M42 Junction 6 Improvement
Scheme Number TR010027
Volume 6
6.3 Environmental Statement
Appendix 14.5 Drainage Strategy Report

Regulation 5(2)(a)

Planning Act 2008

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

January 2019

Infrastructure Planning

Planning Act 2008

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

M42 Junction 6 Improvement

Development Consent Order 202[-]

6.3 Environmental Statement
Appendix 14.5 Drainage Strategy Report

Regulation Number	Regulation 5(2)(a)
Planning Inspectorate Scheme Reference	TR010027
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M42 Junction 6 Improvement

Drainage Strategy Report

Report Number: HE551485-ACM-HDG-M42_GEN_ZZ_ZZ-RP-CD-0001-P03 S4
December 2018

M42 Junction 6 Improvement

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Standard codes for suitability models and documents See BS1192:2007 Table 5 for further details					
Revision	Status	Description	Revision	Status	Description
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P01.01 to P0n.01	S1	Co-ordination	P01.1 etc. to Pn.1 etc.	D2	Tender
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P01 to Pnn	S6	PIM Authorization	C01 to C0n	CR	As Construction Record
P01 to Pnn	S7	AIM Authorization			

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Appendices:

1. INTRODUCTION

1.1. Purpose of the Report

1.1.1. This report has been prepared to outline the framework of design documents, relevant legislation and design methodology that forms the basis of the preliminary drainage design for the M42 Junction 6 Improvement Scheme and associated amendments to the local road network.

1.1.2. A summary of the design approach to all aspects of the drainage infrastructure is given and proposals are made where there are opportunities to rationalise the criteria and improve the drainage design – with particular focus on the potential of Sustainable Drainage Systems to meet client and environmental stakeholder expectations and standards.

1.1.3. This report shall be used by Highways England for reference to clarify the drainage philosophy and as a reference document to which all parties have agreed in principle.

1.1.4. The scope of this paper addresses pre-earthworks drainage, surface water drainage and outfall configurations including any special equipment and risks associated with maintenance activities.

1.2. Scheme Background

1.2.1. The M42 forms the southern and eastern arms of the Birmingham box. On the eastern arm around the M42 Junction 6, the M42 carries around 130,000 vehicles a day and is now running close to capacity. The A45 is a major arterial route for Birmingham, linking it to Coventry and carries around 70,000 vehicles a day.

1.2.2. The M42 Junction 6 is located on the eastern edge of Birmingham, approximately 9 miles from the city centre, near Solihull. The M42 Junction 6 provides connections between the M42 motorway network and the A45 Coventry Road, which provides strategic access to Birmingham (to the west) and Coventry (to the east). The Scheme is within the Area 9 Maintenance Area boundary. The local authority is Solihull Metropolitan Borough Council (SMBC). The location of the junction is shown in Figure 1.1 below

1.2.3. The M42 Junction 6 lies at the heart of an area of dynamic growth and is surrounded by a unique mix of existing and proposed major assets that serve both the local and wider economy. Junction 6 provides access to a number of key businesses including Birmingham International Airport, Jaguar Land Rover, the National Exhibition Centre (NEC), Resorts World Birmingham, Birmingham Business Park, Birmingham International Railway Station, the National Motorcycle Museum (NMM) and the High Speed 2 (HS2) Birmingham Interchange Station.

1.2.4. In addition to these major assets, the area adjacent to Junction 6 of the M42 (immediately to the north-east) is earmarked for development by SMBC as part of the proposed UK Central (UKC) development.

1.2.5. The Junction has almost reached capacity causing severe congestion and delays across the network. Current congestion and journey reliability issues are a significant constraint to future investment and economic growth. Junction 6 does not have sufficient capacity to accommodate predicted traffic growth beyond 2019, even without the inclusion of HS2.

1.2.6. The 'Road Investment Strategy: for the 2015/16 – 2019/20 Road Period' (RIS1), published in March 2015, indicated the project as a committed new scheme. It was first announced in Autumn Statement 2014, stating that the M42 Junction 6 Improvement Scheme is a

> "….comprehensive upgrade of the M42 Junction 6 near Birmingham Airport, allowing better movement of traffic on and off the A45, supporting access to the airport and preparing capacity for the new HS2 station."

Figure 1.1: Junction 6 Location Plan

1.2.7. In February 2017, the High Speed 2 Rail Project (HS2) gained Royal Assent. The proposed location for the HS2 Birmingham Interchange station is immediately to the north of junction 6. In addition to HS2 and the committed growth, there is also SMBC's plan for the UKC mixed use development immediately to the North East of the

Junction. UKC's Urban Growth Company (UGC) published their Hub Growth and Infrastructure Plan (HGIP) which outlines their plan for future aspirational growth in the area.

1.2.8. On 3rd July 2017, AECOM were commissioned by Highways England to undertake the Project Control Framework (PCF) Stage 3 Preliminary Design and Stage 4 Statutory Procedures and Powers of the M42 Junction 6 Improvement. The Scheme forms part of the Midlands Regional Investment Programme (RIP) and has been awarded by Highways England, under Lot 1 of the Highways England Collaborative Delivery Framework (CDF). This will involve development of the Preferred Route Option identified at the end of Stage 2.

1.2.9. Previous stages, PCF Stage 1 and Stage 2 were undertaken by WSP. At Stage 1, forty options that could meet the objectives of the scheme were identified and assessed. Six themes were taken forward to Stage 2 and assessed in more detail

1.2.10. On 7 August 2017, Highways England announced the Preferred Route for the M42 Junction 6 Improvement scheme.

1.2.11. The Preferred Route Option for the scheme includes the following as shown in Figure 1.2 below:

- A new 2.4 km dual carriageway linking the Clock Interchange and the new junction located between Junction 5 and Junction 6 – 'The proposed Southern Junction "Junction 5A". This will provide limited access and be single direction, providing a northbound off slip road and a southbound on slip road. There are proposals for a Motorway Service Area adjacent to this new junction. If these proposals are realised, the new junction will be expanded to serve both directions.
- The new dual carriageway would be to the west of Bickenhill and would generally be below ground level crossing underneath the B4438 (Catherine-de-Barnes Lane), near Bickenhill and towards the M42. The alignment would tie closely into the existing local road corridor to minimise the effect on the green belt.
- Improvements to junction 6 including free flow links around the north-west and north east quadrants of the junction.
- Improvements to Clock Interchange on the Solihull MBC road network and improvements on the A45 between Clock interchange and junction 6.

Figure1.2: Scheme Layout

1.3. Scheme Description

1.3.1. The layout for the M42 Junction 6 Improvement scheme is shown on drawing HE551485-ACM-HGN-M42_GEN_ZZ_ZZ-DR-CH-0012 in Appendix A.

1.3.2. A new grade separated junction will be provided on the M42 approximately half way between the existing M42 Junction 5 and Junction 6, immediately north of the Solihull Road. The new southern junction, Junction 5A, will take the form of a dumbbell junction with south facing slip roads only to the M42.

1.3.3. A dual carriageway link 2.4km in length is proposed from the dumb-bell roundabout junction (Junction 5A) to Clock Interchange, immediately to the south of the Birmingham International Airport. The proposed dual carriageway has been aligned to the west of Bickenhill. A diverge slip is provided in the northbound direction off the proposed dual carriageway to Airport Way Connector Road as a dedicated link to Birmingham International Airport.

1.3.4. The B4438 Catherine De Barnes Lane (CdB Lane) is proposed to be realigned to accommodate the proposed dual carriageway. A roundabout (Barber's Coppice Roundabout) is proposed to the east of Catherine De Barnes with a link to the proposed dual carriageway. The realigned B4438 CdB Lane will pass over the proposed dual carriageway.

1.3.5. Another roundabout (Bickenhill Roundabout) is proposed to the west of Bickenhill for access to the village for traffic on the B4388 CdB Lane and for southbound traffic on the proposed dual carriageway. Another bridge over the proposed dual carriageway is to be provided to the north east of Bickenhill.

1.3.6. Due to the provision of the proposed Junction 5A, the existing Solihull Road overbridge will need to be raised and lengthened to allow construction of the junction and proposed slips and to ensure that adequate headroom is provided for vehicles to pass underneath. It is proposed that the horizontal alignment of Solihull Road remains largely the same as the existing to minimise land take although the Solihull Road alignment will move slightly to the north to ensure that the raised embankments do not negatively impact on the area of ancient woodland and existing properties to the south.

1.3.7. A free flow link is proposed from the A45 eastbound to the M42 northbound at the M42 Junction 6. Another free flow link is also proposed for southbound traffic on the M42 travelling east onto the A45. A diverge slip from M42 southbound to the proposed Eastway roundabout is provided for southbound traffic travelling to the Eastway.

1.3.8. At Clock Interchange, the existing carriageway will be reconfigured to increase the number of approach lanes from two lanes to three lanes. This has been achieved by adjusting the kerbline and widening on the outside of the gyratory carriageway.

1.3.9. Bickenhill Lane, north of the Clock Interchange will also be reconfigured to increase from two lanes to three. Widening will need to take place to the west of Bickenhill Lane and this will require the free flow link from the A45 diverge to Bickenhill Lane to be realigned to the west also.

1.3.10. The following Table 1.1 details the increase in impermeable surface areas along the length of the route, in addition to the existing, which require to be drained.

Indicative Catchment	Approximate Increase in Impermeable Area (ha)
Junction 5A including slips	8.5
A45 Eastbound to M42 Northbound link	0.8
M42 Southbound to A45 Eastbound link	2.1
Mainline and Side roads	10.5

Table1.1: Catchment Areas

1.4. Existing Drainage

1.4.1. The existing slip roads on the approach to and leaving the M42 Junction 6 are also kerbed with gullies and are the main method for draining the carriageway.

1.4.2. The M42 mainline carriageway between the junctions within the scheme extents is mainly un-kerbed and filter drains are provided to drain the carriageways.

1.4.3. The proposed dual carriageway mainline and junction interfaces will be constructed off-line within existing fields. The existing greenfield catchments drain to various named and unnamed watercourses, including Shadow Brook, located towards the southern section of the dual carriageway. There is no record of sub-surface land drainage within the existing fields.

1.4.4. The existing drainage on the local road network including Solihull Road, Catherine De Barnes Lane, Bickenhill Lane and also Clock Interchange consists of mainly kerbs and gullies, with some combined kerb drainage.

1.4.5. CdB Lane is kerbed and drained by gullies within the scheme extents. It has been assumed that the gullies outfall into carrier pipe networks, which in turn discharge to existing named or unnamed watercourses.

1.4.6. Solihull Road is kerbed and drained by gullies within the scheme extents. It has been assumed that the gullies outfall either over the edge, or into a carrier pipe network. Runoff flows from Solihull Road and the M42 are then discharged to an existing watercourse on the eastern side of the M42.

1.4.7. Clock Interchange and Bickenhill Lane are kerbed and drained by gullies or combined kerb units, within the scheme extents, into a carrier pipe network. Runoff flows from Clock Interchange and Bickenhill Lane are then discharged to existing watercourses to the north and south of Clock Interchange.

1.4.8. The location of existing drainage on the M42 and the existing side roads at Catherine De Barnes Lane, Shadow Brook Lane, Solihull Road and Clock Interchange will need to be determined to ascertain the level and location of the existing drainage network and outfalls.

1.4.9. The study area covers some of the River Blythe tributaries and other smaller watercourses. The existing catchments drain to various named and unnamed watercourses, including Shadow Brook and Holywell Brook. Shadow Brook, located just north of Solihull Road Overbridge, flows west to east and is culverted under the M42 which then discharges into the River Blythe. Holywell Brook, located north of Junction 6, flows towards the east and is culverted under the M42 which then discharges into the River Blythe.

1.4.10. The new infrastructure will affect the hydrological regime and catchment of the river basin, so a hydrological and hydraulic assessment has been done in order to assess the potential flood impacts.

1.5. Stakeholders and Interested Parties

1.5.1. This section of the report indicates relevant project stakeholders and interested parties for the highway drainage design. The following parties were involved in the ongoing consultation throughout the design phase.

Highways England

1.5.2. Highways England is the maintaining authority for the M42. In addition, Highways England is the Client for the development of the M42 Junction 6 Improvement.

1.5.3. Highways England provided a Position Statement with respect to the Certification of Drainage Designs, their Climate Change Adaptation (CCA) policy and the Drainage Survey requirements for undertaking Drainage Designs. The Position Statement is included in Appendix B.

Solihull Metropolitan Borough Council

1.5.4. Solihull Metropolitan Borough Council is the local council and will be taking Ownership and Maintenance Responsibility for the realigned B4388 CdB Lane and associated side roads.

Environment Agency

1.5.5. The Environment Agency (EA) was created under the Environment Act 1995 to regulate and police the water environment in England and Wales and dispatches the powers bestowed on the public body under various legislation - namely the Water Resources Act 1991, the Land Drainage Act 1991, the Water Act 1989, the Control of Pollution Act 1989 and the Environmental Protection Act 1990.

Birmingham Airport

1.5.6. Birmingham Airport has been consulted on the drainage proposals as open SuDS features can adversely impact the operation of the airport in terms of birds being attracted to the drainage features. Safeguarding maps, lodged with Planning authorities, include a 13km radius centred on the aerodrome to indicate the area which developments, that might attract birds, require consultation with the aerodrome.

Stakeholder	Contact Name	Contact Number	Contact Email
Highways England	Chris Harris	0300 470 3595	Chris.Harris@highwaysengland.co.uk
	Jonathon Pizzey		Jonathon.Pizzey@highwaysengland.co.uk
Solihull Metropolitan Borough Council	Ashley Prior	0121 704 8558	ashley.prior@solihull.gov.uk
Environment Agency	Lisa Pinney / Noreen Nargas	0121 711 2820	enquiries@environment-agency.gov.uk / Noreen.Nargas1@environment-agency.gov.uk
Birmingham Airport	Robert Eaton	0121 767 7032	Robert.Eaton@birminghamairport.co.uk

Table 1.2 - Drainage Stakeholder Register

2. INFORMATIVE LEGISLATION

2.1. Legislation

2.1.1. The following list details the current legislation relevant to the design of drainage.

1. The Management of Flood Risks Directive (2007/60/EC).
2. The Flood Risk (England and Wales) Regulations 2009.
3. The Flood and Water Management Act 2010.
4. The Water Framework Directive (2000/60/EC).
5. The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.
6. The Water Resources Act 1991.
7. The Groundwater Daughter Directive (2006/118/EC).
8. The Groundwater (England and Wales) Regulations 2009.
9. The Management of Health and Safety at Work Regulations 1999.
10. The Construction (Design and Management) Regulations 2015.

2.2. Environment Act 1995

2.2.1. In the context of the M42 Junction 6 Improvement, the EA must be satisfied that flood risk is managed through attenuation and that discharges to watercourses are treated sufficiently.

2.3. Health and Safety at Work Act 1974

2.3.1. The Health and Safety at Work Act 1974 applies to SuDS (which are places of work) as well as the other areas of the drainage infrastructure described above. The management, maintenance and use of the drainage system should be subject to a risk assessment and comply with this legislation.

2.4. Construction (Design and Management) (CDM) Regulations 2015

2.4.1. The aim of CDM 2015 is to integrate health and safety into the management of the project and to encourage all parties to work together to improve planning and management of projects. It aims to identify hazards so they can be eliminated or reduced at the design or planning stage and manage the remaining risks.

2.4.2. The effort devoted to planning and managing health and safety shall be proportional to the risks and complexity associated with the project. The health and safety of those who will maintain, repair, clean, refurbish and eventually demolish the structure as well as the health and safety of users of workplaces and the public shall be considered throughout the design.

2.4.3. The Design shall provide information to ensure that the Principal Designer, Contractor and Authority are aware of remaining risks. Design shall avoid foreseeable risks to those involved in the construction and future use of the drainage infrastructure, and in doing so, eliminate hazards (so far as is reasonably practicable, taking account of other design considerations) and reduce risk associated with those hazards which remain.

2.4.4. The Design shall be critically assessed at an early stage via internal Technical Reviews, Designer's Risk Assessments, the Authority Review, and subsequently throughout the design process, to ensure that health and safety issues are identified, integrated, addressed and auditable.

2.5. Workplace (Health Safety and Welfare) Regulations 1992

2.5.1. Drainage infrastructure will be used as a workplace and shall take account of the provisions of the Workplace (Health, Safety and Welfare) Regulations 1992 which relate to the design of, or materials used in the infrastructure. Risks directly related to the proposed use of the infrastructure, including associated vehicular accesses and operator routes, and risks arising from the need to clean and maintain the permanent fixtures and fittings shall be considered.

2.6. Flood and Water Management Act 2010

2.6.1. The Act takes forward some of the proposals in three previous strategy documents published by the UK Government - Future Water, Making Space for Water and the UK Government's response to the Sir Michael Pitt's Review of the Summer 2007 floods. The Act also takes forward parts of the draft Flood and Water Management Bill and takes into account pre-legislative scrutiny of the draft Bill by the Environment, Food and Rural Affairs Committee.

3. DESIGN DOCUMENTS

3.1. Manual of Contract Documents for Highways Works

3.1.1. The Highway Construction Details (HCD) B Series and F Series are the principal source of verge-side, central reserve and component details and pipe bedding information. Specification of materials and construction is given in the Specification for Highway Works Series 500.

3.2. Design Manual for Roads and Bridges

3.2.1. Drainage design is to proceed and adhere to the mandatory requirements set out in the DMRB Standards and is to follow the guidance given in the various Advice Notes therein on a discretionary basis. The main documents of note are held within Volume 4 Section 2 and are listed below:

- HD 33/16 Design of Highway Drainage Systems.
- HA 37/17 Hydraulic Design of Road-Edge Surface Water Channels.
- HA 39/98 Edge of Pavement Details.
- HA 40/01 Determination of Pipe Bedding Combinations for Drainage Works.
- HA 41/17 A Permeameter for Road Drainage Layers.
- HD 43/04 Drainage Data Management System for Highways Agency.
- HD 49/16 Highway Drainage Design Principal Requirements.
- HD 50/16 The Certification of Drainage Design.
- HD 45/09 Road Drainage and the Water Environment.
- HA 78/96 Design of Outfalls for Surface Water Channels.
- HA 79/97 Edge of Pavement Details for Porous Asphalt Surface Courses.
- HA 83/99 Safety Aspects of Road Edge Drainage Features.
- CD 526 Spacing of Road Gullies.
- HA 103/06 Vegetative Treatment Systems for Highway Runoff.
- HA 104/09 Chamber Tops and Gully Tops for Road Drainage and Services: Installation and Maintenance.
- HA 106/04 Drainage of Runoff from Natural Catchments.
- HA 107/04 Design of Outfall and Culvert Details.
- HA 113/05 Combined Channel and Pipe System for Surface Water Drainage.
- HA 118/06 Design of Soakaways.
- HA 119/06 Grassed Surface Water Channels for Highway Runoff.

- HA 219/09 Determination of Pipe Roughness and Assessment of Sediment Deposition to Aid Pipeline Design.

3.2.2. HD 33/16 is the Highways Standard which dictates the selection of types of surface and sub-surface highway drainage. It obligates the design to remove water from the highway foundation and intercept runoff from external catchments and land drainage. It also dictates the storm design criteria.

3.3. Design for Sustainability

3.3.1. In accordance with HD 49/16 the drainage shall be designed with consideration for life cycle engineering, construction, operation, maintenance, decommissioning and delivering sustainability in accordance with HD 45/09 and HD 33/16, taking into account the following principles and any constraints imposed by the project requirements:

a. Surface water is removed as quickly as possible from the carriageway.

b. The pavement and associated earthwork structures are effectively drained.

c. Road runoff is managed at its source where it is reasonably practical to do so.

d. Road runoff is managed on the surface where it is reasonably practical to do so.

e. The systems are cost-effective to operate and maintain over their design life.

f. The design takes into account the likely effects of climate change as outlined in Government Policies (and changes in impermeable area) over the design life of the systems.

g. The systems minimise the use of energy over their design life.

h. The effect of road runoff on the quality of receiving water bodies is minimised.

i. The generation of waste during construction and operation is minimised.

3.4. Other Design Documents

3.4.1. As discussed in the following Sections, Sustainable Drainage Systems (SuDS) are promoted as an efficient method of meeting the contractual and legislative drainage requirements and the following documents are presented below as the current guidance to best practice:

CIRIA Report C753	The SuDS Manual (effectively replacing CIRIA Report 697)
CIRIA Report C532	Control of Water Pollution from Construction Sites
CIRIA Report C609	Sustainable Drainage Systems, Hydraulic, Structural and Water Quality Advice
CIRIA Report C625	Model Agreements for SuDS (England and Wales only)
CIRIA Report C648	Control of Water Pollution from Linear Construction Projects. Technical Guidance
CIRIA Report C689	Culvert design and operation guide
EA FDG2	Fluvial Design Guide, Environment Agency 2009

3.4.2. National Planning Policy Framework (2018) replaces Development and Flood Risk Practice Guide: Planning Policy Statement 25.

4. DESIGN METHODOLOGY

4.1. Drainage Design Criteria

4.1.1. In accordance with HD 33/16, the hydraulic modelling of the carriageway and earthworks drainage will be undertaken using Micro drainage design software, which uses the modified rational method and has become the industry standard for stormwater drainage design. This software allows the designer to quickly simulate a number of critical storm return periods and durations.

Design Criteria:

- (HD 33/16 7.2) Sealed carrier drains shall be designed to accommodate the one-year storm in-bore and without surcharge and five year storm to ensure that surcharge does not exceed the level of chamber covers.
- (HD 33/16 7.2) Combined drains and ground water drains shall be designed to accommodate a one year storm in bore without surcharge and five year storm to ensure that surcharge does not rise above formation level or sub-formation level where a capping layer is present.
- Combined kerb and drainage units shall be designed to accommodate the five year storm with 20% allowance for climate change.
- Surface water channels shall be designed to accommodate the one year storm in channel and checked to ensure the five year storm does not encroach into the running lane; an allowance of 20% for climate change will be applied.
- Additional checks will be carried out at locations of greater risk such as low points and pipe crossings to ensure there is no failure at critical locations.
- (HD 33/16 7.4) To allow for the effects of climate change the drainage design will incorporate an additional rainfall intensity of 20%. The attenuation for the local networks shall be designed to 40% climate change, as requested by Solihull Metropolitan Borough Council;
- (HD 33/16 8.6) Peak discharge rates will be controlled and appropriate attenuation storage provided to accommodate the 1 in 100 year return period.
- Attenuation storage shall be designed to accommodate the 1 in 100 year return period with 40% allowance for climate change.
- (HA 106/04 5.3) Designed return periods will include the 1 in 1 year and 1 in 5 years as specified in HD33/16 for piped systems, 1 in 75 years for natural catchments without a defined watercourse and 1 in 100 year for the design of attenuation. For culverts that convey permanent watercourses beneath roads the flow rate will be assessed for return periods up to 100 years.
- (HA 106/04 5.6) In order to determine the runoff rates from natural catchment (Greenfield) to control flows to ditches and watercourses, the IH 124 Method will

be used for rural catchments larger than 0.4km2 (or 40ha), and the ADAS Method for catchments less than or equal to 0.4km2 (or 40ha).

- Outfall locations and method of treatment requirements:
  - Pollution / Spillage Control Devices to be provided, as required;
  - Generally, surface water to be kept away from pavement foundation except in cut;
  - Sub-surface drainage to be provided via combined carrier / filter drains in cutting;
  - Gullies to be provided where road is kerbed, e.g. roundabouts, junctions and side roads;
- Combined Kerb Drainage to only be considered where spacing of gullies would be <5m consistently over a significant length;
- Filter drains to be provided in cuttings;

4.1.2. The design criteria stated herein will be agreed with the relevant stakeholders through the design and consultation process to ensure suitability for the location and intended purpose.

4.1.3. Where the proposed carriageway works intercepts any existing drains or ditches, these will be accommodated or diverted within the scope of the proposed pipe network design.

4.2. Pre-Earthworks Drainage

4.2.1. Pre-earthworks drainage will be installed to convey land runoff / intercept existing land drainage. This will either take the form of filter drains or ditches and is particularly important at the top of cuttings and toe of embankments. The DMRB allows the use of either filter drains or ditches as a satisfactory design solution.

4.2.2. Both solutions have a SuDS benefit in that they provide an initial treatment component, although land runoff is unlikely to have a high pollutant load when compared to the road runoff and is considered not to require treatment under SuDS guidelines. Where ditches are at the top of a cutting or toe of embankment, slope stability must be checked to ensure no slippage occurs.

4.2.3. Ditches are simpler to construct and maintain, fit in with the existing drainage philosophy and have higher capacities than typical filter drains but require more land so may not be viable at constrained locations. They also tend to collect litter although litter picking would be included in the requisite maintenance schedules for the Improvement Scheme in any case.

4.2.4. Filter drains use stone resources which typically need to be cleaned or replaced every ten to fifteen years depending on pollutant loading and quality of maintenance.

4.2.5. On the balance of construction cost and maintenance, ditches shall be used by default wherever possible and the design shall resort to filter drains in all other locations.

4.3. Road Drainage

4.3.1. In accordance with HD 33/16 Figure 4.1, below, the options for road drainage vary depending on whether the road is kerbed or not. The three main solutions available alongside a kerbed road are:

- Gullies with adjacent fin drains/narrow filter drains as per HCD B9.
- Grassed surface water channels as per HA 119/06.
- Combined surface and sub-surface drains (also known as filter drains).

4.3.2. Where the proposed road is not kerbed, options vary from combined surface and sub-surface drains to surface water channels with adjacent fin drains/narrow filter drains.

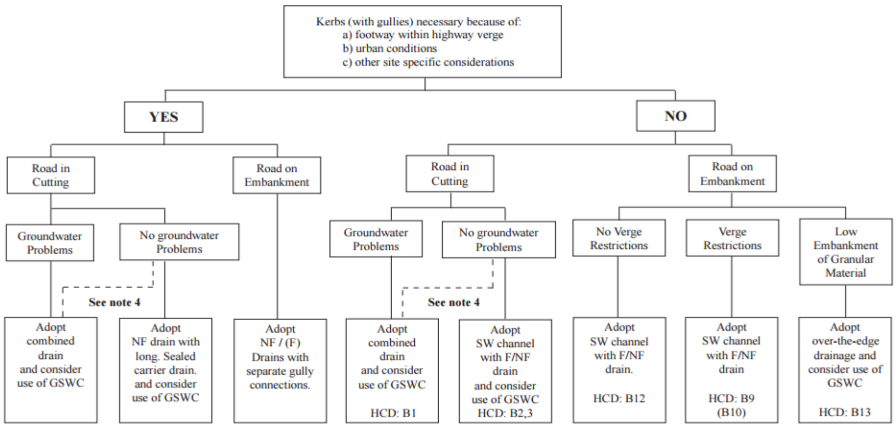


Figure 4.1: Recommended Design Selection Verge-Side Edge Drainage

Note 1: Fin drain usage denoted thus (F) indicates use with road gullies, and should only be permitted if gully connections have no adverse effect on fin drain.
Note 2: NF denotes alternative Narrow Filter Drain.
Note 3: Turf edging between intermittent precast concrete kerb/gully combinations may be acceptable on minor rural roads.
Note 4: This solution can be useful where lack of space inhibits provision of a separate carrier drain + F/NF trench.
Note 5: GSWC denotes Grassed Surface Water Channel.
Note 6: This selection approach has been developed considering the relative costs of the different solutions and their associated maintenance implications.

4.4. Sub-surface Drainage

4.4.1. Sub-surface drainage will convey any water from the sub-base or capping pavement layers to join the surface runoff in the surface water pipe network. This will be achieved through the use of a combined drain or a separate system via carrier drain in conjunction with a narrow filter drain or fin drain.

4.4.2. The DMRB allows the use of fin drains or narrow filter drains. Fin drains can be installed from a roll complete with geotextile. Both drain types can be installed by automatic drain-laying equipment, where ground conditions allow.

4.4.3. The narrow filter pipe is typically 100mm in diameter. It is not anticipated that a larger size will be required.

4.4.4. Narrow filter drains are an alternative to the fin drain option but the filter backfill material must be carefully selected. Actual systems, should they require to be incorporated into the design, will be agreed through the design and consultation process.

4.5. Surface Water Drainage

4.5.1. The surface drainage strategy considers whether the road is to be kerbed and whether it sits on an embankment or within a cutting.

4.5.2. In a kerbed situation, the DMRB allows the use of either gullies or combined kerb drainage (CKD) units. The use of combined kerb drainage will be limited to locations where the geometry is insufficient to accommodate gully spacing greater than 5m. This is due to both the expense and difficulty in constructing a large number of gullies within short lengths.

4.5.3. A double gully should always be situated at a low point to ensure efficiency and to prevent flooding.

4.5.4. From a SuDS perspective, both solutions include the use of sumps, which provide a means of collecting silt from the carriageway, but no actual treatment is provided.

4.5.5. It is proposed that where the road is in cut and unkerbed, combined surface and sub-surface drains will be provided. These will efficiently remove surface water, effectively draining the lower pavement layers.

4.5.6. Where the roads are proposed to be kerbed and on embankment, gullies or kerb drains are proposed with adjacent carrier drain and separate sub-surface drainage, if required.

4.5.7. If in cut, it is proposed to connect the gully tails directly to the combined surface and sub-surface drainage.

4.6. Sustainable Drainage System Philosophy

4.6.1. The term 'Sustainable', as part of the SuDS acronym, reflects the requirement to consider both present benefits and future burdens (both economic and environmental). As a result, in preparing designs for drainage systems, Engineers must consider not only the treatment phase of the SuDS systems but also the:

- Capital cost of construction;
- Maintenance burden of elements to be adopted;
- Capability of the adopting authority to maintain elements in an efficient manner;
- Potential risk to health and safety;
- Fit with the principles of the planning and landscape objectives for the site.

4.6.2. By promoting SUDS, the design aims to reduce runoff volume and rates, reduce pollutant concentration, buffer accidental spills, enhance the amenity and aesthetic value of the development, and promote biodiversity – all through the use of robust, easy to maintain components.

4.6.3. The philosophy is based on the concept of a 'treatment train' whereby runoff is progressively treated and attenuated initially at source and then at site level.

4.6.4. Generally, discharges to watercourses are attenuated to pre-development rates and treatment levels are deemed to be acceptable by the provision of a requisite number and combination of SuDS treatment components.

4.7. SuDS Selection

4.7.1. In accordance with HD 45/09, a risk assessment of potential ecological impacts of runoff to surface water will be carried out on each drainage network.

4.7.2. It is intended that the Highways Agency Water Risk Assessment Tool (HAWRAT) will be used as well as the recommendations set out in the SuDS Manual C753. A spillage risk assessment will also be undertaken to determine likelihood of spillage and the impact on watercourses.

4.7.3. SuDS selection is generally based on the assumption that effective pre-treatment (sediment/debris removal) is in place. This can be achieved by using trapped gully pots and catchpits at 90m maximum intervals to collect the heaviest sediment load.

4.7.4. During consultation process, the drainage proposals were reviewed by Birmingham Airport (BA) and the Environment Agency. Concerns were raised by BA in regards to the safeguarding of airport flight paths, from bird nesting / migration and for their potential for strikes. However this view was contrasted by that of the Environment Agency, who requested detention basins as the primary source of attenuation and treatment of surface water runoff.

4.7.5. Due to these conflicting views, a meeting was arranged with the two stakeholders to agree a solution that satisfied the requirements of both parties. The outcome of this meeting was to modify the attenuation and treatment strategy based on the proposals agreed in the meeting.

4.7.6. For this reason, a Technical Note on attenuation and treatment was produced (and subsequently accepted by both parties), to alleviate concerns and agree upon SuDS measures necessary in order to provide acceptable levels of treatment. The Technical Note, report number HE551485-ACM-HDG-ZZ_SW_ZZ_ZZ-TN-CD-0002 has been included within Appendix C.

4.7.7. The agreed SuDS attenuation and treatment measures, which are adopted within the subsequent drainage design, are further described, below.

4.8. Shallow Reed Beds

4.8.1. Reed beds are areas of grass-like marsh plants, artificially constructed to treat small areas or runoff for suspended particles and associated heavy metals. They are the preferred SuDS solution, providing attenuation and a level of treatment.

4.8.2. The features of the proposed reed beds shall be designed in accordance with the requirements of Birmingham Airport and the reed beds should be netted, with their banks steepened and maintained in compliance with a short grass / planting policy.

4.9. Storage Tanks

4.9.1. In addition to reed beds for attenuation, there is a need to provide storage tank systems. There are a number of materials and types of tanks that can be provided; the most common of these being constructed in concrete and geo-cellular plastic, usually manufactured from recycled material.

4.9.2. Attenuation tanks would not generally provide a level of treatment, unless designed to do so. Additional sediment removal and treatment can happen through the use of sumps and special zeolitic filters, which are known to have a high efficiency associated with the removal of heavy metals from road runoff.

4.9.3. Storage tanks shall only be used where SuDS or other proprietary systems are not achievable, and will generally require flows to be pumped from the storage tank into a downstream SuDS feature.

4.10. Swales / Dry Swales

4.10.1. A swale is a grass lined ditch which serves the dual functions of sediment removal/biological filtering and conveyance of runoff. When an underlying filter material is constructed below the swale, the combined feature is known as a Dry Swale, which can provide enhanced attenuation and treatment.

4.10.2. Check dams can be employed to maintain shallow gradients (prolong runoff detention) and fit local topography. Although not typically deep, land take can be significant due to the requisite shallow side slopes.

4.10.3. Maintenance of this facility to maintain performance is limited to grass cutting (and its removal), litter/debris removal and re-seeding, as required.

4.10.4. Remedial action may be required should excessive erosion occur such as soil replacement or the local installation of erosion control measures.

4.10.5. Swales could be used as a final level of treatment, if additional treatment is required by the HAWRAT tool, or the recommendations in the SuDS Manual.

