A6 to Manchester Airport Relief Road

Flood Risk Assessment

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STOCKPORT METROPOLITAN BOROUGH COUNCIL

MANCHESTER CITY COUNCIL

Cheshire East Council

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Executive Summary

AECOM has prepared this Flood Risk Assessment on behalf of the SEMMMS Project Team, in accordance with the requirements of the National Planning Policy Framework and the associated Technical Guidance, to support the three planning applications for the proposed A6 to Manchester Airport Relief Road.

The proposed scheme comprises a 14km highway which runs from the A6 at Hazel Grove, through to Ringway Road adjacent to Manchester Airport. Approximately 10km is new construction and approximately 4km covers an existing section of the A555. The proposed route passes through predominantly greenfield land, apart from the section where the route encompasses the existing A555.

In undertaking this Flood Risk Assessment AECOM has consulted with all appropriate parties to obtain information relevant to flood risk and confirm their requirements. These include: the Environment Agency, Stockport Metropolitan Borough Council, Cheshire East Council, Manchester City Council, and United Utilities. AECOM has also undertaken site walkovers to gain an appreciation of the route's features in regards to flood risk and obtain further information to support this study.

The report has considered all potential sources of flooding to the development including sea, river, groundwater, land drainage, overland flow, artificial sources, water mains, sewers and surface water drainage arrangements. Climate change has also been considered, which is projected to increase the peak rainfall intensity by 20% and increase the peak river flow by up to 20% over the lifetime of the development.

Examination of the current Environment Agency flood map confirms the route to be located predominantly in Flood Zone 1, with isolated sections in Flood Zone 2. As the vulnerability of the proposed highway scheme, based on the guidance given in the National Planning Policy Framework Technical Guidance, is predominantly 'Essential Infrastructure' with some 'Water Compatible' features, the highway scheme is considered appropriate within the planning context without the need for the Exception Test.

The route lies in a protected corridor identified for such a scheme, and is predominantly located in Flood Zone 1; It is therefore expected that the Sequential Test is considered to be passed for the scheme.

The report identifies a number of potentially significant flood risk sources which may affect or be affected by the proposed highway. The report demonstrates that it is possible to mitigate these risks by the application of appropriate design principles and through adequate maintenance following construction. These potential sources of risk include:

- The proposed realignment of Ox Hey Brook;
- The proposed realignment of Norbury Brook;
- The direct fluvial flood risk from Norbury Brook;
- The proposed bridge crossings of Norbury Brook;
- The direct fluvial flood risk from Spath Brook;
- The direct fluvial flood risk from other Ordinary Watercourses along the route;
- Flooding from public sewers;
- Flooding from existing highway drainage;
- Flooding from Overland flows (pluvial flooding);
- Groundwater flooding; and
- The culverting of existing watercourses and land drains.

Within the report it has been demonstrated that disposal of surface water from the proposed highway is possible, using Sustainable Drainage Systems (SUDS) where appropriate, and that any proposed systems can be managed sustainably and appropriately to ensure the risk of surface water flooding is low and acceptable. The proposed surface water drainage strategy has been developed to manage surface water from the highway in a manner which ensures that the highway itself is adequately protected from flooding, whilst also ensuring that the scheme will not cause an increase in flood risk elsewhere. The developer will need to agree the final proposed drainage arrangements in advance of construction with the Local Authorities, United Utilities and/or the Environment Agency as necessary.

Based on the assessment, AECOM considers that the flood risk from all sources, to and from the proposed development is low and acceptable or can be mitigated to a low and acceptable level. The mitigation measures and recommendations outlined within this report are designed to protect both the users of the highway and surrounding areas, and the highway itself from the effects of flooding.

The report also incorporates an assessment of potential culverting requirements with respect to flood risk, and calculation of minimum culvert sizes along the route.

1 Introduction to the Report

AECOM has been commissioned by the SEMMMS Project Team, on behalf of Stockport Metropolitan Borough Council (SMBC), Cheshire East Council (CEC) and Manchester City Council (MCC), to undertake a Flood Risk Assessment (FRA) to support the three planning applications for the proposed A6 to Manchester Airport Relief Road.

1.1 Basis of Report

This report assesses the proposed 14km highway which runs from the A6 at Hazel Grove, through to Ringway Road adjacent to Manchester Airport. Approximately 10km is new construction and approximately 4km covers an existing section of the A555. A plan of the proposed route is contained in Appendix A1 and an overview given in Figure 1. This report has been prepared with reference to the scheme proposals as of September 2013.

This study has been undertaken in accordance with the requirements of the National Planning Policy Framework (Communities and Local Government; March 2012) (NPPF), and the supporting Technical Guidance to the National Planning Policy Framework (Communities and Local Government; March 2012).

This study supersedes the previous FRA undertaken for the proposed A555 (South East Manchester Multi-Modal Strategy A555 Flood Risk Assessment; Faber Maunsell; July 2006).

1.2 Purpose of Study

The objective of this report is to assess four main issues in relation to flood risk:

- Acceptability of the proposed highway in accordance with planning policy;
- Risk to the proposed highway and users of the proposed highway from all forms of flooding;
- Risk of increasing flooding elsewhere due to construction of the proposed highway (resulting from increased surface water runoff, changes in flood routing through the proposed development and loss of flood plain storage); and
- Appropriate mitigation measures to limit the impact of flooding on the proposed highway and off-site flooding.

As part of this commission, AECOM has also undertaken a review of locations along the route where the culverting of existing land drains or small watercourses may be required. The review considered the requirements for culverting at each location, from a flood risk perspective, and included calculation of indicative minimum size for each culvert. The results of this study are reported in full in Appendix C.

1.3 Basis of Assessment and Safeguards to Design Development

The assessment has been undertaken to support the full planning applications for the A6 to Manchester Airport Relief Road and offers a robust analysis of flood risk with respect to the proposals, as required by NPPF. The assessment is based on the available design detail at the current stage of design development; It must be recognised that future design stages prior to construction will provide greater detail on some aspects of the scheme and proposed infrastructure, with such future design stages being reasonably undertaken after planning permission has been granted.

Therefore, any reference herein to further assessment or specific design which is to be undertaken at the ‘detailed design’ stage does not constitute an inadequate assessment at this stage, but a commitment to ensure that the principles set out herein are included in the ‘detailed design’ so that flood risk impacts of the scheme remain low and acceptable as the detailed design is developed.

It should also be noted that further to the assessment undertaken within this report and any recommendations made for further work, any potential flood risk associated with works to watercourses is safeguarded by the requirement to obtain consent for the permanent and temporary works, either from the Environment Agency (EA) or the Lead Local Flood Authority (LLFA) as detailed in Section 6.1. Appropriate consents will be obtained prior to construction with each consent application being informed by more detailed assessment if deemed to be required by the consenting authority at that stage.

1.4 Sources of Information

The assessment is based on a desk-top study of information listed within the References section. In addition to the desk-top study, a site visit was carried out (See Photographs in Appendix A2) and consultation was undertaken with the following parties:

- The Environment Agency;
- Stockport Metropolitan Borough Council (SMBC);
- Cheshire East Council (CEC);
- Manchester City Council (MCC);
- The operator of Bramhall Oil Terminal; and
- United Utilities (UU).

A summary of consultation outcomes is included in Appendix E.

1.5 Structure of Report

Section 1 provides an introduction to this FRA. This section explains the reasons for undertaking the report, the structure of this FRA, and provides an introduction to flood risk.

Section 2 provides an introduction to the current national and local planning policy on development and flood risk.

Section 3 details the proposed scheme and local hydrology.

Section 4 considers the drainage arrangements for the proposed development. The drainage assessment is based on the requirements of the NPPF, and outlines the surface water drainage strategy and use of SUDS.

Section 5 considers the flood risk from all sources associated with the proposed development, and the potential for the development proposals to impact on flood risk. The assessment of flood risk is based on the requirements of the NPPF, and uses all the information gathered as part of the FRA. This section also considers the construction proposals in relation to the current national and local planning policy on development and flood risk.

Section 6 identifies practical measures which can be introduced to ensure that the flood risks identified can be mitigated to a level which is low and acceptable.

Section 7 provides a summary and recommendations for further work, based on all the work undertaken as part of the FRA.

Appendix A sets out background information on the route and proposals, including site walkover photographs.

Appendix B details the methodology and results for the hydraulic modelling of Norbury Brook.

Appendix C details the assessment and treatment of land drains identified along the route, and the methodology used for sizing the necessary culverts on the small watercourses and drains which pass beneath the proposed highway.

Appendix D summarises the requirements of individual local planning policies on flood risk.

Appendix E details the information gathered through the consultation process. In order to obtain further information on flood risk, consultation was undertaken with the Environment Agency, the Local Authorities, and other relevant parties.

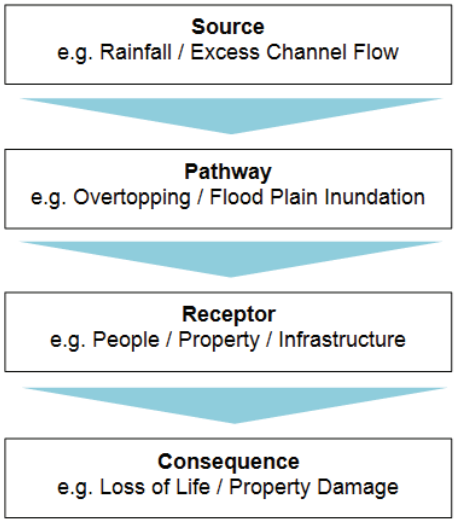
1.6 Flood Risk Introduction

Flood risk takes account of both the probability and the consequences of flooding.

Flood risk = probability of flooding x consequence of flooding

Probability of flooding is usually interpreted in terms of the return period, e.g. 1 in 100 and 1 in 200 year event etc. In terms of probability, there is a 1 in 100 (1%) chance of one or more 1 in 100 year floods occurring in a given year. The consequence of flooding depends on how vulnerable a receptor is to flooding.

The components of flood risk can be considered using the source-pathway-receptor-consequence model:



2 Planning Context

2.1 National Planning Policy: NPPF

The NPPF and the associated Technical Guidance is the current guide on national planning policy in respect to flood risk. Together these documents provide guidance on how to evaluate sites with respect to flood risk.

A summary of the requirements of the NPPF and the Technical Guidance is provided below.

2.1.1 Sources of Flooding

The NPPF Technical Guidance requires an assessment of flood risk to consider all forms of flooding, and lists six forms of flooding that should be considered as part of a flood risk assessment: Flooding From Rivers (Fluvial Flooding), Flooding From the Sea (Tidal Flooding), Flooding from Land (Pluvial Flooding), Flooding from Groundwater, Flooding from Sewers, and Flooding from Other Artificial Sources (i.e. reservoirs, canals, lakes and ponds).

2.1.2 Flood Zones

For river and sea flooding, the NPPF Technical Guidance uses four Flood Zones to characterise flood risk which are also used by the EA. These Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences, and not including for the projected effects of climate change.

- **Flood Zone 1:** Low probability (less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%))
- **Flood Zone 2:** Medium probability (between 1 in 100 and 1 in 1,000 annual probability of river flooding (1%-0.1%)or between 1 in 200 and 1 in 1,000 annual probability of sea flooding(0.5%-0.1%) in any year).
- **Flood Zone 3a:** High probability (1 in 100 or greater annual probability of river flooding (>1%)in any year or 1 in 200 or greater annual probability of sea flooding (>0.5%) in any given year).
- **Flood Zone 3b:** This zone comprises land where water has to flow or be stored in times of flood. Land which would flood with an annual probability of 1 in 20 (5%), or is designed to flood in an extreme flood (0.1%) should provide a starting point for discussions to identify functional floodplain.

2.1.3 Vulnerability and Compatibility

The NPPF Technical Guidance classifies the vulnerability of developments to flooding into five categories. These categories are summarised in Table 1.

Table 1: Flood Risk Vulnerability Classification (Adapted from the NPPF Technical Guidance, Table 2)

Flood Risk Vulnerability Classification	Examples of Development Types
Essential Infrastructure	- Transport Infrastructure - Utility Infrastructure (e.g. grid and primary sub stations, water treatment works)
Water Compatible	- Flood Control Infrastructure - Water and Sewerage Infrastructure - Navigation Facilities
Highly Vulnerable	- Emergency Services which are required in times of flood - Basement Dwellings - Mobile home parks - Installations requiring hazardous substances consent
More Vulnerable	- Hospitals and other health services - Residential Establishments - Educational Establishments - Landfill and hazardous waste management facilities - Caravan and camping sites
Less Vulnerable	- Commercial Establishments (e.g. shops, restaurants and offices) - Emergency Services which are not required in times of flood - Agriculture and forestry land

Based on the vulnerability of a development, the Technical Guidance states what Flood Zone(s) the development is appropriate within. The flood risk vulnerability and Flood Zone 'compatibility' of developments is summarised in Table 2.

Table 2: Flood Risk Vulnerability and Flood Zone Compatibility (Extract from the NPPF Technical Guidance, Table 3)

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test required	✓	✓
	3a	Exception Test required	✓	×	Exception Test required	✓
	3b	Exception Test required	✓	×	×	×

Key to Table 4: ✓ Development is appropriate × Development should not be permitted

2.1.4 The Sequential Test, Exception Test and Sequential Approach

The Sequential Test is a risk-based test that should be applied at all stages of development and aims to steer new development to areas with the lowest probability of flooding. It should be demonstrated that there are no other suitable sites in lower flood risk zones. For strategic sites, this is applied by the Local Planning Authority by means of a Strategic Flood Risk Assessment (SFRA).

The SFRA and NPPF may require the Exception Test to be applied to certain forms of new development. The test considers the vulnerability of the new development to flood risk and, to be passed, must demonstrate that:

i. There are sustainability benefits that outweigh the flood risk;
ii. The new development is safe and does not increase flood risk elsewhere.

