief, sinuous, pool-riffle system, set in a well-developed floodplain on alluvium succeeding Taplow Gravel (sand and gravel deposits) over London Clay. Owing to the geological boundary conditions and low gradient, the channel would have been laterally active within the superficial layers, with a bed characterised by gravels arranged in point bars, pools and riffles synchronous with a dynamically migrating meander geometry.

It is important to note that development constraints limit the river's ecological potential, to the degree that the adopted design term for the river elements of the scheme is "naturalisation", rather than "restoration". True "restoration" is not attainable at this site, because it is impossible to restore floodplains *in lieu* of flood risk.

At preliminary stages, all technical elements involved in the scheme (including river restoration) put forward their 'best scenario' development aspirations. Given the scale of the project, a large amount of compromise between design objectives and ambitions was then required as the holistic design developed, between, for example, geomorphology, flood risk, geotechnics, slope stabilisation and highways. As such, although the river has always been an integral feature of the development, naturalisation efforts have been constrained to a narrow river corridor far removed from the pre-development dynamically active floodplain channel.

In the context of the HMWB, the GEP for the local river will effectively be defined and implemented by the Brent Cross project. As noted above, this is probably the greatest opportunity for attainment of WFD objectives in this part of London, but this needs to be viewed in the context of feasible targets. Accordingly, the main development constraints, and the river potential that can be realised, are summarised below:

- The waterbody is classified as a HMWB due to urbanisation, and is set within a highly developed and urbanised catchment, preventing the establishment of fully natural conditions.
  - *The scheme design seeks to achieve local GEP rather than pristine natural conditions. Although the area available for the 'naturalised' river is limited, the multi-stage channel design allows for a sinuous base channel with gravel berms, contained within a green river corridor.*
- The routing of the channel is constrained by the general site layout and it will not be possible to fully reinstate a natural floodplain, due to flood risk and the space available.
  - *The new channel will be closer to the original planform and will include a multi-stage design, with a sinuous base channel within the curved river corridor.*
- The channel, flood walls, bridge soffits footpaths and access roads are all designed to contain flood levels at prescribed scenarios (20% Annual Exceedance Probability (AEP) to the level of access routes; 1% AEP plus climate change event for the river corridor). This limits in-channel features and habitats with regards to flow conveyance and flood risks, particularly in areas where the river is more tightly constrained within the site.
  - *Channel diversity has been designed as far as flood levels permit, considering that habitat complexity would inevitably attenuate flows and increase flood elevations. A sensitive approach has been taken to use green solutions as far as possible, but in some reaches sheet piling is necessary where it is essential to maximise channel capacity for flood conveyance.*
- The design of the channel will need to be resilient to scour risks to infrastructure and other assets, requiring a degree of hard engineering to ensure stability, safety and maintenance objectives are met.

  - *The new channel will have 'softened' scour protection, including a variety of gravels, cobbles, geotextile membrane matting, flow boards, rip-rap, reno mattresses and gabion baskets, over retaining walls as necessary for site integrity.*

- There is a backwater effect from the Welsh Harp reservoir which will affect flow conveyance for much of the realigned channel. This limits habitat designs, and will affect sedimentation, flow stagnation and physical and chemical ecological quality.
  - *Channel capacity is maximised in this reach to mitigate backwater effects, and the slower flow rates are incorporated into the design of bank reinforcements, including the use of timber banking for habitat creation, in addition to the use of geotextile membranes throughout to promote vegetation suited to the local hydrological regime.*
- Weirs are present upstream and downstream of the planned river realignment, preventing delivery of natural gravels to the site from upstream and species migration from downstream.
  - *The realignment includes an 'over-sized' gravel bed, with substrates designed to be stable during peak flow events. Finer, natural gravel sizes would otherwise be flushed out of the site by high flows events, and not replaced from upstream. The larger gravels will also provide a degree of scour protection.*

4. Screening

4.1 Exemptions

Certain activities on or near waterbodies are exempt from WFD assessments, as summarised in Table 4.1. Although some of these activities apply to elements of the proposed works, in accordance with Environmental Permitting regulations, and the extent of works, a detailed WFD assessment is warranted.

Table 4.1 WFD Exemptions 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
	Skimming/ covering/ grit blasting
	Cleaning and/or painting of a structure
Temporary works	Temporary scaffolding to enable bridge re-pointing
	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
	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 road surface on a bridge
Service crossing	Service crossing below the river bed, installed by directional drilling or micro tunnelling if more than 1.5 m below the natural bed line of the river
	Service crossing over a river. This includes those attached to the parapets of a bridge or encapsulated within the bridge's footpath or road
	Replacement, installation or dismantling of service crossing/ high voltage cable over a river
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
	Outfall to a river ≤300 mm diameter

5. Preliminary Assessment

5.1 Methodology Overview

For non-WFD exempt proposals, a WFD "Preliminary Assessment" is used to rationalise "Further Assessments", by screening out waterbody elements and scheme elements that would not be impacted by the proposals.

5.2 Possible Impacts on Ecological Potential and Objectives

A summary of the potential impacts of the proposed scheme is presented as an assessment matrix in Appendix A. This includes temporary and non-temporary effects associated with the construction and operational phases of the proposed scheme. The matrix is colour coded to help visualise potentially positive, neutral and negative impacts associated with the proposed scheme, as shown in Table 5.2.

For the Preliminary Assessment, the main focuses are:

- Identifying particular WFD elements that will not be impacted by particular proposed scheme elements; i.e. that are not applicable to WFD assessment.
- Identifying elements for which there is high confidence of negligible WFD impact without additional investigation; i.e. that are applicable to investigation, but there is no appreciable risk.