4.11. Spillage / Pollution Systems

4.11.1. The requirement for the provision of vortex separators will need to be determined through consultation with the stakeholders and interested parties outlined in Section 1 of this report. It is expected that the use of SuDS will negate a general requirement to provide proprietary systems for the proposed drainage networks but these could be proposed where adequate SuDS treatment is not provided and there are significant constraints.

4.12. Preliminary Drainage Design Summary

4.12.1. The preliminary drainage design has been carried out in accordance with Highways England and SMBC requirements, DMRB Standards and design guidance documents.

4.12.2. The drainage networks have generally been split over their respective adopting authorities. For side roads, the drainage shall be adopted by Solihull Metropolitan Borough Council. The proposed link road, Junction 5A and free flow links at Junction 6 shall be operated and maintained by Highways England.

4.12.3. An initial assessment of the proposed alignment design has identified networks and outfalls at some locations. These are described below and provide the initial strategy for drainage of the Improvement Scheme. The layout of each of these networks is shown on the drawings attached in Appendix D.

Network 1B & 2B: Proposed Dual Carriageway

4.12.4. Surface water runoff from the proposed dual carriageway drains from a high point on the proposed dual carriageway to two outfall locations, via northern and southern attenuation and treatment areas.

4.12.5. Runoff is proposed to be collected and attenuated via filter drains along the carriageway with SuDS features provided where possible to treat the water before discharging to the existing outfalls.

4.12.6. North of the proposed mainline link, surface water runoff shall be attenuated underground prior to being pumped to a swale, which connects to an existing ditch that runs parallel to the A45 Coventry Road.

4.12.7. The underground attenuation system shall be designed to provide greater levels of treatment and sediment removal via the use of sumps and special zeolitic filters, which are known to have a high efficiency associated with the removal of heavy metals from road runoff.

4.12.8. South of the proposed link road, surface water runoff shall be attenuated underground in a typical storage tank system, without additional filtration, prior to being pumped to a reed bed system prior to discharge into the existing watercourse.

4.12.9. The reed bed system will be netted to discourage bird landings, particularly during the transitionary period when the reeds establish. Reed bed vegetation will be installed at such a density that, once fully established, will act as a visual barrier to migrating birds during sustained rainfall events.

4.12.10. Due to the majority of the proposed dual carriageway being in cut, the level of carriageway drainage will be dictated by proposed road levels. It is therefore considered that pumping stations will be required to allow surface water runoff from attenuation features to be discharged to existing ditches/watercourses.

Network 1A & 2A: Realigned Catherine De Barnes Lane

4.12.11. These networks cover the realignment of Catherine de Barnes Lane from south of Barber's Coppice roundabout to the proposed overbridge to the north west of Bickenhill. Kerbs and gullies will be provided to intercept surface water runoff with narrow filter drains being provided as subsurface drainage, as required. SuDS features will be provided, where possible, to treat surface water runoff before discharging towards existing outfalls.

4.12.12. Attenuation and treatment will be provided for Network 1A and 2A by a series of SuDS features and a storage system and appropriate SuDS features, which will be located to the south of the Clock Interchange.

Network 2C: Clock Interchange West

4.12.13. This proposed network covers short sections of existing, and proposed carriageway/footway, to the west of the Clock Interchange. The existing road is drained by a combination of gully and combined kerb drain units. It is assumed that these units drain into a carrier drainage network that was installed within the verge/central reserve of the existing A45 carriageway.

4.12.14. Existing location and level of the tie-in point will be confirmed following drainage survey to ensure a viable connection to the existing network.

Network 3: Shadowbrook Lane at Oak Tree Lodge

4.12.15. This proposed network covers the realigned Shadowbrook Lane at the junction with the proposed Catherine De Barnes Lane. The existing road does not have any apparent drainage features, such as gullies or chambers, though there are shallow ditches or swales adjacent to the carriageway and it is assumed that these drain the carriageway and outfall to the Shadow Brook.

4.12.16. It is proposed that over the edge drainage is provided on this section of the carriageway similar to the existing drainage, to a proposed grassed channel, which will tie into existing ditches or swales. The proposed carriageway will replace a similar length of road and so there should be little change in contributing areas.

Network 4: Catherine De Barnes Lane – North of Bickenhill Overbridged

4.12.17. This network covers the realignment of Catherine de Barnes Lane at the proposed overbridge to the north west of Bickenhill.

4.12.18. Kerbs and gullies will be provided to intercept surface water runoff with narrow filter drains being provided as subsurface drainage.

4.12.19. It is proposed to connect the proposed drainage into the existing drainage network (pending information). Attenuation will be provided in the form of oversized drains to limit the flow to greenfield runoff rates.

Network 5 & 6: M42 Junction 6 Free flow link Northbound

4.12.20. This network includes the free flow link from the A45 eastbound to the M42 northbound at Junction 6. Kerbs and gullies will be provided to intercept surface water runoff with narrow filter drains being provided as subsurface drainage.

4.12.21. There will be an increase in the impermeable area and therefore it is proposed that attenuation will be provided in the form of oversized pipes.

4.12.22. At the start of the free flow link, it is proposed to outfall a short length of the proposed drainage to the watercourse that is culverted under the A45 and flows south to north. It is assumed that this then flows into the Pendigo Lake where there is increased treatment potential.

4.12.23. The remaining length of the freeflow link falls from the south to the north and will be connected into the existing drainage network (pending information) via oversized pipework, prior to outfalling to the Hollywell Brook.

Network 8: Junction 5A Diverge and Merge Slips

4.12.24. This network includes the M42 Junction 5A diverge and merge slip connecting to the M42 northbound carriageway, where it also intercepts the existing M42 drainage network. This network also includes runoff from east and west sections of the Solihull Road overbridge. Filter drains are proposed along the diverge and merge slips as these will be unkerbed.

4.12.25. Surface water runoff from the existing and proposed M42 Junction 5A carriageway will be collected and conveyed via filter drains into a typical storage tank system, located to the south east of Junction 5A.

4.12.26. Runoff from the storage system will then be pumped up to ground level where it will discharge into a reed bed, which shall attenuate and treat the water, before being conveyed into a grassed dry swale (providing enhanced attenuation and treatment), prior to outfall to the existing ditch.

4.12.27. The area south of Scheduled Ancient Woodland has been earmarked for replanting, therefore, the attenuation and treatment solution needs to be compact in order to minimise land take.

4.12.28. Attenuation to greenfield runoff rates and a level of treatment will be provided by the storage system and SuDS features.

Network 10: Eastway Roundabout – Northeast of M42 junction 6

4.12.29. This network includes the realignment of the Eastway roundabout and the roads connecting to it. Kerbs and gullies will be provided to intercept surface water runoff with narrow filter drains being provided as subsurface drainage, away from the bridge.

4.12.30. There is very little change in impermeable areas flowing through the network therefore it is proposed to connect the proposed drainage into the existing drainage network at the tie in point to the existing alignment (pending information).

Network 11 & 12: M42 Junction 6 – Free Flow Link Southbound

4.12.31. These networks include the free flow link from the M42 southbound to the A45 eastbound at Junction 6. Runoff from the proposed carriageway will be collected and conveyed via filter drains into a reed bed system, which shall attenuate and treat the water, before being conveyed into a grassed swale (providing additional attenuation and treatment), prior to outfall to the existing Hollywell Brook.

4.12.32. A spillage control system such as a Vortex Separator shall be installed prior to discharge into HE maintained SuDS feature and subsequent downstream receptors to maintain pre-development flow rates and to protect them against pollution.

4.12.33. There is an existing ditch to the east of the M42 that outfalls to Hollywell Brook, which will need to be realigned. This ditch accepts surface water runoff from the existing drainage network.

4.13. Estimation of Greenfield Runoff Rates

4.13.1. Greenfield runoff rates were estimated for various catchments, based on the 1 in 100 year storm event. The estimated catchments, and their respective flows, are detailed within the following table 4.1 and shown on the drawing HE551485-ACM-HDG-ZZ_SW_ZZ_ZZ-DR-CD-0001 in Appendix E.

Network	Greenfield Runoff Rate (l/s)
Network 1A	233
Network 1B	282
Network 2A	177
Network 2B	100
Network 8	758

Table 4.1 – Greenfield Runoff Rates

4.13.2. The capacity of Holywell Brook was assessed and modelled, to establish whether there was a need to provide compensatory storage where the proposed improvement scheme crosses Hollywell Brook.

4.13.3. The consequent "Holywell Brook Capacity Assessment & Modelling Report", included within Appendix F, confirmed that Holywell Brook was not expected to overtop it bank during the 1 in 100 year storm event and that the existing brook was estimated to have up to approximately 9.6m^3/s (≈9600l/s) spare capacity.

4.13.4. The areas of proposed development, both permeable and impermeable, have been summarised in a table below and shown on the drawing HE551485-ACM-HDG-ZZ_SW_ZZ_ZZ-DR-CD-0004 in Appendix G:

Network	Proposed Area (Ha)	
	Permeable	Impermeable
Network 1A	0.3	0.9
Network 1B	7.4	3.6
Network 2A	0.4	1.1
Network 2B	4.9	3.9
Network 2C	0.1	0.4
Network 3	0.1	0.1
Network 4	0.1	0.2
Network 5	0.4	1.3
Network 6	0.1	0.8
Network 8	1.7	5.5
Network 10	0.2	0.4
Network 11	1.3	6.4
Network 12	0.1	0.8
Network 13	0.1	0.6
Network 14	0.1	0.6
Network 15	0.0	0.5

Table 4.2 – Proposed runoff areas (approximately)

4.14. Peak Discharge Rates

4.14.1. Peak discharge rates have been calculated for the various networks, based on the 1 in 100 year storm event. These are detailed within the following table 4.3.

Network	Peak Discharge Rate (l/s)
Network 1A	50
Network 1B	210
Network 2A	83
Network 2B	75
Network 2C	To existing
Network 3	5
Network 4	To existing
Network 5	189
Network 6	152
Network 8	400
Network 10	To existing
Network 11	550
Network 12	129
Network 13	164
Network 14	To existing
Network 15	97

Table 4.3 – Peak Discharge Rates

4.15. Cut off Drains

4.15.1. Where possible runoff collected in cut off drains will be kept separate from the carriageway drainage, as per the recommendations in the DMRB. Only where a direct outfall to an existing ditch is not possible, a cut off drain will be connected to the carriageway drainage.

4.15.2. As the proposed dual carriageway is in cut, the impact of the proposed cut on the hydrology of the Bickenhill SSSI will need to be investigated.

4.16. Pumping Stations

4.16.1. The proposed dual carriageway is almost entirely in cut with levels up to 8m below the existing ground level. This makes it difficult for the proposed drainage networks to outfall to existing watercourses under gravity fed conditions, therefore pumping will be required.

4.16.2. Pumping stations will be required for three locations, namely north and south of the proposed dual carriageway and towards the south east of the proposed Junction 5A.

4.16.3. Pumping stations will be fully automatic with provision for remote monitoring by telemetry. Access to the pumping station kiosk, control panels, pumpsets and telemetry communications to be taken off the new access track provided for maintenance of attenuation and treatment features.

4.17. Culverts

4.17.1. It is not envisaged that any new culverts will be provided on the proposed dual carriageway link between the proposed Junction 5A and the Clock Interchange.

4.17.2. The proposed road is almost entirely within cut and any watercourses crossing the route would have to be terminated in a chamber and dropped to a lower level to pass under the proposed carriageway.

4.17.3. Three existing culverts have been identified will require to be extended due to the road widening. The first is on the A45 at the start of the proposed northbound free flow link at Junction 6. This culvert will require to be extended due to the road widening required by the free flow link inclusion.

4.17.4. The second culvert is located under the M42 at the Hollywell Brook. Again due to the provision of A45 eastbound to M42 northbound free flow link, the culvert will need to be extended along the M42 northbound carriageway. Holywell Brook is indicated as a main river on Environment Agency mapping.

4.17.5. The third culvert is under Bickenhill Lane to the north of Clock Interchange. Due to the repositioning of the A45 northbound free flow to Bickenhill Lane, the culvert will need to be extended to meet the diverted ditch.

4.17.6. The diameter of each of these existing culverts will need to be determined by further site investigation.

4.18. Departures from Standard

4.18.1. Currently no departures from standard have been identified for the preliminary drainage design.

5. DATA MANAGEMENT

5.1. Introduction

5.1.1. In accordance with HD 43/04 Drainage, Data management and Interim Advice Note 147/12 all designed drainage assets will be presented and labelled in a manner that is conducive with the recording and future integration of assets into the Highways Agency Drainage Data Management System (HADDMS) or its successor the Integrated Asset Management Information System (IAM IS), referred to as HADDMS/IAM IS.

6. CONCLUSION

6.1. Conclusion

6.1.1. The networks on the proposed dual carriageway will receive levels of treatment in the form of general filter drains, reed beds and swales.

6.1.2. The provision of detention basins in the proximity of the Airport was challenged by Birmingham Airport (BA) due to the risk of any open bodies of water attracting migrating birds within the airport safeguarding zones. The attenuation and treatment strategy was revised to incorporate BA concerns.

6.1.3. Reed beds have been proposed at all outfall locations, except for the northern extent of the proposed dual carriageway, where a sumped storage tank (with added filters) and swale arrangement have been proposed.

6.1.4. All shallow reed beds shall be netted, with their banks steepened and maintained in compliance with a short grass / planting policy.

6.1.5. All proposals shall be analysed as part of a HAWRAT assessment to confirm that carriageway runoff will receive adequate treatment prior to being discharged to existing ditches or brooks.

6.1.6. Furthermore, fully open SuDS features have not been proposed, in order to safeguard airport flight paths, particularly with regards to bird strikes.

6.1.7. Pumping stations will be required at outfalls from reed beds/attenuation systems in order to achieve a connection into the existing watercourses. This is mainly due to the proposed dual carriageway being in cut.

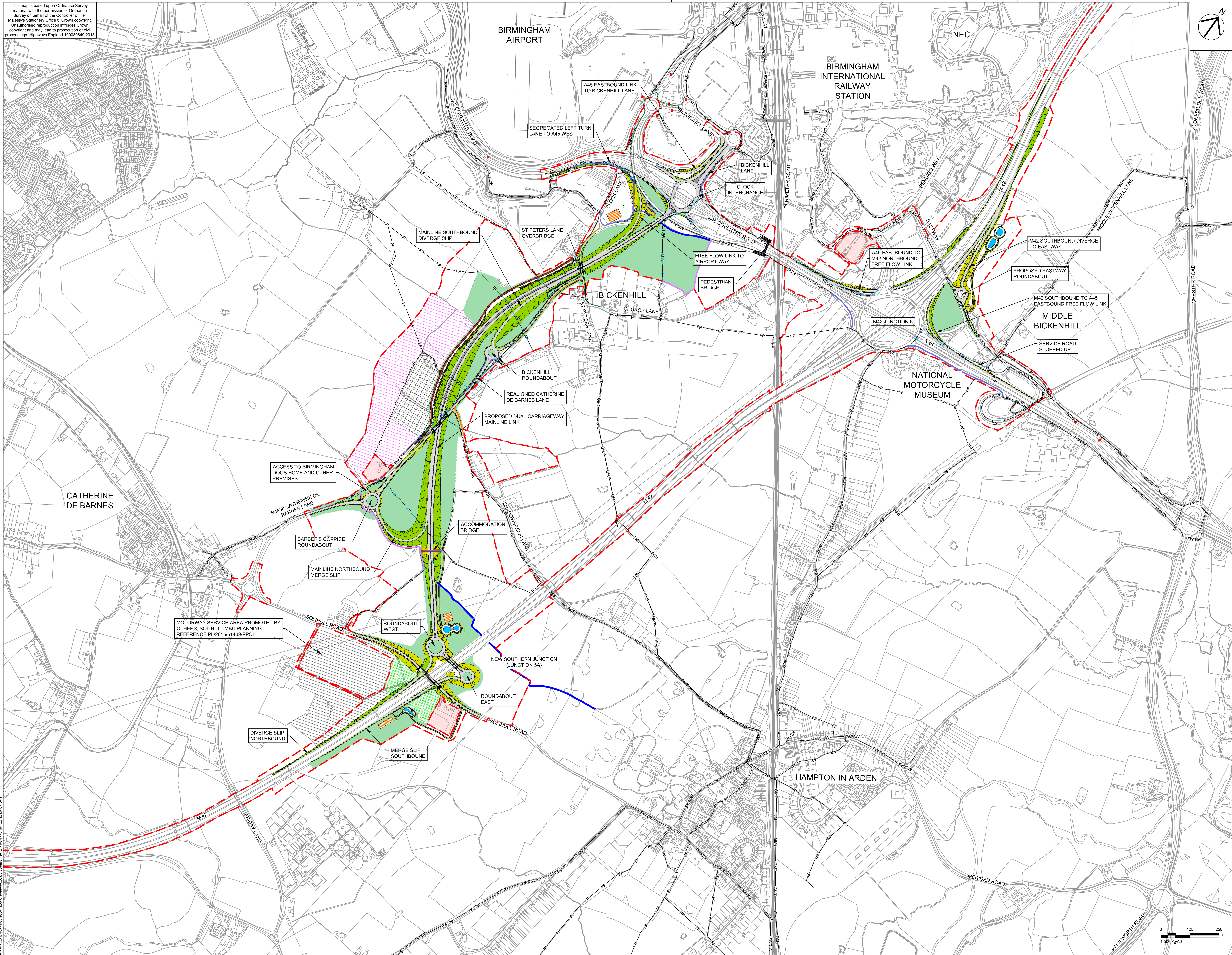
6.1.8. The location of existing drainage on the M42 and A45 will need to be assessed in order to determine whether existing pipework will need to be altered/extended in any way to accommodate the proposed drainage.

6.1.9. Cut off drains will be provided at the top of cut slopes and at the toe of embankments, where the adjacent ground falls towards the proposed works. These will be kept separate from the carriageway drainage where a suitable outfall to an existing watercourse or ditch can be achieved. The effect of the proposed cutting on the hydrology of the Bickenhill SSSI will also be investigated.

6.1.10. Three culvert extensions have been identified, one on the A45 west of M42 Junction 6, second north of Junction 6 at the Hollywell Brook and the third at Bickenhill Lane near the Birmingham International Airport. These will be designed to minimise potential adverse impacts on channel form and function.

6.1.11. Two major ditch diversions have been identified; one to the west of Bickenhill Lane and the other to the east of the M42, north of Hollywell Brook.

APPENDIX A – SCHEME LAYOUT



SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

IT IS ASSUMED THAT ALL WORKS ON THIS DRAWING WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROPRIATE METHOD STATEMENT.

THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT.

EXCEPTIONAL RISKS RELATING TO THE WORKS ASSOCIATED WITH THIS DRAWING ARE IDENTIFIED BELOW.

CONSTRUCTION

MAINTENANCE / OPERATION / DECOMMISSIONING / DEMOLITION

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DOCUMENTATION.
2. DO NOT SCALE FROM THIS DRAWING, USE ONLY PRINTED DIMENSIONS.
3. ALL DIMENSIONS IN MILLIMETRES, ALL CHAINAGES, LEVELS AND COORDINATES ARE IN METRES UNLESS DEFINED OTHERWISE.
4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.

LEGEND

- GMT — EXISTING GREEN MAN TRAIL
- ACR — EXISTING CYCLEWAY
- BW — EXISTING BRIDLEWAY
- FP — EXISTING FOOTPATH
- FP/CW — EXISTING CYCLEWAY/FOOTWAY
- DCR — EXISTING DEDICATED CYCLE ROUTE
- EXTENT OF SCHEME
- ROAD SIGN LOCATIONS
- PROPOSED BRIDLEWAY & PRIVATE MEANS OF ACCESS
- PROPOSED FOOTPATH
- PROPOSED CYCLEWAY/FOOTWAY
- PROPOSED FOOTWAY
- PROPOSED GREEN MAN TRAIL
- STOP UP
- STREAM / RIVER
- DRAINAGE SWALE
- DRAINAGE CARRIER
- DRAINAGE DITCH
- PROPOSED LANDSCAPE SCREENING AND BIODIVERSITY MITIGATION
- EMBANKMENT
- VERGES, CUTTINGS
- CENTRAL RESERVE,SPLITTER ISLANDS & OTHER PAVED AREAS
- CARRIAGEWAYS
- ACCESS TRACK
- REED BEDS
- ANCIENT WOODLAND
- AREA EXCLUDED FROM RED LINE BOUNDARY
- UNDERGROUND STORAGE TANK FOR DRAINAGE
- STRUCTURE
- EXISTING WARWICKSHIRE GAELIC ATHLETIC ASSOCIATION SITE
- INDICATIVE AREA OF SEARCH TO FACILITATE PROPORTIONATE RECONFIGURATION OF THE WARWICKSHIRE GAELIC ATHLETIC ASSOCIATION SITE REQUIRED FOR THE SCHEME

Revision Details	By / Check	Date	Suffix
First Issue	PK / JF	04/09/18	P04

Purpose of issue

FOR INFORMATION

Client
Highways England
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199 Wharfside Street
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0

Working on behalf of highways england

Project Title

M42 JUNCTION 6 IMPROVEMENTS

Drawing Title

M42 JUNCTION 6 COLOURED SCHEME PLAN

Designed	Drawn	Checked	Approved	Date
	PK	RKR	JF	04/09/18

Internal Project No.	Suitability
60543032	S2
Scale @ A0	**Zone**
1:5000	M42

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APPENDIX B – HIGHWAYS ENGLAND'S POSITION STATEMENT

<u>Position Statement with respect to:</u>

<u>Self-certification of Drainage Design, Climate Change Adaptation (CCA) policy and Drainage Survey requirements for undertaking Drainage Designs</u>

This Position Statement outlines the role of SES – Drainage Specialist's involvement in Drainage Design of new schemes

1. Self-certification of Drainage Design

First and foremost, there is no requirement for SES to be involved in 'Drainage Design Review' at any stage except in the case of 'Departures from Standard' and where a 'clarification of the requirements' outlined in our standards is required. DMRB 4.2: HD 49 & HD 50 set out the basic requirements for a Designer to comply with the requisite (published) standards and the need for the Designer to self-certify the design as complying with the standards. In this context, it would be meaningless for SES Drainage Specialist to even attempt to comment on a design as it would go against our published policy.

2. Climate Change Adaptation Policy

All Climate Change requirements are specified in the current DMRB 4.2 documents, especially HD 33 and HD 45. However, there are emerging issues in relation to Climate Change (CC) that may not have been fully incorporated in the current version of our published standards. As such, I consider that it would be useful if I reproduced some of the instructions we gave to our consultants commissioned with the task of updating the Drainage Documents contained within DMRD Vol 4.2, with particular reference to HD33 and HD45. The instruction is as follows:

When it comes to Design of Road Drainage HE advice that designers would normally be expected to adopt the following approach:

- All edge drain details for collection of run off and carrier pipes/conduits for conveyance of that run off shall be designed based on the 'rainfall' experienced by the road catchment. River levels and sea levels are not part of this design consideration. However, all drainage design shall incorporate appropriate discharge controls to comply with the national requirements.

Highways England fully recognises the design standards described in the National Planning Policy Framework (NPPF) for climate change adaptation. NPPF provides the controls we need to ensure the SRN drainage network can be designed, constructed and operated in a safe way, and in order to meet our legal obligation not to increase the risk of flooding. All new schemes shall adopt the following approach to drainage design:

a) For all new schemes that do not involve adaptation of an existing drainage network: Full compliance with the requirements described in NPPF;

b) For all new schemes that involve adaptation of an existing drainage network: Compliance in accordance with HD33, with the exception of Smart Motorways where IAN 161 shall apply;

c) In both a) and b) above, the design solution shall incorporate 20% uplift in peak rainfall intensity. The proposal shall also sensitivity test the design with a 40% uplift in peak rainfall intensity. The difference between the 2 scenarios (Central and Upper) shall enable the end user to understand the range of impact between the climate change risk scenarios. In the light of this knowledge the Project Sponsor shall determine the appropriate course of action to be implemented;

d) For all schemes that use existing outfalls, the current discharge rates shall not be exceeded. The current discharge rates (no rates were historically pre-defined, or pre-agreed) shall be calculated using the current design methods available within DMRB 4.2

e) All schemes shall be checked for a 1 in 100 year flooding compliance

Where rivers and the sea have the potential to influence a highway design the regional effects of climate change must again be taken into account. In this case the impact of climate change on river flows and sea level rise must be taken into account as part of a flood risk assessment. Our HD45 publication, which covers flood risk assessment, signposts the end-user back to Volume 4.2 (HA107) for Culvert design. However, the end user should be aware of, and implement, the most up-to-date climate change guidance to assess risk and design culverts in accordance with the new regional variations defined in NPPF, and to use the higher risk levels when doing so.

Note on Peak Rainfall Intensity allowances*: The working assumption is that all new road infrastructure shall have a design lifetime of 60 years. Under the climate change scenarios for peak rainfall intensity described in NPPF Table 2 the design lifetime of new road infrastructure now places them in the “2080s” banding (Note that NPPF Table 2 brackets the “2080s” peak rainfall intensity scenarios over the 2070 to 2115 period). NPPF text on peak rainfall intensity simply states the need to “understand the range of impact” and refers to the Central and Upper values across all of England that will facilitate this understanding. NPPF Table 2 then defines the “2080s” Central and Upper Peak Rainfall Intensity values as 20% and 40%, respectively. It is in this context that HE requirements are defined. You will note that for completely new road drainage designs our requirements are in full accordance with NPPF, whilst ensuring due diligence is exercised when “understanding” and evaluating the potential effects of a changing climate.*

Please note note that the HD33 guidance on climate change deals with 'drainage design' only. When it comes to the effects of climate change on 'flood risk assessment' HD33 sign-posts the end-user to the requirements of HD 45. This ensures a clear distinction between the effects of changing climate on drainage design, as a consequence of changing 'rainfall intensity', and on flood risk assessment, as a consequence of changing 'river level & sea levels'. Values are defined for both parameters in the National Planning Policy Framework.

3. Additional Drainage Data Survey

On the issue Drainage Data Surveying, it is assumed that the Designers have, as a first step, interrogated the Asset Data available in HADDMS and are proposing to undertake additional Data Survey for the purpose of acquiring the missing data and/or updating the data to assist with the design. Any such survey proposed by the Designer should be undertaken in accordance with MCHW: Volume 5, Section 9, Part 1: SD 15 ; DMRB 4.2: HD 43 and Interim Advice Note IAN 147. It is recognised that, in most cases, such surveys will provide the absolute minimum requirement for undertaking any drainage design to upgrade/improvement any part of the existing drainage network. All new Survey proposals should be agreed with the Project Manager/Sponsor.

4. Policy Statement

Finally, as it is already covered under HD 49&50, there is no need for the Drainage Design to be reviewed by SES (Drainage Specialists). The exception to this is rule is that all 'Departures from Standards' must to be 'reviewed and approved' by the relevant SES Specialist.

This Position Statement is prepared and issued by **Santi Santhalingam, HE Lead Drainage Specialist**

May 2018

APPENDIX C – ATTENUATION AND TREATMENT TECHNICAL NOTE

Project:	**M42 Junction 6 Improvement**	Job No:	**HE551482**
Subject:	**Attenuation and Treatment Proposals**		
Prepared by:	**Ryan Doolan**	Date:	**19/07/18**
Checked by:	**Omar Mirza**	Date:	**19/07/18**
Approved by:	**Javaid Farooq**	Date:	**19/07/18**

ATTENUATION AND TREATMENT STRUCTURE OPTIONS

1. INTRODUCTION

1.1. The preliminary drainage design has been carried out in accordance with Highways England (HE, formally the Highways Agency) and Solihull Metropolitan Borough Council (SMBC) requirements, the DMRB and other design guidance documents, including the National Planning Policy Framework.

1.2. The drainage has been designed to accommodate the runoff from a 1 in 100 year return period, with a suitable allowance for the effects of climate change.

1.1. A drainage strategy and associated drawings were submitted to HE, Birmingham Airport Authority (BAA), Environment Agency (EA) and SMBC in February 2018, to get their feedback on the initial drainage proposals.

1.2. The attenuation strategy was challenged by BAA due to a perceived risk of open bodies of water attracting migrating birds within airport safeguarding zones.

1.3. This view contrasted that of the EA, which requested SuDs basins as the primary means for attenuation and treatment of surface water runoff, before discharging to an existing drainage network or watercourse that may be a tributary to the River Blythe, which is designated as a Site of Special Scientific Interest (SSSI).

1.4. Following receipt of these opposing views, a technical note HE551485-ACM-HDG-ZZ_SW_ZZ_ZZ-TN-CD-0001 was drafted in March 2018 to try and identify the various attenuation and treatment measures acceptable to BAA and the EA.

1.5. A subsequent meeting was held on 8th May 2018 with BAA, EA, HE and AECOM in attendance. Treatment requirements from surface water drainage systems, and the safeguarding of airport flight paths, were discussed with regards to bird nesting / migration and for their potential for strikes. Minutes of the meeting are attached in Appendix A.

1.6. This technical note incorporates the actions agreed at the meeting and provides clarification on the drainage attenuation and treatment proposals for the proposed dual carriageway north and south outfalls, an outfall to the south of the proposed M42 Junction 5A and an outfall to Hollywell Brook, north east of M42 Junction 6.

2. PROPOSED DUAL CARRIAGEWAY - NORTH ATTENUATION AND TREATMENT AREA

2.1. Surface water runoff from the proposed dual carriageway drains from a high point on the road to two outfall locations, via northern and southern attenuation and treatment areas.

2.2. Runoff from the high point at CH1300 on the proposed dual carriageway, falling to the north, outfalls towards an existing ditch prior to connecting into the existing drainage network. Runoff is proposed to be collected and attenuated via filter drains along the carriageway with SuDS features provided to treat the water before discharging to the existing ditch.

2.3. Following the meeting held on 8th May 2018, an open SuDS system was replaced with a storage tank and conveyance swale arrangement. The proposed attenuation and treatment system is now located south of the Clock Interchange on the western side of the mainline, at roughly CH2100, and is approximately 550m to the east of the end of the airport's runway.

2.4. The attenuation and treatment system proposed for this location is shown on drawing HE551485-ACM-HDG-M42_GEN-ZZ_ZZ-SK-CD-0007, attached in Appendix B.

2.5. To summarise, runoff from the proposed carriageway will be collected and conveyed via filter drains into a storage tank system, which shall be designed to provide greater levels of treatment and sediment removal through the use of sumps and special zeolitic filters which are known to have a high efficiency associated with the removal of heavy metals from road runoff. A brochure of a sample system has been provided in Appendix C.

2.6. Partially treated runoff from the storage system will then be pumped up to ground level where it will discharge into a grassed swale (providing additional attenuation and treatment), prior to outfall to the existing ditch.

2.7. A technical report "Solutions to Rainfall-dependent pollution" prepared jointly by EA and HE, refers to similar storage systems being utilised for providing attenuation and some treatment in similarly constrained areas. A copy of the report has been provided in Appendix E.

2.8. This proposal was assessed using the Highways Agency Water Risk Assessment Tool (HAWRAT). The purpose of the HAWRAT is to help highway designers decide whether or not pollution mitigation measures are needed in specific circumstances. The tool determined that the proposed mitigation measures provide adequate levels of treatment, particularly in terms of dissolved and sediment-bound pollutants.

2.9. It is advised that the above mentioned storage tank system may require more maintenance than a typical storage tank, particularly with regards to filter replacement.

2.10. It has been confirmed by an Ornithologist that an adequately maintained conveyance swale should not attract any more birds to the area, than a traditional drainage ditch. Ditches and swales should be regularly inspected and maintained to ensure the throughput of water and to prevent bankside vegetation from providing a habitat attractant.

2.11. It is anticipated that potential spillage control systems, such as Vortex Separators, shall be installed prior to discharge into HE maintained SuDS features and subsequent downstream receptors to maintain pre-development flow rates.

3. PROPOSED DUAL CARRIAGEWAY - SOUTH ATTENUATION AND TREATMENT AREA

3.1. Runoff from the high point at CH1300 on the proposed dual carriageway, falling to the south, outfalls towards Shadow Brook, an existing watercourse.

3.2. Following the meeting held on 8th May 2018, a fully open SuDS system was replaced with an arrangement consisting of storage tank, shallow reed beds and conveyance swale. The proposed attenuation and treatment system is located on the east of the mainline link just north of western dumbbell roundabout.

3.3. The attenuation and treatment system proposed for this location is shown on drawing HE551485-ACM-HDG-M42_GEN-ZZ_ZZ-SK-CD-0006, attached in Appendix B.

3.4. The option of a shallow reed bed was considered appropriate as fully established reed planting will likely mask any water being attenuated and subsequently deter birds from landing.

3.5. In accordance with the recommendations of CAP772, all shallow reed beds should be netted, with their banks steepened and maintained in compliance with a short grass / planting policy.

3.6. To summarise, runoff from the proposed carriageway will be collected and conveyed via filter drains into a typical storage tank system without additional filtration. Runoff from the storage system will then be pumped up to ground level where it will discharge into a reed bed, which shall attenuate and treat the water, before being conveyed into a grassed swale (providing additional attenuation and treatment), prior to outfall to the existing Brook.

3.7. This proposal was assessed using the HAWRAT, which determined that the proposed mitigation measures provide adequate levels of treatment, particularly in terms of dissolved and sediment-bound pollutants.

3.8. It is anticipated that potential spillage control systems, such as Vortex Separators, shall be installed prior to discharge into HE maintained SuDS features and subsequent downstream receptors to maintain pre-development flow rates.

4. SOUTH OF THE PROPOSED M42 JUNCTION 5A ATTENUATION AND TREATMENT AREA

4.1. Surface water runoff from the proposed M42 Junction 5A shall drain to an outfall location to the south east of the proposed junction 5A, via an attenuation and treatment area. This area has also been earmarked for replanting of a Scheduled Ancient Woodland, therefore the attenuation and treatment solution needed to be compact in order to minimise land take.