The Sequential Approach is also a risk based approach to development. In a development site located in several Flood Zones or with other flood risks, the sequential approach directs the most vulnerable types of development towards the areas of least risk within the site.

2.1.5 Climate Change

The NPPF and Technical Guidance make it a planning requirement to account for climate change in the proposed design. The recommended allowances are summarised in Table 3 below.

Table 3: Climate Change Allowances (Extract from the NPPF Technical Guidance, Table 35)

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

Note: A new set of climate change projections (known as UKCP09) were published in 2009, however guidance on their application in flood risk and coastal management has not yet been produced by Defra

2.1.6 Sustainable Drainage

The key planning objectives in the NPPF are to appraise, manage and where possible, reduce flood risk. Sustainable Drainage Systems (SUDS) provide an effective way of achieving some of these objectives, and the NPPF and Volume 4 of the Design Manual for Roads and Bridges (DMRB) directs developers towards the use of SUDS wherever possible.

The Floods and Water Management Act 2010 also reinforces the requirements for SUDS to be implemented where practicable. When fully implemented, the above act requires Local Authorities to act as SUDS Approval Bodies, which will be responsible for reviewing drainage designs and ensuring that the development incorporates SUDS where practicable.

The NPPF states a hierarchy of where surface water should be discharged. This should be followed were practicable, and is listed below:

1) Infiltration
2) Watercourses
3) Public Sewers

2.2 Local Planning Policy and Guidance

Local planning policy and guidance relating to flood risk has been considered as part of this assessment. The proposed highway extends through three Local Authority areas: Stockport Metropolitan Borough Council; Cheshire East Council; and Manchester City Council. The local authority boundaries are as indicated on the plan in Appendix A1.

A full review of local planning policy requirements is included in Appendix D.

From the local planning policy review it can be summarised that the following requirements will apply to the development:

- Development must be in accordance with the principles set out in national planning policy – i.e. the development must not increase flood risk elsewhere and must not be at significant risk of flooding;
- The development must not result in excessive culverting and should not hinder future access to watercourses for maintenance;
- The use of SUDS is to be considered where practicable;
- The development must not result in a loss of floodplain or affect the integrity of existing flood defences; and
- Development must not significantly increase surface water runoff, notably:
  - Where development is on ‘greenfield’ land the rate of runoff to local watercourses must not be increased;
  - Where the highway replaces an existing ‘brownfield’ development (notably along Styal Road, Ringway Road and Ringway Road West, which are within the South Manchester and Trafford Critical Drainage Area), there should be an aim to reduce surface water discharge by at least 50%, with reduction to the equivalent greenfield runoff rate if practicable.

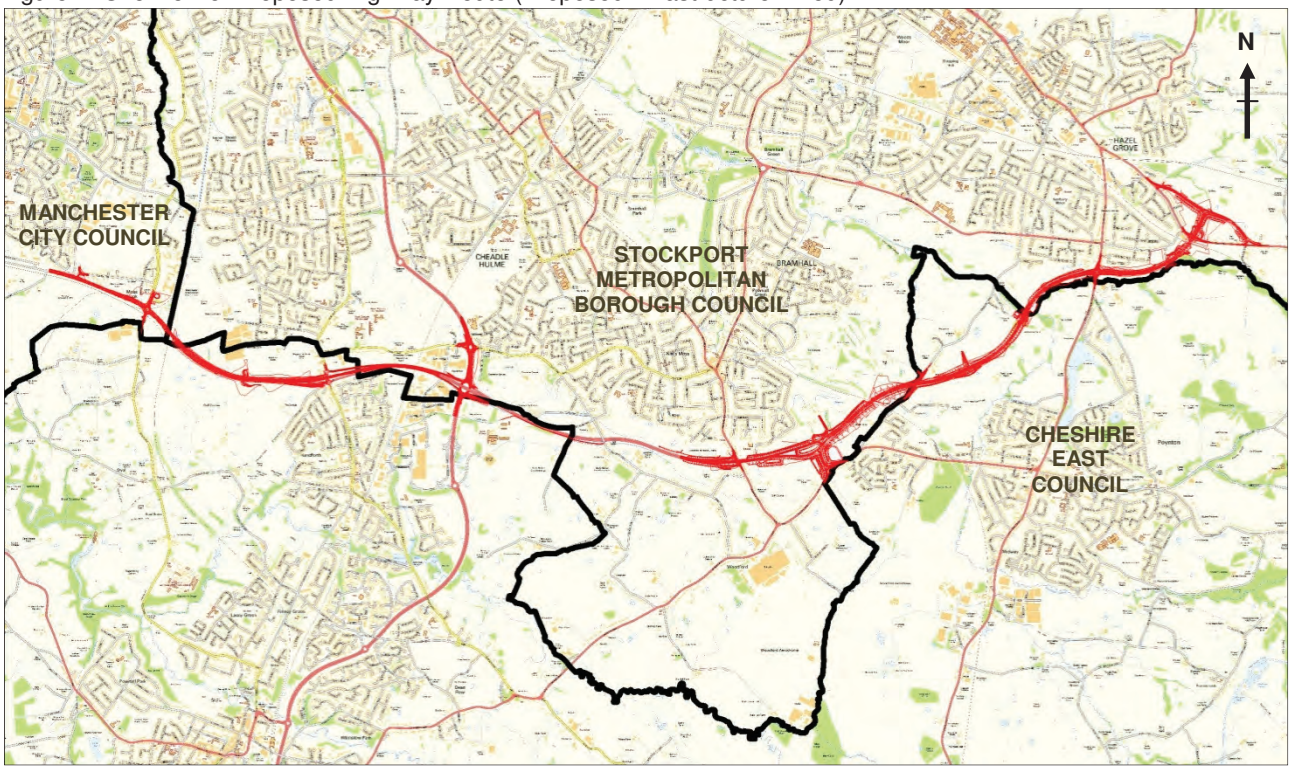
A review of the Strategic Flood Risk Assessment (SFRA) for the three Local Authority areas was also undertaken, relevant details from which are summarised within the appropriate sections of the report.

3 Background Information

3.1 Proposed Scheme

The proposals are to construct the A6 to Manchester Airport Relief Road, as shown in Figure 1. A more detailed route plan indicating the location of key features in relation to flood risk is included in Appendix A1, and site walkover photographs to support the descriptions are included in Appendix A2.

Figure 1: Overview of Proposed Highway Route (Proposed infrastructure in red).



The proposed highway passes through predominantly greenfield land, apart from 4km (approximately) where the route encompasses the existing A555. The route is approximately 14km long and approximately 10km of this route is new highway.

3.1.1 Proposed Infrastructure

The proposed scheme includes the following specific features (from east to west along the route):

- New alignment of the A6 leading to the start of the new highway;
- Realignment of Ox Hey Brook to accommodate realigned A6 carriageway;
- Underpass beneath current A6;
- Underpass beneath Hazel Grove and Buxton railway line;
- Realignment of one meander of Norbury Brook to accommodate new highway;
- At-grade signalised junction at A523 Macclesfield Road incorporating widening of Norbury Bridge;
- Bridge crossing of Norbury Brook;
- Underpass beneath Woodford Road, Poynton;
- Bridge over the West Coast Mainline;
- Link road to junction with A5149 Chester Road;
- Underpass beneath A5102 Woodford Road and continuation onto existing A555;
- Improvements to existing A555/A34 junction;
- Improvements to existing A34/Stanley Road junction;

- Continuation from existing A555, by underpass and junction from B5358 Wilmslow Road;
- Bridge crossing of Crewe to Manchester railway line;
- At-grade signalised junction at B5166 Styal Road;
- Bridge crossing of Manchester Airport railway spur; and
- Continuation onto the improved Ringway Road.

Attenuation ponds/basins are also proposed as part of the drainage infrastructure, located beside the proposed highway as indicated in the plan in Appendix A1.

3.2 Existing Hydrology

The proposed route is in close proximity to the following significant watercourses (from east to west along the route):

- **Ox Hey Brook/Threaplehurst Brook**: At the eastern end of the route the Ox Hey Brook flows from east to west across the existing Hazel Grove Golf Club, and is impacted on by the proposed highway alignment. The Ox Hey Brook is an Ordinary Watercourse according to the EA, and is a tributary of the Threaplehurst Brook. Threaplehurst Brook is designated as a Main River by the EA designated, and is located approximately 500m north of the proposed highway.
- **Norbury Brook**: After crossing the existing A6, the proposed highway route follows the Norbury Brook (a Main River) closely for approximately 4km. The footprint of the proposed highway impacts on one meander of Norbury Brook in this vicinity. Norbury Brook flows in a well defined river valley from east to west, and is in a relatively deep cutting at the location of the interface with the proposed highway.
- **Norbury Brook/ Poynton Brook**: The proposed route crosses Norbury Brook to the west of its confluence with Poynton Brook.
- **Spath Brook**: Near to the centre of the route, Spath Brook crosses beneath the existing A555 twice.

In addition to these defined watercourses there are a number of land drains (small watercourses or drainage ditches) which cross the proposed route or are located in close proximity to it. These have been inspected on site, and the treatment of these drains within the scheme and the flood risk associated with each is discussed in Appendix C.

3.3 Lifetime of the Development and Climate Change Allowance

The NPPF requires climate change to be taken into account in drainage design and the assessment of flood risk. According to the NPPF Technical Guidance (Table 5), rainfall intensity is estimated to increase by 20% until 2085 to allow for climate change. Beyond this, it is expected there will be up to 30% increase in rainfall intensity.

It is understood that the design life of the proposed highway will be less than 75 years, and that therefore an allowance of an additional 20% on rainfall intensity will be applicable. This is in accordance with recommendations of the DMRB, and will be formally agreed with the EA before detailed design.

In accordance with Table 5, an allowance for an increase of 20% on river flows will be allowed in any assessment of watercourses.

4 Drainage Assessment

This drainage assessment seeks to demonstrate that the proposed development is able to discharge surface water flows without increasing the flood risk both on and off site. This assessment considers the following:

- Existing drainage arrangements;
- Proposed drainage arrangements;
- The implications of climate change; and
- The mitigation measures needed for surface water disposal.

The drainage scheme for the proposed highway has been developed to a preliminary design stage by AECOM in parallel to undertaking this FRA, to ensure that design is in accordance with all requirements of the EA and Local Authorities. The full details of the drainage strategy, including proposal drawings. are detailed in the A6 to Manchester Airport Drainage Strategy Report (AECOM, October 2013) ('the Drainage Strategy Report') which should be read in conjunction with this section.

4.1 Existing Drainage Arrangements

4.1.1 Existing Drainage Infrastructure

The existing section of the A555 which forms the centre of the proposed highway is served by two separate drainage systems which discharge via pumping stations to outfalls on Spath Brook. Details of the existing drainage systems have been provided to the drainage designers by CEC. It is understood that the A555 systems have 'spare' capacity, left for the purpose of draining additional highway area if the road were to be extended. The A555 drainage systems will therefore form a key part of the drainage design for the proposed sections of highway.

Along Styal Road and towards Ringway Road there is a combination of MCC highway drainage and UU public sewers facilitating drainage of the existing carriageway; discharge to these from the proposed highway has been considered.

At other highway interfaces, such as the A6, the A523 and the B5166, the existing highway drainage system has been considered for disposal of surface water from the revised existing highways only.

4.1.2 Existing Catchments

The existing surface water catchments along the route have been identified by the drainage design team. As requested by the EA (see Appendix E) the existing catchments have been used to inform the design of the proposed drainage scheme, to ensure that there is no significant change to existing local flow routing.

4.2 Proposed Drainage Arrangements

4.2.1 Proposed Discharge Arrangements

As outlined in Section 2, the NPPF states a hierarchy of where surface water should discharge to, which should be followed where practicable.

4.2.1.1 Infiltration

The potential for infiltration is considered low based on the information provided in the A6 to Manchester Airport, Relief Road, Ground Investigation Report (AECOM, January 2011). Discharge will therefore be to watercourses where practical or public sewers if no suitable watercourse is available.

4.2.1.2 Watercourses

The proposed discharge arrangements along the route are discussed in full in the Drainage Strategy Report and indicated on Drawings 60212470-HIG-0531 and 60212470-HIG-0532 within Appendix A3.

Where a viable discharge to a watercourse has been identified, this has been incorporated following consultation and agreement in principle with the EA or Local Authority. Direct outfalls to Ox Hey Brook/Threaplehurst Brook, Norbury Brook, Lady Brook/Poynton Brook, and an unnamed watercourse are proposed.

In one location the proposed discharge is to a culvert/pipe which is believed to discharge to Gatley Brook. Although the EA have agreed in principle to this discharge, the Drainage Strategy Report identifies that further investigation of the ownership of the intermediate pipe is required at detailed design.

The discharge from the proposed drainage networks either side of the existing section of the A555 will be to Spath Brook via the existing A555 drainage system.

4.2.1.3 Public Sewers

Where there is no viable discharge to a suitable watercourse, discharge to public sewers has been specified in agreement with UU.

4.2.2 Earthworks Drainage

The A6 to Manchester Airport, Relief Road, Initial 'Geotechnical Design Report' (AECOM, January 2011) recommends a number of features and areas which will require earthworks drainage.

As noted in the Drainage Strategy Report, some of the proposed earthworks drainage will be discharged to a separate outfall and in this case will not be attenuated. This will reduce the online storage requirement without detrimental impact to the receiving watercourse, as the permeable earthworks replace existing permeable area which would naturally to drain to the nearest watercourse.

4.2.3 Climate Change

The NPPF requires climate change to be taken into account in drainage design and the assessment of flood risk. As detailed in Section 2.2, an allowance of an additional 20% on rainfall intensity has been applied during the drainage design.