Where risks cannot be screened out, they are summarised concisely in the matrix, and those that require further explanation are carried forward for Further Investigation. The assessment matrix is presented as Appendix A.

Table 5.2. 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

The Brent Cross realignment includes numerous features to improve the ecological, geomorphic and physico-chemical elements of the existing concrete box channel. However, limitations in the amount of space available and the need to control flood risk, mean that the river will remain an engineered channel. The waterbody will certainly not deteriorate from existing WFD conditions, and is designed to achieve its maximum ecological potential within the site boundaries.

The WFD assessment is primarily summarised in Appendix A, but some key points are explained further below.

6.1 Hydromorphology

The Brent Cross channel realignment places channel flow closer to its original course prior to its artificial channelisation. The need to contain peak flows within a narrow corridor rather than a natural floodplain means that the capacity for in-channel features is limited, since habitat complexity is not conducive to efficient drainage. A pragmatic approach has been taken; where sinuosity, gravel and vegetation roughness will attenuate flows and increase peak flow levels, habitat diversity within flood constraints has been maximised through the detailed design and flood modelling.

The existing box channel will be replaced with a sinuous gravel-bedded channel, with gravel berms, banks and side slopes that will have variable flow inundation depths and frequency, all of which will greatly increase morphological and physical habitat diversity. This is a major ecological gain for the channel and a key feature of the river diversion design.

Sedimentation is a key concern, as the existing River Brent is known to have excess and polluted sediment due to the urban nature of the catchment upstream of the Brent Cross development site. Sedimentation will degrade the new gravel bed habitat by clogging interstitial pores, and will effectively increase, together with the associated residence time of pollutants within the channel, since at present fine sediment is rapidly flushed along bare concrete.

Sedimentation at present and in the future is particularly prevalent in Reach 3, where the Welsh Harp impoundment causes flow stagnation and recirculation. Increasing the length of the channel in Reaches 1 and 2 will reduce gradients and sediment transport competence, and the rough gravel bed will trap deposited sediment. However, the detailed design uses a 2 or 3 stage channel to narrow existing over-wide flows, deepen hydraulic habitats, and sustain base flow conveyance, which will mitigate deposition of fine sediment and associated excess nutrients and contaminants.

Although increased fine sediment deposition is likely in the new channel this will not cause deterioration below the current 'Moderate Potential' (current HMWB status). The gravel bed is a major habitat improvement, and it is important to use the development opportunity to prime physical habitat structure, with a view to catchment clean-up in the future reducing the delivery of pollutants to the site from upstream. Continued monitoring of fine sediments is recommended.

6.2 Physico-chemistry

The key control on water quality is the water supplied from upstream (external to the realignment) which is currently 'moderate' status due to the 'poor' status of dissolved oxygen and phosphate. Surface water quality and groundwater monitoring was carried out during 2015[6,7] which confirmed that both are contaminated with TPH, PAHs, some phenols, dissolved metals, E.Coli and some major ions (manganese, copper, iron and phosphorus). The realigned channel will continue to receive these pollutants which will limit future water quality, unless major upstream point and diffuse pollution source improvements are made in separate schemes. However, the Brent Cross redevelopment involves the redesign of drainage throughout the shopping centre extension and highways drainage improvements which will reduce the local impact of point pollution sources from current misconnections.

The channel design evolution analysed the positive and negative impacts of permeable or impermeable channel linings, with regards to pollutant transfer between surface water and groundwater[8]. This informed the decision not

[6] Brent Cross Cricklewood. Factual Groundwater Monitoring Report. AECOM. February 2016. (BXCR-URS-RB-XX-RP-HY-00018 FINAL).
[7] Brent Cross Development. Hydrogeological Conceptualisation Report for the River Brent Diversion (BXCR-URS/-XX-RP-HY-00018-Rev 1).
[8] Brent Cross Cricklewood. Groundwater technical note on stage 1 river channel liner. AECOM. 2017.

to use an impermeable membrane to isolate surface water from contaminated groundwater. Surface water quality is similar, or worse, for most variables[6]. On balance, without a sealed channel bed, groundwater influx will likely have the effect of diluting contaminants.

It is possible that if future physico-chemical remediation is implemented throughout the catchment upstream, the present balance of groundwater and surface water quality could be reversed, so that relatively contaminated groundwater could deteriorate surface water. In reality, the likelihood of full remediation of the entire upstream waterbody is very low, which justifies the decision for a permeable channel lining throughout the length of the realigned channel.

The channel design includes the use of coir roll to promote in-channel vegetation growth and has an area of marginal riparian habitat that is connected when flows reach the stage 2 channel. Vegetation growth is likely to provide in-channel habitat but is unlikely to significantly improve water quality. Some bioremediation (e.g. nitrification, phosphate uptake) may occur as vegetation establishes, but this is expected to be negligible compared with the sediment and water quality inherited form upstream. Fine sediments (rich in nutrients) have the potential to release high levels of phosphorus during low flows leading to algal blooms and eutrophication. Eutrophication is less likely to occur in Reach 1 and 2 of the channel as due to a steeper gradient, low flows are designed to be faster due to the narrower channel compared with the current wide concrete U-shaped channel.