4.2. From the HE HADDMS database it appears that the existing drainage network outfalls to an existing ditch that joins an unnamed watercourse which ultimately flows into the River Blythe, approximately 2 km to the east. The location of the outfall will be confirmed by a drainage survey and parts of the existing M42 drainage network will be retained in this location.

4.3. The attenuation and treatment system proposed for this location is shown on drawing HE551485-ACM-HDG-M42_GEN-ZZ_ZZ-SK-CD-0009, attached in Appendix B.

4.4. To summarise, runoff from the existing and proposed M42 carriageway will be collected and conveyed via filter drains into a typical storage tank system. Runoff from the storage system will then be pumped up to ground level where it will discharge into a reed bed, which shall attenuate and treat the water, before being conveyed into a grassed dry swale (providing enhanced attenuation and treatment), prior to outfall to the existing ditch.

4.5. The provision of a storage tank will reduce the plan area of potential reed beds.

4.6. This proposal was assessed using the HAWRAT, which determined that the proposed mitigation measures provide adequate levels of treatment, particularly in terms of dissolved and sediment-bound pollutants.

4.7. It is anticipated that potential spillage control systems, such as Vortex Separators, shall be installed prior to discharge into HE maintained SuDS features and subsequent downstream receptors to maintain pre-development flow rates.

5. HOLLYWELL BROOK ATTENUATION AND TREATMENT AREA

5.1. Surface water runoff from the proposed M42 Junction 6 works drains to an outfall location to the north east of the existing junction, via an attenuation and treatment area. The location is approximately 2.5 km to the east of the airport's runway and is not affected by airport safeguarding.

5.2. The attenuation and treatment system proposed for this location is shown on drawing HE551485-ACM-HDG-M42_GEN-ZZ_ZZ-SK-CD-0008, attached in Appendix B.

5.3. To summarise, runoff from the proposed carriageway work will be collected and conveyed via filter drains into a reed bed system, which shall attenuate and treat the water, before being conveyed into a grassed swale (providing additional attenuation and treatment), prior to outfall to the existing Hollywell Brook.

5.4. This proposal was assessed using the HAWRAT, which determined that the proposed mitigation measures provide adequate levels of treatment, particularly in terms of dissolved and sediment-bound pollutants.

5.5. It is anticipated that potential spillage control systems, such as Vortex Separators, shall be installed prior to discharge into HE maintained SuDS features and subsequent downstream receptors to maintain pre-development flow rates.

6. CONCLUSIONS

6.1. The proposals outlined above have modified the attenuation and treatment strategy in order to address the concerns raised by BAA and the EA.

6.2. All proposals have been analysed as part of a HAWRAT assessment which confirm that carriageway runoff will receive adequate treatment prior to being discharged to existing ditches or brooks. Furthermore, fully open SuDS features have not been proposed, in order to safeguard airport flight paths, particularly with regards to bird strikes.

6.3. A particular benefit of the storage tank systems will be to reduce the size of the reed beds, particularly in areas of tree planting. Additional emergency shut off valves can be provided at the outlet from tanked storage systems, retaining any pollution incident within their structure.

6.4. In accordance with the recommendations of CAP772, all shallow reed beds should be netted, with their banks steepened and maintained in compliance with a short grass / planting policy.

6.5. It has been confirmed by an Ornithologist that adequately maintained swales should not attract any more birds to the area, than a traditional drainage ditch. Ditches and swales should be regularly inspected and maintained to ensure the throughput of water and to prevent bankside vegetation from providing a habitat attractant.

6.6. Overall the combination of measures is considered sufficient to ensure that the suitability of the reed beds for breeding / roosting birds is significantly limited, thereby minimising the risk to air traffic from Birmingham Airport, in accordance with CAP772.

6.7. A separate Bird Strike Management Plan is currently being drafted, which shall include measures that would be adopted for the proposed drainage design.

6.8. Further consultation is required with Birmingham Airport Authority and the Environment Agency, in order to confirm their acceptance of the drainage proposals.

APPENDIX A – MINUTES OF MEETING

Minutes

Meeting name	Subject	Attendees	Circulation list	Apologies
M42 J6 Drainage Strategy Review	Review of attenutation strategy with respect to Airport and EA requirements	James Hemingway (JCH) Graeme Cowling (GC) Gerard Daly (GD) Timothy Jones (TJ) Andrew Davies (AD) Nick Roberts (ND) Jonathon Pizzey (JP) Noreen Nargas (NN) Giles Matthews-Pipe (GMP) Andrew Crawford (AC)	James Hemingway (JCH) Graeme Cowling (GC) Owen Tucker (OT) Gerard Daly (GD) Timothy Jones (TJ) Andrew Davies (AD) Nick Roberts (ND) Jonathon Pizzey (JP) Noreen Nargas (NN) Giles Matthews-Pipe (GMP) Andrew Crawford (AC) Javaid Farooq (JF) Robert Eaton (RE) Ian Bamforth (IB) Robin Hughes (RH) Lydia Barnstable (LB) Phil King (PK) Jamie Gleave (JG)	
Meeting Date 08/05/2018	**Time** 15:00			
Location Diamond House Birmingham Airport	**Project name** M42 J6 Improvement Works			
Project number HE514485	**AECOM project number** 60543032			
Prepared by James Hemingway				

Topic	Discussion
Introductions	Jonathon Pizzey provided an overview of the scheme and the issues related to the detention basins that had led to this meeting being required.
Design Principles	GD provided an overview of the drainage strategy and the options which were considered as part of the technical note submitted to the Environment Agency and Birmingham Airport following a meeting with the airport on the 28th February 2018. These options considered the following: • Detention Basins • Detention Basins with netting • Buried attenuation tank systems • Buried attenuation tank system with swales.
Specific Items Discussed.	• Environment Agency expressed a desire to see detention basins still implemented as part of the scheme. AC raised the point that similar devices have been installed at Stonebridge Island at the confluence of the A45 and A452. AD's response to this matter was that the Airport already has a wide range of existing constraints that need to be considered and would not permit any additional water bodies being introduced that would create issues for bird nesting/migration. Furthermore AD stressed that unlike the detention basins at Stonebridge Island, the southern detention basin would be on the centreline of the take off and approach surfaces, with the northern detention basin far closer but just outside of these surfaces. • The key issue for the Environment Agency is that the northern surface water attenuation system ultimately discharges to the River Blythe, this is a Site of Special Scientific Interest (SSSI) and is already a severely impacted environment which the Environment Agency does not want to see affected further by the M42 J6 Scheme. • Birmingham Airport clarified that they consider any applications for water bodies within a 13km radius of the centre of the Airport. • AC stressed that Heathrow Airport operates with a number of large reservoirs adjacent to the runway. AD accepted this point but stressed that these water bodies subsequently rely on a robust bird mitigation plan to ensure that these reservoirs do not create an issue for the continued operation of the airport. A fact that Birmingham Airport is also in currently with Pendigo Lake in close proximity. • Birmingham Airport have concerns that any new detention basins features would create a migratory link between other existing water features in the vicinity. AD raised such species as Gulls, Canada Geese and Waterfowl as particular concerns. • For any detention basins to be acceptable to the Airport they would need to be netted and any water

Topic	Discussion

present in the basins during rainstorm events would need to be removed within a timeframe of hours as opposed to days. However Birmingham Airport stressed that even the presence of a water body for a couple of hours still has the potential to attract bird species and is therefore still not their preferred option.

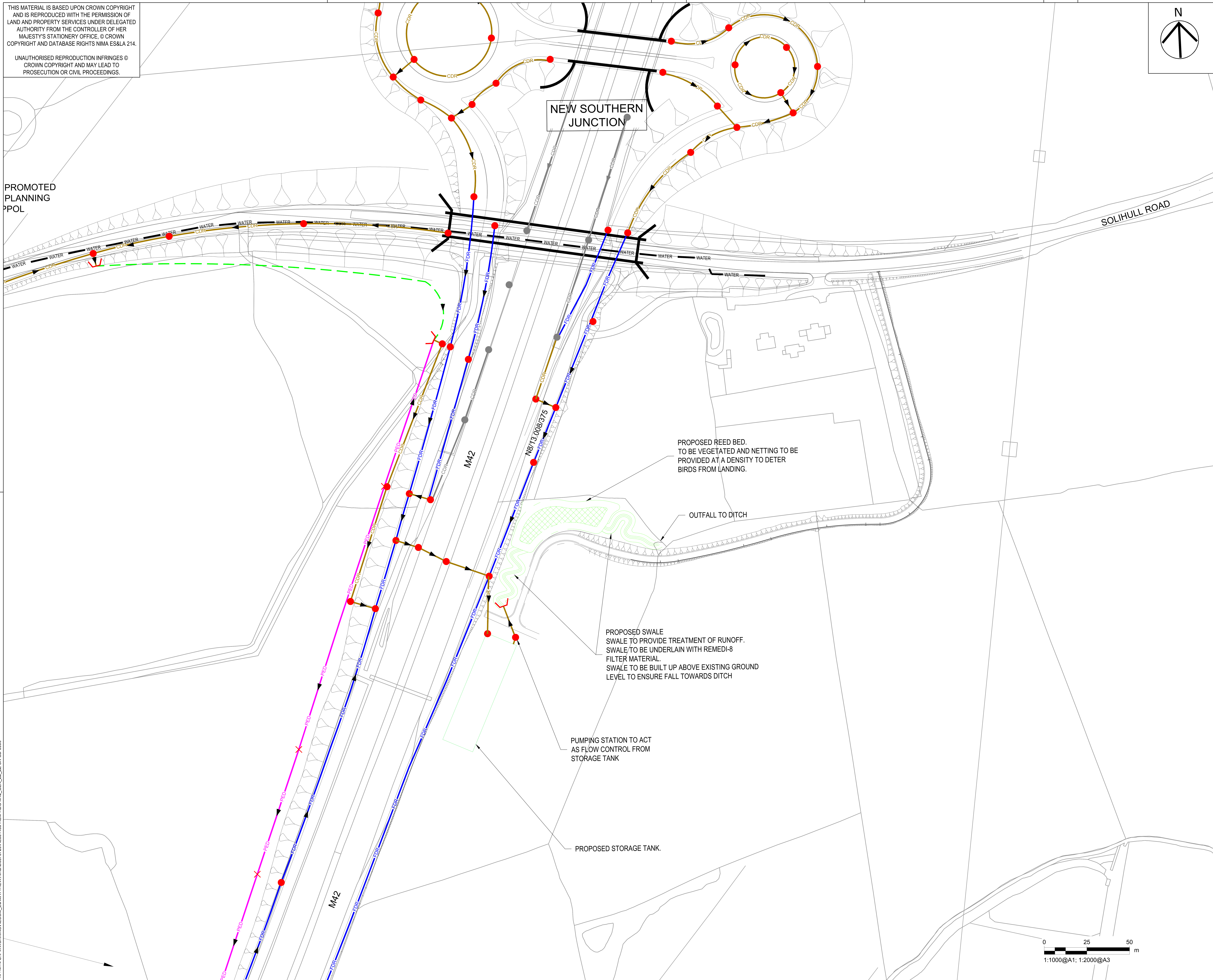
- AC challenged the number of birds that would be attracted to a basin of such a size being promoted by the scheme in the technical note. AD highlighted that a similar basin situated in Hampton in Arden often sees 1000 to 1500 birds present and therefore something of a similar nature so close to the airport would not be acceptable due to placing undue risks to the flight path.
- JCH stressed that currently when comparing the various options proposed in the technical note there is a clear conflict in opinion between the Environment Agency and Birmingham Airport as to the desired surface water attenuation strategy. Ultimately from a design perspective it is the airport safeguarding requirements that take the higher priority due to the risk to aeroplanes of bird strikes. As a consequence it is essential that a middle ground is reached between the two parties to allow a decision to be reached.
- GD highlighted that a storage tank had been identified is considered to provide greater treatment and sediment removal than typical tanks. EA raised concerns over BOD levels with the use of tanks. AECOM to provide details of the tank.
- The issue of deep excavation required for a gravity pipe system into the detention basins was highlighted. It was queried whether a pumping station could be provided prior to the basin, AECOM to investigate this option.
- For the southern storage device a decision was reached for AECOM to investigate the use of reed beds under the following conditions:
    - The reed bed system should be netted during the period where the reeds are being established to prevent the system being used by birds.
    - The reed bed density should be designed to a level whereby it does not attract bird species.
    - The reed bed layout should not be designed so as to create a flight path suitable for landing for birds. This can mean that the reed bed is either in a terraced, zig-zag, or installed in sections connected by culverts.
    - The configuration of the reed bed is to minimise where possible farmland land take which is a concern for the Gooch Estate landowners.
    - A suitable maintenance regime is established and operated to ensure the desired water quality is maintained.
- For the northern storage device a decision was reached for AECOM to investigate the use of an underground storage tank under the following conditions:
    - The attenuation tank uses a system designed to capture sediments prior to discharge.
    - The existing ditch that runs parallel to the A45 is to be upgraded into a swale in order to treat any dissolved metals identified during borehole surveys.
    - The pump system location is to be confirmed (prior or after the attenuation device)
    - The attenuation system is to be suitably designed to ensure that farm vehicles can continue to use the area.
    - A suitable maintenance regime is established and operated to ensure the desired water quality is maintained.
- GD highlighted that the EA had requested treatment and attenuation of runoff from networks where the sections of the existing drainage were picked up by the proposed drainage networks, these were to the south east of the proposed Junction 5A and to the north east of M42 Junction 6. It was highlighted that the area to the south east would be on the same line as the mainline south basin and the airport runway. It was agreed that a similar approach to the south basin should be taken at this location.

Other Items Discussed	• AC queried whether the culvert extension for Holywell Brook underneath the M42 could have an otter bridge installed as otters are regularly killed attempting the M42 crossing.

Topic	Discussion
	• JP highlighted that although it would be possible to add an otter bridge to the extension, the existing section of culvert may not be possible due to being defined as a confined space for working. However, JP did state that it might be possible to undertake a direction drill adjacent to the culvert to create a suitable crossing point. This action might be possible under designated funds. • GC provided an overview of the proposed contiguous replanting to be undertaken for the scheduled ancient woodland. AD has no issues with the proposed replanting location so long as the species and density did not provide a natural attraction point for birds. However AD conceded that there is little issue caused by the current tree types and density to the airport and therefore there should be no issue. • GC provided an overview of the environmental mitigation measures being proposed across the scheme. • JP raised the issue of whether a GAA pitch could be relocated into the field to the north of the clubhouse. AD had immediate concerns with this as it would move the pitch and any associated goal posts within the airport safeguarding zones. AD requested that a study be undertaken to determine whether the goal posts would penetrate the airport safeguarding surfaces. • JP raised the matter of the lighting strategy and areas such as the onslip and offslip for the mainline link being flagged as requiring to be lit. AD stated that he would like to see any proposals in this area, full cut off lighting would be essential. However JCH stressed that the offslip to Bickenhill would be the key issues as it is in the most sensitive area with regards to airport safeguarding and any lighting required would undoubtedly penetrate these surfaces. JP stated that it may be prudent to investigate whether a departure could be ascertained to remove this lighting in order to mitigate this issue.

Ref	Action	Initial
01	AECOM to revise the surface water attenuation design based upon the agreed course of action outlined above.	**GD/JF**
02	AECOM to revise technical note to show how the agreed strategy has been developed and detail how the new configuration will address EA and Birmingham Airport concerns.	**GD/JF**
03	AECOM to issue design and technical note for approval from HE Project Management team.	**GD/JF/IB**
04	AECOM to circulate designs and revised technical note to the EA and Birmingham Airport for review by their respective specialists.	**GD/JF**
05	AECOM to circulate design and revised technical note to Area 9 (Stephen Callister) for review from a maintenance perspective for approval.	**GD/JF**
06	Birmingham Airport and the EA to pass back any comments on the revised design and technical note if required.	**AD/AC**
07	AECOM to prepare statements of common ground to initiate the process of getting agreement in advance of Development Consent Order application.	**JCH/IB/LB**
08	AECOM to investigate the GAA relocation with regards to airport safeguarding	**JCH**
09	AECOM to issue environmental mitigation strategy and associated drawings to Birmingham Airport for review.	**GC**
10	Possibility of an otter bridge to be provided to be added to the list of prospective designated funds ideas to be implemented by the scheme	**JCH/IB/JP**
11	Lighting strategy to be reviewed at Bickenhill Offslip with regards to airport safeguarding. Detailed to be passed to Birmingham Airport.	**JF/JCH**

APPENDIX B - SKETCHES



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LEGEND

EXTENT OF SCHEME
CDR PROPOSED CARRIER DRAIN
FDR PROPOSED FILTER DRAIN
PROPOSED SWALE
PED PROPOSED PRE-EARTHWORKS DITCH
BKD PROPOSED BRIDGE KERB DRAIN
CDR EXISTING CARRIER DRAIN
FDR EXISTING FILTER DRAIN
PROPOSED CHAMBER
EXISTING CHAMBER
OPEN CHANNEL POINT
FLOW ARROW
HEADWALL
PROPOSED STRUCTURE
DB DETENTION BASIN
N8/3.000/225
NETWORK
PIPE NUMBER
PIPE DIAMETER

KEYPLAN

Revision Details	By / Check	Date	Suffix
First Issue	RD / GD	07/06/18	P01

Purpose of issue

FOR REVIEW AND COMMENT

Client
Highways England
The Cube
199 Wharfside Street
Birmingham
B1 1RN
0

Working on behalf of highways england

Project Title

M42 JUNCTION 6 IMPROVEMENTS

Drawing Title

M42 JUNCTION 6 STORAGE ALTERNATIVES NETWORK 8 STORAGE TANK AND SWALE

Designed	Drawn	Checked	Approved	Date
RD	---	---	---	05/07/18

Internal Project No.	Suitability
60543032	S3
Scale @ A1	Zone
1:1000	M42

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Drawing Number
Highways England PIN | Originator | Volume
HE551485 -ACM -HDG-
M42_GEN_ZZ_ZZ -SK-CD-0009
Location | Type | Role | Number

Rev
P02

Plot Date : 16 July 2018 16:33:11
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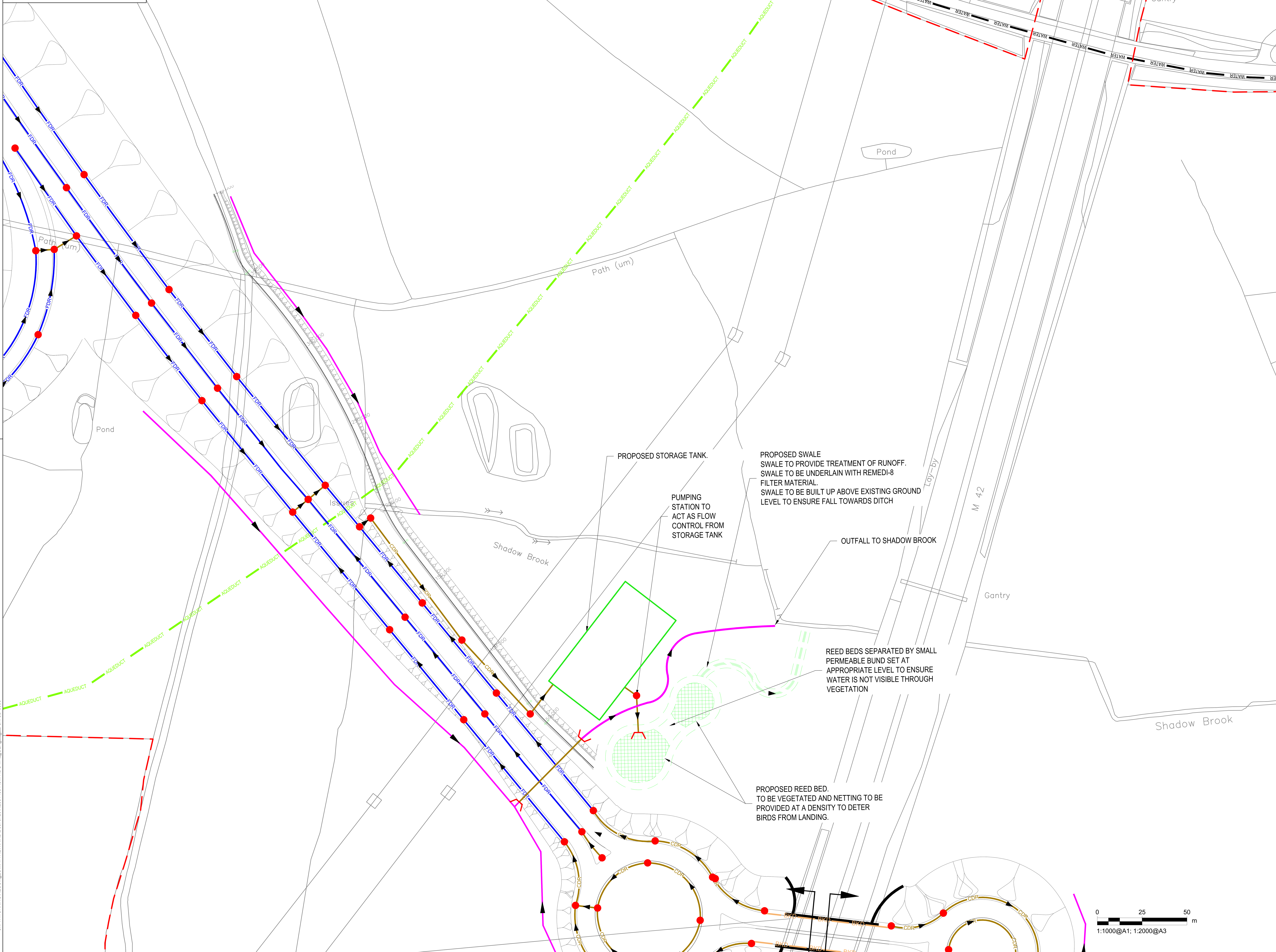

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LEGEND

- EXTENT OF SCHEME
- CDR — PROPOSED CARRIER DRAIN
- FDR — PROPOSED FILTER DRAIN
- PROPOSED SWALE
- PED — PROPOSED PRE-EARTHWORKS DITCH
- BKD — PROPOSED BRIDGE KERB DRAIN
- CDR — EXISTING CARRIER DRAIN
- FDR — EXISTING FILTER DRAIN
- PROPOSED CHAMBER
- EXISTING CHAMBER
- OPEN CHANNEL POINT
- FLOW ARROW
- HEADWALL
- PROPOSED STRUCTURE
- DB — DETENTION BASIN

N8/3.000/225 — NETWORK, PIPE NUMBER, PIPE DIAMETER

KEYPLAN

Revision Details	By / Check	Date	Suffix
First Issue	RD / JF	07/06/18	P01

Purpose of issue: FOR REVIEW AND COMMENT

Client: Highways England, The Cube, 199 Wharfside Street, Birmingham, B1 1RN, 0

Working on behalf of highways england

Project Title: M42 JUNCTION 6 IMPROVEMENTS

Drawing Title: M42 JUNCTION 6 STORAGE ALTERNATIVES NETWORK 1 REED BEDS

Designed	Drawn	Checked	Approved	Date
RD	---	---	---	05/07/18

Internal Project No.	Suitability
60543032	S3
Scale @ A1: 1:1000	Zone: M42

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Drawing Number: Highways England PIN HE551485 - Originator ACM - Volume HDG - Location M42_GEN_ZZ_ZZ - Type SK - Role CD - Number 0006

Rev: P02

Plot Date: 16 July 2018 16:30:23
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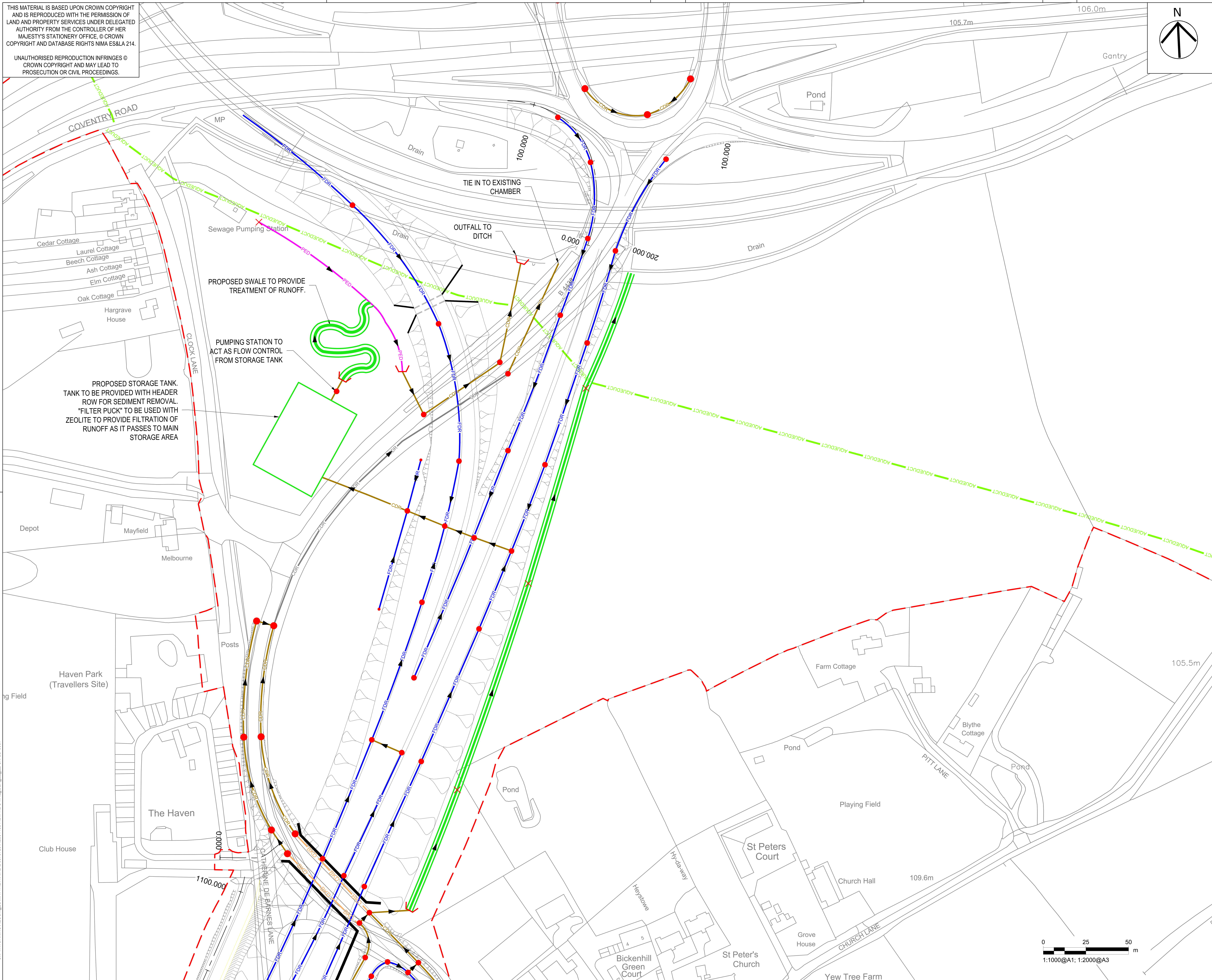

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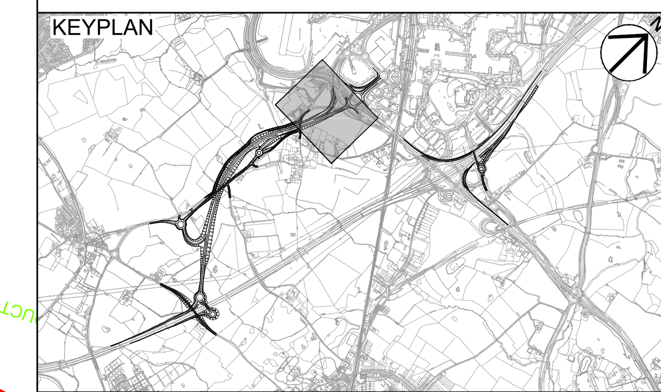
LEGEND

- EXTENT OF SCHEME
- CDR PROPOSED CARRIER DRAIN
- FDR PROPOSED FILTER DRAIN
- PROPOSED SWALE
- PED PROPOSED PRE-EARTHWORKS DITCH
- BKD PROPOSED BRIDGE KERB DRAIN
- CDR EXISTING CARRIER DRAIN
- FDR EXISTING FILTER DRAIN
- PROPOSED CHAMBER
- EXISTING CHAMBER
- OPEN CHANNEL POINT
- FLOW ARROW
- HEADWALL
- PROPOSED STRUCTURE
- DB DETENTION BASIN
- N8/3.000/225 — NETWORK, PIPE NUMBER, PIPE DIAMETER

KEYPLAN



Revision Details	By / Check	Date	Suffix
First Issue	RD / JF	07/06/18	P01

Purpose of issue

FOR REVIEW AND COMMENT

Client
Highways England
The Cube
199 Wharfside Street
Birmingham
B1 1RN
0

Working on behalf of highways england

Project Title

M42 JUNCTION 6 IMPROVEMENTS

Drawing Title

M42 JUNCTION 6 STORAGE ALTERNATIVES NETWORK 2 STORAGE TANK & SWALE

Designed	Drawn	Checked	Approved	Date
RD	---	---	---	05/07/18

Internal Project No.	Suitability
60543032	S3
Scale @ A1	**Zone**
1:1000	M42

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AECOM Infrastructure & Environment UK Limited
Registered in England Registered number: 880328
Registered office: Scott House, Alencon Link, Basingstoke, Hampshire RG21 7PP

Drawing Number
Highways England PIN | Originator | Volume
HE551485 -ACM -HDG -
M42_GEN_ZZ_ZZ -SK -CD -0007
Location | Type | Role | Number

Rev
P02

Plot Date : 16 July 2018 11:09:18
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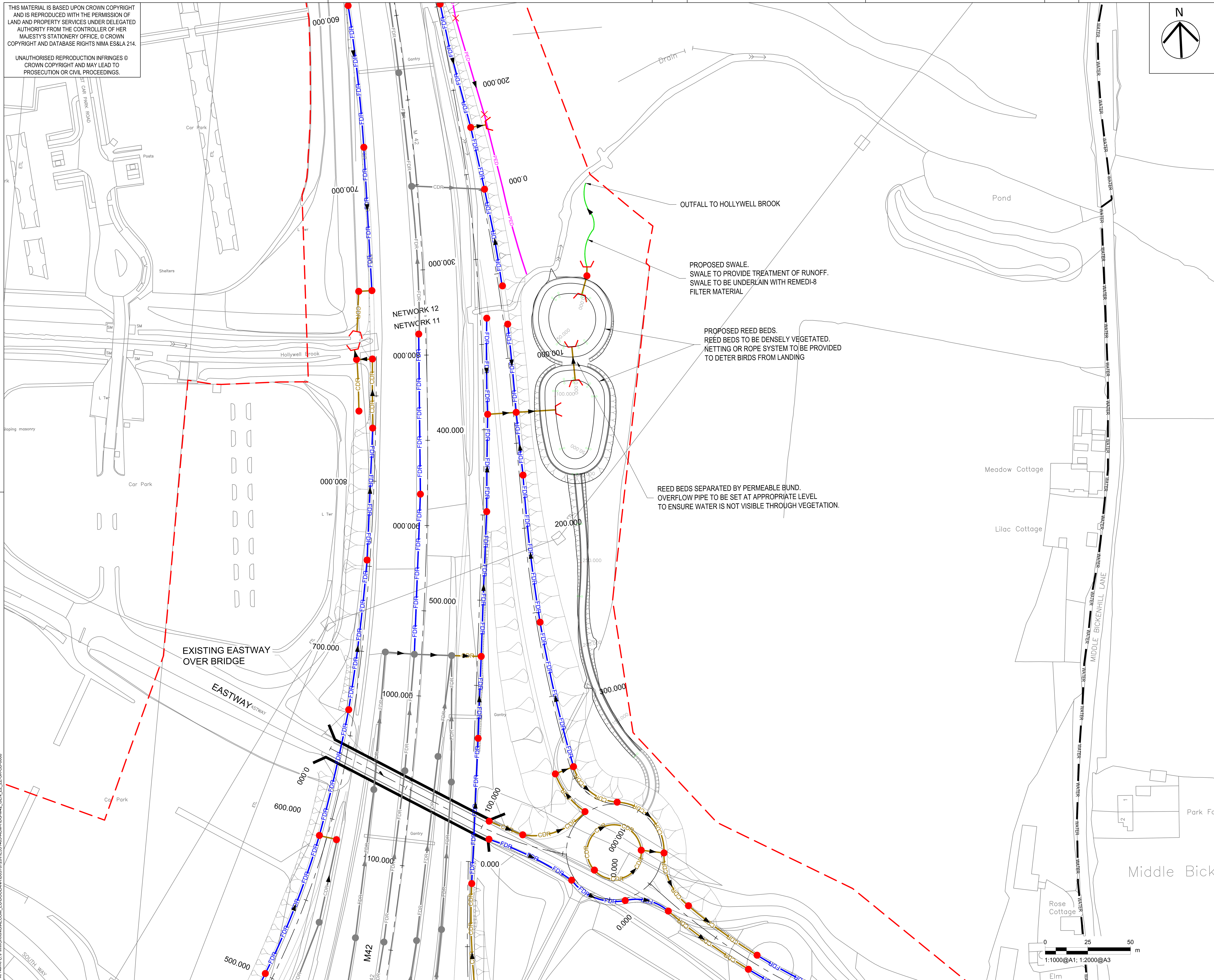

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199 Wharfside Street
Birmingham
B1 1RN
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Working on behalf of
highways england

Project Title

M42 JUNCTION 6 IMPROVEMENTS

Drawing Title

M42 JUNCTION 6 STORAGE ALTERNATIVES NETWORK 11 REED BEDS & SWALE

Designed	Drawn	Checked	Approved	Date
RD	---	---	---	05/07/18

Internal Project No.	Suitability
60543032	S3
Scale @ A1	**Zone**
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HE551485 -ACM -HDG -
M42_GEN_ZZ_ZZ -SK -CD-0008
Location | Type | Role | Number

Rev
P02

Plot Date : 13 July 2018 16:30:07
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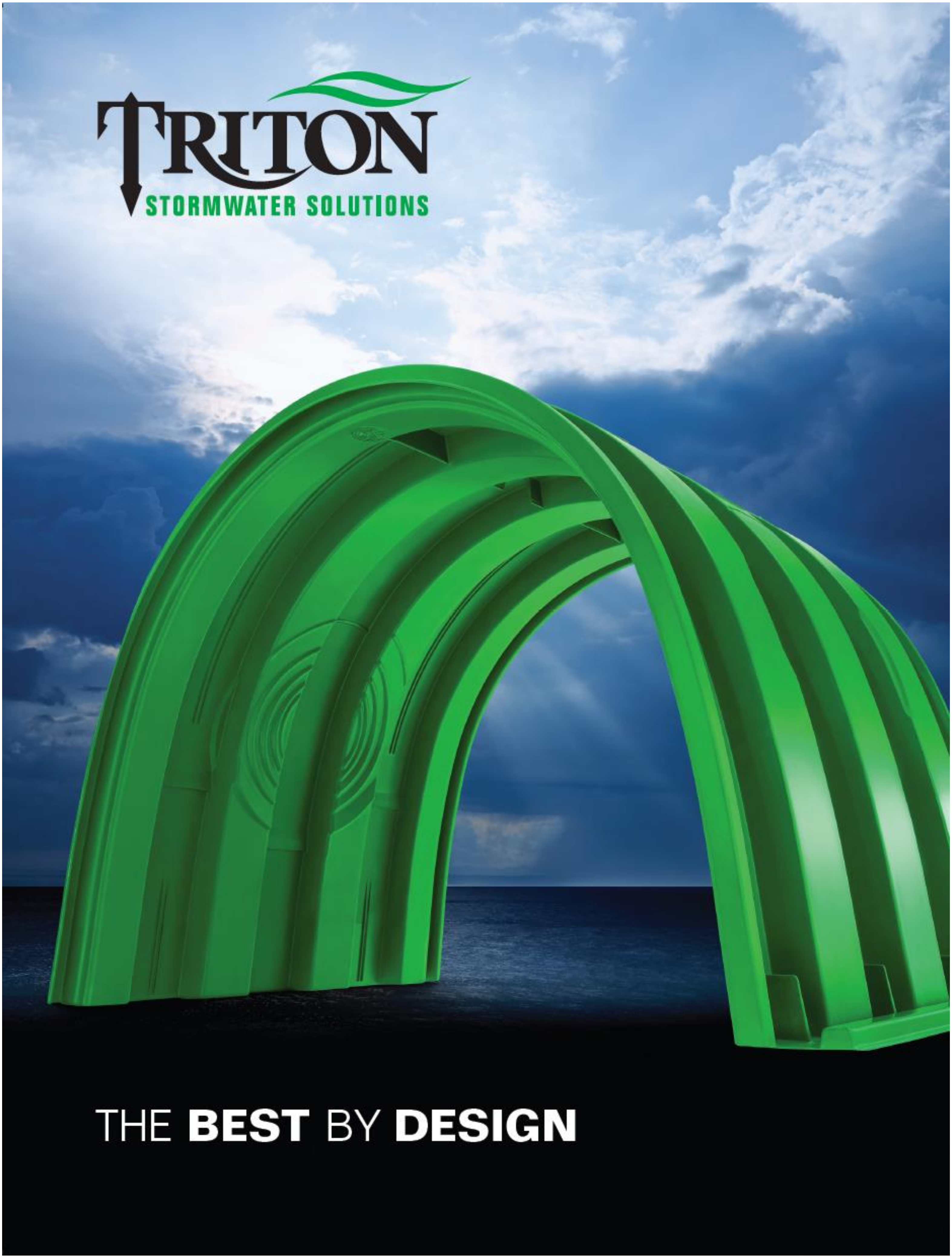
APPENDIX C – STORAGE TANK BROCHURE


TRITON
STORMWATER SOLUTIONS
THE BEST BY DESIGN

Triton Stormwater Chambers — The Best By Design

Triton Stormwater Solutions gives you the most-effective, most-flexible and most-economical underground system for managing stormwater on any size project. The key is that each component in the system has been designed to maximize strength, storage and flexability, allowing project managers the freedom to create a system that can work in small footprints, or in terrain that competitive products can't.