4.2.4 Attenuation Requirements

4.2.4.1 Outfalls to Watercourses

It was agreed with the EA (Appendix E) that discharges to watercourses will be restricted to the equivalent greenfield runoff rate, based on the method described in the Institute Of Hydrology Report 124: Flood Estimation for Small Catchments (IH124 Method). Calculation of the allowable discharge for each proposed drainage network is included in the Drainage Strategy Report.

In accordance with the requirements of the DMRB, storage to cater for the 1 in 100 year plus 20% climate change return period storm event has been proposed upstream of any direct discharges to watercourses. Calculation of the required storage for each proposed drainage network is also included in the Drainage Strategy Report. This is the basis of the proposed flow rates and attenuation volumes from the new highway as it outfalls to the various watercourses.

As prescribed in the local SFRA, all surface water discharges within the MCC area should take into account the requirements of the South Manchester and Trafford Critical Drainage Area (CDA). This requires the designer to consider a reduction in surface water runoff rates from the existing situation. This will be comfortably achieved by the scheme where discharges are restricted to greenfield runoff rates.

4.2.4.2 Outfalls to Public Sewers and Highway Drainage

The attenuation requirements for discharges to public sewers and highway drainage are dependent on the requirements of those responsible for these assets. The rate of discharge to public sewers has been agreed in principle with UU. Discharge limits and subsequently required attenuation volumes for discharges into the existing A555 drainage systems are based on the available spare capacity in these systems and the rate at which surface water is discharged from them.

Storage to cater for the 1 in 30 year plus 20% climate change return period storm event is proposed upstream of any discharges to highway drainage or public sewers, and storage to cater for the 1 in 100 year plus 20% climate change

return period storm event upstream of any direct discharges to watercourses. Calculation of the required storage for each proposed drainage network is also included in the Drainage Strategy Report.

4.2.5 Sustainable Drainage Systems (SUDS)

As outlined in Section 2.1.6, the NPPF and Volume 4 of the Design Manual for Roads and Bridges (DMRB) direct developers towards the use of SUDS wherever possible. As noted previously in this document, the EA and the Local Authorities also encourage the use of SUDS.

Not all SUDS methods are suitable or necessary for all developments. Many factors, such as available space and ground conditions, will influence the choice of methods for a particular development.

A number of attenuation ponds are proposed for inclusion at strategic locations along the proposed route. The proposals also include attenuation and storage by means of tank sewers and cellular storage. The proposed locations of these are indicated on the drainage drawings within the Drainage Strategy Report.

5 Flood Risk Assessment

In accordance with the NPPF, flood risk must be assessed for all sources of flooding and development should be carried out in such a way as to mitigate any potential flood risk to both the Site and third parties and their property. This section identifies all potential sources of flooding and assesses the flood risk associated with each source of flooding based on the research undertaken specifically for this study.

An assessment of the acceptability of the proposed development in the planning context is included in Section 5.11.

5.1 Risk of Tidal Flooding

The route is not located in close proximity to any sea or tidally influenced watercourse. The risk of flooding from this source is therefore considered low and acceptable.

5.2 Risk of Fluvial Flooding

As described in Section 3.2, there are a number of points along the route which are in close proximity to watercourses, require the crossing of watercourses, or require the realignment of watercourses. Where these interactions occur there is a requirement to consider the risk to the proposed highway from the watercourse, and the potential for the proposals to increase flood risk from the watercourse. This section considers these risks.

In addition to this, the potential impact of the proposed discharge of surface water to watercourses along the route is considered within this section.

5.2.1 Ox Hey Brook

5.2.1.1 Realignment of Ox Hey Brook

The proposed route impacts upon the existing alignment of Ox Hey Brook, an Ordinary Watercourse, within the land currently occupied by Hazel Grove Golf Club. Realignment of a short stretch of Ox Hey Brook (as shown in Figure C1.1 in Appendix C1) is required to accommodate the proposed highway.

The realignment of any watercourses has the potential to affect the flow regime in the watercourse, which could potentially cause a flood risk upstream or downstream if flows are restricted or increased by the works.

The detailed design of this realignment must therefore be undertaken so as to maintain the existing channel capacity across the diverted section, thereby ensuring no increase in flood risk upstream or downstream of this location. Detailed survey of the cross section of the watercourse will be required to allow an assessment of channel capacity to be made and thereby inform the detailed design of the realignment. The proposed realignment will be subject to Land Drainage Consent being obtained from the LLFA (SMBC) prior to construction (see Section 6.1), and appropriate details of the proposed realignment will be agreed in full with the LLFA through this process.

Assuming implementation of the above, the risk of the proposed highway increasing flood risk from the Ox Hey Brook is considered low and acceptable.

5.2.1.2 Direct Flood Risk from Ox Hey Brook

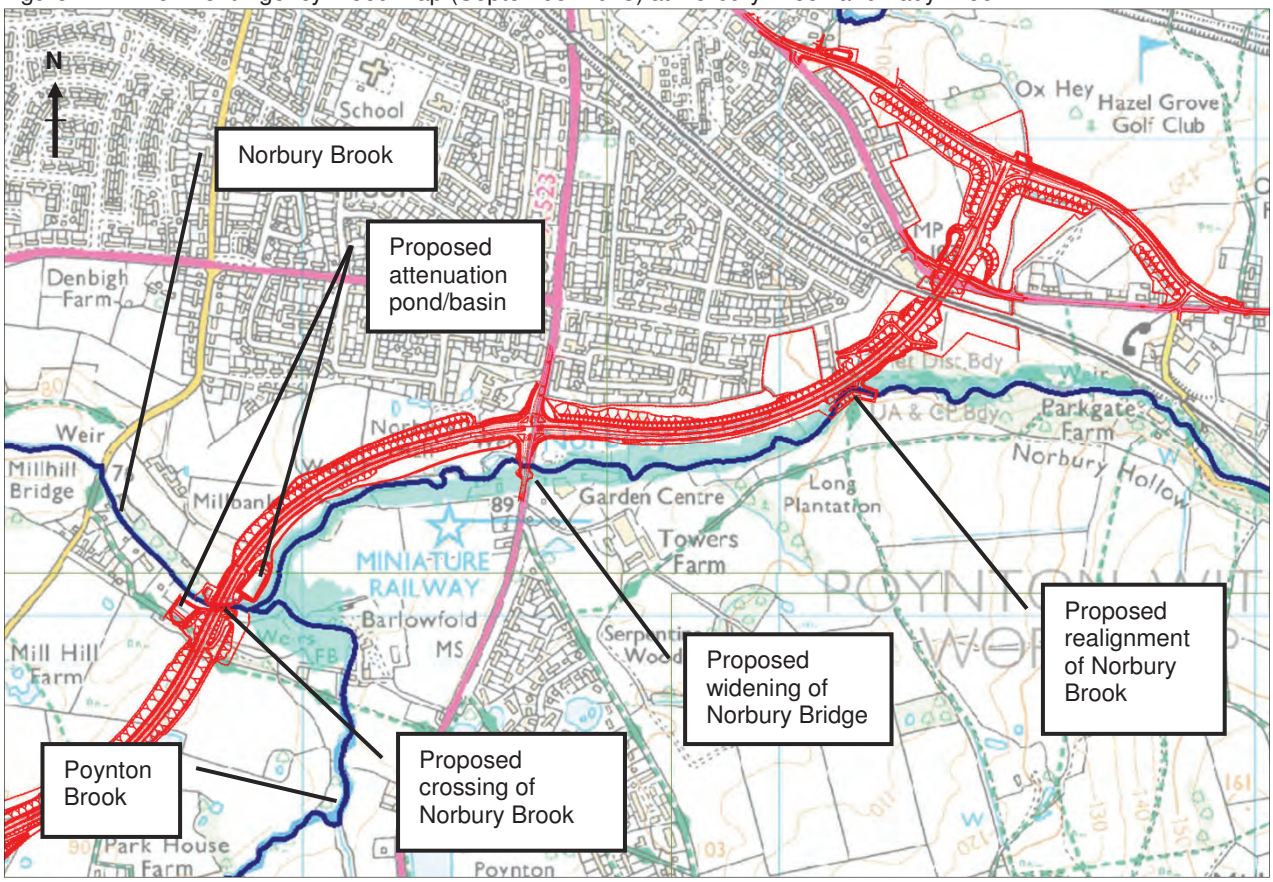
The EA and the local authorities did not report any knowledge of flooding from Ox Hey Brook in the vicinity of the proposed highway. The information within the Stockport SFRA does not indicate any significant flood risk from the watercourse. As demonstrated in Section 5.2.1.1, the realignment will not increase the flood risk from the watercourse.

The flood risk to the proposed highway from Ox Hey Brook is therefore considered to be low and acceptable.

5.2.2 Norbury Brook

Towards the eastern end of the route, the proposed highway is in close proximity to Norbury Brook and then crosses it following its confluence with Poynton Brook. The approximate location of the proposed route in relation to Norbury Brook and the current EA flood zones is shown in Figure 2.

Figure 2: Environment Agency Flood Map (September 2013) at Norbury Brook and Lady Brook



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Key to Flood Maps:

- Flood Zone 3
- Flood Zone 2
- Flood Zone 1
- Flood Defence
- Areas Benefiting from Flood Defences
- Main River
- Approximate Proposed Highway Works

There are three key issues which must be addressed in relation to Norbury Brook:

- The proposed realignment of the watercourse has the potential to increase flood risk from the watercourse upstream or downstream if flows are restricted or increased by the works;
- Direct fluvial flood risk to the proposed highway from the 1 in 1000 year flow event is indicated as a potential risk by the current EA flood maps and potential loss of flood storage in these areas must also be considered;
- The proposed new bridge crossing of Norbury Brook and the proposed widening of Norbury Bridge have the potential to increase flood risk from the watercourse upstream or downstream if not correctly sized or if works affect the watercourse channel, or by impacting on the local flood zone extents.

In order to inform the assessment of these risks, a detailed hydraulic modelling exercise has been undertaken for Norbury Brook. The methodology and results of this modelling exercise are reported in Appendix B.

5.2.2.1 Proposed Realignment of Norbury Brook

The detailed hydraulic modelling, as reported in Appendix B, has demonstrated that the proposed realignment of Norbury Brook does not significantly affect the flows or water levels in the brook during the 1 in 100 year plus climate change event. The EA have reviewed the hydraulic model and further supporting information submitted by AECOM, and have confirmed that it is acceptable and demonstrates that the realignment will not detrimentally impact on flood risk.

The proposed realignment will be subject to Flood Defence Consent being obtained from the EA prior to construction (see Section 6.1), and appropriate details of the proposed realignment will be agreed in full with the EA through this process. It is recommended that further hydraulic modelling be undertaken at that stage to ensure that the final detailed design of the realignment continues to have no detrimental effect on the flows or water levels in the brook.

Assuming appropriate detailed design, confirmation by hydraulic modelling that the detailed design does not have a detrimental impact on flood risk, and obtaining of Flood Defence Consent, the risk of the proposed realignment increasing flood risk from Norbury Brook is considered to be low and acceptable.

5.2.2.2 Direct Fluvial Flood Risk from Norbury Brook

It can be seen from Figure 2 that in the vicinity of Norbury Brook the proposed route is largely in Flood Zone 1, except at the location of the proposed brook realignment and the proposed point of widening of Norbury Bridge where the route is in Flood Zone 2.

The hydraulic modelling undertaken for the FRA (reported in Appendix B) confirms that the proposed highway is unaffected by the 1 in 100 year plus climate change flood event from Norbury Brook, which would be largely constrained to the river channel. However, it can be seen from Figure 2 that at the location of the proposed realignment and the proposed widening of Norbury Bridge, the proposed highway route falls within Flood Zone 2, indicating a potential risk of fluvial flooding to the highway from events between the 1 in 100 year to 1 in 1000 year flood events.

The majority of the route is therefore at low risk of fluvial flooding from Norbury Brook and does not stand to affect flood risk from this watercourse. However, the point of the proposed realignment and the proposed point of widening warrant further consideration as set out below.

Point of Realignment

The level of the proposed carriageway at this point is over 4m higher than the modelled 1 in 100 year plus climate change flood level in the adjacent watercourse. The carriageway will not therefore be at risk of flooding once constructed. There may however be a small loss of flood plain storage due to the development.

The loss of flood storage at this point is likely to be insignificant as it represents only a fraction of the 1 in 1000 year flood extent from the watercourse. However, further hydraulic modelling should be undertaken at detailed design to confirm that the detailed design of the proposed realignment does not have any significant impact on the 1 in 1000 year flood

extents elsewhere. The impact is expected to be negligible as there is no significant impact on the 1 in 100 year plus climate change event, and it is likely that any change can be mitigated within the detailed design.

Considering the above, the risk of the proposed highway being impacted by direct flooding from Norbury Brook and the risk of the proposed highway increasing flood risk from Norbury Brook through loss of storage is considered to be low and acceptable.

Point of Widening (Norbury Bridge)

The proposed widening of Norbury Bridge may encroach into an area at risk of flooding from the 1 in 1000 year flood extent. Although the highway over the widened bridge may remain at risk of flooding during the 1 in 1000 year event, the direct risk to the highway will not be increased by the widening. There may however be a small loss of flood plain storage due to the development.

The loss of flood storage at this point is likely to be insignificant as it represents only a fraction of the 1 in 1000 year flood extent from the watercourse. However, further hydraulic modelling should be undertaken at detailed design to confirm that the detailed design of the proposed widening does not have any significant impact on the 1 in 1000 year flood extents elsewhere. The impact is expected to be negligible as there is no significant impact on the 1 in 100 year plus climate change event, and it is likely that any change can be mitigated within the detailed design.