6.3 Biology

Overall, the realigned channel marks a clear increase in localised habitat availability for macrophytes, phytobenthos and macroinvertebrates compared with the current concrete U-shaped channel. The marginal habitat adjacent to the stage 1 channel[9] will benefit macroinvertebrate communities together with the varying gravel sizes within the channel design (40-120 mm). Macrophytes will be encouraged by the use of coir roll to promote in-channel vegetation, and a gradient of terrestrial to aquatic vegetation will form in the geotextile membrane (for the stage 2 channel), further strengthening bank protection. However, fine sediments brought from upstream may restrict macrophyte growth and need to be carefully managed, through inspection and removal if excessive. Pollution tolerant macrophytes identified in the *Brent Cross River Naturalisation Options Appraisal*[10] include the spiked water-milfoils (*myriophyllum*) which can root in a range of substrates such as sands and gravels, soft rush (*Juncus effusus*) which is suited to fine organic to mineral deposits and water plantain (*Alisma plantago-aquatica)* which is suited to nutrient rich substrates. Additionally, common reedmace (bulrush) (*Typha latifolia*) and common reed (*Phragmites australis*) are suited to marginal habitats, with common reed suited to nutrient rich substrates (e.g. fine sediment) and slow moving waters.

Algal blooms can occur when phosphate concentrations in slow moving watercourses are high, either from effluent release upstream or release from fine sediments. Eutrophication can result in oxygen depletion, which can lead to fish kills. Some algae can be cytotoxic to wildlife which may use the channel as a water source. This is a risk that remains in the present design, although it should be noted that the current concrete lined U-shaped channel is unlikely to be suited to large fish populations, and so the ‘naturalisation’ constitutes an improvement.

It is unlikely that diverse fish populations will establish in the near future, due to off-site weirs and connectivity issues (e.g. the Welsh Harp impoundment structure), and the continued sub-optimal water quality received from upstream. As noted above, the gravel bed will prime physical habitats ready for future catchment clean-up. In order for fish to re-populate the reach, aside from water and sediment quality improvements, barriers will need to be removed elsewhere in the connecting watercourses.

[9] Brent Cross Cricklewood Phase 1A. River Brent General Arrangement Plan – Sheet 6. AECOM. 2017. (BXCR-ACM-RB-06-DR-HD-00016).
[10] Brent Cross Cricklewood. Technical Advice Note 11 – River Naturalisation Options Appraisal. AECOM. January 2014. (BXCR-URS-RB-XX-RP-HY-00011).

7. Mitigation measures

Mitigation measures specific to the 'Dollis Brook and Upper Brent' waterbody, set by the Environment Agency have been listed in Table 2.4. This section summarises the measures in the detailed design to address these objectives:

7.1 Removal of weir at Brent Cross – Changes to Locks

- Not part of this scheme.

7.2 Enhance Ecology

- The detailed design includes the re-routing of the Brent Cross channel closer to its original planform, adoption greater sinuosity, despite a constrained area (*see Brent Cross Cricklewood WFD Assessment, URS, 2013*).
- The scheme design is a major improvement from the existing concrete box channel, and will achieve the maximum ecological potential possible within the site boundaries.
- Ecological features included in the design include a 2/3 stage channel, use of natural materials and bank protection where possible (e.g. coir roll, geotextile membranes), a more 'natural' gravel lined bed (supporting in-channel biodiversity) and an area of backwater marginal vegetation (*see General Arrangement Plan – Sheet 6*)[9].

7.3 Misconnections rectification for polluted surface water catchments – *restrict drainage modifications by unqualified people*

- The Brent Cross redevelopment will repair potential misconnections within the vicinity of the site and upgrade systems using SuDS, reducing fine sediment release into the channel.
- Misconnections upstream and in the Clitterhouse Stream which continue to impede water quality will remain. Water companies, the Environment Agency and Local Authorities are advised to continue to improve sewer separation upstream and in connecting watercourses. The Brent Cross redevelopment will not affect the repair of misconnections upstream or in the Clitterhouse Stream.

7.4 Preserve or restore habitats

- The realigned Brent Cross river detailed design includes major habitat naturalisation, including a gravel bed 2/3 stage channel within a green river corridor, use of natural materials and softened bank protection where possible, a gravel]bed, and an area of backwater marginal vegetation (*see General Arrangement Plan – Sheet 6*)[9].

7.5 In-channel morphological diversity

- The variable gravel bed forms (compared with the existing concrete lining), together with vegetation, will diversify substrate and hydraulic habitats.

7.6 Fish passage

- The gravel bed will prime physical habitats ready for future catchment clean-up, and provide greatly improved habitat connectivity between existing discrete pockets of viable fish habitat from the Welsh Harp to the upstream catchment of the River Brent.
- However, fish passage will remain restricted by weirs upstream of the realigned channel and at the major impoundment structure at the Brent Harp.

8. Monitoring

An Operation and Maintenance manual is currently being produced by AECOM to describe the expected maintenance requirements for the river once it is adopted by the developers. This will help both the Environment Agency and developers agree on riparian vegetation management and strategies to control artificial material (e.g. litter) which may wash into the river, due to its future amenity value adjacent to the shopping centre.

The river realignment detailed design will remove the current over-wide and over-deepened channel, allowing a more natural sediment regime, despite the continued use of some hard engineering to ensure flood risk and scour protection objectives are maintained. Vegetation will be allowed to establish, both within bank protection (e.g. in geotextile membrane) and in vegetated marginal areas, which will help to 'green' and soften any hard engineering solutions. Small variations in gravel bed forms are expected to occur with flows and supplementary material may need to be applied in the vicinity of scour protection following storm events. These should all be monitored as the naturalisation design takes effect post-construction, and into the future.

At a minimum, for hydromorphological purposes post-project appraisal should include repeat site visits by experienced river restoration personnel, documented with photographs or aerial surveys, together with notes on relevant issues. Site visits are recommended to take place at least seasonally (4 times per year) for the first two years at a minimum, then twice annually for the next three years and also following significant storm events. Monitoring would then be co-ordinated with flood risk specialists, ecologists and structural engineers. The need for future monitoring would be reviewed after two years. As stated in the water quality monitoring plan[11] for the Brent Cross realignment, at a minimum quarterly monitoring for a period of 12 months of a range of organic and inorganic determinands within surface water and groundwater will take place.