1

MAIN HEADER ROW (MHR)

The heart of the Triton system is the Main Header Row. Working as a collection point and management center for incoming stormwater runoff, the Main Header Row allows sediments to be captured onto Triton's patented Sediment Floors before passing the water into the Distribution Chamber Rows. Intelligently designed, it can work in conjunction with a variety of catch basin pre-treatment devices if required. It can also completely eliminate the need for a manhole altogether; as our chambers are strong enough to take a direct connection into the front, top side of the Chamber!

2

POLLUTION CONTROL OPTIONS

The key to the system's robust pollution abatement is twofold. First, the Main Header Row will allow the sediment to settle out as the water from the inlet manhole rises to the connecting pipe inverts. Then, once the water is inside the Main Header Row the Triton-designed Elbow and Filter Puck system gives designers the ability to use any type of filtration media (Zeolite, Granular Activated Carbon (GAC), MetalZorb etc.). This flexibility allows the user to target a wide range of common contaminants before the water is sent to the distribution chambers. The water in the distribution (storage) chambers then leaches back through the soil to recharge aquifers just as it would in nature. If a liner is used with the system, the water can be used for landscape irrigation, toilets or for wet fire suppression systems. [The image above shows three different options: Connecting pipes without the Elbows, with Elbows and Filters Pucks pointing up, and the Connecting pipes with the Elbows and Filter Pucks pointing down].

3

EFFICIENT EQUALIZATION

Any number of Equalization Pipes can be placed anywhere within the Triton System to allow for the most efficient equalization of the system based on flow rates coming into the Distribution Rows.

4

STRENGTH, STORAGE & FLEXIBILITY

Triton chamber systems are the strongest in the market. The Triton products were designed to exceed the ASTM F2418, F2787, F2922 standards and AASHTO LFRD Bridge specifications, and have been validated through independent third-party performance testing. Because of their strength, the Triton chambers can be double- or triple-stacked to allow for greater storage in a smaller area and can be buried to depths of 50 feet. The strength of the chambers allows for direct connections into the front, side or top of the units so the Triton system can eliminate the need for cumbersome manifold systems and expensive catch basins.

5

INSPECTION & MAINTENANCE

Large inlet and access ports are easily accommodated into the Triton system to allow for easy inspection and clean-out, and can be placed virtually anywhere in the system per the engineer's requirements.
The access pipes can be PVC or dual-wall corrugated pipe that sits inside a concrete top slab with a frame and lid. Refer to the Triton Details found on the Downloads page of the Triton website for full details.

6

SEDIMENT CONTROL

Sediment sumps can be incorporated into the system to help act as a collection point for sediment and debris. These sumps provide a location for sediment trapped within the Main Header Row to backwash into, as well as helping to expedite cleaning via a Jet Vac Truck during the maintenance phase.

TRITON
STORMWATER SOLUTIONS

Superior Stormwater Management Solutions

Triton Stormwater Solutions is the premier provider of underground stormwater management systems. As the need to effectively manage stormwater has become a paramount issue around the world, it is essential to work with a company that has a customer-service-minded business approach. At Triton, we have the experience to ensure successful results by providing superior products and service.

LIGHTER

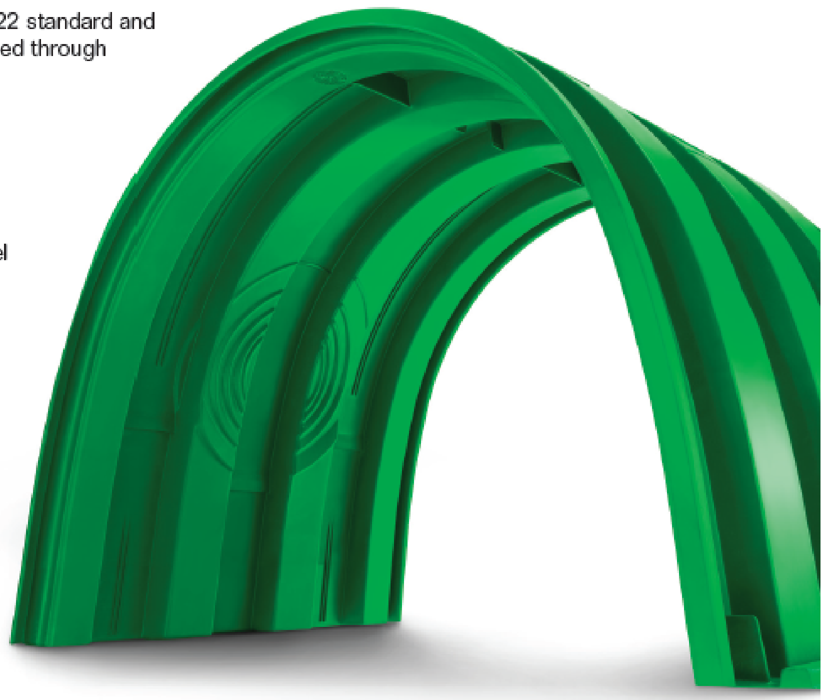
- 46% lighter per cubic foot of storage
- Chambers weigh just 32 pounds – a fraction of what the competition weighs
- Nest easily for ease of shipping and carrying

FLEXIBLE

- Modular system can be adapted to fit small drain fields
- Can be used with or without catch basins and manifolds
- Double- or triple-stack capability proven since 2007
- Inline or perpendicular Main Header Row for inflow management

STRONGER

- Exceeds ASHTO LFRD Bridge Design Spec 1
- 48,000-pound single-axle load-bearing capacity
- Bury up to 50' deep
- H-30 Load Rating
- Designed to exceed ASTM F2418, F2787, F2922 standard and AASHTO LRFD Bridge specifications; all validated through third-party performance testing



GREENER

- Eco-friendly soy-based construction
- Carbon-neutral product
- Can achieve up to 18 LEED credits
- Lightweight and easily nested chambers save fuel in shipping
- Filter options to target specific pollutants

COST EFFECTIVE

- Lower shipping costs
- Fewer man-hours per cubic foot to install
- Soy-resin based – more stable pricing than competitors
- 120-year lifespan
- Less stone required
- Direct connections to top, front and side eliminate manifold systems and catch basins

EASIER TO INSTALL

- Lightweight – allows one-person installation
- Three chambers can be installed in less than eight seconds
- Engineered connection allows easy placement of chamber sections
- Direct connections to top, front and side
- Requires less stone and geofabric than competitive systems

L.E.E.D. CERTIFICATION

Note: Because of its eco-friendly attributes, Triton chambers can help a project achieve up to 18 credits from the Leadership in Energy and Environmental Design (LEED) Green Building Rating System. [Sustainable Sites – 5 credits; Water Efficiency – 5 credits; Materials and Resources – 4 credits; Innovation and Design process – 4 credits; Carbon neutrality – 3 credits].

U.S. GREEN BUILDING COUNCIL MEMBER

Installations that tell our story

The key to Triton's effectiveness lies in a patented, ultra-efficient chamber design coupled with the use of advanced, earth-friendly soy-based composites that create a strong, lightweight product. This gives developers a flexibility that competitive products and traditional approaches simply cannot match:

Triton chambers have a composite compressive strength of 30,457 psi – 2 ½ times greater than other makers.

Triton chambers can be buried to 50' and boast an H-30 load rating. They exceed the 50-year ASTM F2418 CREEP modulus with a safety factor five times greater than traditional choices, even when tested at 20 times the required load.

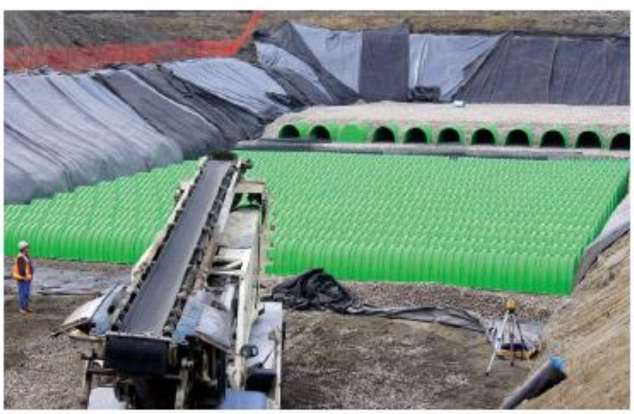
Our products also have a 120-year lifespan.

Because of this, Triton Stormwater Solutions' chambers are ideal for a wide variety of installations

RETAIL DEVELOPMENT SOLUTIONS:

Ace Hardware, Bloomingdale, FL

A great advantage of underground stormwater systems is the ability to fully utilize the land above. In this case, the store's parking lot was placed directly above the stormwater system, utilizing the Triton chambers' strength and the developers' vision for maximizing space. The design of the system gives ample protection in heavy rainfall events, and the Main Header Row's sediment collection will pay maintenance dividends well into the future.



COMMERCIAL DEVELOPMENT SOLUTIONS:

Toronto Retail Center

Engineers for Terrafix Geosynthetics needed a high-volume, high-strength underground stormwater system to support a 600,000 square-foot retail center in Toronto. Additionally, site restrictions and existing infrastructure dictated that the chambers be strong enough to be buried at a depth of 24 feet and matched up to an existing inlet pipe. Triton met all criteria and stored 22,000 cubic meters in just a 20m x 70m area.

INDUSTRIAL DEVELOPMENT SOLUTIONS:

Arena Expansion

Developers needed to replace an existing stormwater pond with an underground system to better utilize surface space for parking. The Triton system allowed the project team to store 1,500 cubic meters of stormwater under the new parking lot while working around the existing infrastructure in a customized drain field and accepting runoff from several inlet points.

AIRPORT DEVELOPMENT SOLUTIONS:
Duluth International Airport

A new terminal at Duluth International Airport built on 13 acres of impervious surface created the need for a robust and easily maintained stormwater management system; one that could handle the runoff that includes de-icing chemicals and protect the area's environment. The development team was able to create 32,000 cubic feet of storage in a 200' x 85' trench. The system saved land and helped to eliminate the hazards associated with above-ground retention ponds.

AUTOMOTIVE DEALERSHIP SOLUTIONS:
Luther Brookdale Chevrolet

Luther Brookdale Chevrolet needed a proven stormwater management solution to support a complete upgrade and expansion of their facility. Because parking lot space is critical to the dealership's success, an underground system that maximizes all available surface space was mandatory. The system also had to meet stringent local regulations for 10-year and 100-year storm events – which called on Triton's impressive storage capacity; 18,100 cubic feet in just 6,760 sq. feet!

MUNICIPALITY/GOVERNMENT SOLUTIONS:
St. Cloud Civic Center

The City of St. Cloud, Minnesota, needed a robust underground stormwater system to support the expansion of its civic center – a project that would create three acres of impervious surface, but had a limited 36' x 140' storage area. To get the needed storage in such a tight space, developers relied on Triton chambers' strength and capacity – designing a double-stacked system to essentially double the storage without expanding the drain field!

URBAN DEVELOPMENT SOLUTIONS:
Metro Transit Station

When Metro Transit of Minneapolis/St. Paul needed to expand its Hiawatha Line operations and maintenance facility, they needed additional stormwater management capacity – a big challenge given the site's constraints. Ultimately, designers chose a Triton double-stacked system with a maintenance-saving Main Header Row with cleaning port. More than 10,200 cubic feet of storage was created in just 2,837 square feet.

TOUGH GEOGRAPHY SOLUTIONS:
University of St.Thomas, St. Paul, MN

Stormwater management needed to be done at two separate locations to support the construction of an 180,000-square-foot athletic facility. Triton Stormwater Solutions' chambers created more than 41,000 cubic feet of storage – draining 145,000 square feet at the south site and 16,300 square feet at the east site. The Triton SWS chambers' unrivaled storage capacity, and the system's design flexibility were key to the project's success.

UNIVERSITY DEVELOPMENT SOLUTIONS:
Ingalls Mall, University of Michigan, Ann Arbor, MI

Stormwater management was a critical requirement of the renovation of the University of Michigan's historic Ingalls Mall. Triton SWS was chosen and a system was designed to store over 21,000 cubic feet of stormwater without altering the traditional layout of the area. Another unique feature was a high voltage duct bank that had to be worked around – highlighting the Triton Stormwater Solutions chambers' modular design flexibility.

Support from Design to Installation

Triton Stormwater Solutions does not simply sell underground stormwater chambers – we work hand in hand with leading civil engineering firms, developers and contractors from around the globe to design and create world-class stormwater systems. We are committed to working together to solve challenges and create innovative ways to preserve existing features, protect land and water resources – and keep projects on time and on budget.

We believe in consultative sales and our engineering department is ready to work with project leaders to find the most efficient solutions at all phases of a development.

TRITON
STORMWATER SOLUTIONS

When you need world-class stormwater management, rely on Triton Stormwater Solutions to give you Power Over Water!

www.tritonsws.com
810.222.7652

GOING green®

	TRITON STORMWATER SOLUTIONS	VS Competitor
COMPRESSIVE STRENGTH	**30,457 PSI** (More then 2X Stronger)	7,981-12,000 PSI
LOAD RATING	**H-30** (The Only Chamber System H-30 Rated)	H-20
INSTALLATION CAPABILITIES	**Double or Triple Stack**	Single Stack Only
	Bury 50 Ft.	12 Ft. Max.
CAPACITY S29 vs. SC740 **46% Larger and Lighter than Competitor**	**9.96 ft.³ / Linear Ft. 32 Lbs.**	6.4 ft.³ / Linear Ft. 74 Lbs.

TRITON STORMWATER SOLUTIONS

5/1/17

LIFETIME SYSTEM WARRANTY

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Brighton, Michigan 48114

Power over Water®

APPENDIX D – SOLUTIONS TO RAINFALL DEPENDENT POLLUTION REPORT

Solutions to rainfall-dependent pollution

Choosing effective treatment systems to retrofit for surface water runoff outfalls which cause pollution

Project Output Report: RENW002045#1   FINAL DRAFT

August 2014

Introduction and acknowledgements

This guide has been created as a technical output from the joint Highways Agency and Environment Agency 'Highway Outfalls Project'. The project was jointly funded as both organisations were keen to learn more about the impact of highway outfalls on the water environment. We also needed to learn about the techniques that are available to treat those highway outfalls. To achieve this we've worked very closely with a number of partners and we are very grateful to everyone who has contributed to the document.

The guide is written using 'we' to include the Environment Agency and all its partners and asset owners who are working together to reduce pollution, including the Highways Agency, highway authorities, water companies, product manufacturers and designers. No one organisation can deal with highway runoff alone so we really do need to work together.

Author: Jo Bradley, Environment Agency, Highway Outfall Project Manager

Stormwater often runs down gully pots and on to the water environment

Scope

This report has been created as an output of the Highways Outfall Project, so the focus of the work has been highway outfalls, but the principles and solutions apply to all sorts of surface water discharges to the water environment.

This guide describes pollution from rainfall-dependent surface water outfalls and the options available to treat that pollution. An array of options exist and we've encouraged the manufacturers of treatment products to consider new applications for their products to maximise the potential for environmental improvements from every product.

If we don't describe a product that solves your problem in this report, do not despair. Many other products are available, especially on the international market. And the UK based manufacturers are very keen to work with us to create new solutions to new problems.

This guide deals with the water **quality** of outfalls, not the water **quantity**. Although flood risk management is very important, we do not deal with it here.

This is not a design guide. It is intended to help decision makers, regulators, SuDS Approval Boards, planners and asset owners to have an overview of the problems and solutions that they assess, and to steer initial planning decisions so that sensible suggestions are made. At the end of the guide, you will find references to comprehensive design guides where all the necessary design information is provided. The intended audience is Environment Agency staff, local authority planning staff, highway engineers, asset owners and developers.

It is written so that if you have an outfall like the one pictured below, you can consider all your constraints and options and decide on a preferred treatment option which you can then take forward for design and specification.

It is intended for **use on existing outfalls**; pollution prevention for new outfalls should be embedded in the design of the sustainable drainage system.

It will help you to decide which of your outfalls are a priority and what to do about them, and you will quickly be able to identify outfalls where treatment is infeasible, which will save you time and money.

Rainfall dependent discharges are those that are simply conveying rainfall runoff from various surfaces into the water environment. They wash pollutants off hard surfaces and then wash them into rivers, streams, drains and groundwaters. They cause pollution when it rains and can be difficult to treat because the rates of flow are very erratic.

Contents

Chapter 1: Pollutants of interest

For every urban outfall, we have to be clear about the pollutants that are of concern before we ask partners to invest in asset improvements. It's not enough to simply illustrate that an outfall is causing pollution; we must prove that it is having an impact on the receiving water and that the waterbody is either failing to achieve Water Framework Directive compliance or is at risk of deterioration. For highway outfalls, the pollutants of interest are toxic metals, suspended solids and Poly Aromatic Hydrocarbons (PAHs). The waterbody may be failing to comply with the Directive because of elevated levels of PAHs or toxic metals. But it may also be failing because there are inadequate populations of fish or invertebrates and the link has yet to be made between that failure and elevated levels of PAH or metals. We must not assume that a pollutant is not a problem in the waterbody; we may just not have looked for it yet.

We need to know which pollutant loads need reducing so that we can select the correct treatment device.

River Basin Planning: If you find an outfall that is causing pollution and may be contributing to WFD failure, make sure it is detailed in the relevant River Basin Plan by speaking to the Environment Agency River Basin Planning Manager for your area.

This small highway outfall contains some low levels of pollutants but it discharges to a large, fast flowing river so the levels of pollution are acceptable and no treatment is necessary.

Although the pipe needs repairing!

This guide can also be applied to other polluting outfalls where the pollutants of interest might be oil from industrial estates, toxic metals from abandoned mines, suspended solids from a quarry access road or pesticides from a municipal park. The principles are the same and the guide should be useful.

Groundwater pollution

Discharges to groundwater, often via infiltration devices and soakaways, also need remediation if there is a risk of them discharging persistent, toxic substances into groundwater. If the outfall you are considering discharges to ground, you need to speak to the Groundwater and Contaminated Land experts at the Environment Agency to understand what level of treatment you need to provide.

Chapter 2: Source control

For all urban outfalls, we need to consider the possibilities of controlling the pollution at source rather than installing treatment devices at outfalls.

Gully pot management and street sweeping

Most highways already have gully pots on the drainage system and these trap suspended solids and some oil residues and rubbish. If they are properly maintained, they effectively remove some of the gross solids, but, in very heavy rainfall, the solids are liable to 'wash-out' and enter the water environment. Street sweeping removes some of the solids deposited on the roads, and this reduces the volume of pollutants that run into the gully pot.

However, you need to consider carefully if increased road sweeping and gully pot emptying is going to remove the pollutants reliably and cost effectively. Usually, these activities are resource intensive and expensive so any increases in these services are beyond the budget of the local authority.

Other activities in the catchment might also have an impact on the level of pollution in the discharge and, sometimes, the road drains act as a conduit for pollutants. These can sometimes be managed using improved housekeeping or site management. So, for example, if a highway outfall is badly polluted because the local road leads to a quarry, the quarry operator should improve his performance and wheel washing activities before we consider asking the highway authority to install a treatment device.

Non-engineered solutions

Sometimes the source of the pollution is simply due to poor behaviours and bad practices and improvements can be made by changing behaviours rather than installing an engineered device. The 'Yellow Fish' scheme addresses these situations by using a combination of marketing and education to teach local people not to put anything down the road-side gullies that can cause pollution. 'Yellow Fish' is well established and if you think that it might be an appropriate solution for your outfall, search 'Yellow Fish' on the internet for more information.

Pollution containment

On sites where particularly toxic or polluting chemicals are stored, manufactured or handled, we must consider the risk of spillages, leaks and fires on site leading to pollution incidents in the receiving waters and any drainage devices like ponds and wetlands. In the event of a fire, huge volumes of fire-fighting water can be used, and if this leaves the site via the drainage network or by overland flow-paths, it can cause dramatic and far-reaching pollution. On these sites, the owners can complete pollution containment spill mapping to accurately determine where the fire water and spillages would leave the site. Site mitigation measures and closure devices (pollution containment valves) can then be installed on the drains and these will contain any polluted water on site until it can be safely removed by a licensed waste disposal contractor. Closure devices can operate automatically as the fire alarm is activated, or manually in the event of a spillage or leak. More sophisticated systems are also available which detect pollutants in surface water and close automatically. If necessary, specialist consultants can be commissioned to undertake pollution containment spill mapping for the site owner.

Chapter 3: Proportionality – how do we get it right ?

We have to work out which pollution is worth fixing. For large, complex sources, we can work this out using a formal cost/benefit analysis. But for smaller, less complicated sources, it may not be practical to complete a formal analysis for each outfall. In these circumstances, we need to be confident that the source is contributing to pollution of the water environment and that we have selected a cost-effective treatment device that will reduce the pollution.

There are estimated to be over one million highway outfalls in England; we can't afford to fix them all. We need to work out which ones are causing enough pollution to justify the installation of a treatment device or a sequence of devices known as a 'treatment train'.

Some asset owners are easier to identify and have good asset plans. This doesn't mean that we can disproportionately target them to install treatment devices – we should target the most polluting discharges and those which are having the greatest impact, regardless of their ownership.

Local authorities may have up to 120,000 gully pots in their area.

They might be connected:

- straight to a river;
- to an adopted surface water sewer;
- to a foul sewer;
- to a private or unadopted drain;
- to a soakaway;
- to an existing SuDS scheme;
- or we may not know where it is connected to.

So you can see how complicated it can sometimes be to work out who is responsible for the pollution.

Chapter 4: Waste arisings and management

The treatment devices take pollutants out of the runoff. As they do this, they generate waste, much of which is hazardous. We have to balance the benefits to the waterbody with the impact of waste arisings. It may not be acceptable to take all the pollutants out of the runoff and, in so doing, create large volumes of waste to landfill. We have to balance the need for clean rivers, whilst also recognising the capacity of rivers to disperse and deal with a proportion of the pollution. Think about this when you are designing or selecting treatment devices and consider the revenue budget that is available to maintain the treatment device and dispose of the associated waste.

Chapter 5: Maintenance, operation and ownership of devices

All treatment devices need some level of maintenance and operation. This may be grass cutting on swales, dredging of basins or emptying of gully pots and separators. Before you propose the installation of any devices, you must be confident that the asset owner has the resources to operate and maintain it properly. Many devices will stop working altogether if they are not maintained and so you must sort this out before you proceed.

Conventional oil/water separators need emptying once or twice a year. Lots of competent contractors are available and they are familiar with this operation.

New devices may not have such an established network of maintenance contractors, but we should all work together to build that capacity and to develop the necessary services.

Ownership and access issues must also be sorted out early on. Some drainage systems have multiple owners and, if this is the case, those parties need to work together to agree who will pay for the installation, who will own it, and who will maintain and operate it. This can be a particular problem for highway drainage in urban areas where private drains, water company sewers and local authority highway drains are interconnected. These parties will need to work together to identify where the treatment device should be installed and whose responsibility it will be. The parties also need to consider the uncomfortable question of who would be liable if the device failed and caused pollution, possibly leading to prosecution.

Chapter 6: Pollution prevention and the Green Economy

Many pollution treatment devices, engineering services, design services and maintenance contractors can be sourced locally so that the money we spend on improving water quality can also support the local economy both in the short and long term. There is a wealth of knowledge and experience on topics such as reed-bed design and the hydraulics of surface water runoff across the UK and we should use that to make sure we install the right solutions. Then we can build on our knowledge and build up case studies to share with other asset owners who need to install devices. The more information and experience we can collect, the more quickly and confidently we can select devices.

Chapter 7: Selection Criteria – which solution for each outfall

Checklist:

Before you select the appropriate treatment device, check that the installation of a device is necessary and justifiable.

☐	Does the outfall cause pollution?
☐	Is the receiving waterbody failing Water Framework Directive or at risk of deteriorating?
☐	Are the pollutants in the outfall of concern in this surface water or groundwater?
☐	Have you considered if an effective source control technique would be more cost-effective and appropriate?
☐	Can any waste arisings be properly managed within the existing waste management facilities available locally?
☐	Can the asset owner undertake the ongoing maintenance and operation of the treatment device?

If you still think that a treatment device is necessary after completing the checklist, you'll need to consider some site specific details before you select your treatment device.

- How much space is available?
- Who owns the land? Does it flood?
- Is the underlying groundwater vulnerable or are there protected habitats in the area?
- What level of access will be needed and can that be provided?
- Are there any land use restraints: for example, is the area a protected site? Is there public access to the site? Are there lots of buried services?
- What depth is the existing pipework? This can significantly affect the cost of retrofitting a device.

We installed this device in Lancashire but, because of the depth of the existing pipework, we had to excavate to a depth of 7m which increased the costs.

Chapter 8: Multiple benefits and ecosystem services

We need to be certain that we're getting the best for the environment for every pound we spend, whoever is spending the money. So an element of site selection must be the consideration of other benefits that can be delivered by the completion of the scheme. For many surface runoff treatment schemes, there is an opportunity to introduce some flow attenuation which will help manage flood risk. Equally, whenever flood risk management work is being undertaken on surface water drainage systems, there's an opportunity to introduce some pollution treatment.

We must also look for opportunities to introduce habitat creation, biodiversity improvements, social benefit and economic growth.

This is a treatment wetland in Preston – it has created a lovely habitat even though it's in an urban area next to a busy roundabout.

Ecosystem services is defined in the DEFRA publication: '**What nature can do for you: A practical introduction to making the most of natural services, assets and resources in policy and decision making'** 18 October 2010.

This document is available online at: https://www.gov.uk/government/publications/what-nature-can-do-for-you

Ecosystem services are defined as services provided by the natural environment that benefit people. These benefits include:

- **resources for basic survival**, such as clean air and water;
- a **contribution to good physical and mental health**, for example through access to green spaces, both urban and rural, and genetic resources for medicines;
- **protection from hazards**, through the regulation of our climate and water cycle;
- **support for a strong and healthy economy**, through raw materials for industry and agriculture, or through tourism and recreation; and
- **social, cultural and educational benefits**, and wellbeing and inspiration from interaction with nature.

When designing outfall treatment systems, we need to take account of the ecosystem services approach and consider how the treatment devices can contribute to the services delivered by the ecosystems we create, and how they might interact with other ecosystems in and around the site.

These two outfalls convey surface runoff from a retail park into the brick culvert on the right of the picture, which then discharges into a small fishing pond. The outfall structures and the channel are unattractive and offer very little pollution control or ecological benefits.

This outfall conveys surface runoff from a housing development. Although the outfall structure is still an unattractive concrete structure, it discharges into a large treatment pond with wetland planting around the margins.

This creates a beautiful wildlife habitat which is very nice to look at. It also removes pollutants from the runoff.

The local children enjoy feeding the ducks that live on the pond.

Chapter 9: Options

If you've been through the rest of the document and concluded that you **do** need to install some treatment to deal with a polluting outfall, this section will help you to decide which treatment device or devices might be best for your site.

This is not a design guide. It is intended to help decision makers, regulators, SuDS Approval Boards, planners and asset owners to have an overview of the problems and solutions that they assess, and to steer initial planning decisions so that sensible suggestions are made. At the very end of the guide, you'll find references to comprehensive design guides which provide all the necessary design information.

Many different treatment options exist and a selection of them are listed below. You need to know some site details to decide which is best for the site in question, or complete some research to see if there's a more suitable device available. There are some other devices available internationally so if you have a complex problem, you may need to consider those.

You need to know the size of the area drained through your outfall so that you can work out the maximum flow rate that might be discharged in heavy rainfall. Ideally, you should provide treatment for the runoff during a 1 in 1 year storm of 30 minutes duration. But, because we're focussing on retrofitting devices in this guide, this will not always be possible due to space constraints or financial constraints. In this case, we can only do our best and install as much treatment as is possible.

You also need to consider what will happen when it rains very hard, perhaps during a one in a hundred year storm event. This should be included in your flood risk assessment.

Each site should be considered on its own merits and we should always install vegetative treatment devices where we can, to provide multiple benefits for the community and the environment.

We're not considering flood risk management in this guide but if you need to consider those aspects of the outfall, consult the SuDS Manual which is detailed in Appendix 1.

Treatment trains:

On most sites, a selection of devices installed as a 'treatment train' will be the best solution. This can provide a number of treatment techniques and target different pollutants. It can also allow a combination of vegetative devices and engineered devices to be brought together if necessary. Don't feel like you have to choose just one device – remember you can have a few if you need them.

So, for example, on a trading estate, you might have room for:

Swales along the roadside to treat road runoff

An oil/water separator to retain oil spills and remove the gross suspended solids

And a stormwater wetland to treat any residual and soluble pollutants and to attenuate flows a little

This is a **treatment train** delivering a sustainable drainage system (SuDS)

Sustainable Drainage Systems (SuDS)

SuDS are defined on the Susdrain website

Sustainable Drainage Systems (SuDS) manage surface water runoff to manage water quantity (localised flooding), water quality (pollution) and improve local amenity/biodiversity. SuDS mimic nature and typically manage rainfall close to where it falls before discharging to streams, rivers, other watercourses or sewers. SuDS can be designed to slow water down (attenuate) before it is discharged, they provide areas to store water in natural contours and can be used to allow water to soak (infiltrate) into the ground or be evaporated from surface water and lost or transpired from vegetation (known as evapotranspiration).