Considering the above, the risk of the proposed highway being impacted by direct flooding from Norbury Brook and the risk of the proposed highway increasing flood risk from Norbury Brook through loss of storage is considered to be low and acceptable.

5.2.2.3 Proposed Crossings of Norbury Brook

The construction of the two proposed crossing of Norbury Brook create a potential risk of flooding if the structures have an impact on the flow in the watercourse or flows during flood events. Restriction of the flow by either bridge or the associated groundworks could cause afflux flooding (backing up of flows) upstream, and any changes to the channel or works within the adjacent flood plain could cause increased flood risk upstream or downstream of the structure.

For bridge crossings of Main Rivers, the EA require that soffit levels of the bridge are set at least 600mm above the design flood level to allow floating debris to pass beneath without causing restriction. The bridge should not impact on the watercourse channel so as to ensure there is no change to the flows in the watercourse.

The proposed crossings will be subject to Flood Defence Consent being obtained from the EA prior to construction (see Section 6.1), and appropriate details of the proposed crossings will be agreed in full with the EA through this process.

The two proposed crossings are discussed in further detail below.

Proposed Highway Crossing

At the location of the proposed crossing of Norbury Brook, downstream of its confluence with Poynton Brook, it can be seen from Figure 2 that the flood zones do not extend significantly beyond the watercourse channel. The hydraulic modelling in Appendix B confirms that the 1 in 100 year plus climate change flow event is constrained to the river channel at the location of the proposed road bridge, therefore the bridge itself would not be expected to impact on flows or flood risk from the watercourse provided it is designed to the EA's minimum standards.

If there are any proposed changes to the river channel as part of the works, hydraulic modelling may be required at the detailed design to confirm that the detailed design of the proposed crossing does not have any significant impact on the flood extents elsewhere.

Provided the bridge is developed in accordance with the above requirements of the EA including that of obtaining Flood Defence Consent, and provided any necessary hydraulic checks are carried out at detailed design, the risk of the proposed crossing increasing flood risk from Norbury Brook is considered to be low and acceptable.

Proposed Widening of Norbury Bridge

The proposed widening of the bridge occurs on the downstream side and is therefore unlikely to have significant impact on the upstream or downstream water levels and flood extents providing the widened bridge opening is equal to or larger than the existing bridge cross section.

The modelling in Appendix B confirms that the 1 in 100 year plus climate change flow event is constrained to the river channel at the location of the proposed widening, therefore the bridge itself would not be expected to impact on flows or flood risk from the watercourse provided it is designed to the EA's minimum standards.

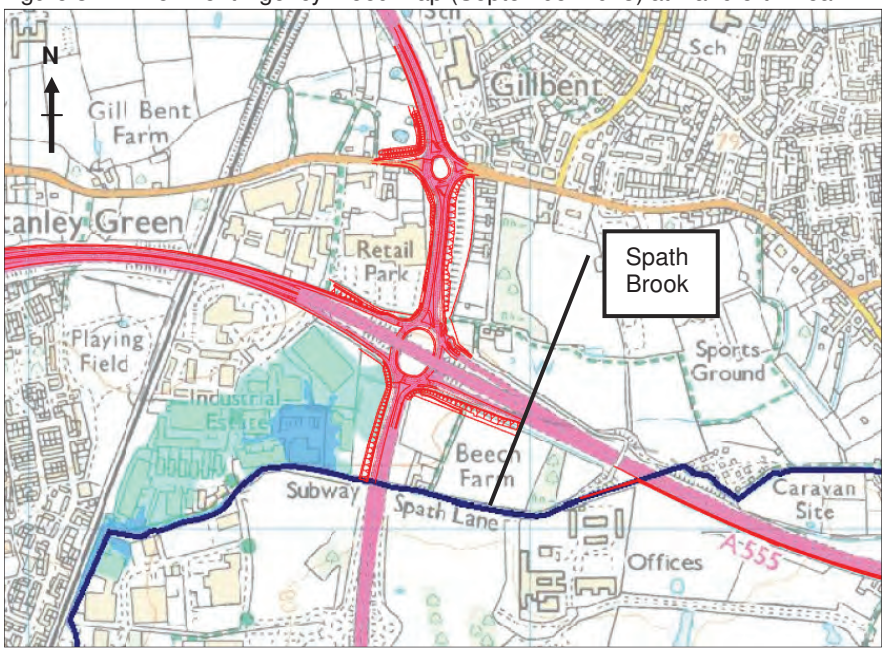
If there are any proposed changes to the river channel or upstream bridge cross section as part of the works, hydraulic modelling may be required at the detailed design to confirm that the detailed design of the proposed widening does not have any significant impact on the flood extents elsewhere.

Provided the scheme is developed in accordance with the above requirements of the EA including that of obtaining Flood Defence Consent, and provided any necessary hydraulic checks are carried out at detailed design, the risk of the proposed crossing increasing flood risk from Norbury Brook is considered to be low and acceptable.

5.2.3 Spath Brook

Towards the centre of the route, the proposed scheme includes for some widening works to the existing A555/A34 junction north of Handforth Dean. As can be seen from Figure 3, a relatively small area of these works will be located in Flood Zone 2 and could therefore be at risk of flooding from Spath Brook during the 1 in 1000 year event.

Figure 3: Environment Agency Flood Map (September 2013) at Handforth Dean



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5.2.3.1 Direct Flood Risk from Spath Brook

The level of the carriageway at this point is significantly higher than the adjacent ground level where the risk of flooding is indicated. The carriageway will not therefore be at risk of flooding once constructed.

The risk of flooding to the proposed highway from Spath Brook, is therefore considered low and acceptable.

5.2.3.2 Loss of Flood Storage

The proposed widening works on the northbound A34 carriageway to the south of the A34/A555 junction will result in a small loss of flood plain (at the outer reaches of the 1 in 1000 year flood extent). The EA have confirmed that the small area of flood plain which will potentially be lost by the carriageway widening is insignificant, and that mitigation will not therefore be required.

The risk of the proposals increasing flood risk from Spath Brook, is therefore considered low and acceptable.

5.2.4 Other Ordinary Watercourses

The proposed highway has the potential to impact on other Ordinary Watercourses along the route, including the unnamed watercourse at DF3/C006.

5.2.4.1 Direct Flood Risk from Ordinary Watercourses

The EA and the local authorities did not report any knowledge of flooding from the Ordinary Watercourses in the vicinity of the proposed highway. The information within the three SFRAs does not indicate any significant flood risk from the Ordinary Watercourses.

Therefore, the flood risk to the proposed highway from these sources is therefore considered low and acceptable.

5.2.4.2 Ordinary Watercourse Crossings

A number of new culverts will be required to allow the flow of water in existing Ordinary Watercourses to continue as at present. These are identified on the plan in Appendix A1 and considered in detail in the assessment in Appendix C1.

The construction of such watercourse crossings introduces the risk of afflux flooding; If the crossings are undersized then the effective flow area at the structure is less than the flow area of the watercourse directly upstream, the structure therefore impedes the flow causing the upstream water level to increase and flooding may occur.

An assessment of culverting requirements for the Ordinary Watercourses is made within Appendix C1 and an initial assessment of culvert size is also included in Appendix C4.

The proposed culverts will be subject to Land Drainage Consent being obtained from the appropriate LLFA prior to construction (see Section 6.1), and appropriate details of the proposed culverts, including final size, will be agreed in full with the LLFA through this process. It is demonstrated in Appendix C2 that appropriate sizing of the culverts will be undertaken based on methods and parameters to be agreed in full with the LLFA through Land Drainage Consent applications, to ensure that the passage of flows is not impeded. This design process will also incorporate the requirements for ecology, access and buildability.

Base on implementation of the above, the risk of afflux flooding from Ordinary Watercourse culverting is considered to be low and acceptable.

5.2.5 Surface Water Discharges to Watercourses

As outlined in the Drainage Assessment in Section 4, discharges of surface water from the proposed highway to the following watercourses are proposed:

- Threaplehurst Brook;
- Norbury Brook;
- Spath Brook (via the existing A555 drainage system); and
- Gatley Brook (via existing intermediate piped drainage).

There is a risk of increasing flood risk from these watercourses if there is an increase of surface water flows into them due to the proposed highway drainage discharges.

5.2.5.1 Threaplehurst Brook and Norbury Brook

It has been demonstrated in Section 4 how the proposed surface water discharges to Threaplehurst Brook and Norbury Brook will be limited to the equivalent greenfield runoff rate, as agreed with the EA. Limiting discharges to this rate aims to ensure that the flows reaching the watercourses do not exceed the existing natural flows, and that the flow in the watercourse under a flood event is not increased by the new discharge.

Based on implementation of these principles, the risk of increasing flood risk from these watercourses as a result of surface water discharges is considered low and acceptable.

5.2.5.2 Spath Brook

The existing discharges to Spath Brook are a function of the existing A555 drainage system. It has been demonstrated in Section 4 that discharge of additional surface water into the existing A555 drainage system will be undertaken via appropriate attenuation and storage so as not to adversely affect the performance of the existing system. The discharges themselves are achieved by pumping of surface water flows, and there are no proposals to increase the pump rate as part of this scheme.

The risk of increasing flood risk from Spath Brook as a result of surface water discharge is therefore considered low and acceptable.

5.2.5.3 Gatley Brook

As outlined in Section 4, discharge of a small section of the proposed highway to Gatley Brook via an existing public sewer is proposed. The discharge will be limited to the equivalent greenfield runoff rate, as agreed with the EA, to ensure that the flows reaching the watercourse do not exceed the existing natural flows, and that the flow in the watercourse under a flood event is not increased by the new discharge.

Based on implementation of these principles, the risk of increasing flood risk from Gatley Brook as a result of surface water discharges is considered low and acceptable.

5.3 Risk of Flooding from Public Sewers

Inevitably, as the proposed route passes in close proximity to a number of residential areas and across a number of major roads, it will cross a number of existing public sewers. The United Utilities public sewer records for areas adjacent to the proposed route have been obtained and reviewed by the highway design team and drainage design team.

The highway design team have undertaken consultation with United Utilities to establish the requirements for diversion and protection of these existing services as appropriate. The exact location of public sewers relative to the proposed highway and specific requirements for their diversion will be agreed between UU and the highway designers prior to construction to ensure no detrimental impact to existing services.

5.3.1 Risk to the Development from Existing Flooding

No instances of existing public sewer flooding adjacent to the route have been identified. Existing public sewers are the responsibility of UU, and are therefore likely to be maintained to an appropriate standard. Also, the consequences of such flooding are likely to be negligible, as the extents of any flooding would be localised and would not have a significantly detrimental impact on the users of the proposed highway. The risk of flooding from public sewers affecting the proposed highway is therefore considered to be low.

5.3.2 Risk of Increasing Flooding Due to the Development

The proposed discharge of surface water to public sewers at some points along the route was outlined in the Drainage Assessment in Section 4. Without appropriate control this has the potential to increase flood risk from the public sewers in these areas. However, the proposed discharge is to be at a limit to be agreed with UU who are ultimately responsible for the performance of the sewer network. The discharge is to be set based on the available capacity of the existing sewers. In addition to the requirements of UU, the requirements of the MCC SFRA to reduce surface water runoff has been considered in the MCC area.

Based on implementation of these principles, the risk of the proposed development increasing flooding from public sewers is considered to be low and acceptable.

5.4 Risk of Flooding from Existing Private and Highway Drainage

Inevitably, as the proposed route passes in close proximity to a number of residential areas and across a number of existing highways, it will impact on existing highway drainage and private drainage, potentially including piped land drainage systems. Records of private and highway drainage along the route have not been obtained as part of this study, however any requirements for diversion or protection, will be identified at a future stage by the design team or on site before construction.

This section considers the risk of the proposed highway development increasing flooding from existing drainage, and the risk of the proposed highway being affected by existing drainage flooding issues.

5.4.1 A6 Drainage

In early consultation SMBC noted that there may be a ‘problem’ with the drainage on the existing A6 in Hazel Grove near to the proposed scheme, but did not give any detail as to the nature or significance of the existing problem. SMBC have since confirmed that this is a drainage issue relating to a private land owners between the realigned A6 and the existing A6. This was investigated by the SMBC Flood Management and Drainage Team Leader Manager and remedial works were carried out. Based on this information, the risk of flooding to the proposed highway from the existing A6 drainage is considered low and acceptable.

New drainage infrastructure will be required in the existing A6 to accommodate the new overbridge across the proposed highway, however there are no proposed additional discharges into the existing A6 highway drainage from the proposed highway. The risk of the proposed development increasing existing flooding is therefore considered low and acceptable.

5.4.2 A5102 Drainage

The Reported Incidents of Historic Flooding map within the Stockport SFRA indicates that there is a ‘reported drainage hotspot’ along the A5102, south of the junction with the A555 (the point at which the proposed highway meets the existing A555). The report does not detail how significant this problem is, but in general, it is considered unlikely that a local highway drainage problem would result in a significant amount of flooding or affect the proposed highway. For completeness, it is suggested that the existing problem be investigated further by SMBC, with local improvements to the drainage system within the A5102 being implemented as part of the scheme if necessary to alleviate any residual problem.

Based on the above, the risk of flooding to the proposed highway from the existing A6 drainage is considered low and acceptable.

There are no proposed additional discharges into the existing A5102 highway drainage from the proposed highway. The risk of the proposed development increasing existing flooding is therefore considered low and acceptable.

5.4.3 A555 Drainage

The existing A555, the central section of the proposed route, is served by a drainage system which discharges to Spath Brook via existing attenuation and storage systems. There is no recorded history of flooding along the existing section of the A555 and the drainage systems are relatively new, therefore the existing flood risk does not require further consideration. The proposed highway has been designed to ensure no increase in surface water flooding from the existing A555 drainage as discussed in Section 5.4.3.1 and 5.4.3.2 below.