The river realignment also offers the opportunity to develop a more detailed monitoring scheme, to help record the outcome of good practices and assess the effectiveness of ecological and hydrogeomorphic elements in the design.

Monthly water chemistry sampling could be conducted:

- upstream prior to the realigned channel;
- in three locations within each reach of the realigned channel, and;
- within riparian vegetation areas.

This would enable comparison with existing Environment Agency monitoring of the waterbody to assess if channel naturalisation (e.g. through in-channel vegetation establishment) has any measurable effect on in-channel water chemistry determinands.

Vegetation surveys (to capture species diversity) could also be conducted seasonally to track the development and immigration of plant species, with the aim to help advise future schemes on the most effective methods of river restoration to ensure increases in species diversity.

Together, monitoring could form an effective educational tool as this river realignment will be in close proximity to the redeveloped shopping centre. Site information boards, updated with the progress of vegetation and geomorphic in-stream establishment, together with public information tours would make use of this invaluable educational and research resource.

[11] Brent Cross Cricklewood Regeneration. Water Monitoring Plan. September 2014. URS. (47067191).

9. Conclusions

This Water Framework Directive assessment update has been prepared by AECOM to support the detailed design phase of the Brent Cross river realignment scheme. The river realignment is a critical element of the overall regeneration masterplan.

The river enhancements summarised in this report and detailed in the design documents will not degrade the existing 'Moderate Potential' of the HMWB, and will locally greatly improve morphological ecological processes. The findings of this assessment can be summarised as:

- The 900m Brent Cross river diversion project is probably the single greatest opportunity that exists to enhance the 17km waterbody towards Good Ecological Potential (GEP).
- The local waterbody has a 2015 current status of 'Moderate Ecological Potential' as it is designated a Heavily Modified Waterbody (HMWB). The detailed design is developed on physico-chemical, biological and hydromorphological principles to ensure the channel realignment will not deteriorate existing WFD potential or prevent future mitigation measures.
- Fine sediment delivered into the channel from upstream will continue to be polluted, and deposition will be increased areas of lowered gradient and roughened gravel bed. To mitigate this, a multi-stage channel will sustain base flows, and planting will help bioremediation to some extent. However, the backwater effect from the Welsh Harp will continue to cause sedimentation issues.
- Ecological features included in the design include a 2/3 stage channel, use of natural materials and bank protection where possible (e.g. coir roll, geotextile membranes), a more 'natural' gravel lined bed (supporting in-channel biodiversity) and an area of backwater marginal vegetation
- The scheme will not directly influence the condition of the SSSI and LNR, but there will be residual and cumulative benefits to the protected habitat, in terms of improved physico-chemical flow quality, and habitat connectivity along the river corridor.
- The scheme will naturalise the local waterbody to maximum achievable ecological potential, and will be a major step towards the GEP of the waterbody as a whole.

In terms of WFD objectives, it is considered that the proposed River Brent at Brent Cross realignment scheme (detailed design), with mitigation, would support WFD objectives, because it would:

- Not cause deterioration in the ecological status or potential of any waterbodies.
- Not prevent the waterbody from meeting its objective of 'Good Potential'.
- Not prevent or compromise WFD objectives being met in other waterbodies.
- Not result in a deterioration of groundwater status (which is already locally compromised).
- Not prevent the implementation of mitigation measures designed to achieve 'Good Potential'.

Appendix A

Screening Matrix to Summarise the Impacts of the BXC Channel Realignment on WFD Objectives

Waterbody Name	Dollis Brook (River Brent)
Waterbody ID	GB106039022980
Current status	Moderate Potential
Status objective	Good
Waterbody designation	HMWB
Reasons for not achieving 'Good'	Waste water incidents, sewerage discharge, drainage, urbanisation, flood protection structures

Legend
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 effect 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