SuDS is an approach, rather than a specific feature or component. SuDS components can range from smaller rain gardens, swales through to permeable block paving and larger components that provide storage like ponds and underground storage tanks. SuDS components can either be at the surface or underground, and can be vegetated or more engineered products. The design of the SuDS scheme and selection of the component will depend on the opportunities and challenges posed by a site.

Susdrain at: http://www.susdrain.org/

In this guide, we're really focusing on treating **existing** polluted rainfall dependent outfalls so we're not necessarily going to be able to design a full SuDS scheme. But, we should always be mindful of the benefits of SuDS and try to get the best scheme we can with the money available. For new build schemes, the design of a full SuDS scheme is likely to be a requirement.

A selection of treatment devices is listed below, which is then followed with some information about each one. Once you have information about your site and the discharge, you should be able to identify those solutions that might work, and those that won't. Remember, this guide is focusing on water quality treatment devices, so there are other devices that offer flow attenuation alone but we don't consider them here. A description of the classifications (e.g. Low, Medium and High) assigned to each device are provided in Appendix 2.

And remember that you can select a number of different devices and create a 'treatment train'

On some sites, the installation of treatment devices is impossible and, if this is the case, we should consider source control techniques and the installation of devices on other outfalls in the same catchment to reduce the overall load of pollutants. For example, we looked at one highway outfall in the centre of Wigan where the outfall structure is in culvert under the main road at a busy junction in the city centre. There's no space to install any device, be it sub-surface or above surface, and anyway, it's not feasible to close this busy junction for a number of weeks to complete extensive engineering works. We will have to consider other outfalls where treatment is feasible.

The treatment devices you might consider:

Vegetative Devices	Non-vegetative devices constructed in-situ
Infiltration/detention basin	Subsurface storage with integral treatment
Bioretention System	Permeable/Porous pavement
Filter strip	
Ponds/Wetlands	Proprietary Devices/Engineered Devices
Swale	Hydrodynamic vortex separators
Filter/infiltration trench	Upflow filters
Tree in soil support filter system	Oil/water separator
	Oil sorbents
	Linear treatment channel
	Closure valves

Vegetative Treatment Devices

a) Infiltration/Detention Basin

Like all devices, detention basins, like the one shown, need looking after. When the authors revisited two detention basins that have been in place for over 10 years, they were completely overgrown and one of them had mature willow trees growing in it!

What does it do?
It holds the water back during high flow events and then allows it to discharge at a controlled rate once the storm has passed. It can be designed for water to infiltrate to ground or to pass forward to surface water. It removes some pollutants by sedimentation whilst the water is detained, and where infiltration is used, pollutants will be removed as the water passes through the underlying soils. Also, the vegetative growth will remove some nutrients from the runoff and the effects of daylight and micro-organisms will break down residual pollutants such as hydrocarbon derivatives.

What flow rate can it cope with? High.
It can cope with high flow rates, only really limited by the area you have available and the capacity of the pipework leading to and from the basin.

Maintenance cost and difficulty? High and Low.
De-silting basins is expensive and generates volumes of waste to dispose of, but grass cutting and vegetation management is inexpensive.

Maintenance frequency? High and Low.
De-silting may not need to be done for many years, sometimes more than 20 years. Grass cutting or vegetation management needs to be done several times during the summer when the grass is growing.

Space required for installation? Variable.
The basin can be large and need a large area for construction. However, it is quite shallow so construction costs can be relatively low. Sometimes, a very small infiltration basin can be useful, just for a few car parking spaces or a pedestrian area and you can have several of these across a site if the ground conditions allow. So don't think you can't have a basin just because you haven't got a large space.

Suitability for retrofitting? Variable.
They need a large surface area so are often not possible on existing sites, but sometimes you can find space for a few little basins and these can be really useful.

Multiple benefits? Yes.
The basin alleviates flooding as well as treating pollution. It also provided biodiversity opportunities and if it is well maintained and remains attractive, it can improve the amenity value of the area.

Flow attenuation capabilities? High.
The basin can be designed to contain large volumes of water and the rate of outflow from the basin can be regulated.

b) Bioretention system

This is one of a series of small bioretention systems that have been retrofitted to a street in the Midlands. You can see how attractive it is, and yet it takes the runoff from the road and reduces the flow and the pollution going forward.

What does it do?
Plants and shrubs are planted in a media or engineered soil in a shallow basin. Surface runoff is directed into the bioretention area and the treatment is provided by the soils (and sometimes treatment media) and this is supported by the plant growth. Excess flows are directed via an outlet to a surface water drainage system. If underlying soil conditions allow, subsurface infiltration and infiltration into surrounding soils can also occur. Bioretention areas are ideal for residential roads, school playgrounds etc where pollutant loads are quite low, there's space available, and the people in the area can benefit from the pleasing display of plants and shrubs.

What flow rate can it cope with? Medium.
It can retain and treat most small rainfall events but the bioretention area will have an overflow for onward passage of excess flows. Its capacity will, to some extent, depend on the capacity for infiltration into surrounding soils.

Maintenance cost and difficulty? Low.
Much like a flower-bed, the bioretention area may need weeding, mulching, pruning, scarifying and maybe watering in the summer. These are low cost activities but resource intensive so it's better if the local residents/pupils/occupants can be encouraged to do these tasks. There is often a need for litter picking too, and the inlet may need any build-up of silt removing with a trowel. If these have to be done by a local authority, they are quite time consuming and need to be accounted for.

Maintenance frequency? High.
The routine tasks described above need doing seasonally like for a flower bed, and watering may need to be done weekly. Structural restoration tasks like removing silt build-up and re-profiling the soil surface might need doing once every year or two.

Space required for installation? High.
These take up a large surface area so they're not suitable for sites where space is limited, although they can be provided in multiple small units so can lend themselves to fragmented sites.

Multiple benefits? High.
They can be very attractive and provide increased habitats for biodiversity improvements.

Suitability for retrofitting? Medium.
They're quite easy to retrofit because the excavation can be quite shallow. But they take up a lot of space so they're not suitable for some sites. They are ideal for school playgrounds, pedestrian areas or small residential roads, although residents may be concerned if they take up parking spaces.

Flow attenuation capabilities? High.
Depending on ground conditions, the capacity of the basin underlying the bioretention area can be quite high and attenuate significant flows.

c) Filter strip

This filter strip is alongside the A96 in Scotland – the runoff goes over the filter strip and then enters a filter drain to the left.

What does it do? A filter strip is a vegetated strip that the stormwater runs over before it gets to a waterbody or another treatment device. It slows the flow down and pollutants can be filtered out a bit as the runoff flows over the vegetation. If it is designed properly and the flow is slow enough, some of the polluted water will infiltrate into the filter strip and some pollutants will be adsorbed or degraded by the topsoil.

What flow rate can it cope with? High.
It can cope with high flows but it doesn't provide much treatment once the flows increase and start to 'rush' across the filter strip.

Maintenance cost and difficulty? Medium.
Just routine grass cutting during the growing season and litter picking. The filter strip might also need some more extensive work once a year to remove silt deposits at the upper margin and to scarify the surface to improve infiltration.

Maintenance frequency? High.
The grass may need cutting several times in the growing season.

Space required for installation? High.
The filter strip takes up a lot of land, but it is a linear device so there might be a strip of unused land around the curtilage of a site.

Multiple benefits? Low to Medium.
Although a filter strip creates a large grass or vegetative area it is often a simple grass seed mix that doesn't offer much in the way of biodiversity habitat. But, they can be enhanced by introducing other species or shrubs if the pollutant load isn't too high.

Suitability for retrofitting? Low but higher for linear developments like roads.
Unless there's an obvious piece of land that lends itself to a filter strip, these take up a large surface area. Also, the gradient of the strip must be right for the flow velocity so it might need regrading

Flow attenuation capabilities? Medium.
If the filter strip offers infiltration then the flow attenuation for small rainfall events can be good, especially following a period of dry weather. But once that capacity is reached, no more attenuation is provided, although the rate of runoff can be slowed down.

d) Ponds/Wetlands

This pond treats runoff from a large business park in Lancashire and it has also become a habitat used by a variety of birds and insects.

What does it do?
Ponds and wetlands are magnificent! They can remove solids and soluble pollutants whilst providing a diverse habitat and an attractive feature for local residents to enjoy. They retain the surface runoff and allow micro-organisms to break down organic pollutants, suspended solids to settle out, sunlight to break down persistent pollutants, and vegetative growth to take up nutrients.

What flow rate can it cope with? High.
The only controlling factor is the size of the pond or wetland that you are able to build, the topography of the site and the capacity of the associated pipework or conduits.

Maintenance cost and difficulty? Variable.
Depending on the design of the pond or wetland, they may require grass cutting around the margins and possibly occasional harvesting of vegetation. If there's a high silt load entering a pond and this sediment requires removing, this can be particularly difficult and extremely expensive, so it is best to design a sediment forebay, or install a device to remove solids upstream of the pond.

Maintenance frequency? High and Low.
Management of vegetation and grass-cutting may need to be done a few times during the growing season. Sediment removal is only likely to be needed after 10 years or more.

Space required for installation? High.
The bigger the pond the better, although even a small pond can deliver benefits.

Multiple benefits? High.
Ponds and wetlands are excellent for providing a biodiverse natural habitat, a pleasing view, amenity value for local residents and improvements in water quality.

Suitability for retrofitting? Low.
When we consider polluted urban runoff from towns and cities, the runoff rate and the pollutant loads are often high so we need to think about the appropriateness of a pond or wetland. It is unacceptable to create a natural habitat and then to grossly pollute it, so source control is important and, if high sediment loads are expected, it's better to have a device to remove sediment upstream. Also, if oil spillages are possible, a device to contain and sorb those spillages upstream of the pond or wetland is essential. If other chemicals may be spilled and pose a risk to the habitat, then closure devices may be necessary. But if space is available and the scheme is well-designed, ponds are an excellent device for any site.

Flow attenuation capabilities? High.
The capacity of the pond can be designed so that headroom is included to attenuate high flows.

e) Swale

This swale is down the centre of the road in a large mixed-use development in Chorley. It conveys the road runoff away and directs it to other treatment devices on the estate including ponds and wetlands.

What does it do?
A well-designed swale accepts surface runoff from the surrounding area and provides some treatment as the water runs over the grass. Also, some of the water will infiltrate into underlying soils where further biological treatment occurs. Then, higher flows may run down the swale and overflow into another treatment device or drainage system. The infiltration capacity of the swale depends on the nature of the underlying soils. Sometimes a swale must be lined to protect underlying groundwater.

What flow rate can it cope with? High.
Because each metre of swale only receives the flow from a linear meter of the road, it only has to deal with a relatively small volume of water, so a long swale of many metres can accommodate large volumes of runoff.

Maintenance cost and difficulty? Medium.
The grass will need cutting during the growing season. Sometimes a build up of sediment will need digging out and overflow structures may need cleaning of debris. Litter picking might be necessary too, depending on the catchment.

Maintenance frequency? High.
Grass cutting and litter picking only need doing a few times a year.

Space required for installation? High.
Although the swale is quite narrow, it often needs to be quite long, so the surface area needed is quite high. But there is sometimes a strip of land around the site or along a roadside that can lend itself to the creation of a swale.

Multiple benefits? Low.
Although a swale is a vegetative device, it's usually a simple grass mix that doesn't offer much biodiversity habitat. But if they are not down the middle of a busy road, like the one shown, they can be planted with other species and can be attractive for local residents.

Suitability for retrofitting? Medium but higher for linear developments like roads.
They can be OK for retrofitting if an area of land lends itself to this sort of linear device, but the underlying soil conditions need to be appropriate. Where road runoff is causing urban pollution, they can be an effective retrofit to remove some or all road runoff from the outfall.

Flow attenuation capabilities? High.
If underlying soils can accept infiltration they can provide good levels of attenuation.

f) Filter/Infiltration trench

This is a filter drain alongside the A68 at Jedburgh. Overhanging vegetation can make maintenance more difficult as the top of the filter might need clearing.

What does it do?
A properly constructed filter drain can provide very good attenuation and treatment for road runoff, as the layers of aggregates offer sorbtion and biodegradation opportunities and sediments are filtered out in the upper layers of aggregate. The bottom of the filter drain can be lined and there is often a perforated underdrain to convey excess water to a drainage system. Where underlying groundwater allows and soil conditions are suitable, infiltration trenches can be used where the runoff simply passes through the aggregate layers and infiltrates into the underlying soils.

What flow rate can it cope with? High.
Because it is a long linear device, a filter/ infiltration trench can handle most rainfall events off the carriageway.

Maintenance cost and difficulty? Medium.
Depending on the local environment, maintenance requirements vary. If there's a lot of overhanging vegetation, the surface of the drain might need clearing more than once each year. And if weeds grow into the drain, they may need removing once every year or two. But where there's little overhanging vegetation and sediment loads are low, maintenance requirements can be very low. Periodically, maybe once every 10 years, the upper layers of aggregate may need removing, cleaning and replacing. Specialist equipment is available to do this.

Maintenance frequency? Variable.
It really depends on the local environment and pollutant levels. In the right place, filter drains can be low maintenance and effective treatment devices.

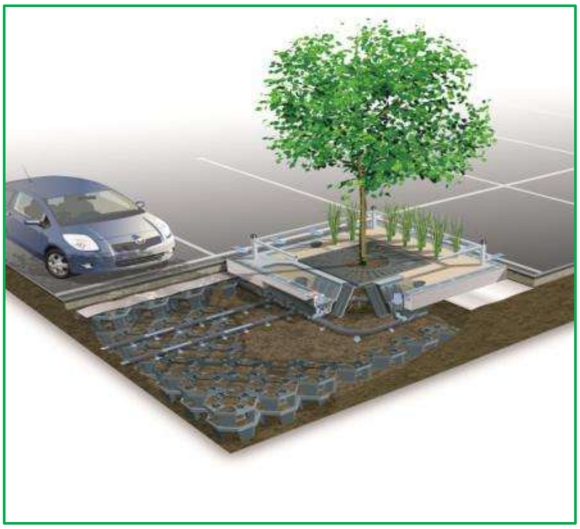
Space required for installation? High.
As with other linear devices, there may be a stretch of land alongside a site or a roadside that is ideal for a filter drain.

Multiple benefits? Low.
They provide little or no habitat or biodiversity benefits.

Suitability for retrofitting? High particularly for linear developments like roads.
In certain locations, they can be relatively cheap and easy to install but note the information about maintenance and the surrounding environment as this affects their suitability.

Flow attenuation capabilities? High.
Because they are linear devices, they can have a high capacity for flow attenuation.

g) Tree in a soil support filter system



What does it do? A tree or shrub is planted in a specially engineered soil/media in a subsurface chamber or structure. The runoff is directed into the soil/media where pollutants are filtered and sorbed; if aerobic conditions can be supported, biodegradation can also take place. Once the tree is mature, it may also use up some nutrients in the runoff and contribute significantly to the flow attenuation as it uses up the water within the system, preventing it from passing into the drains. If the tree systems are carefully selected and located they can be attractive and very effective.
What flow rate can it cope with? High. The capacity in the subsurface chamber or system can be high if the underlying ground conditions allow for a deep enough excavation. Each system can accommodate significant volumes of runoff and a series of these devices along a street or in a car park can cope with a large rate of runoff.
Maintenance cost and difficulty? Low. There may be a need for litter picking if the device is in an urban area, and silt deposits may need removing from the inflow devices if they're included.
Maintenance frequency? Medium. If litter picking is not necessary, the device might only need checking once every couple of years.
Space required for installation? Medium. The space required at surface is low and can often be accommodated in urban areas, streets and car-parks.
Multiple benefits? Medium. The trees are attractive and can provide shade in an urban area. They also provide habitat for birds and insects although this is limited if the tree is isolated from other habitats.
Suitability for retrofitting? Medium. The devices do require space so they may not be acceptable where this is limited, although they use less space than other vegetative systems. They require quite a deep excavation and underlying ground conditions must be suitable to support the tree growth.
Flow attenuation capabilities? High. If there is enough space to have multiple devices on site, these Tree Systems can retain a large volume of water, especially in summer months when the trees are in leaf and are consuming lots of water.

Non-Vegetative devices constructed in-situ

a) Permeable/Porous Pavement

This permeable pavement is in a garden centre car park in Liverpool. The designer has used a variety of treatment devices across the site to create an effective SuDS scheme without affecting the functionality of the car park at all.

What does it do? Permeable paving allows rainfall to run down through the spaces between the blocks to underlying aggregate where aerobic micro-organic activity can break down pollutants. The aggregate also provides opportunities for sorbtion of pollutants and membranes can be added to enhance the treatment capacity. It can be very useful for reducing pollution from highway outfalls if areas of the catchment can be converted to permeable paving, reducing the flow to the outfall and the pollutant load. But if the underlying groundwater is vulnerable, there may have to be an impermeable liner beneath the paving to convey the runoff to additional treatment devices.

What flow rate can it cope with? High.
Because each square metre of paving only has to cope with the rainfall that lands on it, as long as the underlying ground isn't saturated, and has good infiltration properties, it can cope with most rainfall events.

Maintenance cost and difficulty? Low.
The paving just needs good housekeeping – sweeping up any dirt that gathers and sorbing any small oil spills.

Maintenance frequency? Low.
The paving might need specialist cleaning if the permeability slows down, but this is unlikely to be necessary for up to 20 years

Space required for installation? Low.
Once the paving is in place, the surface can be used as normal and so no space has to be sacrificed.

Multiple benefits? Low.
The paving can be attractive but it offers no amenity or biodiversity benefits.

Suitability for retrofitting? High.
Permeable paving is good for retrofitting where pollutant loading is low enough to allow the passage of runoff down through the paving and the underlying ground is appropriate. It's relatively expensive to install, but has low maintenance costs.

Flow attenuation capabilities? High.
If properly designed and installed, permeable paving can intercept all but the largest of rainfall events.

b) Subsurface storage with integral treatment

What does it do? Subsurface storage vessels don't normally provide much treatment; they are simply designed as a storage vessel to attenuate flows. But new products are coming onto the market that allow suspended solids to be settled in the storage and then removed from a central location. There are also enhanced systems available that have cartridge filters between vessels and on any overflow to ground, so that the runoff can be treated for a variety of pollutants as it passes from the storage vessel. At sites where there is a risk of flooding, and there's no option for treatment at surface, these may be an option.

What flow rate can it cope with? High.
The vessels are often designed to attenuate peak flows and release them back into the network after the storm has passed. They can be as large as the ground conditions and site constraints allow.

Maintenance cost and difficulty? Medium to Low.
They should be de-silted periodically if that is possible, although on some of the older systems, no access is possible

Maintenance frequency? Medium to Low.
There may be no maintenance requirements or it may just be de-silting once every year or two. If treatment filter cartridges are included, these will need changing according to the manufacturers' instructions.

Space required for installation? Medium.
They don't take up any surface area, but they need a large amount of subsurface space and the ground conditions need to be suitable. The surface above them may only be suitable for pedestrian use or play areas depending on the load bearing capabilities of the chosen product.

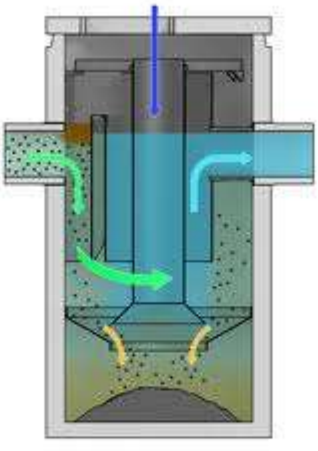
Multiple benefits? Low.
Treatment can be limited and there are no biodiversity or amenity benefits.

Suitability for retrofitting? Low.
They require a large excavation which is expensive and disruptive to the existing site.

Flow attenuation capabilities? High.
They are designed as a flow attenuation device and can provide very large storage capacities.

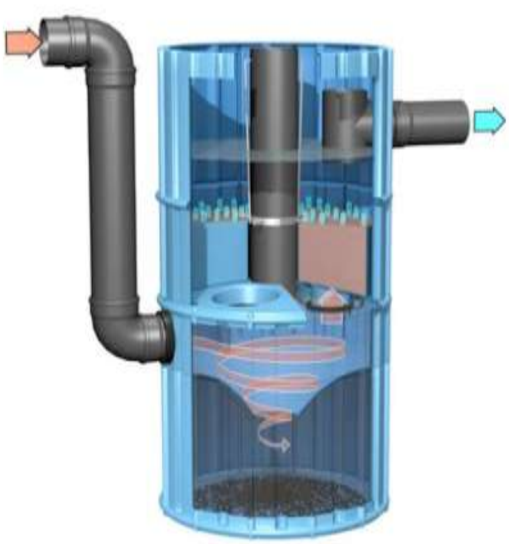
Proprietary treatment devices

a) Hydrodynamic Vortex Separators



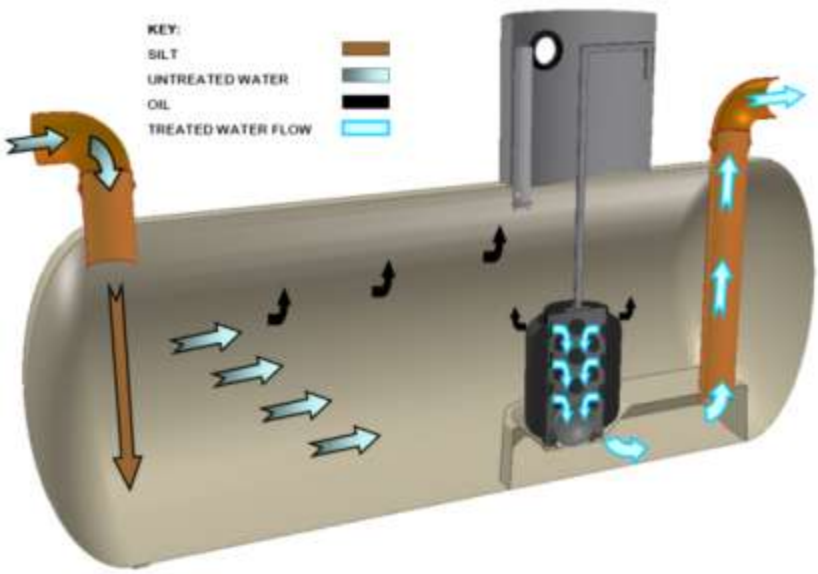
What does it do? As the runoff enters the device, it creates a vortex in the runoff which makes the solids settle out in the storage chamber at the bottom. Then the 'skirt' prevents re-entrainment of those solids in wet weather when the flow is very high. The device also removes some litter and oil although this is limited and its primary role is solids removal.	
What flow rate can it cope with? High. The devices can handle high inflow rates per unit and multiple units can be used in parallel if necessary. Treatment capacities are lower than the overall hydraulic capacity so if you overload the system, the quality of treatment lessens. It's important to select the right size of device so that the runoff receives effective treatment.	
Maintenance cost and difficulty? Medium. It's very straight forward to maintain – you simply suck out the settled solids from the bottom of the device with a vacuum tanker. Sometimes litter and oil may need sucking out from the surface too.	
Maintenance frequency? High. Usually once or twice a year.	
Space required for installation? Medium. These devices are installed underground so the amount of space required at surface is low. But the subsurface excavation required might be large as the largest units tend to be 2 or 3m in diameter and in depth which may impose constraints on some sites.	
Multiple benefits? Low. They are subsurface devices so offer no biodiversity or amenity benefits.	
Suitability for retrofitting? Medium. They are relatively small and can be installed under a car park or road verge. But installation requires a large excavation which can make them unsuitable for some sites.	
Flow attenuation capabilities? Low. This device has no flow attenuation capacity, but it can be installed as part of a treatment train with flow attenuation devices upstream which enhances the level of treatment provided by the vortex separator.	

b) Upflow filters



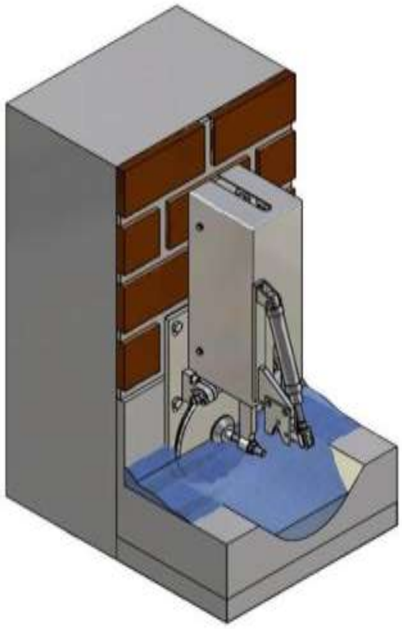
What does it do? The runoff enters the bottom of the device where suspended solids settle out. This process can be enhanced by the use of vortex flows similar to those in the hydrodynamic vortex separators illustrated above. The flow then passes up the device through filter packs. These can be simple filter material or fluidised bed filters containing a range of materials to target different pollutants. The filter can also include oil sorbents to remove any residual free-phase hydrocarbons in the runoff. This gives a higher level of treatment than a hydrodynamic vortex separator and the range of pollutants removed can be enhanced, and the use of filtration can remove smaller particles from the runoff. They're not suitable for very polluted runoff because high solids content will block the filters.
What flow rate can it cope with? Low. Because the device relies on filtration as one of its treatment mechanisms, the flow has to be relatively low to allow passage through the filters. Multiple units can be installed in a large chamber so increased flows can be accommodated in that way.
Maintenance cost and difficulty? Medium. Installation of the device needs to be carefully designed and managed because the filter packs need to be changed and therefore access to the top of the device must be good. Removing the silt from the bottom of the device is straight-forward and is done using a conventional vacuum tanker. But the filter removal and replacement is more of a specialist job and needs careful planning.
Maintenance frequency? High. Solids should be removed every 6 or 12 months depending on the pollutant load from the site. Filters need replacing in accordance with the manufacturer's instructions, but typically every 5 to 10 years.
Space required for installation? Low. This is a sub-surface device and requires a relatively small excavation, but a larger excavation will be necessary if multiple units are going to be installed.
Multiple benefits? Low. This is a subsurface device and provides no amenity or biodiversity benefit.
Suitability for retrofitting? Medium. The devices can be readily retro-fitted where they're appropriate, needing a relatively small excavation.
Flow attenuation capabilities? Low. This device doesn't attenuate flows.

c) Oil water separators



What does it do? It slows the flow of runoff so that suspended solids settle to the bottom of the tank and oil floats to the top. Class 1 separators also include a coalescing filter which helps the oil droplets stick together so that they float more easily. Oil/water separators are ideal for a site where significant oil spillages are likely, or lots of small leaks and spillages might occur frequently, such as a lorry park. They're useful for installation upstream of other vegetative SuDS devices to protect them from acute pollution. They also remove gross solids pollution, although there's some risk that they might 'flush out' in high rainfall events.	
What flow rate can it cope with? High. Typically in the UK, separators can treat up to 30 l/s of runoff although much bigger units can be manufactured and provided. It is important to size the unit properly so that there is no risk of the solids being 'flushed out' in high flows. By-pass separators are also available, although these are only suitable for limited applications where the risk of pollution is low.	
Maintenance cost and difficulty? Medium. Oil/water separators are simple to empty with a vacuum tanker, and the filters should be checked, cleaned and replaced if necessary.	
Maintenance frequency? High. The device should be inspected and, if necessary, emptied once or twice a year depending on the pollutant load and the filter also needs to be checked, cleaned and replaced if necessary.	
Space required for installation? Medium. This is a sub-surface device and needs only a small amount of space and a relatively small excavation.	
Multiple benefits? Low. Because it's a sub-surface device, it offers no amenity or bio-diversity benefits.	
Suitability for retrofitting? Medium. They are relatively easy to retro-fit as they only require a relatively small excavation and can be located under car-parks, access roads etc.	
Flow attenuation capabilities? Low. Oil/water separators don't attenuate flows.	

d) Closure valves



Closure valves are particularly useful on sites where fire-water would cause pollution. The valves can be manually or automatically closed in the event of a fire, so that the contaminated fire-water is contained for subsequent removal.

What does it do? Closure valves can be operated manually or remotely, and they can be designed to close automatically if they detect certain pollutants. They don't treat pollution, but they can contain it so that it can be dealt with or removed. Closure valves can protect downstream SuDS devices from acute pollution incidents and spillages.
What flow rate can it cope with? High. They can be manufactured to fit any conventional pipework diameter.
Maintenance cost and difficulty? Low. Their operation should be checked according to manufacturer's instructions. It may simply be a question of checking that the valve works once or twice a year.
Maintenance frequency? Low. Servicing should be done according to manufacturer's instructions.
Space required for installation? Low. The valve is installed on existing pipework so requires very little additional space.
Multiple benefits? Low. Valves provide no amenity or biodiversity benefits.
Suitability for retrofitting? High. Where there's a risk of acute pollution, they're good for retrofitting.
Flow attenuation capabilities? Low. They have no flow attenuation capacity, although they can be closed to stop all flow, which should only be done in the event of an incident; they are not intended to attenuation flow.

e) Oil sorbents

These bags of oil sorbents are ideal for placing in gully pots on high-risk sites. They preferentially sorb any spilt oils and retain them until the device can be removed and disposed of.

What does it do? The sorbents are designed to either a**d**sorb or a**b**sorb free-phase oils. They repel water and usually float so they can be placed in ponds, chambers and oil/water separators. The true absorbents 'lock' the oil up into their structure so that it can't leach back out into the water so these are ideal to prevent pollution as they can hold onto the oil until the sorbents are removed and disposed of.
What flow rate can it cope with? High. They can be sized to fit in any chamber, pond or vessel so there are no limits to the flow rate they can cope with. However, the runoff needs to 'pause' long enough for the oil to separate from the water and float up to the location of the sorbents.
Maintenance cost and difficulty? Low. The sorbents can usually be removed manually and removed off site. They are classified as Hazardous Waste and must be dealt with accordingly.
Maintenance frequency? Variable. It really depends on the level of oil pollution. On a busy haulage yard where sorbents are located in the drains or gully pots, they may need to be changed once every three months. But on a site where oil spills are infrequent, the sorbent might be able to stay in place for years.
Space required for installation? Low. The sorbents can be fitted into most existing drainage devices and so require no extra space. If a specific sorbent chamber is constructed on the drainage network, it's likely to be a sub-surface device and will not need to be very big.
Multiple benefits? Low. The sorbents don't contribute to amenity or biodiversity benefits.
Suitability for retrofitting? High. Sorbents can be retrospectively fitted to many types of devices and are excellent for retrofitting.
Flow attenuation capabilities? Low. Sorbents don't attenuate flows.

f) Linear treatment devices

When the underlying groundwater is vulnerable, the linear channel can be sealed and convey the water to another treatment device or into a river

What does it do? The runoff enters a linear channel at the edge of the impermeable surface. The treatment media within the linear channel can be designed to meet the specific requirements of the site. The media typically contains small stone chippings, sorbents, organic material and, sometimes, activated carbon granules. The proportions of these can be adjusted to treat pollutants such as pesticides, oils and organic pollution. The channel can be designed to allow the flow to infiltrate to ground at the bottom, or it can be directed along the channel to collection chambers where it can be directed to further treatment devices or straight to a river or stream.

What flow rate can it cope with? High.
Because each metre of channel only has to treat the runoff from a relatively small surface area, the capacity of this treatment device is only limited by the length of device that you can install. If the device is designed to discharge to ground, you must also consider the infiltration capacity of the underlying ground.

Maintenance cost and difficulty? Medium.
When the filter media needs to be changed, it can be sucked out with a vacuum tanker and simply replaced. Routine maintenance such removing leaf cover is a low-cost operation.

Maintenance frequency? Low.
Depending on the pollutant load from the catchment area, the media might only need replacing once every 10 – 20 years. Routine maintenance might need carrying out a couple of times a year to keep the tops of the channels clear.

Space required for installation? Low.
Because this is essentially a subsurface structure that can be installed in trafficked areas, it doesn’t need any space at surface.

Multiple benefits? Low. They are subsurface so offer no biodiversity or amenity benefits

Suitability for retrofitting? High.
Because these are subsurface structures, they don’t take up any space at surface. They are a linear installation too, so can often be accommodated around the edge of a site, and they require a shallow excavation.

Flow attenuation capabilities? High.
The capacity within the channels can attenuate flows a little, and even out flows passing into the watercourse or subsequent treatment devices. If the channels are able to discharge to ground by infiltration, then flow attenuation capacity is far greater, diverting flows away from surface waterbodies and drainage networks.

Chapter 10: Permitting the discharge and groundwater protection

Rainfall dependent surface runoff has often been considered to be ‘clean, uncontaminated surface water’ and so has not required Permitting or Authorising. With the introduction of the Water Framework Directive, environmental regulators may now need to consider controlling contaminated surface water outfalls by using Permits and Authorisations. But this is only likely to be necessary if the owner of the outfall can’t carry out the necessary remedial work voluntarily. If a Permit or Authorisation is issued, it may detail the maximum admissible level of pollutants in the discharge and this may require the installation of far more rigorous treatment techniques and devices. The expectation is that environmental regulators, asset owners and local authorities can work together to identify solutions to priority outfalls and include the investment on those outfalls in future plans and forward programmes wherever possible. This will improve water quality without the need for regulatory control.

Where discharges infiltrate to ground, the environmental regulator must be confident that no residual persistent, toxic pollutants will find their way into underlying groundwater. This will mean that regulatory controls for discharges to ground may be issued more often than for discharges to rivers and streams, because the regulatory framework controlling those pollutants is more stringent.

Chapter 11: Feeding information back into the River Basin Plans

The Water Framework Directive requires that environmental regulators publish Plans for every waterbody, describing the sources of pollution and other factors affecting the waterbody such as weirs and culverts. This Plan then has to detail the measures needed to bring the waterbody into good ecological status or its ecological potential.