5.4.3.1 Changes to A555/A34 Junction

Proposed changes to the existing A555/A34 junction will not result in a significant increase in the impermeable area to be drained and will be designed with appropriate surface water collection (e.g. gullies) to adequately remove surface water from the carriageway. The surface water will drain into the existing A555 drainage system, which includes appropriate attenuation and storage. The risk of increasing flood risk from the existing A555 drainage by improvements to the junction is therefore considered low and acceptable.

5.4.3.2 Additional Drainage into A555 System

A significant length of the proposed highway drainage either side of the existing A555 will discharge into the existing A555 systems which discharge to Spath Brook. As has been demonstrated in the Drainage Assessment in Section 4, the new drainage systems will incorporate appropriate attenuation and storage to ensure that only the spare capacity of the existing A555 systems is utilised. CEC provided details of the drainage along the existing A555 which has allowed the drainage designers to ensure that this is achieved. The risk of increasing flood risk from the existing A555 is therefore considered low and acceptable.

The potential to increase fluvial flood risk by the discharge of surface water to Spath Brook via the existing A555 drainage system is considered in Section 5.2.6.

5.4.4 Other Existing Highway Drainage

There are a number of further locations where the proposed highway will impact on the existing carriageway, thereby requiring changes to the existing highway drainage systems to be made. This will occur at: The at-grade junction with Macclesfield Road; the Woodford Road overbridge across the proposed highway; the at-grade junction with Chester Road; the Wilmslow Road bridge at the western end of the existing A555; the at-grade junction with Styal Road; and the interface with Ringway Road.

There are no known existing flooding problems at these locations. The changes required in these areas are likely to be minimal and are unlikely to significantly increase the impermeable area draining to the existing systems. The required amendments will be considered further at detailed design to ensure that any changes do not cause an increased risk of flooding from the existing drainage systems.

Assuming implementation of the above, the risk of the proposed development increasing flooding from these highway drainage systems is considered to be low and acceptable.

5.4.5 Uncharted Existing Drainage

It is possible that uncharted private drainage (potentially including piped land drainage) or highway drainage will be encountered along the route. Efforts will be made to identify such assets before construction begins. Where the

proposed highway impacts on such drainage, the existing drains will be diverted as appropriate, or removed if they no longer serve a purpose.

There are no proposals to discharge surface water to any existing private or highway drainage systems, other than those outlined within the report.

Based on the above, the risk of increasing flooding from other existing private or highway drainage, and the risk of the proposed highway being affected by other existing private or highway drainage, is considered to be low and acceptable.

5.5 Risk of Flooding from Proposed Surface Water Drainage

The scheme will result in an overall increase in impermeable area across the route. Additionally a predicted increase in rainfall intensity by 20% over the lifetime of the development is likely to further increase surface water runoff from the highway over its lifetime.

Surface water drains for the development will be designed to Volume 4 of the Design Manual for Roads and Bridges (DMRB) and in accordance with other current good practice and legislation. It was demonstrated in Section 4 that safe discharge of surface water is possible, with the implementation of SUDS where practicable. The proposals follow the requirements and recommendations of the EA and the Local Authorities.

As the drainage system will be designed and constructed to the above standards, the risk of flooding from proposed surface water drains is considered to be low and acceptable.

There remains a residual risk however from blockages of the drainage system or exceedance of its capacity. Mitigation, as discussed in Section 6.2, reduces the impact of these risks further.

As far as practically possible, surface water drainage will be achieved by gravity. As it is proposed to create a number of cuttings along the route, a number of pumping stations will be required to drain some areas of the proposed highway. In the event of failure, overflow from a pumping station could pose a flood risk. However, any pumping station should be designed to DMRB standard which allows for the provision of emergency storage and telemetry to warn of high levels/pump failure. Regular inspection and maintenance should ensure the pumping station remains in a suitable condition. Based on implementation of these principles, the risk to the development and off-site areas from pumping station failure is considered to be low and acceptable.

The potential for increasing flood risk by the proposed discharge of surface water to the watercourses, public sewers, and existing highway drainage along the route is considered within the appropriate section for the receiving asset.

5.6 Risk of Surface Water (Pluvial) Flooding

Some areas along the eastern end of the route are shown to be susceptible to surface water flooding by the Susceptibility to Surface Water Flooding map within the Stockport SFRA. The areas shown to be at risk appear to be the lower lying areas of the route, including the Norbury Brook river valley.

The SFRA report notes that there is no record of historical pluvial flooding in Stockport, and that the methods used in mapping the susceptibility were broad-scale modelling, and that the maps should be interpreted with caution. It is noted that the map identifies a low-lying part of the existing A555 to be susceptible to surface water flooding, which suggests that the mapping does not take into account any existing drainage that may be provided.

The Macclesfield Borough SFRA and the Manchester, Salford and Trafford SFRA do not indicate any significant known or predicted surface water flooding issues along the remainder of the route.

As it is proposed that the route is to be significantly developed, with impermeable areas being served by a positive drainage system, the detailed drainage design should take account of any natural falls which may introduce pluvial flows to developed site. These additional areas should be allowed for when designing the drainage system in that locality in

order to ensure that any such pluvial flows are conveyed safely away from the development by the drainage system, thus reducing the risk of pluvial flooding. This is true for both rural and urban locations.

In addition, the proposed development could introduce new overland flows as a result of increased hard paved areas, which may cause an increased risk of flooding from overland flows to properties on-site and off-site. Therefore, landscaping and drainage will be designed to dispose of any runoff resulting from increased hard paved areas which will mitigate any increase in risk to off-site areas from this source of flooding.

Based on implementation of these principles, the risk of flooding from overland flow caused by the development and the risk of flooding to the development from off-site overland flow is considered to be low and acceptable.

5.7 Risk of Groundwater Flooding

The information within the three local SFRAs suggests that the risk of groundwater flooding along the route is generally low:

- The Stockport SFRA states that there are no records of groundwater flooding in Stockport and that the risk of groundwater flooding is generally low in the area.
- The Macclesfield SFRA also notes that groundwater flooding is not a significant issue in the area.
- The maps in the Manchester, Salford and Trafford SFRA indicate that the route is not in an area at risk of groundwater flooding.

Based on the above, groundwater flooding is not considered to be a significant issue in the area, however there is a more significant risk that groundwater could present itself where the proposed highway is in cutting.

As noted in Section 4.2.2, recommendations have been made for the required earthworks drainage to mitigate the risk of groundwater flooding at susceptible points along the highway, with particular attention paid to cuttings.

Based on implementation of the necessary earthworks drainage within the detailed design, the risk of groundwater flooding is considered to be low and acceptable.

5.8 Risk of Flooding from Land Drains

The proposed route will cross a number of existing land drains which have been identified on the plan in Appendix A1 and considered in detail in the assessment in Appendix C1.

There could be a risk of flooding if these drains are not dealt with appropriately within the proposal for the scheme, as severance of the land drain without providing continuity of flow could cause localised surface water flooding upstream.

An assessment of potential culverting requirements for Land Drains is made within Appendix C1 which will inform the decision on which land drains require culverting. An initial assessment of culvert size is also included in Appendix C4.

Where culverting is proposed, the construction of such land drain crossings introduces the risk of afflux flooding; If the crossings are undersized then the effective flow area at the structure is less than the flow area of the watercourse directly upstream, the structure therefore impedes the flow causing the upstream water level to increase and flooding may occur.

The proposed culverts will be subject to Land Drainage Consent being obtained from the appropriate LLFA prior to construction (see Section 6.1), and appropriate details of the proposed culverts, including final size, will be agreed in full with the LLFA through this process. It is demonstrated in Appendix C2 that appropriate sizing of the culverts will be undertaken based on methods and parameters to be agreed in full with the LLFA through Land Drainage Consent applications, to ensure that the passage of flows is not impeded. This design process will also incorporate the requirements for ecology, access and buildability.

Based on implementation of the above, the risk of afflux flooding from land drain culverting is considered to be low and acceptable.

Where it is concluded that certain land drains may not require culverting, their natural catchment and any new land profile will be considered as part of the earthworks drainage scheme in that locality. This will ensure that although the function of the land drain itself may be lost, there will be no increase in flood risk in that area.

It is possible that existing piped land drainage will be encountered along the route. Efforts should be made to identify this before construction begins or it should be identified on site. Where the scheme impacts on such drainage, the existing drains will be diverted as appropriate, or removed if they no longer serve a purpose. Land drains which are severed by the new highway will need to be routed beneath the new highway to ensure continuity of flow, or be intercepted into the earthworks drainage for the proposed highway.

Based on implementation of the above, the risk of flooding from land drains affecting the proposed development, and the risk of the proposed development increasing flood risk from land drains is considered low and acceptable.

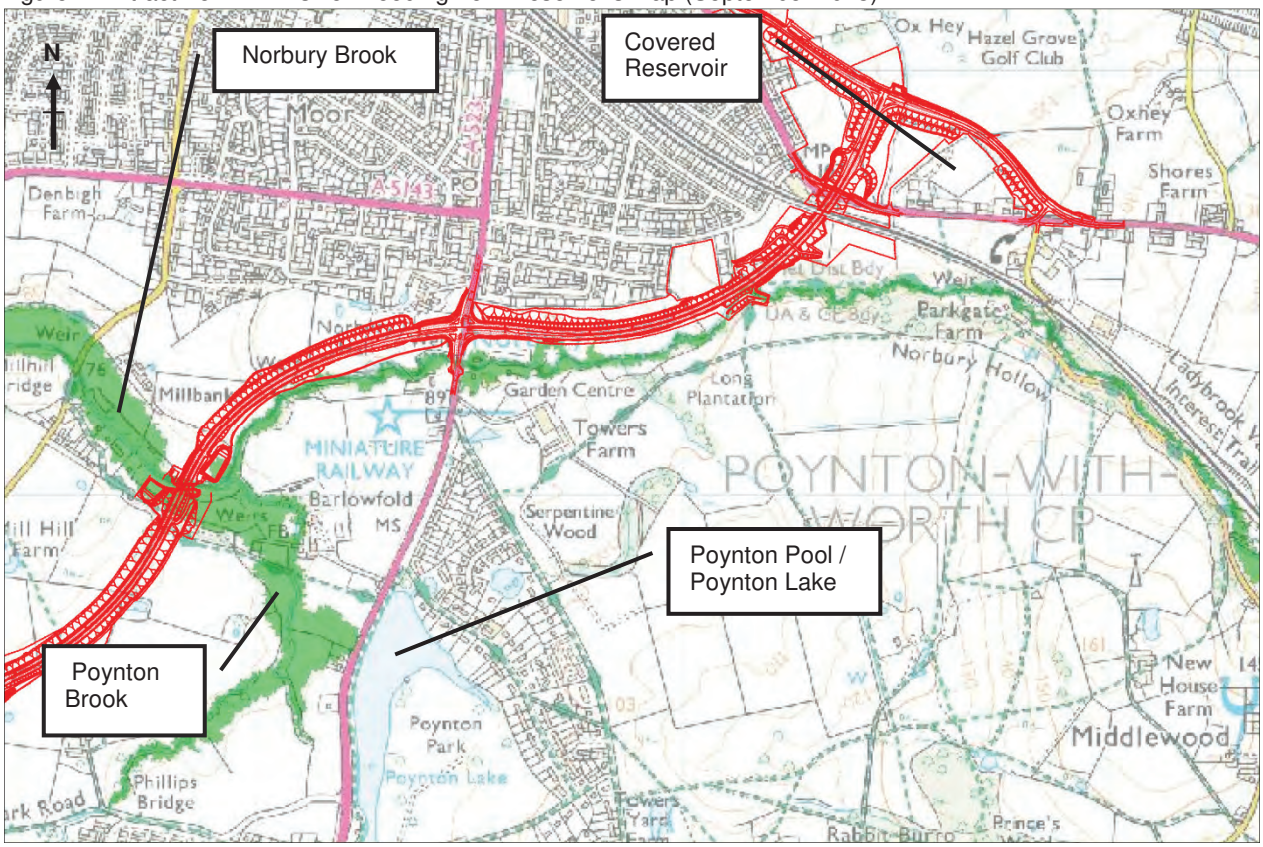
5.9 Risk of Flooding from Artificial Waterbodies

A number of artificial waterbodies in the vicinity of the proposed highway have been identified as follows:

- There is a covered reservoir, understood to be a UU asset, located within the Hazel Grove Golf Club, to the south of the proposed highway;
- Poynton Lake/Poynton Pool is located approximately 0.5km to the south of proposed highway, next to the A523. This is understood to be a CEC asset;
- There are storage ponds a ‘reservoir’ shown on OS maps within the Bramhall Oil Terminal, located to the north of the proposed junction with Woodford Road; and
- There are a number of small ponds in close proximity to the western part of the proposed route between the existing A555 and Styal Road, currently located within Styal Golf Club.

The EA publish a Risk of Flooding from Reservoirs map to show the largest area which would be flooded in the event of reservoir failure. The map has been reviewed along the length of the proposed highway, but only one section shows any significant potential risk (Figure 4). From the map it can be seen that the areas at risk are largely confined to the river valley of Norbury Brook and Poynton Brook. Interrogation of the data associated with the map indicated that this risk is attributable to Bollinhurst Reservoir (a UU asset at Disley, approximately 5km south east of the proposed highway) and Poynton Lake/Poynton Pool.

Figure 4: Extract from EA Risk of Flooding from Reservoirs Map (September 2013)



Not to scale (www.environment-agency.gov.uk)

Key to Map:

Maximum extent of flooding

Approximate Proposed Highway Works

5.9.1 UU Reservoirs and Poynton Pool

The consequences of failure of Bollinhurst Reservoir or Poynton Pool are not considered significant to the proposed highway as the flooding is shown by Figure 3 to be largely contained within the river valleys and is unlikely to affect the highway.