WFD / Design Element		Current status (2015) or additional monitoring	Noise and vibration	Upstream interface	Channel realignment, including Clitterhouse stream confluence	Bridges	Access ramps	Drainage	Outfall structures	Scour protection and slope stabilisation	Gravel bed	Habitat creation	Contaminated ground mitigation
Biological elements	Macrophytes and phytobenthos	Not assessed	Not applicable	The upstream interface with the existing channel will retain vertical concrete retaining walls to allow TfL visible access to the highway structure for maintenance. The bed will also need to be concrete lined for scour protection (i.e. continuous with upstream), but 'softening' features can be installed such as embedded stones. This would limit potential habitat value in the short transitional reach,	Channel realignment will increase the length of open channel and habitat availability for macrophytes and macroinvertebrates. The channel will include habitat feature such as sinuosity, bed and berm gravels, diverse flow rates, depths and inundation frequencies, creation of new marginal and wetland habitats (e.g. General Arrangement Plan - Sheet 6) & use of COIR Roll (to promote in-channel vegetation growth). These will be major local benefits, and represent probably the greatest opportunity in the waterbody for restoring towards GEP.	Shading can reduce photosynthetic activity in macrophyte communities leading to reduced biomass and primary productivity, and potentially a change in community composition within the shaded area. No sensitive vegetation is documented at present, and existing vegetation is sparse. Some new shading will occur as a minor localised effect, which will restrict improvement potential. but there would be no significant impact relative to existing community structure.	The ramps are designed to provide access to the channel as sensitively as possible, and have a small footprint on the restored reach. There could be some local impacts on biodiversity due to the use of scour protection and rip-rap, and the potential for build up of contaminated fine sediment in the ramp locations.	Improvements in drainage quantity and quality, including the use of SuDS, and repair of localised misconnections, will help reduce effluent outwash including excess nutrients and contaminants. This should help reduce the localised inputs of fine sediments and adsorbed pollutants compared with the current state of the channel. However, these problems will continue to be sourced from upstream and through Clitterhouse Brook. Overall, there is likely to be a slight localised improvement in the potential for macrophyte and phytobenthos communities to support macroinvertebrate and fish populations, compared with areas previously adjacent to less sustainable drainage.	Outfall structures are appropriately designed to prevent scour including the use of rip rap & gabion matressing where appropriate, ensuring bank stability and reducing erosion of any in-channel vegetation development, which support phytobenthos and macroinvertebrate communities.	Scour protection is essential to prevent undercutting of infrastructure and supporting slopes, so it is not possible to reinstate a freely or even controlled meandering channel. In places, retaining walls are necessary because of the need for vertical walls to maximise channel capacity. As far as possible alternative materials such as rock roll, gabion matressing and rip rap are being used for naturalisation. Scour protection will also prevent erosion into brownfield contaminated land.	In reaches 1 and 2 the gravel bed will be better for macrophyte rooting, compared with the current concrete lined channel. However, water quality will remain poor, restricting species diversity. Fine sediment deposition is likely to increase due to the roughening effects of gravel compared to existing bare concrete , combined with the overall lengthening of the channel and reduced gradient. This would be mitigated with a multi-stage channel and base channel narrowing to sustain flow conveyance. Overall the gravel bed is a key positive for the scheme, but it must be acknowledged that while it is possible to improve the physical habitat, it will also have an unwanted effect on trapping fine sediment from upstream.	In-channel diversity, backwaters, marginal habitats will encourage macrophytes (General Arrangement Plan - Sheet 6). Diffuse sediment contaminants and nutrient pollution (e.g. phosphate) may prevent growth of pollution intolerant species. However, compared with the previous channel this is an improvement as more habitat will be available.	Monitoring has revealed that surface water is contaminated to an equal or greater degree (considering all variables) than groundwater, so an impermeable lining to the channel (which would inevitably degrade over time) was deemed unnecessary. As contaminants will continue to be delivered from upstream including, nutrients, heavy metals and petroleum by-products, these substances will continue to restrict macrophyte growth and phytobenthos species diversity. Although some bioremediation may occur owing to the increased habitat availability in the channel, this is expected to be minimal as habitat in the channel has not been designed for enzyme activity. Heavy metals will continue to bio-accumulate in fish populations limiting growth.
	Macroinvertebrates	Currently assessed as 'Poor' status for the overall waterbody. Assessment of the macroinvertebrate community of the Clitterhouse Stream (2014), a tributary of the Brent found that CSO discharges are having negative impacts, resulting in 'poor' and 'bad' sampling point status.				Macroinvertebrate communities rely on habitat heterogeneity and the presence of macrophytes, varying substrates and marginal habitat. Although, shading may inhibit macrophytes communities in places, bridges are likely to have a neutral effect on macroinvertebrate communities (particularly relative to nutrient contamination from upstream point and diffuse sources).					Macroinvertebrates are sensitive to bed form with the presence of coarse substrates (as provided by design gravel bed) are able to promote species diversity. Fine sediment deposition has the potential to restrict communities, but compared with a concrete lined channel the change in bed substrate will be beneficial.	Increased vegetation, particularly in the marginal habitat adjacent to the channel (e.g. General Arrangement Plan - Sheet 6) will benefit macroinvertebrate communities, but poor water quality from upstream will limit species diversity.	
	Fish	Not assessed	The new channel will be built prior to diversion of existing channel, which will mitigate impacts on in situ biota. However, it is still noted that noise and vibration may cause mortality or injury at high levels and behavioural responses at low levels. Fish status is not directly sensitive to noise and vibration impacts, although changes in fish abundance and composition can occur. The scale of in-channel works and existing biodiversity means that significant effects are not anticipated, but are highlighted here because effects must be managed.		Gravel and hydraulic habitats will be physically primed for target fish species, but fish passage to BXC will be restricted by upstream weirs and downstream Brent Reservoir. A multi-stage channel will create deeper daily and reduce the likelihood of stagnation. The backwater effect from the downstream reservoir will result in limited flow habitat in reach 3, and there are risks of the low water quality inherited from upstream resulting in eutrophication and potential algal blooms, particularly when combined with phosphorus-rich fine sediment deposition and upstream effluent discharge. This could lead to oxygen depletion and potential risks to fish survival at various life stages. Overall the effect will be beneficial, but spatially limited.	Shading from bridges may locally increase habitat heterogeneity for fish providing refuge from predators, and shade from the UV effects of sunlight. However, the shading effects will also reduce macrophyte growth on which fish feed. On balance, bridges are likely to have a neutral effect on fish populations.			No effect is expected on fish populations. Reno mattresses to protect against bed scour at high pipe discharge would not represent available spawning habitat, but would be continuous with the gravel bed and an improvement on existing bare concrete.		In reaches 1 and 2 the gravel bed combined with increased flows will have a beneficial effect on fish habitat at all life stages, by increasing habitat heterogeneity. However, contamination from upstream delivered fine sediments will remain a problem, particularly in the lower flow reach 3, potentially preventing fish spawning. Overall, this is considered to be a positive effect, albeit with caveats.	The backwater effect from Brent Reservoir in Reach will limit fish habitats, but otherwise the gravel bed and narrowed stage 1 channel are significant enhancements. Fine sediment deposition to interstitial voids in the rough gravel compared to bare concrete is likely to limit available spawning habitat and survival rates for some species, but this is certainly not detrimental relative to existing conditions, and the implementation of a gravel bed is a key benefit towards GEP.	