If you identify an outfall that’s causing pollution, this should be described in the Plan. And then if you design a scheme that will address that pollution, that should also be added to the Plan, even if you can’t afford to deliver the scheme at the moment. This allows the environmental regulator to understand how much work is needed on every waterbody, how much it will cost, and where there are opportunities for one investment scheme to achieve multiple improvements. To feed information into a River Basin Plan, please speak to your local environmental regulator.

Chapter 12: Performance of treatment devices

The performance of manufactured (or proprietary) treatment devices can be measured using standard test procedures where the ‘substance retention capability’ is measured for pollutants which can then be declared by the manufacturers. For example, a device might be able to remove up to 64% of total suspended solids at a flow rate up to 25 litres per second. This can aid the selection of treatment devices, especially where a comprehensive risk assessment is being completed for a specific site. Unfortunately, a Standard Test Procedure doesn’t exist yet in the UK, but there are established tests available in Germany and America which can be completed. British Water groups are also working on the publication of a Code of Practice in the UK which will offer an alternative test protocol for UK manufacturers to complete. This means that SuDS Scheme designers can fairly readily access performance information for manufactured (proprietary) devices.

For vegetative devices or devices constructed on site, it's more difficult to know what the performance of the device will be. But there are examples of vegetative devices such as ponds and wetlands where the device has been measured and the Susdrain website (http://www.susdrain.org/) provides case studies that illustrate the effectiveness of vegetative devices in the UK. The CIRIA SuDS Manual also gives information on the performance of vegetative treatment devices.

Chapter 13: Conclusions

This report has suggested what you need to consider if you're responsible for a rainfall-dependent surface water outfall. Hopefully you've been able to work out if it's causing significant pollution or not and if it requires the installation of a treatment device.

The guide has helped you to consider the factors affecting the selection of the best treatment device, and Chapter 9 has guided you through the selection of the best device, or devices for you to install.

The next steps may include a formal design process for the scheme, and a funding bid to pay for the scheme.

If money isn't available now, you should identify the outfall and the scheme in your forward planning programme so that next time any civil engineering work is being completed in the area, the installation of the treatment scheme can be included.

Appendix 1: Where to find design guidance

There are two main sources of information about the design of sustainable drainage schemes:

1. The CIRIA SuDS Manual, C697

The SuDS Manual is widely recognised as the primary source of design information for SuDS schemes in the UK. The original version is available for free download on the CIRIA website at http://www.ciria.org/ A new version is due out early in 2015 so make sure you use the most up-to-date version.

2. Design Manual for Roads and Bridges

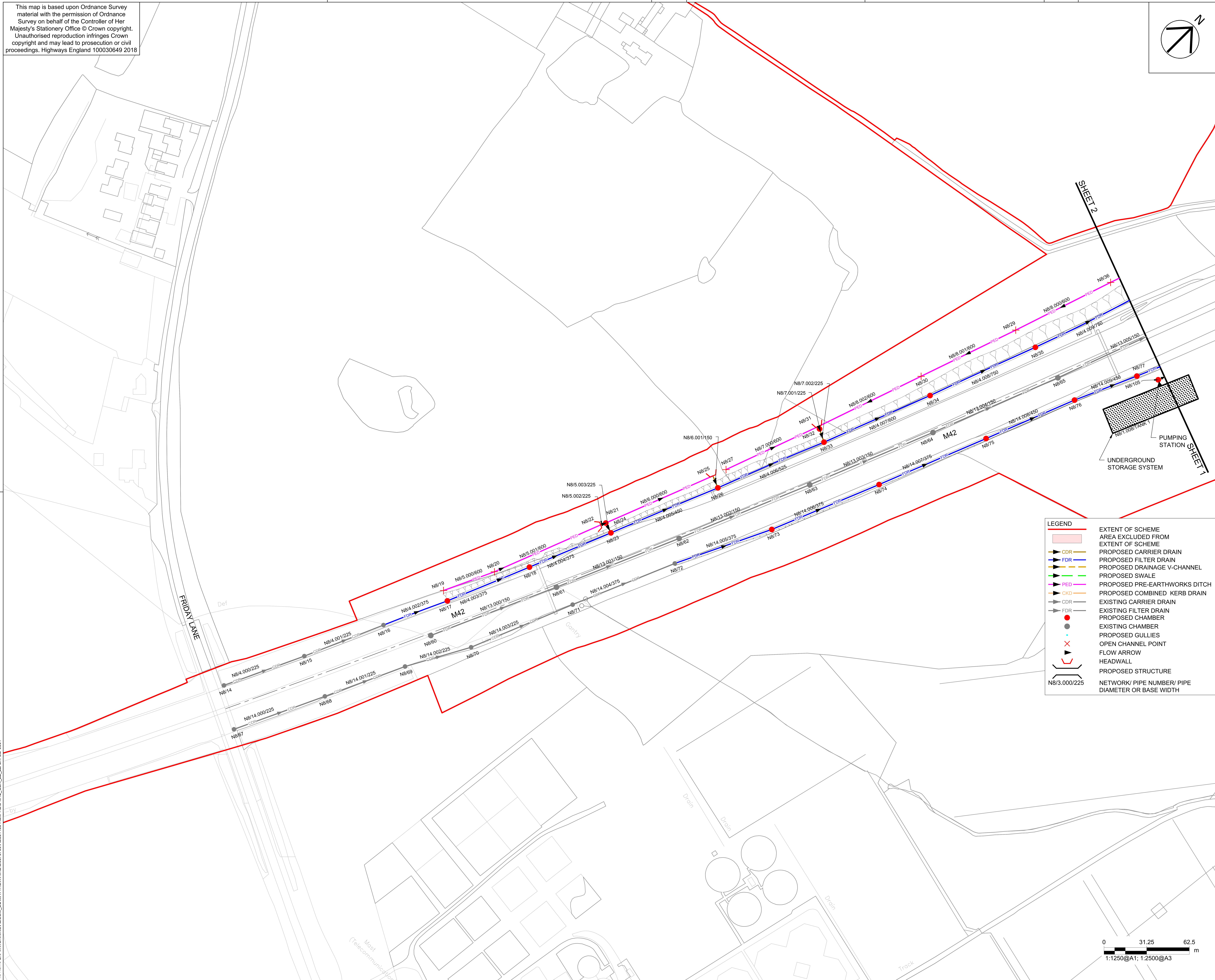
The DMRB is used by the Highways Agency and other highway authorities to design the entire drainage network for new-build road schemes. The Manual contains a wealth of information on the design of sustainable drainage for road schemes and should be used if the outfall you are concerned with is a highway outfall.

DMRB is published by the Highways Agency and is available for free download at http://www.dft.gov.uk/ha/standards/dmrb/ The Section 'HD 45/09 Road Drainage and the Water Environment' can be found in Volume 11, Section 3, Part 10.

Appendix 2 – Descriptions of the classifications assigned to each device in Chapter 9

Category	Classification HIGH	Classification MEDIUM	Classification LOW
What flow rate can the device cope with?	Can accommodate most flow rates, usually only restricted by the space available or the capacity of the pipework	Can accommodate some flow rates but limited by functional or structural constraints of the device	Can only treat limited flow rates due to limited capabilities of the device. These might be acceptable for treatment of partial flows with a bypass.
Maintenance cost and difficulty	Specialised contractors or equipment needed	Mechanical tasks such as grass cutting or vacuum tinkering that are routinely carried out by asset owners	Manual tasks only such as litter picking and sweeping up deposits. Could potentially be completed by residents or volunteers
Maintenance frequency	More than once per year	At 2 – 5 year intervals	At intervals more than 5 years
Space required for installation	Significant surface area has to be sacrificed for the installation	Limited surface area has to be sacrificed but any sub-surface excavation needed is significant	Subsurface devices with little or no need for the sacrifice of surface area, and also with shallow or smaller sub-surface excavation requirements.
Suitability for retrofitting	Easy to retrofit on an existing urban development needing little space and shallow or no excavation	Less easy to retrofit to an existing urban environment due to the need for some surface area or shallow excavations where services may be buried	Difficult to retrofit to an existing urban area due to a need for large surface area or a deep excavation where buried services may be a problem and structural stability of existing structures may be compromised
Multiple benefits	Amenity & biodiversity benefits will be provided, along with other benefits such as cooling or recreational opportunities	Amenity **or** biodiversity benefits will be provided	Neither amenity nor biodiversity benefits will be provided
Flow attenuation capabilities	The device or system has the capacity to retain design exceedence flows for part or all of the site	The device or system can retain or detain flows and will reduce the off - site runoff rate in rainfall events	The device or system does not attenuate flows at all

APPENDIX D – PRELIMINARY DRAINAGE DESIGN LAYOUTS



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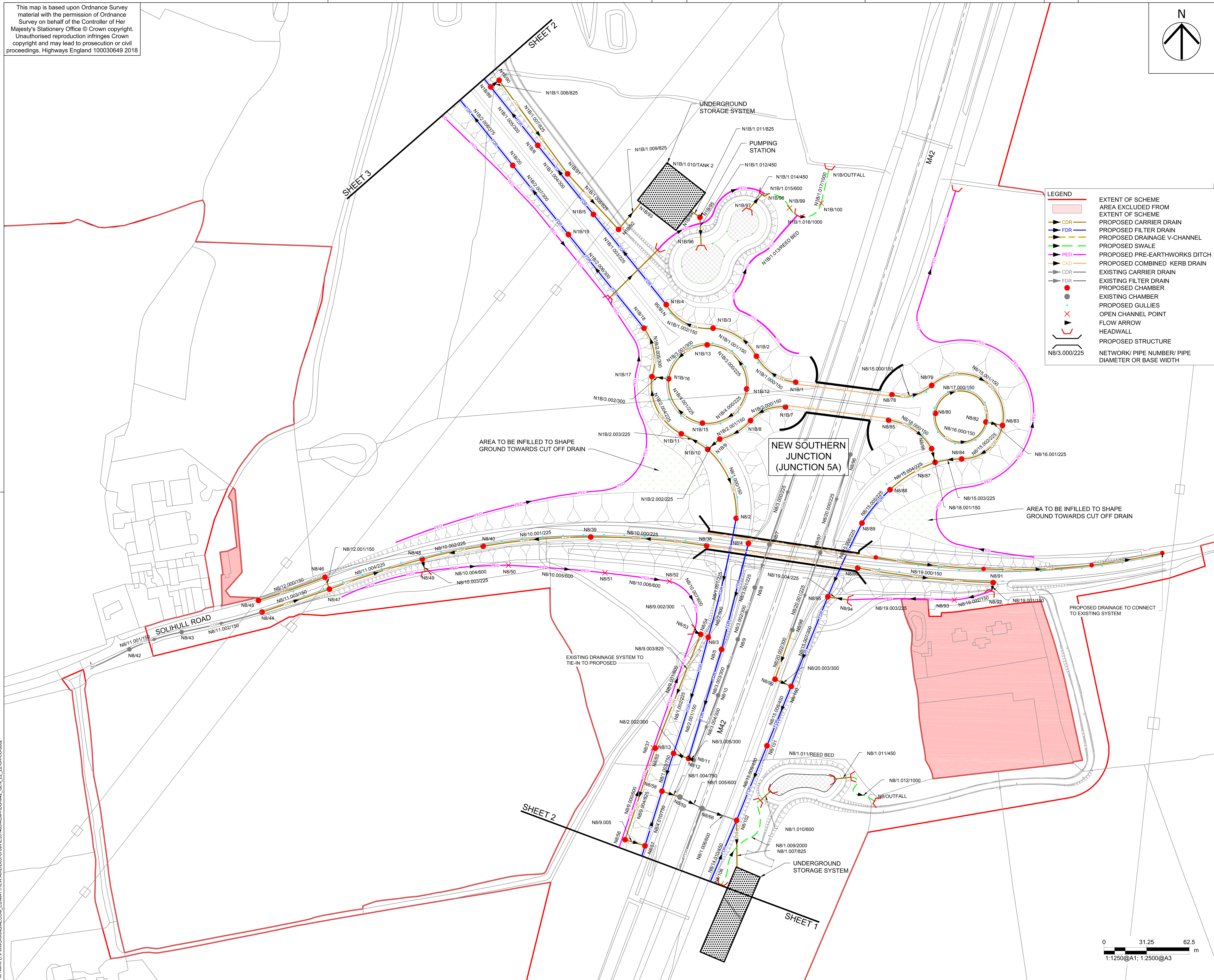

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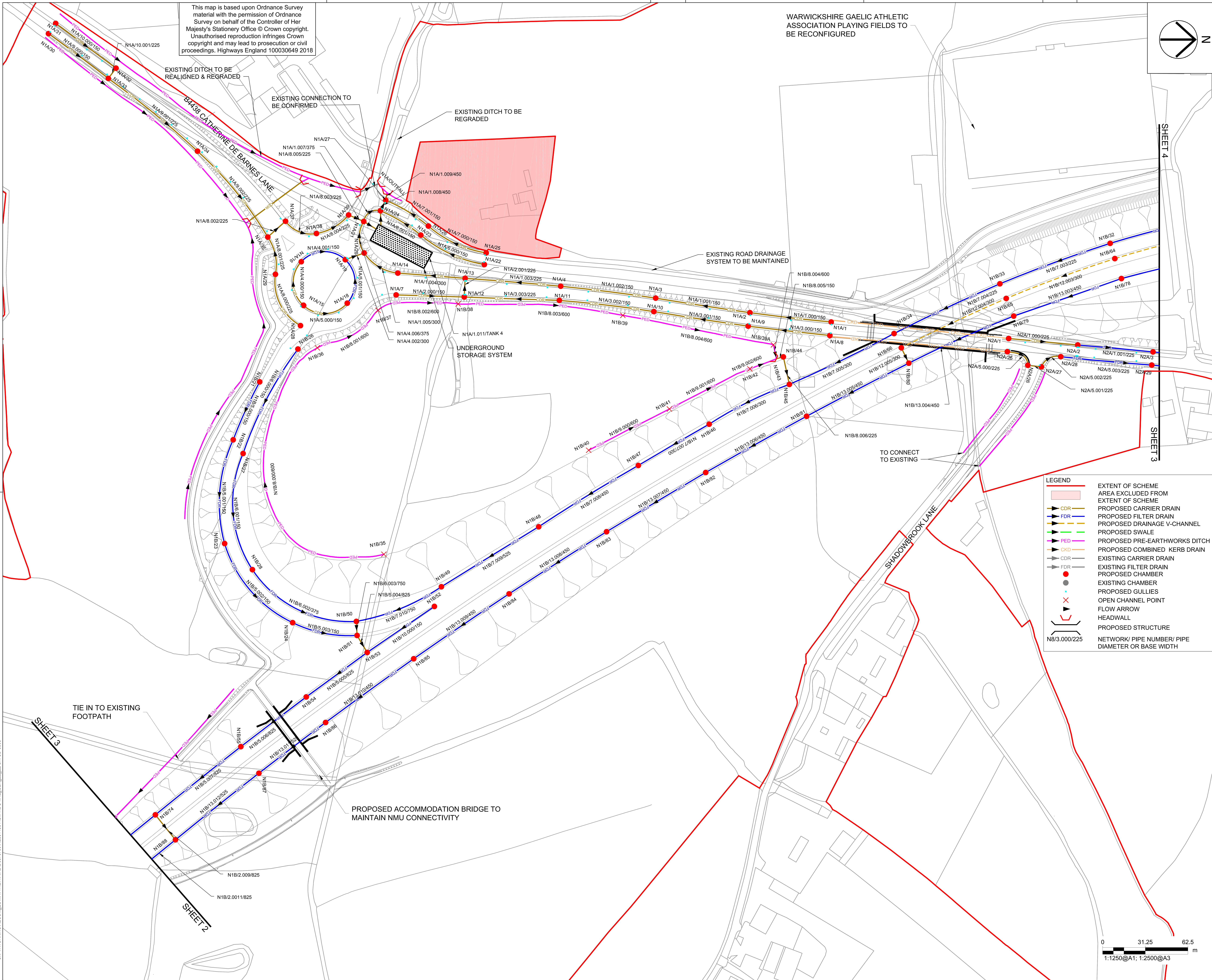

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- FDR — PROPOSED FILTER DRAIN
- PROPOSED DRAINAGE V-CHANNEL
- PROPOSED SWALE
- PED — PROPOSED PRE-EARTHWORKS DITCH
- CKD — PROPOSED COMBINED KERB DRAIN
- CDR — EXISTING CARRIER DRAIN
- FDR — EXISTING FILTER DRAIN
- PROPOSED CHAMBER
- EXISTING CHAMBER
- PROPOSED GULLIES
- OPEN CHANNEL POINT
- FLOW ARROW
- HEADWALL
- PROPOSED STRUCTURE
- N8/3.000/225 — NETWORK/ PIPE NUMBER/ PIPE DIAMETER OR BASE WIDTH

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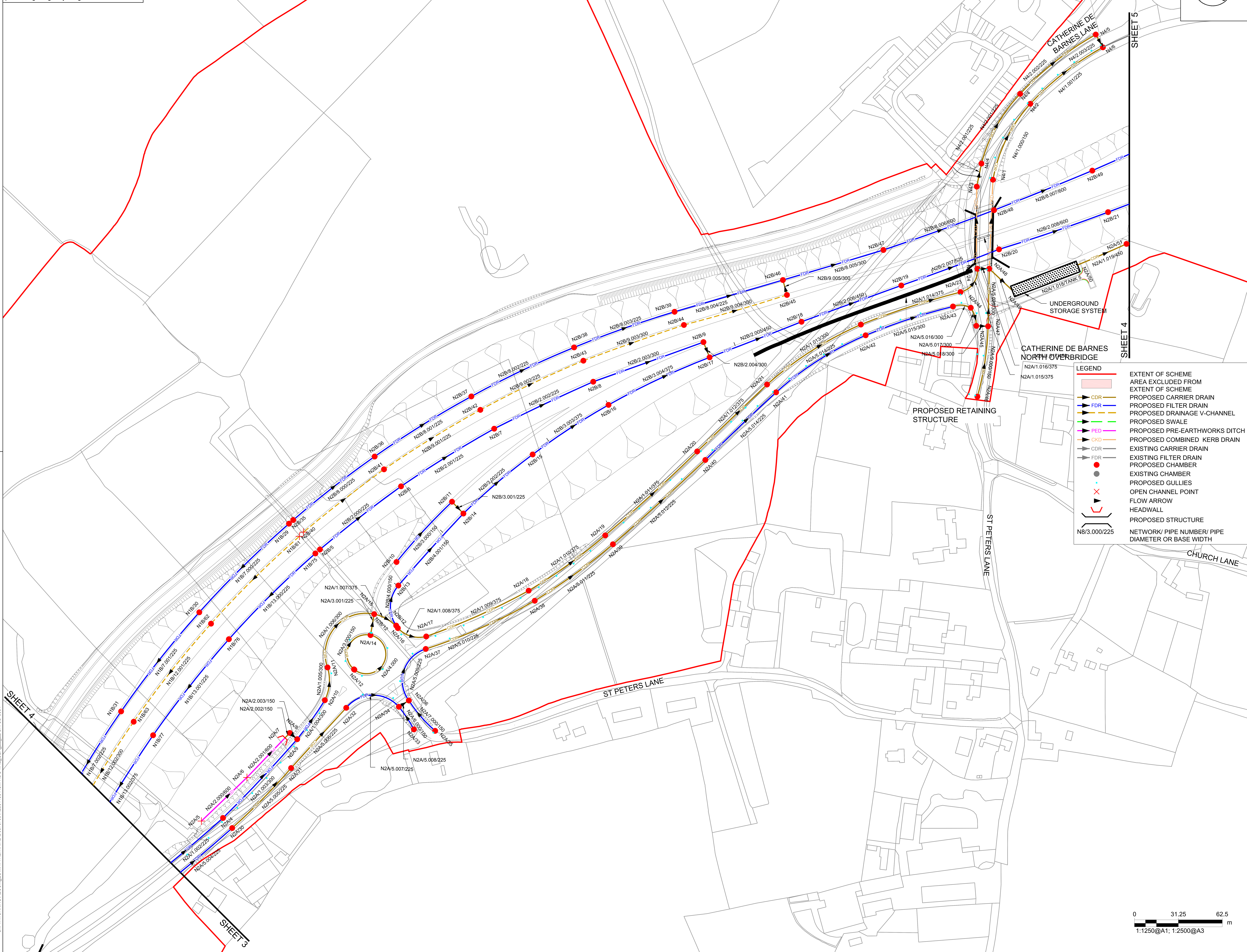

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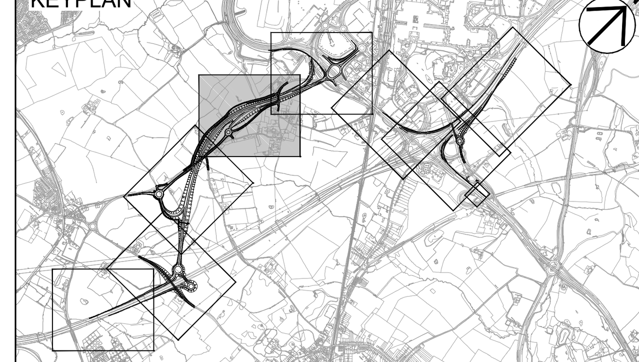

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Scale @ A1 1:1250	Zone M42

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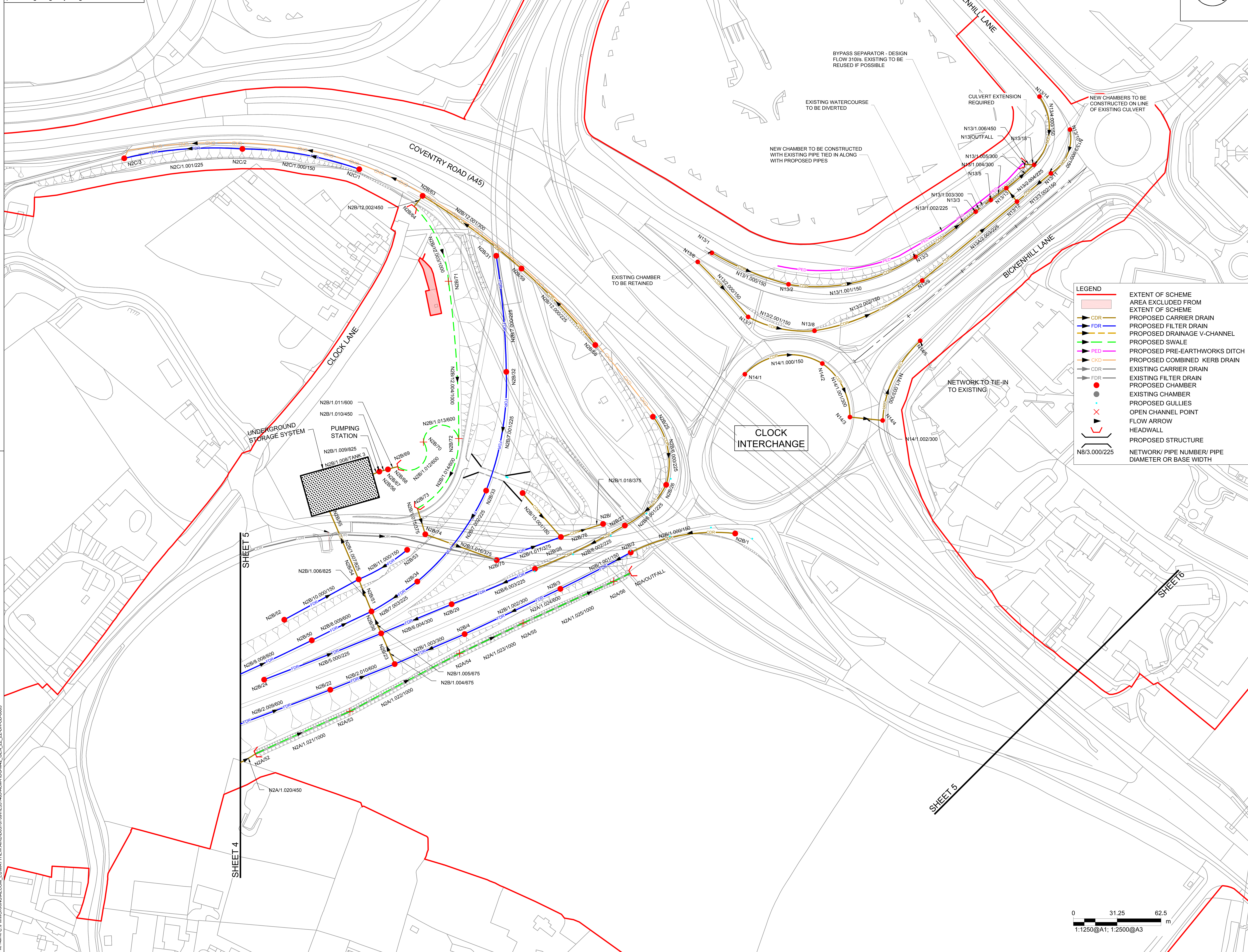

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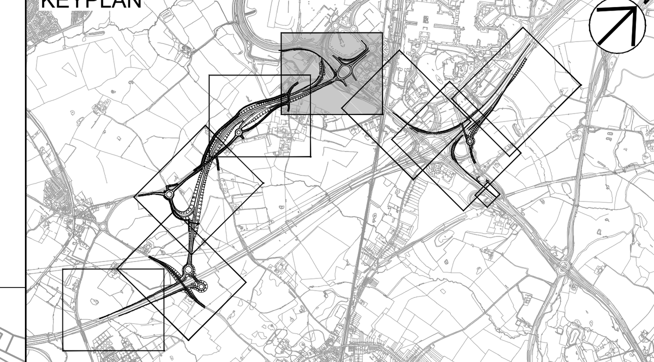

Revision Details	By	Check	Date	Suffix
First Issue	RD	JF	14/12/18	P03

Purpose of issue
FOR STAGE APPROVAL

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Working on behalf of highways england

Project Title
M42 JUNCTION 6 IMPROVEMENT

Drawing Title
M42 JUNCTION 6 PROPOSED DRAINAGE SHEET 5 OF 8

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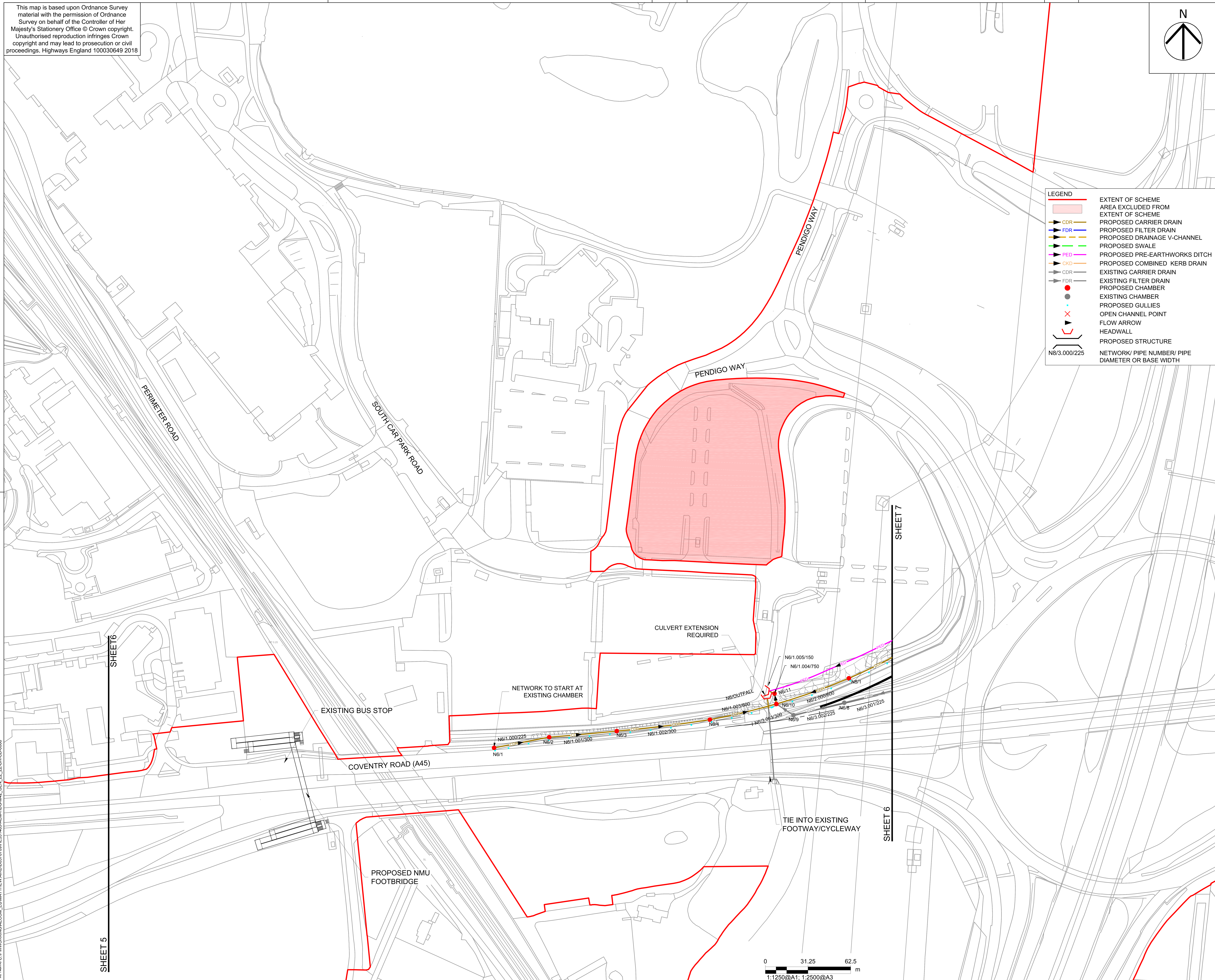

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FDR	PROPOSED FILTER DRAIN
	PROPOSED DRAINAGE V-CHANNEL
	PROPOSED SWALE
PED	PROPOSED PRE-EARTHWORKS DITCH
CKD	PROPOSED COMBINED KERB DRAIN
CDR	EXISTING CARRIER DRAIN
FDR	EXISTING FILTER DRAIN
	PROPOSED CHAMBER
	EXISTING CHAMBER
	PROPOSED GULLIES
	OPEN CHANNEL POINT
	FLOW ARROW
	HEADWALL
	PROPOSED STRUCTURE
N8/3.000/225	NETWORK/ PIPE NUMBER/ PIPE DIAMETER OR BASE WIDTH

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M42 JUNCTION 6 PROPOSED DRAINAGE SHEET 6 OF 8

Designed	Drawn	Checked	Approved	Date
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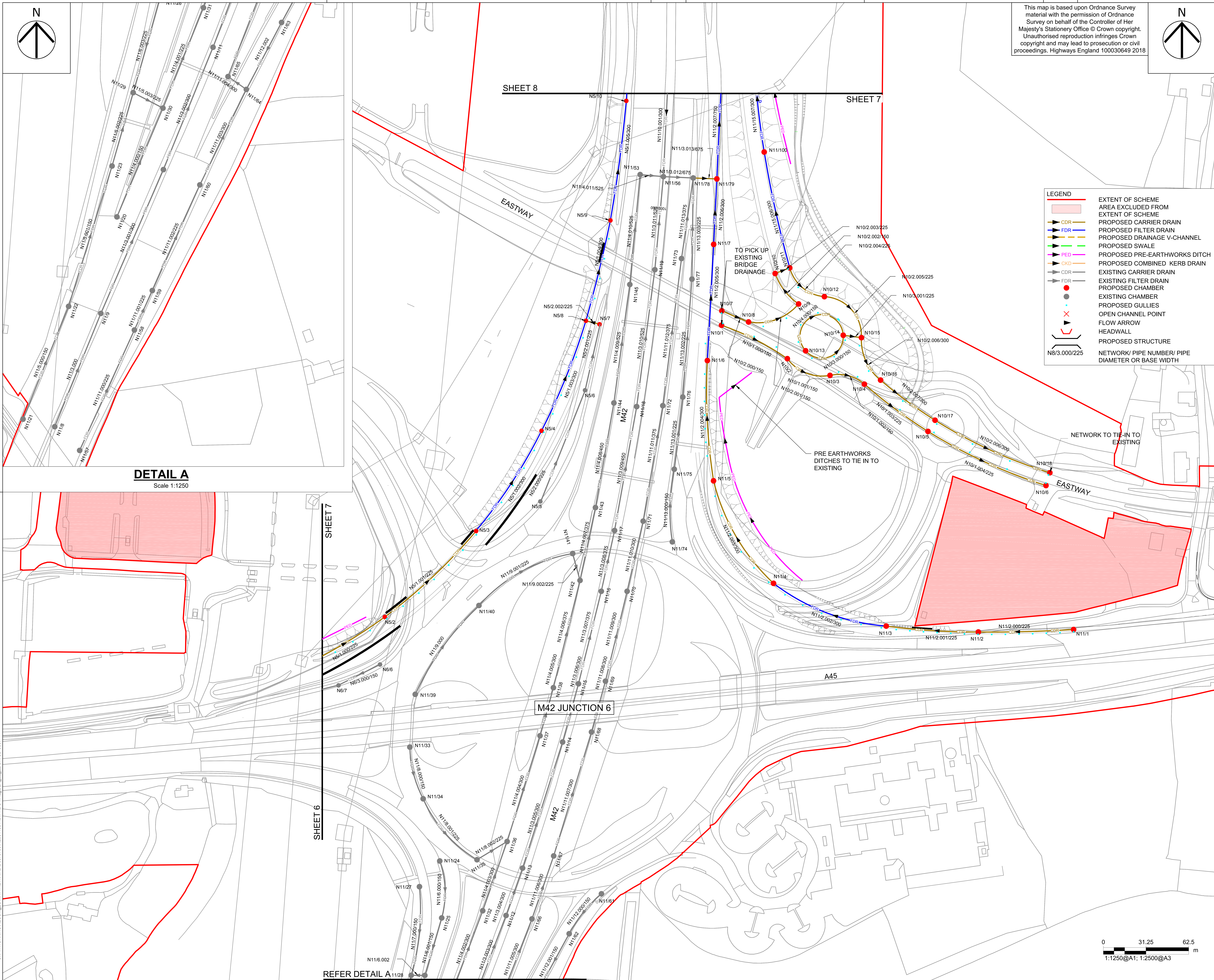