The consequences of failure of the covered reservoir which is in close proximity to the eastern end of the route (indicated on Figure 3) may be significant to the proposed highway due to the relative proximity of the two. (The likely flood path from this asset is not indicated by the EA Map in Figure 3 which may suggest that the reservoir is no longer operational). However, the probability of reservoir failure, particularly the UU assets, is considered to be low as design standards are generally high and regular inspection is generally undertaken.

Based on the above, the flood risk from these artificial waterbodies is considered to be low and acceptable.

5.9.2 Bramhall Oil Terminal

The reservoirs and tanks at the Bramhall Oil Terminal are not of a volume large enough to cause significant flooding. The line and level of the proposed highway at this point means that there are no significant flow paths from these structures to the proposed highway. In the unlikely event of failure, the impact on the highway is likely to be negligible, and the flood risk from this source is therefore considered to be low and acceptable.

5.10 Risk of Flooding from Water Mains

Inevitably, as the proposed route passes in close proximity to a number of residential areas and across a number of major roads, it will cross a number of existing water mains.

As the existing public water mains are the responsibility of UU and are therefore likely to be maintained to an appropriate standard, it is considered that the probability of flooding from this source occurring is low. Also, the consequences of such flooding are likely to be negligible, as the extents of any flooding would be localised and would not have a significantly detrimental impact on the users of the proposed highway.

The highway design team have undertaken consultation with United Utilities to establish the requirements for diversion and protection of these existing services are appropriate. The exact location of water mains relative to the proposed highway and requirements for their diversion will be agreed between UU and the highway designers prior to construction to ensure no detrimental impact to existing services.

The flood risk from water mains is therefore considered to be low and acceptable.

5.11 Vulnerability and Flood Zone Compatibility of the Development

During the course of the assessment, the development proposals for the route were considered against the planning context described in Section 2.1.3.

With reference to the NPPF Technical Guidance (Table 1), as the proposed development is to be a major transport route it is to be considered as Essential Infrastructure. However the proposed attenuation ponds/basins should be considered as Water Compatible development.

Based on the Technical Guidance (Table 2), Water Compatible development is considered acceptable in any flood zone making the attenuation pond/basins acceptable in the planning context.

Essential Infrastructure can be located in Flood Zone 1 and 2 without further justification. Based on the current EA flood maps (as discussed in Section 5.2) the proposed highway is predominantly within Flood Zone 1, with isolated areas in Flood Zone 2 (at Norbury Bridge, adjacent to Norbury Brook at the proposed point of realignment, and at the existing A555/A34 roundabout north of Handforth Dean), making it acceptable in the planning context in these areas.

The proposed scheme is therefore considered acceptable in the planning context without the need for the Exception Test to be applied.

5.11.1 The Sequential Test

The Sequential Test, as outlined in Section 1.3.5, is a risk-based test that should be applied at all stages of development, which aims to steer new development to areas at the lowest probability of flooding.

The route lies in a protected development corridor identified for such a scheme, and is predominantly located in Flood Zone 1. It is therefore expected that the Sequential Test is considered to be passed for the scheme.

6 Flood Risk Mitigation

This section demonstrates that it is possible to mitigate the residual flood risks identified in Section 5. The mitigation measures outlined below are designed to protect both the users of the highway and the surrounding receptors from the effects of flooding.

6.1 Flood Defence and Land Drainage Consents

The following consents will be required for works affecting watercourses. The requirement for these consents to be obtained before works to watercourses take place will act as a safeguard against any works which could potentially affect the flood risk associated with watercourses along the route.

6.1.1 Main Rivers

Flood Defence Consent is required from the EA under Section 109 of the Water Resources Act 1991 for any works in, over or under a Main River.

In addition to this the local Land Drainage Byelaws will require that prior approval is give to any works within a set distance, usually 9m, from the Main River. This distance is measured from the top of the watercourse or, where there is a raised flood bank or wall, from the landward toe of the bank/wall. For works going over or under the main river the byelaw consent is normally encompassed into the EA Section 109 consent. Any works running parallel to the main river, within the byelaw distance, will require EA byelaw consent.

6.1.2 Ordinary Watercourses

The Flood and Water Management Act 2010 established Lead Local Flood Authorities (LLFA) which now have the regulatory powers on ordinary watercourses. Land Drainage Consent will be required from the LLFA under Section 23 of the Land Drainage Act 1991 (as amended by the Flood and Water Management Act 2010) for any works which may affect the flow in the land drains and small watercourses along the route.

The appropriate LLFA will be the prevailing Local Authority at each location. The LLFA for each potential culvert location is noted in the schedule in Appendix C4.

6.2 Residual Risk of Flooding from Drainage Systems

There is a residual risk of flooding from blockage or restriction within the proposed surface water drainage systems and from any SUDS if poorly maintained. Regular inspection and maintenance should be undertaken to ensure drainage infrastructure, including the land drain and SUDS, remains in a suitable condition.

There is a residual risk of flooding if the capacity of the surface water drainage system is exceeded. It is not practical to provide further mitigation against this, although it is noted that the drainage design is to a minimum of a 1 in 30 year plus climate change standard with no significant flooding, and therefore the event is considered unlikely.

The residual risk of flooding from the proposed drainage systems is considered to be low and acceptable

6.3 Residual Risk of Flooding from Pumping Stations

In the event of failure, overflow from a pumping station could pose a flood risk. However, a pumping station should be designed to Volume 4 of the Design Manual for Roads and Bridges (DMRB) which allows for the provision of telemetry to warn of high levels/pump failure. Regular inspection and maintenance should ensure the pumping station remains in a suitable condition. As further mitigation a standby pump could be installed, this will become operational if the first pump fails.

The residual risk from pumping station failure is therefore considered to be low and acceptable.

7 Conclusions and Recommendations

7.1 Conclusions

This FRA has assessed the flood risk associated with the development of the proposed A6 to Manchester Airport Relief Road, in accordance with the requirements of the NPPF. The report has considered all potential sources of flooding and has considered the projected effects of climate change.

The report has shown that the proposed development is acceptable in the planning context and is to be undertaken in accordance with relevant local planning policy.

Within the report it has been demonstrated that the proposed infrastructure has been developed in such a way that it is not at risk of flooding and does not cause an increase in flood risk elsewhere. Appropriate further design, consenting, construction, and maintenance of the highway and the associated infrastructure will ensure that the risk remains low.

Based on the assessment, AECOM considers that the flood risk from all sources, to and from the proposed development is low and acceptable or can be mitigated to a low and acceptable level. The mitigation measures and recommendations outlined within this report are designed to protect both the users of the highway and surrounding areas, and the highway itself from the effects of flooding.

7.2 Recommendations

The following is a summary of the recommendations made within the report to ensure the development is not subject to or responsible for an unacceptable risk of flooding:

- Proposals for the realignment of Ox Hey Brook which will ensure the channel capacity is not reduced, should be developed at detailed design and agreed in full with the LLFA through the Land Drainage Consent application;
- The existing drainage problem on the A5102 should be investigated further by SMBC at detailed design to ensure no detriment to the proposed scheme;
- The proposed realignment of Norbury Brook should be developed at detailed design and agreed in full with the EA and local authorities through the Flood Defence Consent application, with further hydraulic modelling checks being undertaken as neccessary;
- The proposed Norbury Brook crossing designs should developed at detailed design and agreed in full with the EA and local authorities through the Flood Defence Consent applications, with hydraulic modelling checks being undertaken as appropriate;
- Culverting requirements and final sizing should be agreed between the designer, the Environmental Consultant, EA and LLFAs, and should be agreed in full with the LLFA through the Land Drainage Consent application;
- Regular inspection and maintenance should be undertaken to ensure drainage infrastructure, including SUDS and pumping stations, remains in a serviceable condition.

References

National Planning Policy Framework; Communities and Local Government; March 2012.

Technical Guidance to the National Planning Policy Framework; Communities and Local Government; March 2012.

C624 – Development and Flood Risk – Guidance for the Construction Industry; CIRIA; 2004.

C522 – Sustainable Urban Drainage Systems – Design Manual for England and Wales; CIRIA; 2000.

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Macclesfield Strategic Flood Risk Assessment; JBA Consulting; June 2008.[2]

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Institute of Hydrology Report 124 (IoH124), Flood Estimation for Small Catchments; Institute of Hydrology; 1994.

Design Manual for Roads and Bridges; HA 107/04 - Design of Outfall and Culvert Details; Highways Agency; November 2004.

SEMMMS, A6 to Manchester Airport Relief Road, Drainage Strategy Report; AECOM; October 2011.

[1] Faber Maunsell is a former operating company of AECOM.

[2] Although the SFRA was produced for the former Macclesfield Borough Council, CEC have confirmed that the Macclesfield SFRA is still valid for this local area.

Appendices

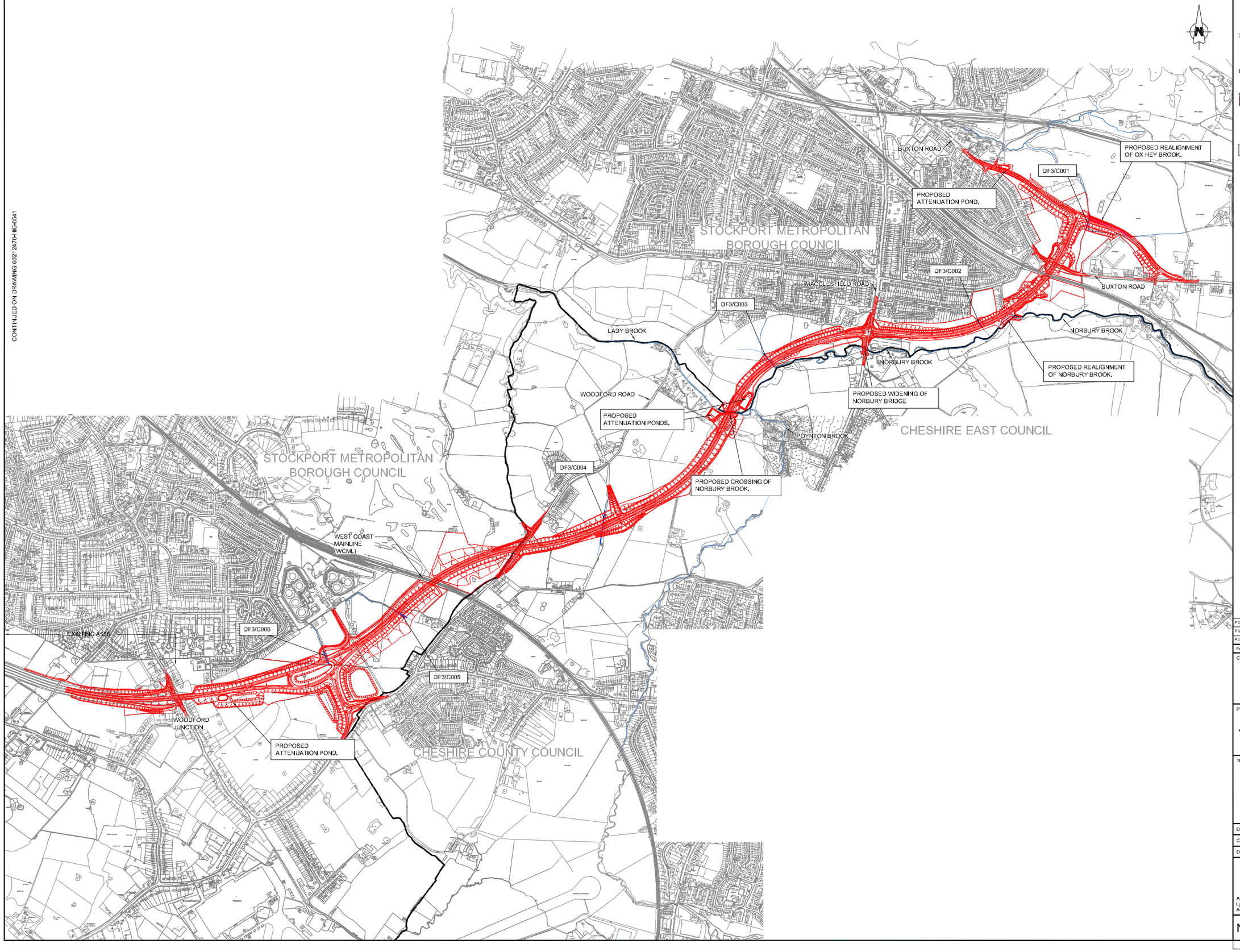
Appendix A – Route Information

A1 Proposed Route Plan

A2 Site Walkover Photographs

A3 Catchment Details Plan

CONTINUED ON DRAWING 60212470-HIG-0541



NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH SEMMMS A6 TO MANCHESTER AIRPORT FLOOD RISK ASSESSMENT REPORT.
2. FOR DETAILS OF POTENTIAL CULVERTING REQUIREMENTS REFER TO FLOOD RISK ASSESSMENT REPORT.