Screening Matrix to Summarise the Impacts of the BXC Channel Realignment on WFD Objectives		Legend	
			Not applicable
Waterbody Name	Dollis Brook (River Brent)		Major beneficial effect that could result in improved overall status of the waterbody
Waterbody ID	GB106039022980		Minor beneficial effect that would have local benefits but would not contribute to status change at waterbody scale
Current status	Moderate Potential		Neutral effect, i.e. no effect or an overall balance of minor beneficial and adverse effects
Status objective	Good		Localised and/or temporary adverse effect that needs to be acknowledged but would not have an effect on WFD objectives
Waterbody designation	HMWB		Major adverse effect on one WFD element at waterbody scale
Reasons for not achieving 'Good'	Waste water incidents, sewerage discharge, drainage, urbanisation, flood protection structures		Major adverse effect that could result in deteriorated overall status of waterbody

WFD / Design Element		Current Status (2015) or additional monitoring	Noise and vibration	Upstream interface	Channel realignment, including Clitterhouse stream confluence	Bridges	Access ramps	Drainage	Outfall structures	Scour protection and slope stabilisation	Gravel bed	Habitat creation	Contaminated ground mitigation
Physico-chemical elements	pH	High	Not applicable	The upstream interface with the existing channel will feature a roughened concrete bed, e.g. with stones embedded in concrete, to transition from the engineered channel upstream to the naturalised reaches in BXC. This could help to mix and oxygenate flow from upstream, but the aeration benefits would be small. Channel erosion would be prevented, reducing the likelihood of contaminant entrainment from adjacent brownfield land.	The diversion of the Brent Cross restores the channel closer to the pre-straightened course of the river, increasing channel length & compensating for the loss of some open areas of the Clitterhouse stream which are known to have poor water quality and associated low diversity of macroinvertebrates. Lengthening the channel will reduce its gradient and promote settlement of contaminated fines. The backwater effect from the downstream reservoir will continue to influence Reach 3 deposition of fine sediments, which has the potential to lead to eutrophication & algal blooms, particularly in the downstream section. This would not be a deterioration from existing conditions, but would limit future potential.	Open span bridges will not impact physico-chemistry.	Neutral effect	Drainage in the redeveloped site will be improved, including use of SuDS where appropriate. Separation of foul and surface water runoff will be employed where current misconnections exist. Water quality entering form the local site should therefore improve. However, water and sediment quality inherited from upstream will still be poor, so this will remain a minor localised benefit.	The outfall structures themselves will not affect the composition of drainage they discharge.	Scour protection is unlikely to affect water quality. Bank protection will prevent mass failure which could cause a temporary change in water chemistry, or supply contaminants fro adjacent brownfield or contaminated ground. Local inputs of fine sediment would be reduced.	The gravel bed and berms, coir rolls and river corridor landscaping and planting will encourage macrophytes. This, in turn, could encourage minor nitrification and phosphorus uptake and fixing by some species, albeit it a far lower rate than the delivery of nutrients, effluent and contaminants from upstream. The rough gravel bed will increase fine sediment trapping and the residence time of pollutants in the local channel, which at present are easily flushed through the BXC reaches due to the smooth concrete bed. it is acknowledged that this is likely to result in deterioration from existing conditions. However, it is emphasised that the principal of the gravel bed is to use this unique development opportunity to improve physical habitat conditions to 2027 GEP, and there is inevitably a reliance on upstream catchment clean-up improving physico-chemical conditions.	As for the gravel bed, habitat creation and channel diversification could increase the residence time of fine sediment and associated pollutants in the channel. There is potential for some bioremediation if certain plant species establish, but this would be very limited at waterbody scale and the delivery of pollutants from across the catchment.	Groundwater is locally contaminated with TPH, PAHs, phenols, dissolved metals, E.Coli, and some major ions (manganese, copper, iron & phosphorus). Surface water monitoring revealed similar, or worse, contamination for most variables (AECOM, 2016). On balance, groundwater influx will likely have the effect of diluting contaminants. It is possible that if future physico-chemical remediation was implemented upstream, the present balance of groundwater and surface water quality could be reversed, so that relatively contaminated groundwater could become an issue. In reality, the likelihood of full remediation of the entire upstream waterbody is very low, which justifies the decision for a permeable channel lining through BXC.
	Ammonia (total as N)	Moderate					Neutral effect						
	Phosphate	Poor					Contaminated fine sediments could accumulate at the base of access ramps containing adsorbed phosphate, although this would be localised.						
	Dissolved inorganic nitrogen	Not assessed					Neutral effect						
	Dissolved oxygen	Poor					Neutral effect					Improved biotic flow conditions brought about by channel narrowing and a more turbulent boundary layer, together with planting, could improve oxygenation in reach 1, especially during lower flows through Reach 1 and Reach 2. However, in Reach 3 the backwater effect is likely to continue to cause flow stagnation, deposition or recirculation of pollutants, localised eutrophication, and high oxygen consumption.	
	Specific pollutants (Annex VIII)	Triclosan = High TPH, PAHs, Xylenols, E.Coli, Copper, Zinc = Poor (Above Screening Value)					Contaminated fine sediments could accumulate at the base of access ramps containing adsorbed heavy metals, effluent or organic contaminants, although this effect would be localised.					Surface water pollutants are a key issue in the waterbody, some localised bioremediation may occur. However, habitats have not been designed to support bioremediation so on balance this is expected to have a neutral effect.	