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M42 JUNCTION 6 PROPOSED DRAINAGE SHEET 7 OF 8

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Internal Project No. 60543032	Suitability S4
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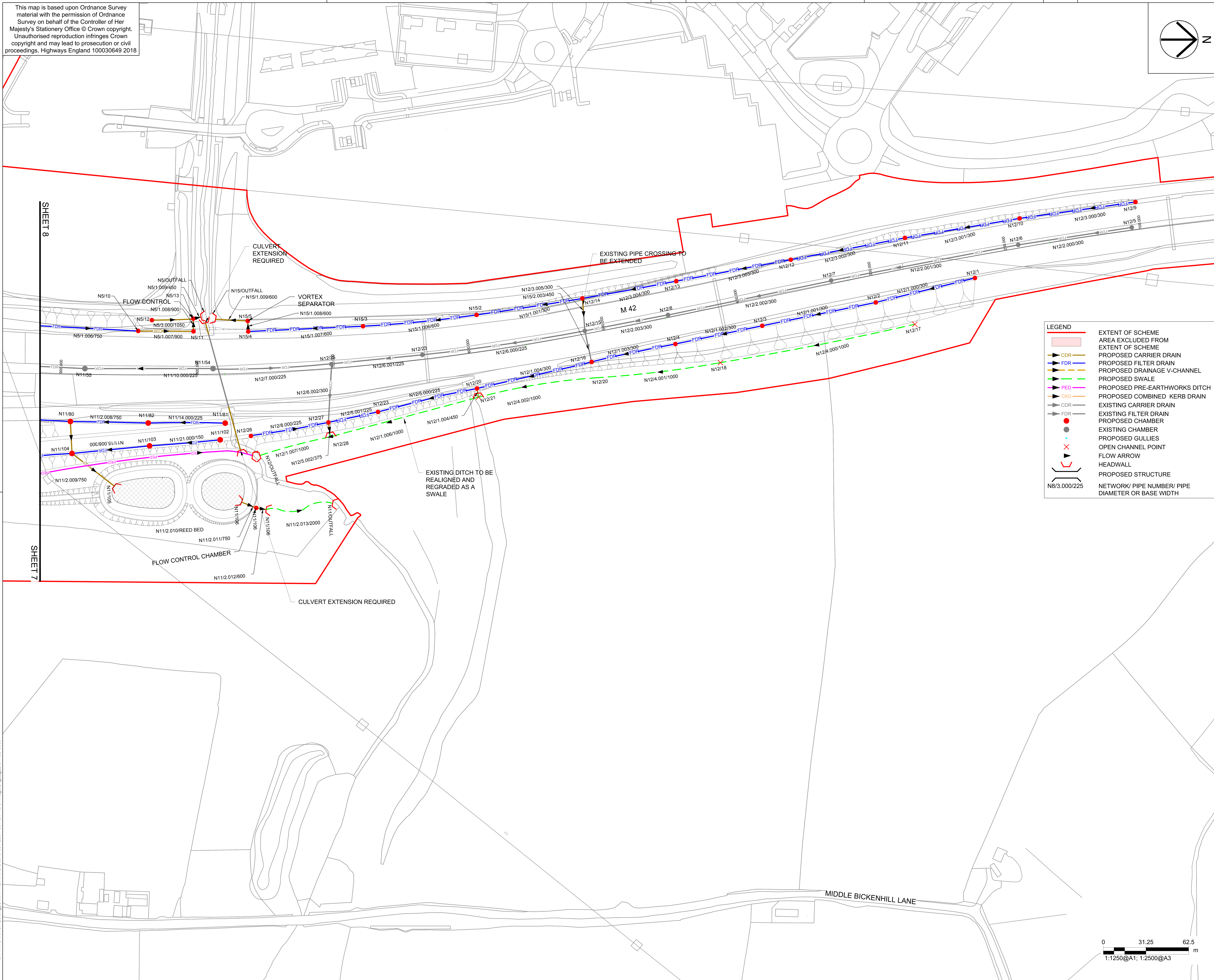

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M42 JUNCTION 6 PROPOSED DRAINAGE SHEET 8 OF 8

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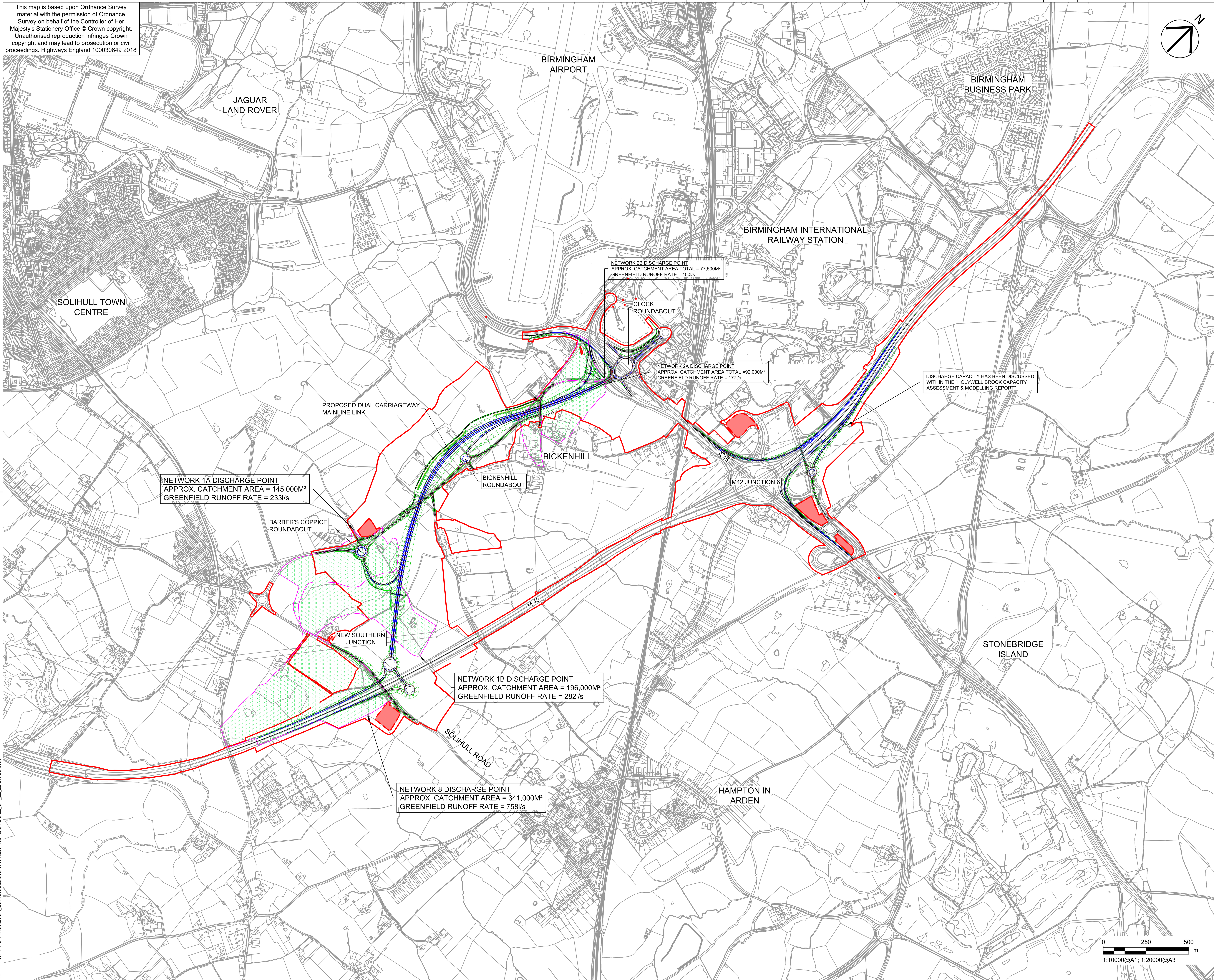
APPENDIX E – GREENFIELD CATCHMENT AREAS



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- GREENFIELD CATCHMENT BOUNDARY
- GREENFIELD CATCHMENT
- AREA EXCLUDED FROM EXTENT OF SCHEME

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Project Title

M42 JUNCTION 6 IMPROVEMENT

Drawing Title

M42 JUNCTION 6 GREENFIELD CATCHMENT AREAS AND RUNOFF RATES

Designed	Drawn	Checked	Approved	Date
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APPENDIX F – HOLLYWELL BROOK CAPACITY ASSESSMENT & MODELLING REPORT

Holywell Brook

Capacity Assessment & Modelling Report

9 August 2018

Quality information

Prepared by	Checked by	Verified by
Hotten, Daniel J.W Digitally signed by Hotten, Daniel J.W DN: cn=Hotten, Daniel J.W, ou=UKLDS2 Location: Leeds Date: 2018.09.28 10:50:00 +01'00'	PP	
Daniel Hotten Graduate Engineer	Christopher Irwin Senior Engineer	Nick Maynard Associate Director

Revision History

Revision	Revision date	Details	Authorized	Name	Position

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Table of Contents

Figures

Tables

1. Introduction

AECOM has developed this report in conjunction with the M42 Junction 6 improvement Flood Risk Assessment. The report assesses the capacity of Hollywell Brook and discusses its impact on the motorways's permanent road drainage design. Ultimately, this is to inform whether flood compensation storage is required as part of the works, and if so how much.

2. Background

Site Details & Proposal

The proposed scheme comprises:

- a new dumbbell roundabout junction (junction 5A) on the M42, north of Solihull Road bridge;
- new 120 kph (70 mph) dual carriageway link towards Birmingham Airport and Clock Interchange on the A45 aligned to the west of Bickenhil;
- the realignment of the existing B4438 Catherine de Barnes Lane; and;
- junction improvements to the M42 Junction 6.

As part of the proposed scheme, a number of improvements to Junction 6 of the M42 would be undertaken to compliment the proposed bypass – these would include dedicated on and off-slip lanes in a northbound and southbound direction on to and off the existing M42 from the A45 Coventry Road.

The proposed works impact the existing crossing of Hollywell Brook, to the north of the M42 Junction 6, where an extension of an existing culvert will be required. This will require construction over areas designated as Flood Zones associated with the watercourse.

Previous AECOM Assessments

Flood Compensation

The slip roads for the proposed improvements to the M42 J6 disrupt the flood plain of Hollywell Brook, which the Environment Agency identifies as being in Flood Zone 3 and Flood Zone 2 (Figure 1). Definitions of the Environment Agency flood zones are summarised in Table 1 below.

Table 1. EA Flood Zone Definitions

Flood Zone	Definition	Probability of Flooding
Flood Zone 2	Land that has a medium probability of flooding (between 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1-1%), or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1-0.5%))	Medium
Flood Zone 3	Land that has a high probability of flooding (1 in 100 year or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%))	High

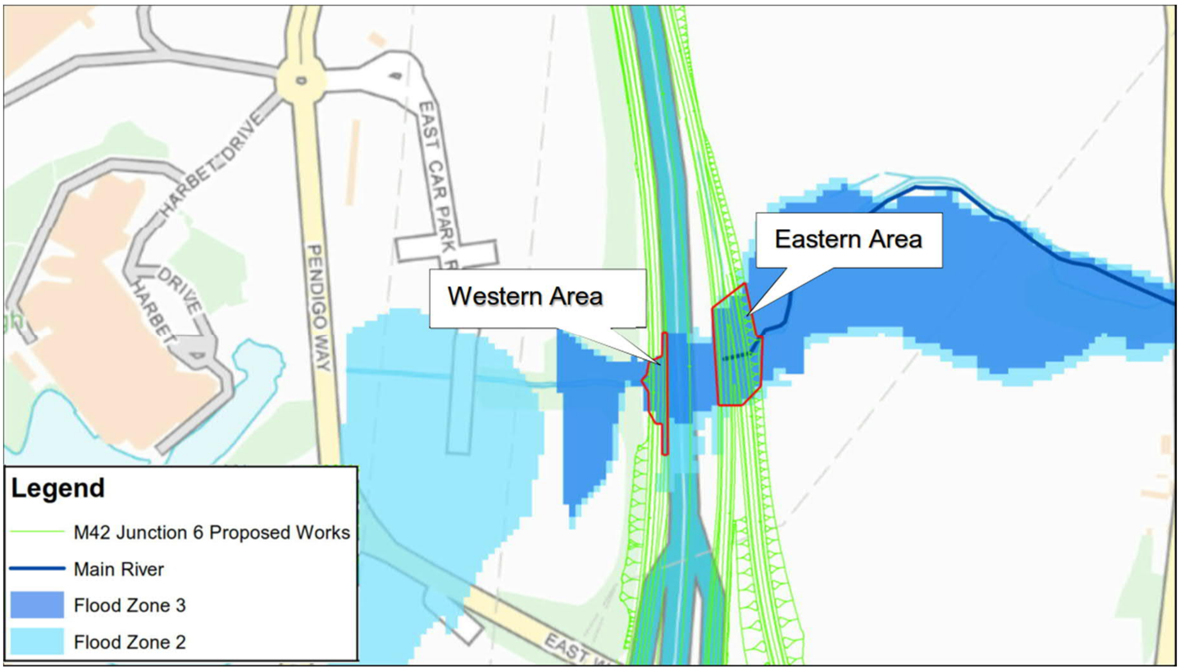


Figure 1. Flood Zone extents for Hollywell Brook and the Proposed Scheme Crossings

Based on the EA Flood Mapping, flood flows overtop the channel banks and are stored in the surrounding plains. The proposed design would reduce the land available for this storage and could increase flood risk downstream. If this is the case then compensatory flood storage could be required. AECOM calculated potential storage volumes, based on available topographical data and an assumption of top water level (TWL) based off of the topographical data. This process is detailed in Appendix A. The volumes that were calculated as part of this assessment are listed in Table 2.

Table 2. Lost Flood Volumes Summary

Storage Area	Volume (m^3)	Area (m^2)	Assumed TWL (m AOD)
Western Area	120	860	89
Eastern Area	1230	2560	88.7
Combined – Flood Zone 3	1350	320	N/A

During this assessment, the accuracy of the EA Flood Mapping for this area was questioned, as the supposed flooding extents did not follow the topography of the site according to the available data.

Channel Capacity Assessment

Due to the conflicting and limited information of the initial calculations, and the EA flood mapping, it was decided to undertake a brief calculation to assess the capacity of the Hollywell Brook channel. This was additionally intended to verify the TWL's used in the previous assessment. A 90 m stretch of the Brook immediately downstream of the M42 Culvert was chosen for this assessment. Calculations are detailed in Appendix B.

Topographical data from the available survey data was used, in conjunction with Manning's open flow calculation to estimate both the capacity of the channel before overtopping, and the freeboard available during the 1% Annual Exceedance Probability (AEP) + 50% Climate Change (CC) event.

The results from this assessment indicate that the channel has a capacity of 16.2 m^3/s, which is significantly higher than expected during the worst case design condition of a 1% AEP + 50% CC event (6.6 m^3/s). Additionally, the design flow for this event provides 1.16 m of freeboard (i.e. the channel will not overtop). This suggests that the EA Flood Zone 3 could be inaccurate for this area. This could mean that there is no flood storage in this area and therefore the proposed works would have no impact on downstream flood risk.

Therefore, it was decided that hydraulic modelling was necessary to better assess the accuracy of the EA Flood Zone 3 and furthermore, the requirement for flood compensatory storage.

3. Hydraulic Modelling

To better assess the accuracy of the EA Flood Zone 3, a 1D model was created using Flood Modeller. As it was assumed that the channel would not overtop during the 1% AEP + 50% CC event, a 1D only model was deemed to be adequate for this scenario.

Cross Sections were extracted from the Civils 3D topographical drawing. These cross sections were chosen to reflect the nature of the channel. As highlighted in Figure 2, three cross sections are located within the boundary of the proposed slip roads and therefore would be good indicators of whether the proposals impact the existing flood zone. The data source of the topographical data is unknown, but the level of detail provided is thought to suggest LIDAR and therefore a sufficiently accurate base for this assessment.

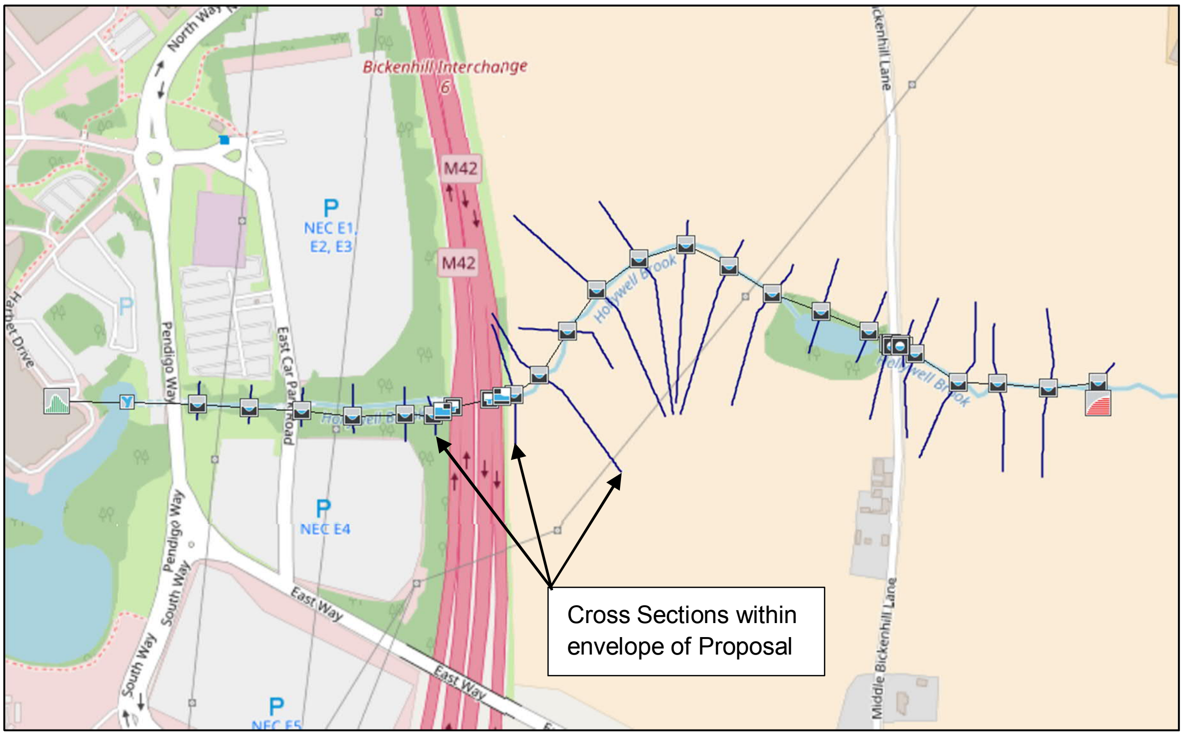


Figure 2. 1D Model of Hollywell Brook

An inflow of 6.6 m^3/s was used as the model input which represents the peak flow during the 1% AEP event. This was calculated using ReFH2 by AECOM (Appendix C), assuming an allowance of 50% for Climate Change.

A global Manning's roughness coefficient of 0.04 was chosen for the watercourse and the floodplains which is suitable to represent both; a clean, winding channel with some pools and shoals, and a pasture flood plain with high grass. A Manning's coefficient of 0.011 was chosen for the concrete culverts within the bridge at Middle Bickenhall Lane and is suitable to represent concrete culverts that are straight and full of debris. A Colebrook White roughness of 0.02 chosen for the culvert under the M42 which is representative of a corrugated steel culvert. This is discussed within Highways England's survey of the existing M42's culvert as seen in Appendix D.

A sensitivity analysis was performed on the Manning's coefficient. Two separate model runs were performed, with the roughness globally modified by ± 20%. Colebrook White roughness values were also modified by ± 10%. It was found that this had an insignificant effect on the output of the model. A sensitivity analysis was also performed on the downstream boundary condition, with the slope modified by ± 50%. Similarly, it was not found that this had a significant impact on the results of the model.

4. Results

The results from the modelling show that, during the 1% AEP + 50% CC event, the Holywell Brook is not expected to overtop at the cross sections within the envelope of the proposals. This is shown in Figure 3.

If all flow remains in channel, then there is no storage at any point and therefore no storage area lost as a result of the planned works. This means that there will be no impact to flood risk downstream.

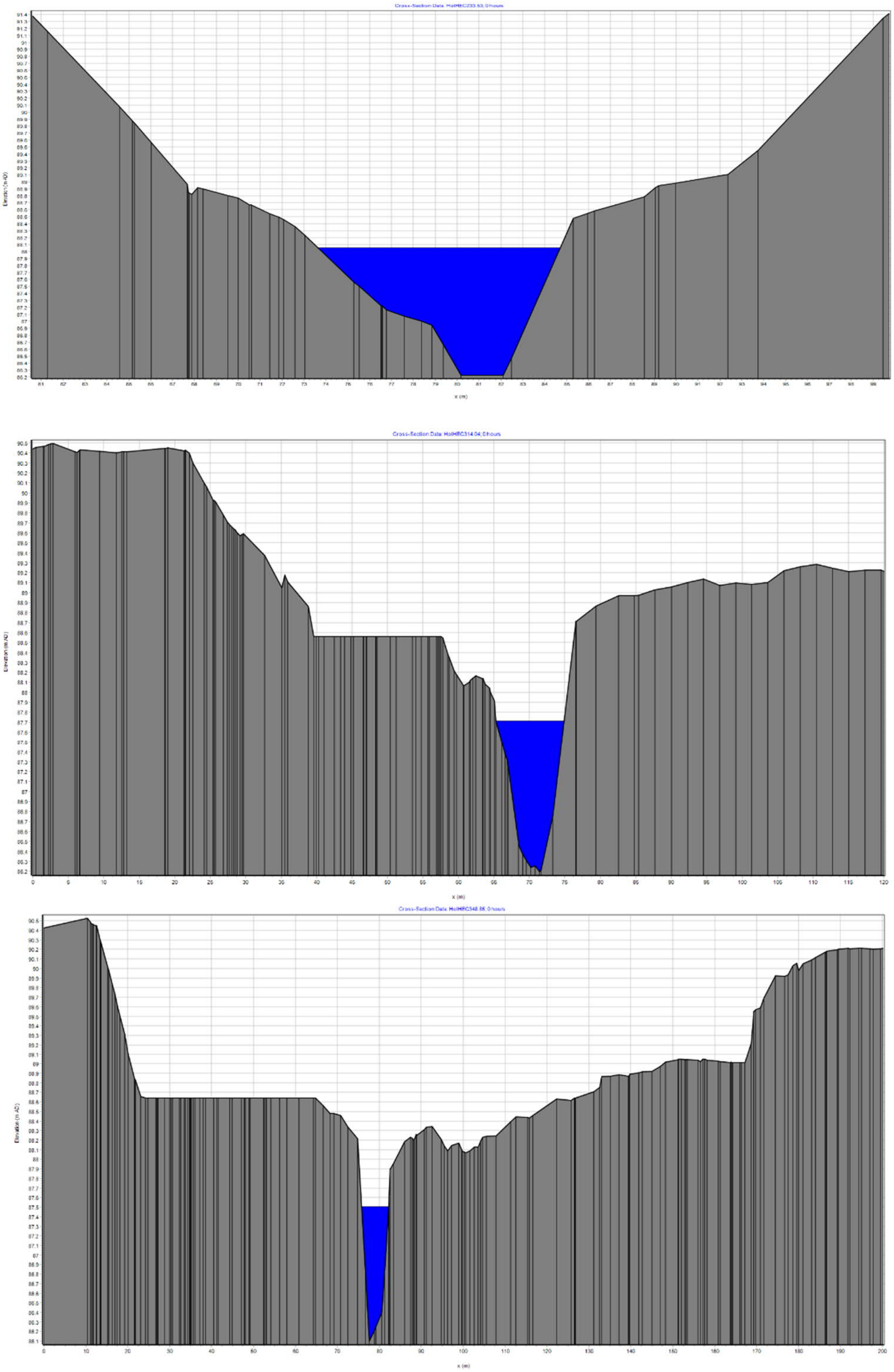


Figure 3. Modelling Results for Cross Sections of Interest

Therefore, it is expected that the proposals do not encroach on a flood plain. Due to this, there is no requirement to provide flood compensatory storage in conjunction with the scheme.

Appendix A – Flood Storage Initial Calculations

Technical Note

Project:	**M42 Junction 6 Improvement Scheme**	Job No: **60543032**
Subject:	**Flood Compensation**	
Prepared by:	**Daniel Hotten**	Date: **12th July 2018**
Checked by:	**David Asensio / Jo Somerton**	Date: **13th July 2018**
Approved by:	**Cathryn Spence**	Date: **13th July 2018**

1 Introduction

As part of the Flood Risk Assessment (FRA) for the M42 Junction 6 Improvement Scheme, AECOM has developed this Technical Note to identify the required compensatory flood storage volumes required for the Hollywell Brook where the Proposed Scheme crosses the Flood Zone 3 flood extent associated with the watercourse. This technical note should be read in conjunction with M42 Junction 6 Improvement Scheme FRA.

2 Site Details

The Site is located within an area of predominantly arable agriculture to the east of Solihull. The northern extent of the Site borders the National Exhibition Centre (NEC) site and Birmingham Airport. A railway line crosses the A45 south of Birmingham International Railway Station to the west of the M42 Junction 6. The proposed new road passes immediately west of the village of Bickenhill, with the village of Catherine de Barnes being within 1km of the proposed scheme to the southwest.

The proposed scheme would be located to the west of the existing M42 Junction 6 in the area of green belt between Junction 5 and Junction 6 and would involve tie-in points to the existing Strategic Road Network (SRN) at the following locations: M42 Clock Interchange (SP: 18778 82970) and a proposed junction (SP: 19307 81306); and junction enhancements at the existing M42 Junction 6 (SP: 19819 83061).

3 Proposed Development

The Proposed Scheme comprises a new dumbbell roundabout junction (southern junction) with the M42, north of Solihull Road bridge and a new 120kph (70mph) dual carriageway link towards Birmingham Airport and Clock Interchange on the A45 aligned to the west of Bickenhill, the realignment of the existing B4438 Catherine de Barnes Lane and junction improvements to the M42 Junction 6.

As part of the Proposed Scheme a number of junction flow improvements at Junction 6 of the M42 would be undertaken to compliment the proposed bypass - these would include:

- dedicated on and off-slip lanes in a north bound and southbound direction on to and off the existing M42 from the A45 Coventry Road; and
- a dedicated off-slip in a southbound direction off the existing M42 on the A45 Coventry Road in an eastbound direction.

The proposed scheme works impact the existing crossing of the Hollywell Brook, to the north of the M42 Junction 6, where an extension of an existing culvert will be required. It will also include construction over the flood zones associated with the watercourse.

4 Flood Risk

Hollywell Brook

Hollywell Brook (classified as an Ordinary Watercourse upstream of the M42 crossing) flows east out of Pendigo Lake at the NEC, and is culverted beneath the M42.

The channel of Holywell Brook itself is approximately 3m wide with steep embankments and the culvert beneath the M42 is circular and is approximately 3m in diameter. As noted in the FRA, at the time of the site visit, the culvert did not appear to have excessive influence on the flow regime.

Figure 1: Hollywell Brook downstream of the M42

Downstream of the M42 culvert the watercourse becomes an Environment Agency Main River and flows in a wide channel with steep banks (see Figure 1). To the east of the motorway, as it crosses a fallow field, the channel gradually narrows to approximately 1.5m wide..

Flood Extents

The slip roads for the proposed improvements to the M42 J6 sever the flood plain of Hollywell Brook which the Environment Agency flood maps identify as being in Flood Zone 2 and Flood Zone 3 (shown in **Figure 2**). Definitions of the Environment Agency flood zones are summarised in Table 1 below.

Table 1 - EA Flood Zone Definitions

Flood Zone	Definition	Probability of Flooding
Flood Zone 2	Land that has a medium probability of flooding (between 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1-1%), or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1-0.5%)	Medium
Flood Zone 3	Land that has a high probability of flooding (1 in 100 year or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%)	High

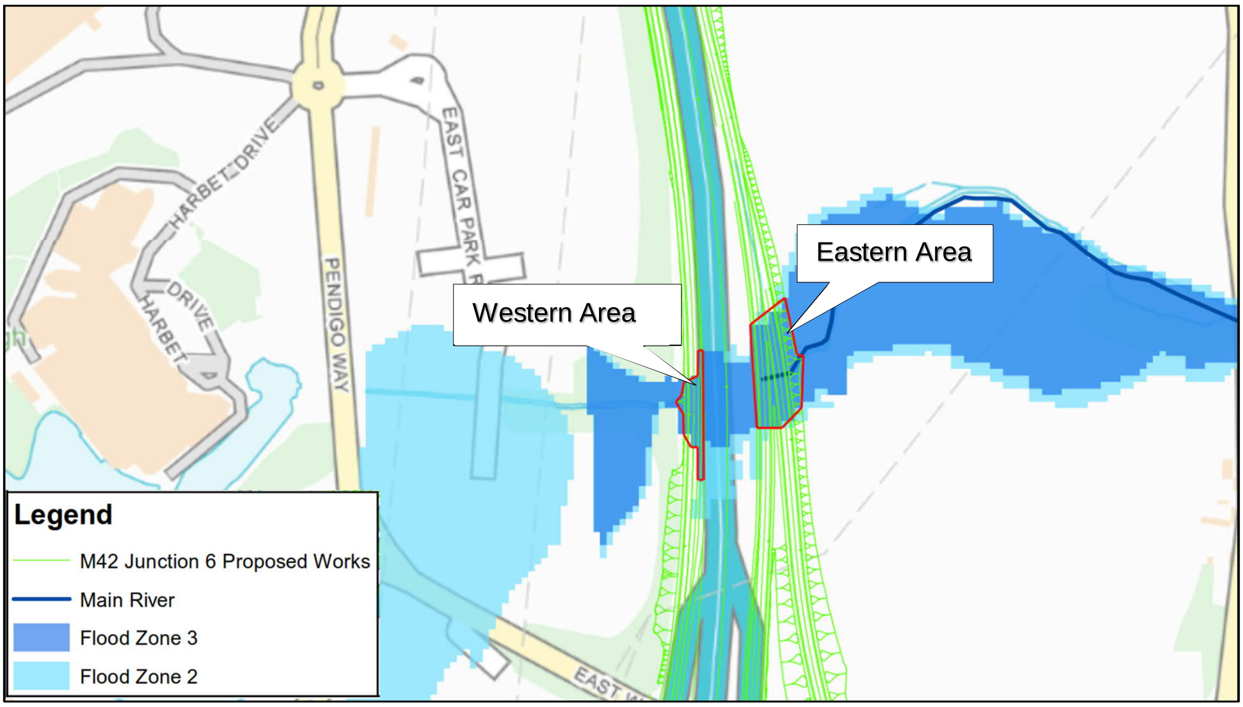


Figure 2: Flood Zone extents for Hollywell Brook and the Proposed Scheme Crossings

The location of the proposed on and off-slip lanes across the Flood Zone 3 extent will require appropriate compensatory flood storage measures to avoid increasing flood risk downstream.

Compensatory Storage

As the proposed design would reduce flood storage and could increase flood risk downstream compensatory flood storage is required

To determine the volume of compensatory flood storage required and develop the design of compensatory flood storage a calculation of the loss of flood storage is required.

Flood Compensation Volumes

The flood compensation volumes for the Proposed Scheme (where scheme crosses the Hollywell Brook) (See Figure 2) have been calculated using the volumes dashboard functionality of Civil3D. 3D surfaces were created using the existing survey data, and compared against a surface representing the top water level (TWL) of the flood area (Figure 4).

In the absence of detailed flood modelling results, the TWL has been assumed using the extents of the Flood Zone 3 (as shown above) and identifying an approximate location and associate level on the the topographic data. TWL's are listed in Table 1.

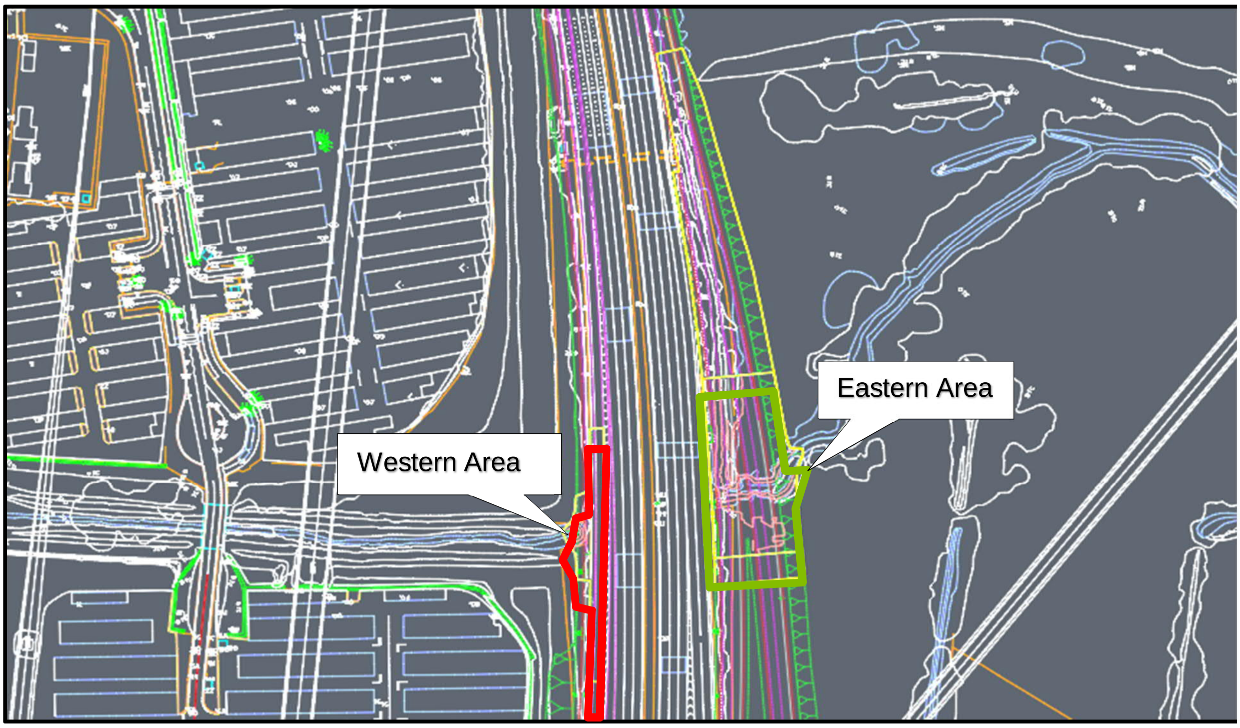


Figure 3. Flood Compensation Areas – Civil 3D

A 3D representation of the ground surface (taken for topographic survey information for the area) and the TWL used to derive the storage volume calculations for the Eastern Area (where the Hollywell Brook is classified as an Environment Agency Main River) is presented in Figure 4 below.