KEY:

- EXISTING WATERCOURSE
- PROPOSED HIGHWAY WORKS
- PROPOSED WATERCOURSE REALIGNMENT
- POTENTIAL CULVERT LOCATION
- DF3/C00X — POTENTIAL CULVERT REFERENCE
- COUNTY BOUNDARY

Rev	Date	Detail	Made	Chk'd	Appr'd
P03	09/09/13	LATEST ROUTE PLAN ADDED	MW	CS	CS
P02	04/09/13	LATEST ROUTE PLAN ADDED	MW	CS	RL
P01	17/10/12	ISSUED FOR INFORMATION	MW	CS	RL

Client:
STOCKPORT METROPOLITAN BOROUGH COUNCIL

Project:
SEMMMS
A6 TO MANCHESTER AIRPORT RELIEF ROAD

Title:
ANNOTATED ROUTE PLAN SHEET 1

Design:	MW	CAD:	MW
Chk'd:	CS	App'd:	RL
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A1

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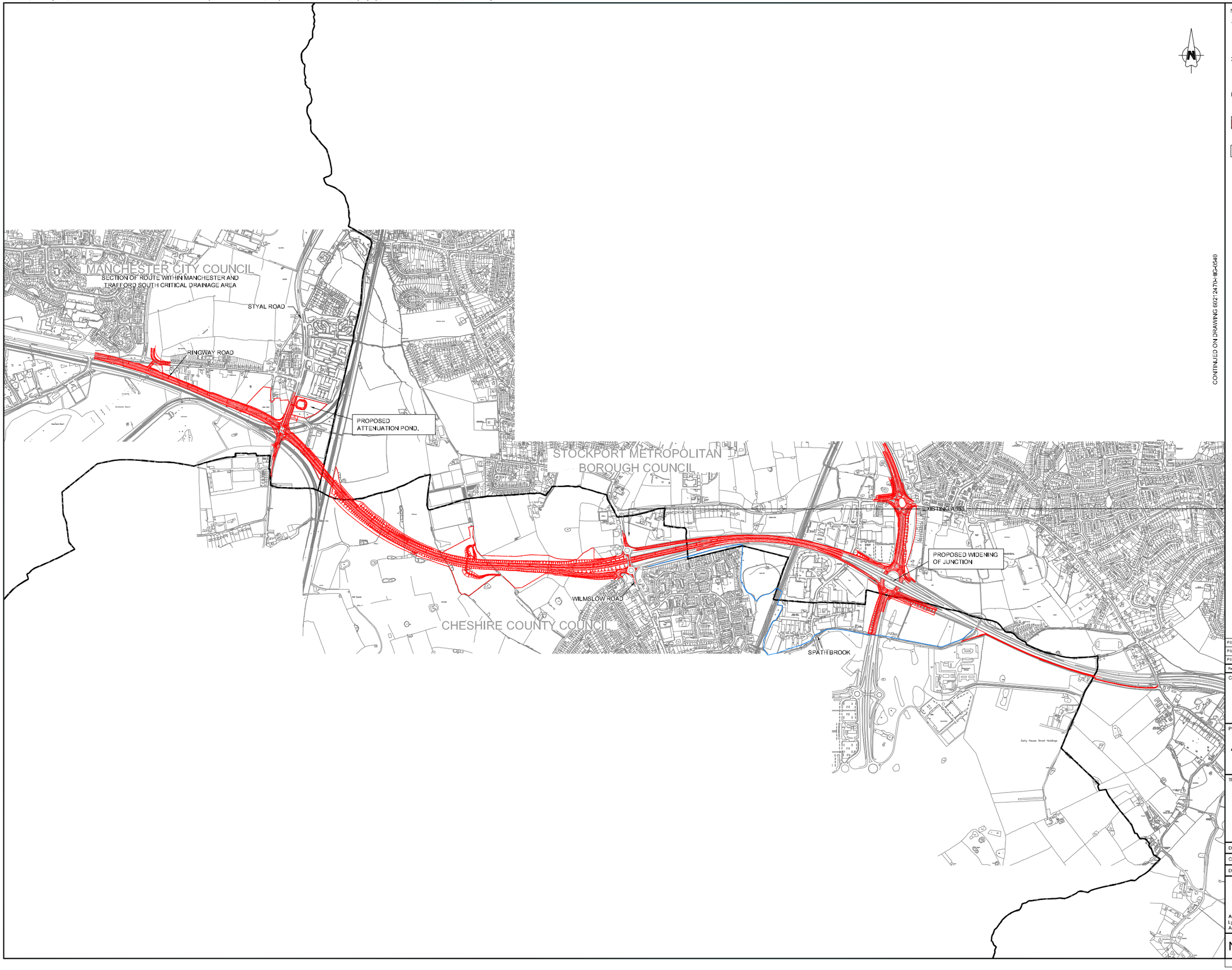

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NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH SEMMMS A6 TO MANCHESTER AIRPORT FLOOD RISK ASSESSMENT REPORT.
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KEY:

- EXISTING WATERCOURSE
- PROPOSED HIGHWAY WORKS
- POTENTIAL CULVERT LOCATION
- DF3/C00X — POTENTIAL CULVERT REFERENCE
- COUNTY BOUNDARY

Rev	Date	Detail	Made	Chk'd	Appr'd
P03	09/09/13	LATEST ROUTE PLAN ADDED	MW	CS	CS
P02	04/09/13	LATEST ROUTE PLAN ADDED	MW	CS	RL
P01	17/10/12	ISSUED FOR INFORMATION	MW	CS	RL

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Project:
SEMMMS
A6 TO MANCHESTER AIRPORT RELIEF ROAD

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Design: MW	CAD: MW
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A1

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A2 Site Walkover Photographs

For details of locations refer to Route Plan in **Appendix A1**.

Ox-Hey Brook and DF3/C001

Could not be accessed during site visit.

Norbury Brook (at point of proposed realignment) and DF3/C002

Photograph 1: View south onto existing footbridge across Norbury Brook

Photograph 2: View west (downstream) along Norbury Brook from footbridge.

Photograph 3: View east (upstream) along Norbury Brook from footbridge.

Photograph 4: View north towards Norbury Brook across approximate proposed realignment location. Location of DF3/C002 along tree line in background on right

Photograph 5: View north on Norbury Brook from top of embankment at approximate location of proposed realignment.

Photograph 6: View north west on Norbury Brook from top of embankment at approximate location of proposed realignment.

Norbury Brook (at point of crossing) and DF3/C003

Could not be accessed during site visit.

DF3/C004

Photograph 7: View on existing pond at southern end of land drain, to south of approximate location of proposed highway.

Photograph 8: View north along land drain, south of approximate location of proposed highway.

Photograph 9: View north along land drain at approximate location of proposed highway.

Photograph 10: View north along land drain at approximate location of proposed highway.

Photograph 11: View north along land drain from approximate location of proposed highway.

Photograph 12: View north along land drain to north of approximate location of proposed highway.

DF3/C005

Photograph 13: View south east along tree line at location of DF3/C005.

Photograph 14: View north west along open land drain to north of proposed highway.

Photograph 15: View on outfall pipe to open land drain north of proposed highway.

Photograph 16: View on start of downstream pipe from open land drain north of proposed highway.

DF3/C006

Photograph 17: View south along drain.

Photograph 18: view south along drain at existing culvert.

Photograph 19: View on outfall pipes to drain.

Photograph 20: View north along drain from outfall pipes.

Photograph 21: View north west towards location of proposed DF3/C006

OUTFALL AND CATCHMENT INFORMATION

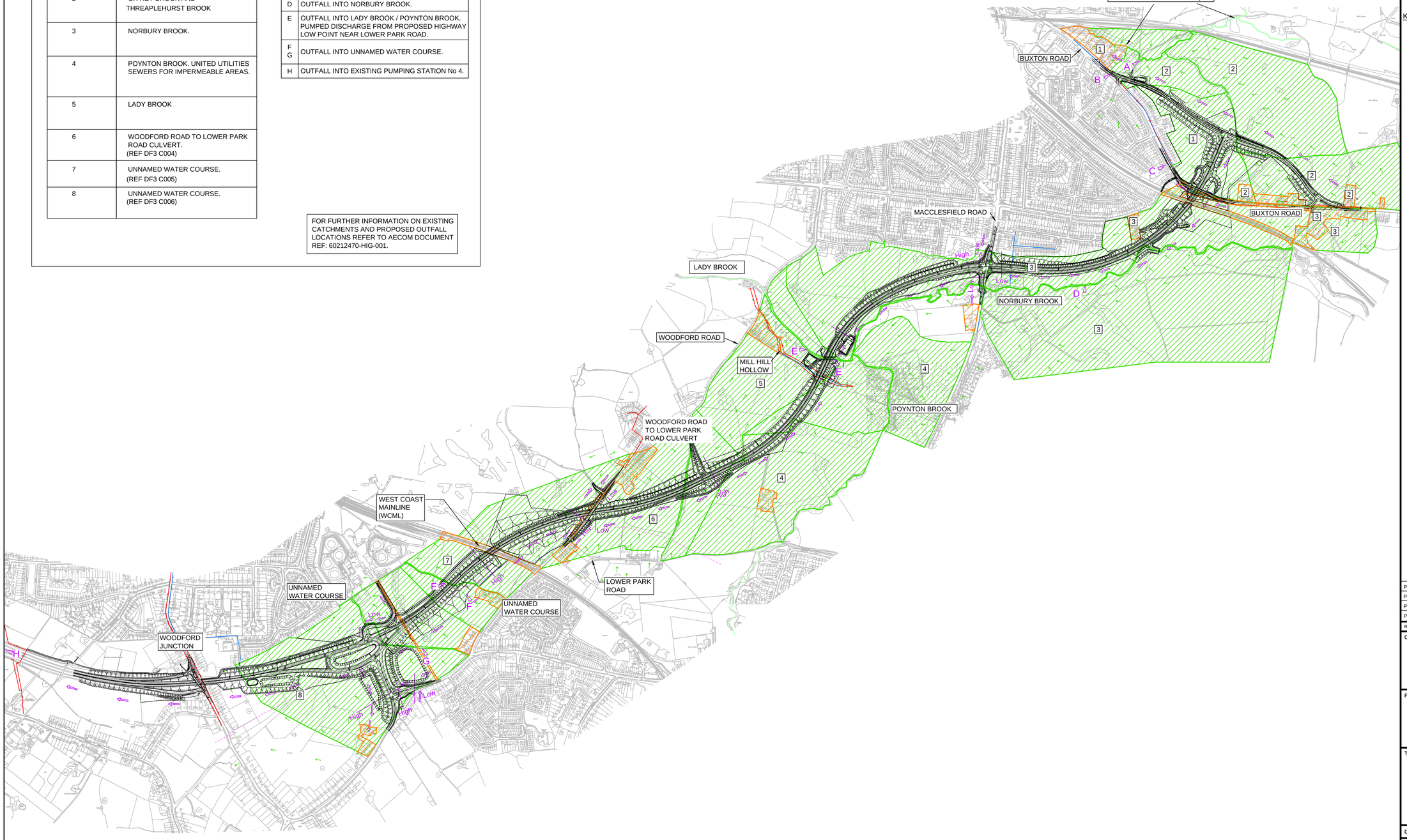
EXISTING CATCHMENT SUMMARY

CATCHMENT No.	OUTFALL LOCATION.
1	UNITED UTILITIES SEWER (BUXTON RD)
2	OX HEY BROOK AND THREAPLEHURST BROOK
3	NORBURY BROOK.
4	POYNTON BROOK. UNITED UTILITIES SEWERS FOR IMPERMEABLE AREAS.
5	LADY BROOK
6	WOODFORD ROAD TO LOWER PARK ROAD CULVERT. (REF DF3 C004)
7	UNNAMED WATER COURSE. (REF DF3 C005)
8	UNNAMED WATER COURSE. (REF DF3 C006)

PROPOSED OUTFALL LOCATIONS

A	OUTFALL AT LOW POINT OF PROPOSED HIGHWAY INTO OX HEY/ THREAPLEHURST BROOK.
B C	OUTFALL INTO EXISTING UNITED UTILITES SURFACE WATER SEWER AT BUXTON ROAD
D	OUTFALL INTO NORBURY BROOK.
E	OUTFALL INTO LADY BROOK / POYNTON BROOK. PUMPED DISCHARGE FROM PROPOSED HIGHWAY LOW POINT NEAR LOWER PARK ROAD.
F G	OUTFALL INTO UNNAMED WATER COURSE.
H	OUTFALL INTO EXISTING PUMPING STATION No 4.

FOR FURTHER INFORMATION ON EXISTING CATCHMENTS AND PROPOSED OUTFALL LOCATIONS REFER TO AECOM DOCUMENT REF: 60212470-HIG-001.



NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS, ANY DISCREPANCIES, ERRORS OR OMISSIONS TO BE BROUGHT TO THE ATTENTION OF THE OVERSEEING ORGANISATION.
2. CATCHMENT AREAS SHOWN EXTEND ONLY TO LIMITS OF AVAILABLE TOPOGRAPHICAL SURVEY.
3. LATEST HIGHWAY DESIGN RECEIVED FROM STOCKPORT METROPOLITAN BOROUGH COUNCIL IN FEBRUARY 2013. HIGHWAY DESIGN REFERENCE: TEST RUN 1.