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	WFD / Design Element	Noise and vibration	Upstream interface	Channel realignment, including Clitterhouse stream confluence	Bridges	Access ramps	Drainage	Outfall structures	Scour protection and slope stabilisation	Gravel bed	Habitat creation	Contaminated ground mitigation
Hydromorphological Elements	Quantity and dynamics of river flow	Not applicable	The upstream interface limits the design elements that can be used due to the need to gradually redirect flows from the concrete lined channel, to the new more sinuous planform of the naturalised channel. Additionally TfL require visible access for maintenance of the north circular flyover and adjacent access roads, restricting the naturalisation options in this short interface. Where appropriate, stones will be embedded into the concrete lining. The short distance of the interface combined with its effect in enabling the downstream naturalisation, prevent this section having a major effect on the WFD status at the waterbody scale, but there will be improvements from the existing bare concrete.	The detailed design includes 'macroform' realignment back towards the natural channel path, and a more sinuous channel 'microform', which will promote a more natural channel slope in reaches 1 and 2, locally variable flow hydraulics. In Reach 3, the backwater effect of the reservoir will remain a negative influence on water slope. The catchment and local area will remain positively drained, and hydrological regime of the catchment as a whole due will remain very flashy to urbanisation. Overall, reinstating towards to pre-realignment form is a positive impact.	The detailed design includes the use of clear span bridges to ensure the top of the bank is not impacted.	The access ramps in the final detailed design take a small footprint of the riparian zone, and marginal channel where there is some potential for some excess fine sedimentation directly in the vicinity of the ramp. To avoid this the final design uses rip-rap in ramp area to deflect and absorb flows, reducing proximal sedimentation and promote vegetation development.	The extended development will include SuDS to manage runoff quantity and quality runoff, so some local point inflows will be mitigated but any runoff will remain insignificant compared with the expected flows of the overall channel.	The outfall structures themselves will not affect the rates of drainage they discharge.	Not applicable	Compared with the existing concrete-lined channel the gravel bed (of varying sizes 40-120 mm) will be able to adjust with flow as it interacts with the increased sinuosity of the channel. In turn, this will promote flow diversity for hydraulic habitats.	The multi-stage channel will narrow mean daily flows that are presently over-wide, which will improve flow depths and hydraulic habitats. The more sinuous planform, closer to the original planform is beneficial to flow dynamics, relative to the existing concrete box channel.	Not applicable
	Connection to groundwater	Not applicable		Groundwater and surface water are both heavily contaminated and so the originally intended use of an impermeable membrane in the final design was deemed unnecessary. Waterbody connectivity will therefore not be significantly affected.	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Groundwater - surface water interactions will be sustained, so waterbody connectivity will not be significantly affected.	Groundwater and surface water are both heavily contaminated and so the originally intended use of an impermeable membrane in the final design was deemed unnecessary. Waterbody connectivity will therefore not be significantly affected.
	River continuity	Not applicable		Continuity will be improved locally, and restoring towards pre-modified conditions could enable future improvements in habitat connectivity if other pars of the waterbody are similarly restored.	Open span bridges will not affect channel morphology.	The access ramps in the final detailed design take a small footprint of the riparian zone and marginal channel, and are necessary for channel maintenance. Access ramps are designed to enable the continued sinuosity, bed form and structure of the channel, but some slight detrimental impact directly in the vicinity of the ramps, due to use of more engineered substrate (e.g. Rip-rap, compared with gravels). The greater impact would be on riparian continuity on the channel slopes , for example the switch from reinforced geotextile matting to rip-rap, but this is likely to grow 'green cover'.			Although elements of hard engineering have been used in the detailed design (rip-rap, gabion banking, rock-roll), the use of more diverse bank and scour protection marks a significant improvement in continuity, structure & substrate compared with the current concrete lined channel.	The in-channel features and continuity of the design have been sensitively chosen to develop a more 'naturalised' channel, marking a key improvement compared with the current concrete lined banks and bed. Gravel bedding will allow the development of bed forms when combined with the greater sinuosity of the new channel. Whilst this a major improvement to the best GEP that can be achieved in the BXC reach, and waterbody scale the spatial effect is limited.	Channel naturalisation will locally improve physical habitats and improve the potential to connect to existing and future habitats throughout the waterbody.	Not applicable
	River depth and width variation	Not applicable		The channel design includes a three stage channel with a narrowed base channel, to maintain naturalised flow depths and sustain higher velocities in comparison to flow spread across the existing box channel. In Reach 3 the Welsh Harp backwater effect will continue to impede flow, although this is not a deterioration from present. Overall there is a beneficial effect due to improvements in channel geometry toward natural conditions.				The positioning of outflows have been carefully designed to tie in with continuation of the 2/3 stage channel, avoiding a return to the existing U-shaped channel design.			Compared with the concrete lining of the existing channel the new channel will have greatly improved habitats, with a more 'natural' flow geometry able to develop together with bed diversity.	
	Structure and substrate of river bed	Not applicable		The detailed design of the channel includes various gravels between 40 and 120mm thick, together with coir roll, rock-roll and rip-rap strategically placed to ensure bed substrates remain stable at high flow. The bed substrates are oversized to remain stable at peak flows, which are concentrated through a narrow corridor, as opposed to dissipating across an historic floodplain. Fine sediment received from upstream is likely to deposit at a greater rate due to lengthening of the channel and increased gravel roughness, and it is inevitable that the bed will degrade by sedimentation. Reinstating a gravel bed is, however, a major benefit for morphology and biodiversity compared with existing bare concrete.			Potential misconnections directly within the redeveloped site will be reduced through the use of SuDS which will control sediment influx and associated fine sediments. The majority of fine sedimentation is however sourced form upstream and so any benefits will be minor.	The need for additional strength to reduce scour in the vicinity of outfalls includes the use of more heavily engineered materials including coarser gravels, rip-rap and gabion banking. This can locally vary the structure and substrate of the river bed, but may locally increase some flow heterogeneity. Compared to bare concrete, this is still a benefit.				