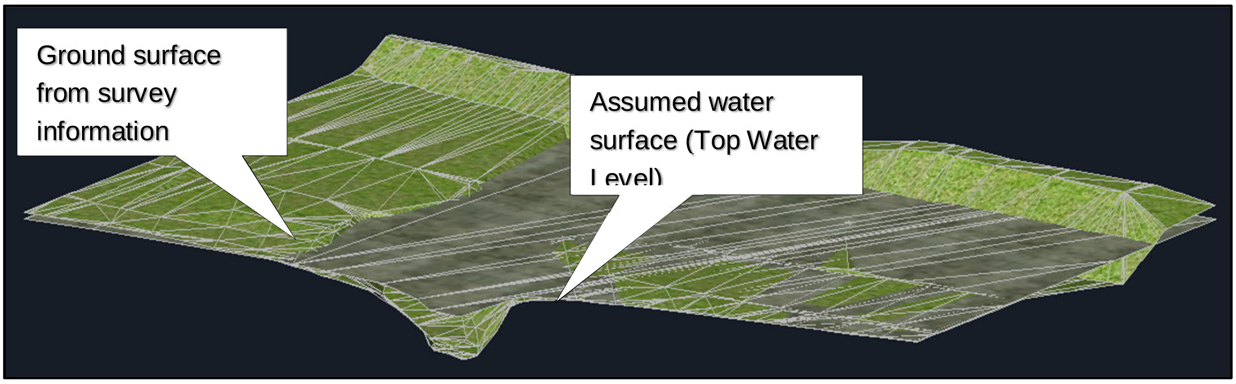


Figure 4. 3D representation of flood depths for Eastern area (Flood Zone 3)

The combined flood volume has been calculated as 1350 m^3 for the Western and Eastern Area extents located within the Environment Agency Flood Zone 3 extent. Individual volumes are shown in Table 2

Table 2. Lost Flood Storage Volumes Summary

Storage Area	Volume (m^3)	Area (m^2)	TWL (m AOD)
Western Area	120	860	89
Eastern Area	1230	2560	88.7
Combined – Flood Zone 3	1350	320	N/A

Further flood modelling would be required to estimate the compensation volumes with greater accuracy.

Compensatory flood storage must provide the same volume, and be at the same level relative to flood level, as the lost storage (known as 'level for level' or 'direct' compensation). Ideally the compensatory storage should be created immediately next to the location of the development.

5 Summary/Conclusion

This Technical Note outlines the need for flood compensatory storage to the north of the M42 Junction 6 Improvement Scheme where the Proposed Scheme crosses the Hollywell Brook.

Flood compensatory storage volumes have been estimated from the topographic survey data and flood zone extent mapping outputs obtained from the Environment Agency GeoStore service using Civil3D.

Through the detailed design process further flood modelling would be required to estimate the compensation volumes with greater accuracy and to test the efficacy of the proposed design. The Environment Agency flood zones are likely to have been developed using only low resolution techniques and LiDAR data. Detailed hydraulic modelling of the watercourse using watercourse survey data would provide a more robust indication of the extent and volume of flooding. The modelling could also be used to test designs for flood compensation.

Appendix B – Hollywell Brook Capacity Assessment

Technical Note

AECOM

Project:	**M42 Junction 6 Improvement Scheme**	Job No: **60543032**
Subject:	**Hollywell Brook Capacity Assessment**	
Prepared by:	**Daniel Hotten**	Date: **24th July 2018**
Checked by:	**Christopher Irwin**	Date: **25th July 2018**
Approved by:	**Cathryn Spence**	Date: **25th July 2018**

1 Introduction

The following technical note should be read in conjunction with *'M42 Flood Storage Tech Note 2018-07-13'*. (Appendix A)

Further discussions have taken place between the M42 design team and the Leeds Water team. As seen in drawing HE551485-ACM-HDG-M42_GEN_ZZ_ZZ-SK-CD-0008-P02 (Appendix A), the proposed slip road toward Junction 6 encroaches into an EA Flood Zone 3. In addition, reed beds have been proposed to provide surface water runoff treatment, however these have been place within the EA Flood Zone 3 also.

2 Scope

Due to the available flood storage being reduced, as part of the M42 upgrades (as discussed above) the M42 design team are required to provide compensatory storage. However, a number of uncertainties with the accuracy of the EA flood mapping have been highlighted. Leeds Water team have been tasked with undertaking a high level calculation to assess the capacity of the Hollywell Brook, and to determine if it overtops during the below specified events.

3 Methodology and data

The Hollywell brook is under the influence of the Humber river basin district. Therefore, will be assessed by the following Annual Exceedance Probability (AEP) plus climate change (CC) as recommended by the Environment Agency[1].

Table 1. AEP + Climate change assessments

Flood zone	Infrastructure classification	AEP% + CC
3a	Essential infrastructure	1% AEP + 50% CC
3a	Less vulnerable	1% AEP + 30% CC

[1]Environment Agency. Flood risk assessments: climate change allowances. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#what-climate-change-allowances-are

Manning's open channel flow equation has been used to evaluate the capacity of the Hollywell brook. The topographical data was provided by the M42 design team. The channel's cross sectional shape is similar to a trapezoid shape, therefore a trapezoidal channel has been assumed in the calculations.

A manning's 'n' value of 0.04 has been chosen, which reflects a sluggish natural channel. A 90 m length, downstream of the culvert under the M42 was sampled to calculate the slope of the brook. This slope is consistent with the downstream cross section modelled in the HS2 London – West Midlands Environmental Statement[2].

Table 2. Key Data (90m length downstream sample)

Channel Dimension	Value
Upstream Bed Level	86.40 m AOD
Downstream Bed Level	85.97 m AOD
Length of Channel	90.00 m
Channel Gradient	1 : 205 m
Base width of Channel	2.40 m
Depth of Channel	2.20 m (with 0.3m freeboard)
Gradient of side slope of Channel	1 : 0.70 m

4 Outputs

As seen in Appendix B the capacity of the Hollywell brook has been calculated to be **16.20 m^3/s**. This capacity was compared against the assessed flow rates for the Hollywell Brook sourced from the HS2 London – West Midlands Environmental Statement. These flow rates are shown in Table 3.

Table 3. Peak Flow calculations

AEP% + CC	Flow (m^3/s)
1% AEP + 30% Climate Change	5.70
1% AEP + 50% Climate Change	**6.60**

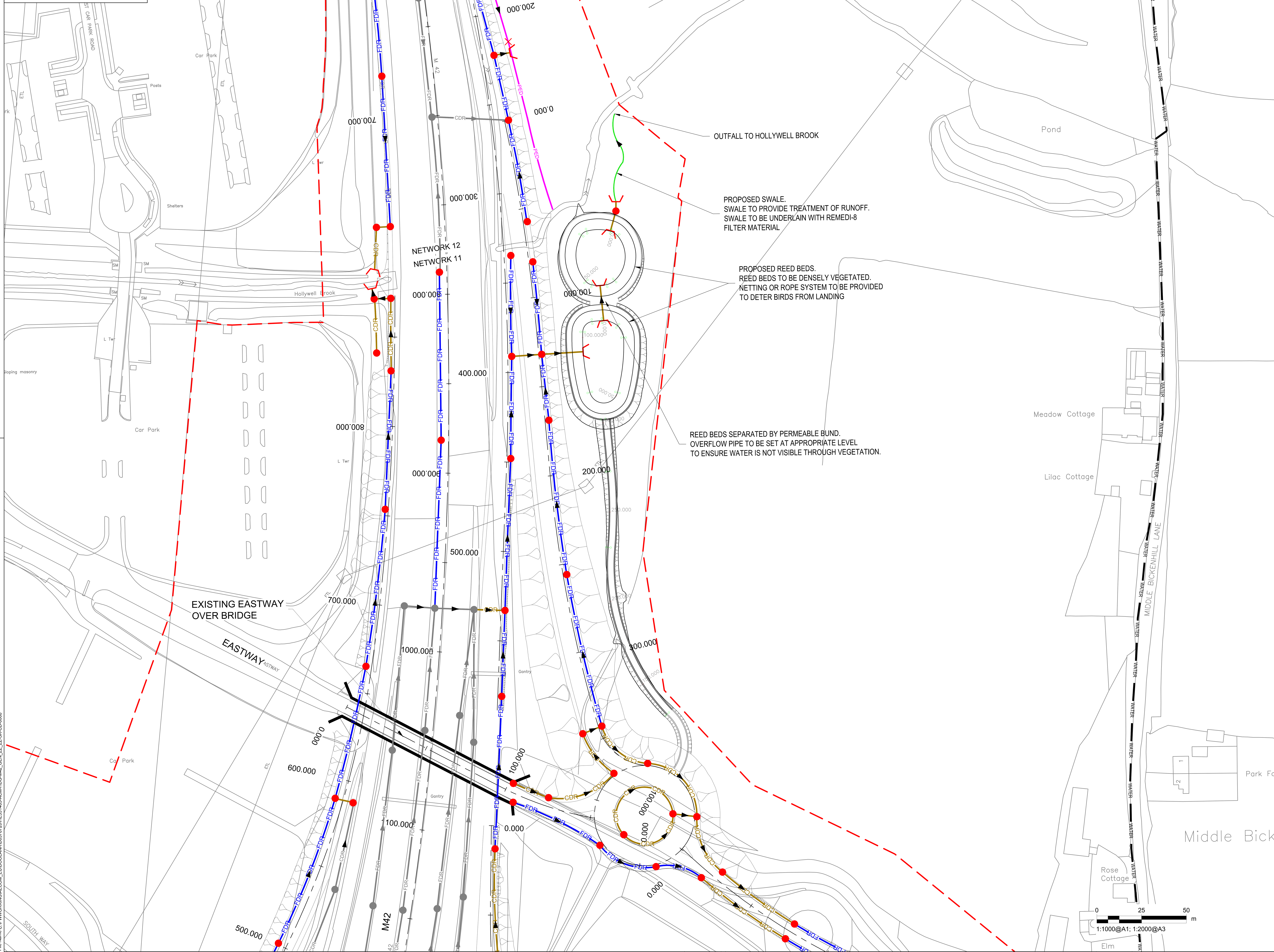
As seen in Appendix C when the flow rate of 6.60 m^3/s was achieved, the depth of flow within the brook was approximately 1.34 m. As a result, this provided a freeboard 1.16 m. It is therefore not expected that the brook will overtop during the 1% AEP + 50% Climate Change event.

5 Further Actions

To confirm the true accuracy of the EA Flood Zone 3's extents, a more detailed hydraulic model is required. The hydraulic model will assess the Hollywell Brook during the 1% AEP + 50% CC scenario. The above calculations do not consider downstream constrictions that may result in overtopping and out of bank flooding. There is a road culvert downstream that constricts flow and could result in flooding. It is recommended that AECOM open discussion with HS2 about the using their current hydraulic model, which already include both the downstream storage pond and the under road culvert.

[2] HS2. (2013). London - West Midlands Environmental Statement. Volume 5 | Technical Appendices, p.27. Available at: http://webarchive.nationalarchives.gov.uk/20140613023457/http:/assets.dft.gov.uk/hs2-environmental-statement/volume-5/water/Vol5_CFA2324_Water_resources_River_modelling_technical_report_WR-004-018.pdf

Appendix A



N

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4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE PROJECT HEALTH & SAFETY FILE FOR ANY IDENTIFIED POTENTIAL RISKS.

LEGEND

- EXTENT OF SCHEME
- CDR PROPOSED CARRIER DRAIN
- FDR PROPOSED FILTER DRAIN
- PROPOSED SWALE
- PED PROPOSED PRE-EARTHWORKS DITCH
- BKD PROPOSED BRIDGE KERB DRAIN
- CDR EXISTING CARRIER DRAIN
- FDR EXISTING FILTER DRAIN
- PROPOSED CHAMBER
- EXISTING CHAMBER
- OPEN CHANNEL POINT
- FLOW ARROW
- HEADWALL
- PROPOSED STRUCTURE
- DB DETENTION BASIN

N8/3.000/225 — NETWORK, PIPE NUMBER, PIPE DIAMETER

KEYPLAN

Revision Details	By	Check	Date	Suffix
First Issue	RD	JF	07/06/18	P01

Purpose of issue

FOR REVIEW AND COMMENT

Client

Highways England
The Cube
199 Wharfside Street
Birmingham
B1 1RN
0

Working on behalf of highways england

Project Title

M42 JUNCTION 6 IMPROVEMENTS

Drawing Title

M42 JUNCTION 6 STORAGE ALTERNATIVES NETWORK 11 REED BEDS & SWALE

Designed	Drawn	Checked	Approved	Date
RD	---	---	---	05/07/18

Internal Project No.	Suitability
60543032	S3

Scale @ A1	Zone
1:1000	M42

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Registered in England Registered number: 880328
Registered office: Scott House, Alencon Link, Basingstoke, Hampshire RG21 7PP

Drawing Number

Highways England PIN | Originator | Volume
HE551485 -ACM -HDG -
M42_GEN_ZZ_ZZ -SK -CD -0008
Location | Type | Role | Number

Rev P02

Appendix B

Mannings calculation - Open channel flow

Spreadsheet Originator / creator:	Adrian Hill	Date:	19/03/2014
Calculation undertaken by:	DH	Date:	20/07/2018
Checked by:	CI	Date:	23/07/2018
Approved (for use) by:		Date:	

Project: **M42**

Project no: **60543032**

Description: **High level channel capacity analysis**

Option: **Full capacity check**

Mannings equation

$$V = \frac{k}{n}\left(\frac{A}{P}\right)^{2/3} S^{1/2}$$

Key:

Cells which require user input

Cells with inbuilt formulas or cells which do not require user input

Superelevation at bends

rc =	1000	Radius of curvature to the centerline of the channel, m
ro =	1002.95	Radius of curvature to the outside flow line around the bend, m
ri =	997.05	Radius of curvature to the inside flow line around the bend, m (ft)
ΔZ/2 =	0.001	**m (unlined channel)**
ΔZ/2 =	0.001	**m (lined channel)**

$$\Delta Z = Z_o - Z_i = \frac{V^2}{g r_c}(r_o - r_i)$$

$$\Delta Z = \frac{V_{max}^2}{2g}\left\{2 - \left(\frac{r_i}{r_c}\right)^2 - \left(\frac{r_c}{r_o}\right)^2\right\}$$

Change in velocity at bends

% change	0%	1.87	**m/s (outer bend)**
		1.86	**m/s (inner bend)**

V = **1.87** **m/s (centre line of channel)**

Vc = (g*dm)^0.5 =	3.94	**m/s**
Froude number =	**0.47**	(Non-dimensional)

Q = VA

Q = **16.20** **m3/s**

(select from drop down list)

Manning's variations (Click on +/- button to expand / contract)

Flow variations (Click on +/- button to expand / contract)

Where		Values used		or User defined
Type of structure	single channel/culvert	(select from drop down list for type of channel)		
n =	0.0400 Natural channels - sluggish, deep pools	0.0400	(select from drop down list). Mannings n (see table)	**0.0350**
R =	Trapezoidal channel	(select from drop down list for type of channel) Hydraulic radius = A/P		
So =	0.0048	Use So calculator		

So calculation

86.40	m AOD - Bed level at point A
85.97	m AOD - Bed level at point B
90.00	m - Distance between point A and point B
205.00	Channel gradient (1 in)

Values of R

Data for rectangular and trapizoidal channels only channel

2.40	Base width of channel (b)
2.20	Depth of flow (y)
2.50	Depth of channel / culvert
0.70	gradient of side slope of channel (x)

5.90	m Top width of channel (inner face to inner face)
0.30	m Freeboard
0.30	m Freeboard (with super elevation at bends - worst case)

Channel type	**A**	**P**	**R**	**B**	**dm**	**Channel width**
Rectangular channel	5.28	6.80	0.78	2.40	2.20	2.40
Trapezoidal channel	8.67	7.77	1.12	5.48	1.58	5.90
User defined	345.00	94.00	3.67	100.00	3.45	100.00

Table of typical Maning values (taken from Hydraulics in Civil and Environmental Engineering, 2nd edition) - (Click on +/- button to expand / contract)

Appendix C

Mannings calculation - Open channel flow

Project:	**M42**	Spreadsheet Originator / creator:	Adrian Hill	Date:	19/03/2014
Project no:	**60543032**	Calculation undertaken by:	DH	Date:	20/07/2018
Description:	**High level channel capacity analysis**	Checked by:	CI	Date:	23/07/2018
Option:	**1% AEP + 50% CC check**	Approved (for use) by:		Date:	

Mannings equation

$$V = \frac{k}{n}\left(\frac{A}{P}\right)^{2/3} S^{1/2}$$

Key:

- Cells which require user input
- Cells with inbuilt formulas or cells which do not require user input

Superelevation at bends

rc = 1000 Radius of curvature to the centerline of the channel, m

ro = 1002.95 Radius of curvature to the outside flow line around the bend, m

ri = 997.05 Radius of curvature to the inside flow line around the bend, m (ft)

ΔZ/2 = 0.001 **m (unlined channel)**

ΔZ/2 = 0.001 **m (lined channel)**

$$\Delta Z = Z_o - Z_i = \frac{V^2}{g r_c}(r_o - r_i)$$

$$\Delta Z = \frac{V_{max}^2}{2g}\left\{2 - \left(\frac{r_i}{r_o}\right)^2 - \left(\frac{r_c}{r_o}\right)^2\right\}$$

Change in velocity at bends

% change 0% 1.49 **m/s (outer bend)**

1.48 **m/s (inner bend)**

V = **1.48** **m/s (centre line of channel)**

Vc = (g*dm)^0.5 = 3.20 **m/s**

Froude number = **0.46** (Non-dimensional)

Q = VA

Q = **6.60** **m3/s**

(select from drop down list)

Manning's variations (Click on +/- button to expand / contract)

Flow variations (Click on +/- button to expand / contract)

Where		Values used		**or User defined**
Type of structure	single channel/culvert	(select from drop down list for type of channel)		
n =	0.0400 Natural channels - sluggish, deep pools	0.0400	(select from drop down list). Mannings n (see table)	**0.0350**
R =	Trapezoidal channel	(select from drop down list for type of channel) Hydraulic radius = A/P		
So =	0.0048	Use So calculator		

So calculation

86.40	m AOD - Bed level at point A
85.97	m AOD - Bed level at point B
90.00	m - Distance between point A and point B
205.00	Channel gradient (1 in)

Values of R

Data for rectangular and trapizoidal channels only channel

2.40	Base width of channel (b)	5.90	m Top width of channel (inner face to inner face)
1.34	Depth of flow (y)	1.16	m Freeboard
2.50	Depth of channel / culvert	1.16	m Freeboard (with super elevation at bends - worst case)
0.70	gradient of side slope of channel (x)		

Channel type	**A**	**P**	**R**	**B**	**dm**	**Channel width**
Rectangular channel	3.21	5.07	0.63	2.40	1.34	2.40
Trapezoidal channel	4.46	5.66	0.79	4.27	1.04	5.90
User defined	345.00	94.00	3.67	100.00	3.45	100.00

Table of typical Maning values (taken from Hydraulics in Civil and Environmental Engineering, 2nd edition) - (Click on +/- button to expand / contract)

Appendix C – ReFH2 Rate for Hollywell Brook

AECOM

Revitalised Flood Hydrograph (ReFH2) Method

Flood Estimates from the ReFH2 Method

Return Period	Site Code						
	Hollywell	A45 Drain	Bickenhill				
2	1.51	0.24	0.12				
5	2.01	0.33	0.17				
10	2.41	0.40	0.21				
20	2.86	0.47	0.25				
25	3.03	0.50	0.26				
30	3.18	0.52	0.28				
50	3.63	0.60	0.32				
75	4.05	0.66	0.35				
100	4.38	0.71	0.38				
200	5.29	0.86	0.46				
1000	7.76	1.25	0.67				

The ReFH2 FEH 2013 model peak flows are based on the 'urbanised' design rainfall, rather than the 'as rural' design rainfall/flow.
All flow rates are in m3/s

Appendix D – Highway England's Survey of Existing M42 Culvert

HIGHWAYS AGENCY

Culvert 11 Holywell Brook

ROADS 277 (smis)

HA Structure No.	**/M42//32.90/Q/**	HA ST Key	**24377**	Year Structure Commissioned	**1976**
O/S Grid Ref. (E/N)	**419890 /283640**	MA Structure Ref		Design Office	**Not Known**
County/Borough	**Solihull**			Design Load	**HA + 45 HB**
Maintaining Region	**West Midlands**	Date of Production	**17/04/2018**	Special loading/restriction	**N/A**
Structure Agent	**Kier Highways - Area 9**	Date of Last Principal Inspection	**27/05/2016**		
Structure Owner (if not HA)	**Highways Agency**				
Assigned road	**M42**				

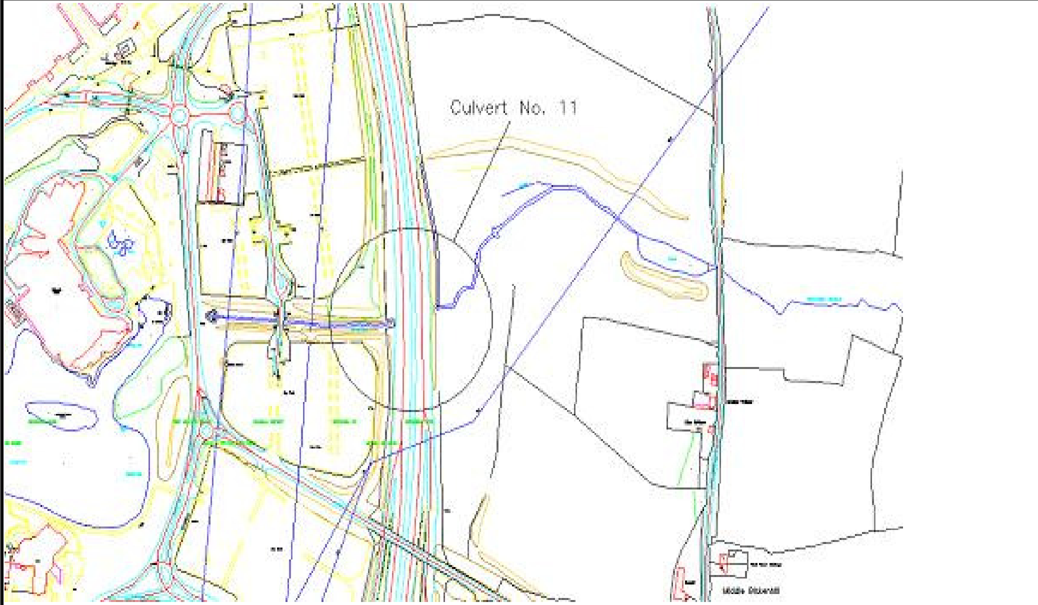
The **Road M42** goes **over Small Culvert**,authority **Highways Agency**
The **Natural Watercourse** goes **under Culvert 11 Holywell Brook**,**is not** tidal,**is not** navigable,authority **Environment Agency**

Structure Susceptible to Scour?	**N**
Structure on High Load Route?	**N**
Structure on Heavy Load Route?	**N**
Structure Ancient Monument?	**N**

SuperStructure Construction Details

Deck/Wall/Mast etc. Materials	**Corrugated Rolled Steel**
Type of Construction	**Corrugated Steel Buried Structure (CSBS) - Arch Profile With Footings**

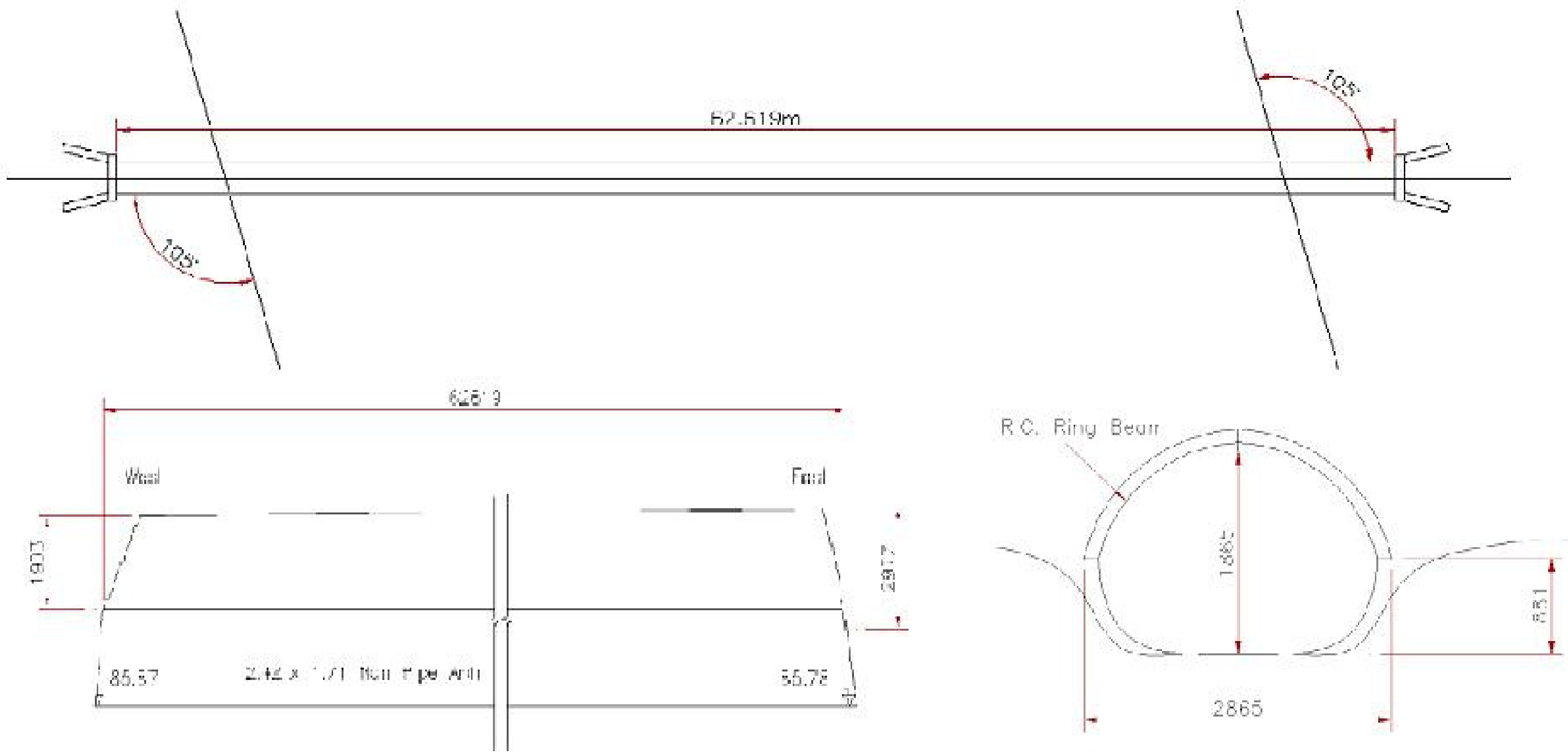
SubStructure Construction Details



HA ST Key 24377 This is produced from SMIS data current at Date of Production 17/04/2018

Culvert 11 Holywell Brook

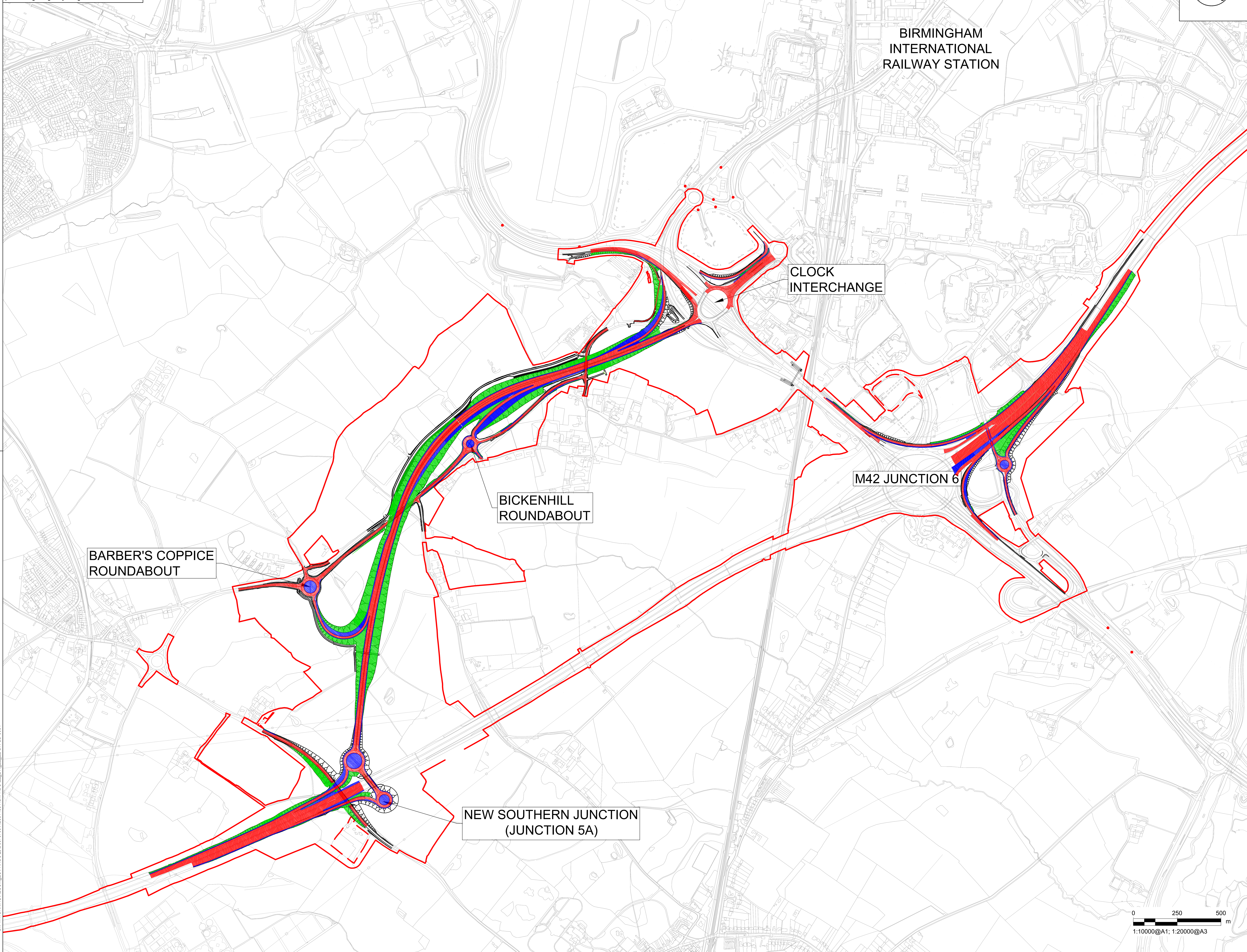
ROADS 277 (smis)



	Manufacturer	Type	Component	Manufacturer/Fabricator	Type

HA ST Key 24377 This is produced from SMIS data current at Date of Production 17/04/2018 aecom.com

APPENDIX G – PROPOSED DRAINAGE CATCHMENT AREAS



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LEGEND

- EXTENT OF SCHEME
- CARRIAGEWAY AREAS
- VERGE AREAS
- EARTHWORK AREAS

Revision Details	By / Check	Date	Suffix
First Issue	RD / JF	15/10/18	P01

Purpose of issue

FOR STAGE APPROVAL

Client
Highways England
Floor 5
Two Colmore Square
38 Colmore Circus
B4 6BN

Working on behalf of highways england

Project Title

M42 JUNCTION 6 IMPROVEMENT

Drawing Title

M42 JUNCTION 6 PROPOSED DRAINAGE CONTRIBUTING AREAS

Designed	Drawn	Checked	Approved	Date
RD	RD	JF	JF	15/10/18

Internal Project No.	Suitability
60543032	S4
Scale @ A1	**Zone**
1:15000	Scheme Wide General

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Registered in England Registered number: 880328
Registered office: Scott House, Alencon Link, Basingstoke, Hampshire RG21 7PP

Drawing Number
Highways England PIN | Originator | Volume
HE551485 -ACM -HDG - ZZ_SW_ZZ_ZZ -DR-CD-0004
Location | Type | Role | Number

Rev
P01

Plot Date : 14 December 2018 15:27:26
File Name C:\PWWORKING\AECOM_EU\FAROOQJ\D0376709\HE551485-ACM-HDG-ZZ_SW_ZZ_ZZ-DR-CD-0004