	Structure of riparian zone	Not applicable		The longer channel length will provide increased riparian areas, which will be promoted by the use of coir roll and planting, where hydraulically suitable. In the stage 2 channel reinforced earth using geotextile matting will both provide scour protection and enable vegetation colonisation - which in turn will provide further soil stabilisation. The creation of new marginal and wetland habitats (e.g. General Arrangement Plan - Sheet 6) will allow riparian establishment, increasing biodiversity.			Not applicable	Outfall structures will break some elements of the riparian zone continuity and employ scour protection (e.g. rip-rap & gabion banking), but have been designed to maintain a natural visual appearance. However, compared with the use of reinforced earth fill, outfall structures will be more engineered to reduce the likelihood of scour. Overall a slight local adverse effect.	The detailed design makes extensive use of reinforced geotextile membranes to ensure bank stability in moderately impacted reaches. Over time as vegetation establishes bank protection will be further stabilised. This will be particularly key during flood events when scour protection is greatest. Coir rolls set within the Stage 1 channel where appropriate will help ensure cross-sectional vegetation connectivity.	The gravel bed, marginal berms and naturalised and vegetated riparian zones are a major improvement compared to existing conditions. Retaining walls, where necessary to maximise conveyance capacity within flood level constraints, do, however, prevent a barrier to full riparian connectivity.	Riparian connectivity will be greatly increased in the new 2 or 3 stage channel, compared with previous concrete lined channel. Use of geotextile membrane will help promote vegetation colonisation, with coir roll used in places to encourage connectivity. The area of marginal and wetland habitats (e.g. General Arrangement Plan - Sheet 6) will also promote riparian connectivity.	
	Sediment regime	The realigned channel is planned to be constructed prior to the diversion of flows, avoiding the release of sediment (potentially by noise and vibration) downstream, into the Brent Reservoir. However, construction activities have the potential to severely increase sediment delivery to aquatic habitats. During the construction phase it is assumed best practice and method statements will be used to mitigate risk. Potential risk is highlighted to ensure appropriate construction management.		The gravel bed is designed to not be dynamic, since gravel supply is limited by upstream modifications, and gravels would not naturally be replenished. The present channel receives excess fine sediment from the catchment upstream, but this is generally flushed through the smooth concrete channel. Lengthening the channel will reduce gradients and lead to increased sedimentation, even though this is closer to the natural channel gradient. The effect relates to catchment pollution, and it is not possible to assume that this will be cleaned up in accordance with WFD timescales. Reaches 2 and 3 have a multi-stage channel to mitigate this by sustaining lower flow conveyance by narrowing and deepening mean daily flows. In Reach 3 the sedimentation effect is likely to continue to be severe due to the backwater influence of the Welsh Harp, although this would not be a deterioration from existing conditions. Overall there is a major local improvement with installation of gravel, but a dynamic sediment regime is not possible to achieve and gravel voids will degrade due to the condition of the upstream catchment. Fine sediment should be monitored to understand and mitigate effects in the future.		Localised fine sedimentation is a risk due to the effect of the access ramps on channel hydraulics. Design elements (use of rip-rap, careful positioning of ramps) should help to avoid this and the access areas are small in proportion to the overall channel length.	Although use of SuDS may reduce sediment influx locally, in terms of the overall sediment regime of the channel this is likely to be a small gain.	The outfall structures themselves will not affect the rates of drainage the sediment regime, and flow and sediment discharges are assessed elsewhere.	The low flow stage 1 channel in reaches 1 and 2 will be maintained by a mixture of rip-rap, rock-roll, coir roll and gabion matressing as appropriate, helping to maintain flows and reduce fine sediment deposition. In reach 3 the backwater effect of the Brent Reservoir mean banks need to be set wider to ensure year-round stability and so fine sedimentation here is likely. Overall a neutral effect as minor beneficial and adverse effects balanced.	The gravel bed, particularly in the lower reach 3 (where flows will be slower) is likely to continue to attract fine sediment deposition. However, this is offset by increased flows in reaches 1&2 which due to the natural channel, should help maintain competence and capacity, although the bed will degrade due to inherited fine sediment.	The gravel bed and vegetation growth, particularly in Reach 3 will increase fine sediment deposition. However, this is mitigated by narrowed and deepened flows in Reaches 1&2 which should help maintain competence and capacity, although the bed will degrade due to inherited fine sediment.	
	Planform Migration	Not applicable		Scour protection is essential to prevent undercutting of infrastructure and supporting slopes, so it is not possible to reinstate a freely or even controlled meandering channel. In places, retaining walls are necessary because of the need for vertical walls to maximise channel capacity. As far as possible alternative materials such as rock roll, gabion matressing and rip-rap are being used for naturalisation. Scour protection will also prevent erosion into brownfield contaminated land. This will restrict natural planform migration, but a stable-designed more natural planform is a significant improvement from the existing straight channel.		Access ramps form a very minor component of the channel and so are not the main reason for the restriction of planform migration.	Not applicable	Not applicable	Scour protection is essential to prevent undercutting of infrastructure and supporting slopes, so it is not possible to reinstate a freely or even controlled meandering channel. This will deliberately prohibit natural planform migration where naturally, the River Brent will have dynamically adjust its planform. This restricts the achievable ecological potential, but the realigned river will be closer to the original planform (identified through historical mapping), and the new 'naturalised' banks will be a clear improvement compared with the current artificial channel.	Not applicable	Planform migration will be restricted due to set back floodwalls, but within channel fluctuations in gravel bed forms will be possible, benefiting habitat particularly for macroinvertebrates. However, fine sedimentation (particularly of phosphorus) is a risk which may in Reach 3 lead to stagnation, restricted oxygen concentrations and eutrophication.	