KEY:

- EXISTING PERMEABLE CATCHMENT AREA
- EXISTING IMPERMEABLE CATCHMENT AREA
- EXISTING BROOK / WATERCOURSE
- EXISTING UU SW PIPE
- EXISTING UU WW PIPE
- EXISTING FLOW ARROW DERIVED FROM TOPOGRAPHICAL SURVEY
- PROPOSED HIGHWAY WORKS BOUNDARY
- PROPOSED FLOW ARROW DERIVED FROM LATEST HIGHWAY DESIGN LEVELS. SEE NOTE 3.
- A PROPOSED OUTFALL LOCATION

Rev	Date	Detail	Made	Chk'd	App'd
P04	10.09.13	UPDATED TO DESIGN 'DF7'	JR	PB	MCBH
P03	22.03.13	UPDATED TO DESIGN 'TEST RUN 1'	JR	PB	MCBH
P02	15.08.11	DETAILS ADDED	VUM	MCBH	PJ
P01	21.04.11	ISSUED FOR INFORMATION	VUM	MCBH	MCBH

Client:

STOCKPORT METROPOLITAN BOROUGH COUNCIL

Project:

SEMMMS A6 RELIEF ROAD

Title:

CATCHMENT DETAILS SHEET 1

Design: PB	CAD: VUM
Chk'd: MCBH	App'd: MCBH
Date: 20/04/2011	Scale: 1:8000 @ A1

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No. 60212470-HIG-0531

Rev: P04

OUTFALL AND CATCHMENT INFORMATION

EXISTING CATCHMENT SUMMARY

CATCHMENT No.	OUTFALL LOCATION.
9	SPATH BROOK/UNITED UTILITIES SEWER
10	GATLEY BROOK AND UNIDENTIFIED LAND DRAINAGE/PONDS
11	UNITED UTILITIES SEWER
12	BAGULEY BROOK

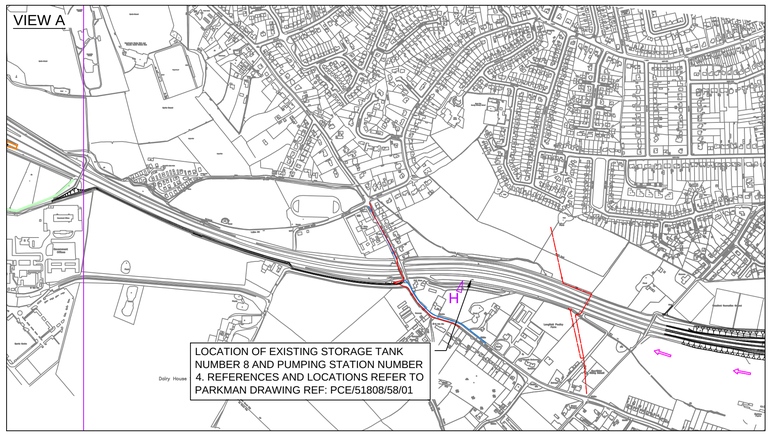
NOTE; EXISTING CATCHMENT/TOTAL AREA FOR CATCHMENT 10 NOT INDICATED ON PLAN DUE AREA DISCHARGING TO SEVERAL DIFFERENT LOCATIONS. REFER TO AECOM REPORT 60212470-HIG-001 DRAINAGE STRATEGY REPORT FOR FURTHER DETAILS.

PROPOSED OUTFALL LOCATIONS

I	OUTFALL AT EXISTING PUMPING STATION INTO SPATH BROOK.
J	OUTFALL TO EXISTING UNITED UTILITIES SURFACE WATER SEWER IN TEDDER DRIVE.

FOR FURTHER INFORMATION ON EXISTING CATCHMENTS AND PROPOSED OUTFALL LOCATIONS REFER TO AECOM DOCUMENT REF: 60212470-HIG-001.

VIEW A



NOTES:

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KEY:

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- EXISTING UU WW PIPE
- EXISTING FLOW ARROW DERIVED FROM TOPOGRAPHICAL SURVEY
- PROPOSED HIGHWAY WORKS BOUNDARY
- PROPOSED FLOW ARROW DERIVED FROM LATEST HIGHWAY DESIGN LEVELS. SEE NOTE 3.
- A PROPOSED OUTFALL LOCATION

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P04	10.09.13	UPDATED TO DESIGN 'DF7'	JR	PB	MCBH
P03	22.03.13	UPDATED TO DESIGN 'TEST RUN 1'	JR	PB	MCBH
P02	15.08.11	DETAILS ADDED	VUM	MCBH	PJ
P01	21.04.11	ISSUED FOR INFORMATION	VUM	MCBH	MCBH

Client:

STOCKPORT METROPOLITAN BOROUGH COUNCIL

Project:

SEMMMS A6
RELIEF ROAD

Title:

CATCHMENT DETAILS
SHEET 2

Design: PB	CAD: VUM
Chk'd: MCBH	App'd: MCBH
Date: 21/04/2011	Scale: 1:8000 @ A1

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Rev. P04

Appendix B – Hydraulic Modelling of Norbury Brook

B1 Hydraulic Modelling Introduction

Purpose of Modelling

Discussions with the Environment Agency indicated that there were no models available of this reach of the Norbury Brook. AECOM undertook hydraulic modelling to analyse the existing flood risk from Norbury Brook and to determine that the re-alignment of Norbury Brook and associated structures had no impact on flood risk. The modelling was developed to provide a tool for the analysis of appropriate mitigation, if required.

Technical review and acceptance of modelling by Environment Agency

Following completion of the modelling, a final report and further technical note were provided to the Environment Agency to aid technical review. The EA's review concluded that the modelling of the proposed realignment of Norbury Brook was adequate and showed the proposed realignment to have no detrimental impact on flows or water levels.

Overview of Modelling

Norbury Brook is well contained within its broader floodplain, 1d modelling of the watercourse was therefore considered appropriate to provide robust estimate of flood levels and the impact of the proposed realignment. Norbury Brook is an un-gauged catchment, therefore hydrometric data such as measured flow and level were not available to undertake model calibration. We have therefore undertaken sensitivity testing of the model to ensure the model provides robust estimates of flood levels.

The modelling was undertaken in the following stages:

- Ground model was developed;
- Detailed channel sections representing the watercourse were extracted, upstream and downstream of the proposed realignment and watercourse crossings;
- Hydrological analysis was undertaken to determine design flows up to 1% AEP flows.
- Model of the existing watercourse was undertaken (Basecase Modelling);
- Model results were used to define existing flood risk along Norbury Brook;
- Model was modified to simulate the "with development" scenario which included re-alignment of the watercourse and culverts.

Cross sections of the channel were developed at a spacing of 50m along the river channel with more detailed spacing of 20m upstream and downstream of the proposed realignment. Further detail was also required to model major changes in channel geometry. These cross-sections form the basis of the hydraulic model.
The cross-sections were imported into Infoworks RS.

Ground Model

The channel sections were supplemented by a ground model of the area along Norbury Brook. The ground model data was processed using MOSS (supplied by the Local Authorities) and combined with the topographic survey data that was collected as part of the channel survey.

Hydrology at Norbury Brook

In order to determine the appropriate hydrological inputs for the hydraulic model, the Flood Estimation Handbook (FEH) method was applied. The modelling required two inflows, the upstream inflow representing Norbury Brook and the intermediate in-flow representing Poynton Brook. The full details of the steps taken in the flow estimation are outlined below.

The NPPF requires climate change to be taken into account, an allowance for climate change of an additional 20% on river flows has been applied to the modelling.

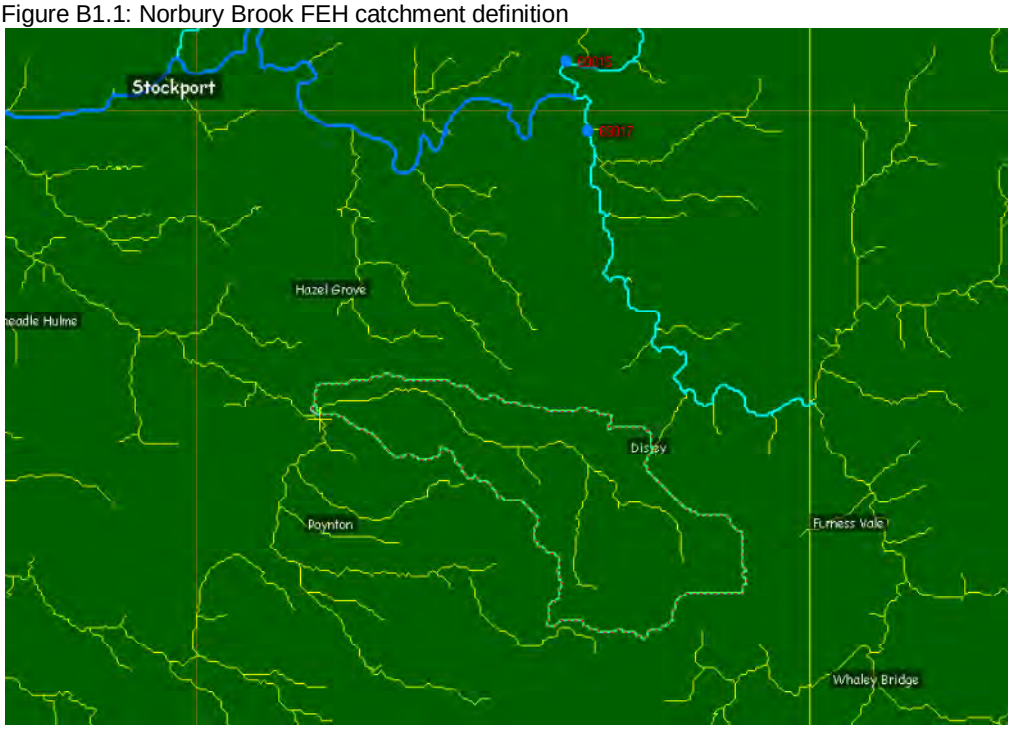
Flow Estimation

There are no flow gauging stations on Norbury Brook. As the catchment urbanisation indices were variable between 0.01 and 0.38 and there were no significant upstream storages a combination of the statistical and rainfall-runoff methods were applied to develop the flow estimates for Norbury Brook and Poyton Brook as follows:-

- FEH Station 69011 applicable to the Lady Brook (the combination of Norbury and Poynton Brooks) was the only suitable donor station.
- Catchment characteristics were extracted from the FEH CDROM. From this data, the index flood, QMED was calculated using standard Flood Estimation Handbook methods and adjustment applied for urbanisation where appropriate.
- Suitable analogue stations were chosen from the pooling groups created by WINFAP FEH. The stations were reviewed to ensure that catchment descriptors compared favourably with the subject sites and urbanisation indices were low, these stations were selected for data transfer. Typically, the top 5 characteristics as listed in the FEH CDROM were used in judging station similarity.

Flow Estimation by the Statistical Approach for Norbury Brook

Figure B1.1: Norbury Brook FEH catchment definition



Calculation of QMED rural from catchment descriptors

Application of equations to the Norbury Brook catchment descriptors:

AREA	12.53
SAAR	978
BFIHOST	0.406
SPRHOST	38.6
FARL	0.984
URBEXT	0.021
$QMED_{site\ rural}$	5.18

PRUAF	1.01
UAF	1.03
$QMED_{site\ urban}$	5.33

Adjustment of $QMED_{urban}$ from catchment descriptors by data transfer

Norbury Brook analogue sites:

Gauging Station	15002 - Newton burn at Newton	15809 Muckle burn at Eastmill	27051 - Crimple at Burn Bridge
$QMED_{am}$ / $QMED_{rd}$	0.906	1.267	1.102
Weighting given	0.33	0.33	0.33

Using these weightings, data transfer adjusts the value of QMED for the Norbury Brook from 5.33 m^3/s (based on catchment descriptors) to 5.66 m^3/s.

Calculation of Growth Factors and the T year Flood

Norbury Brook pooling group adjustments:

Station number	Added, moved, deleted?	Reason
21002 Whiteadder Water	Del	Inaccurate series
22008 Alwin at Clennel	Del	Short record

Pooling Group Details:

Norbury Brook pooling group details:

Station	Years	L-CV	L-Skewness	L-Kurtosis	Discordancy	Distance
52020 Gallica Stream @ Gallica Bridge	8	0.289	0.015	0.255	1.891	0.202
28070 (Burbage Brook @ Burbage)	56	0.344	0.502	0.452	2.143	0.266
27010 (Hodge Beck @ Bransdale Weir)	41	0.224	0.293	0.246	0.561	0.479
40809 (Pippingford Brook @ Paygate)	15	0.097	-0.126	-0.126	1.509	0.483
40017 (Dudwell @ Burwash)	17	0.225	-0.028	0.221	1.408	0.501
203049 (Clady @ Clady Bridge)	11	0.177	-0.025	0.026	0.324	0.581
12004 (Girnock Burn @ Littlemill)	26	0.235	0.016	0.032	0.229	0.618
41016 (Cuckmere @ Cowbeech)	15	0.442	0.445	0.166	2.455	0.619
15809 (Muckle Burn @ Eastmill)	20	0.242	0.034	-0.005	0.292	0.643
15002 (Newton Burn @ Newton)	24	0.202	0.274	0.11	0.796	0.666
27054 (Hodge Beck @ Cherry Farm)	17	0.142	-0.041	0.085	0.635	0.679
41020 (Bevern Stream @ Clappers Bridge)	33	0.232	0.274	0.237	0.413	0.693
28058 (Henmore Brook @ Ashbourne)	9	0.241	-0.096	-0.086	1.05	0.697
41026 (Cockhaise Brook @ Holywell)	11	0.299	0.147	-0.107	1.565	0.707
72014 (Conder @ Galgate)	9	0.35	0.088	-0.057	1.617	0.713
68011 (Arley Brook @ Gore Farm)	8	0.147	0.295	0.023	2.549	0.715
27051 (Crimple @ Burn Bridge)	30	0.203	0.07	0.112	0.098	0.772
22003 (Usway Burn @ Shillmoor)	21	0.316	0.266	0.145	0.364	0.781
41028 (Chess Stream @ Chess Bridge)	27	0.19	0.199	0.161	0.359	0.808
28038 (Manifold @ Hulme End)	13	0.157	0.167	0.146	0.601	0.834
22002 (Coquet @ Bygate)	11	0.204	-0.003	0.03	0.224	0.835
15005 (Melgan @ Loch of Lintrathen)	38	0.132	0.042	0.228	1.223	0.873
28033 (Dove @ Hollinsclough)	20	0.352	0.388	0.372	1.372	0.874
27042 (Dove @ Kirkby Mills)	22	0.273	0.049	0.064	0.323	0.879
Total	502					
Weighted means		0.251	0.212	0.191		

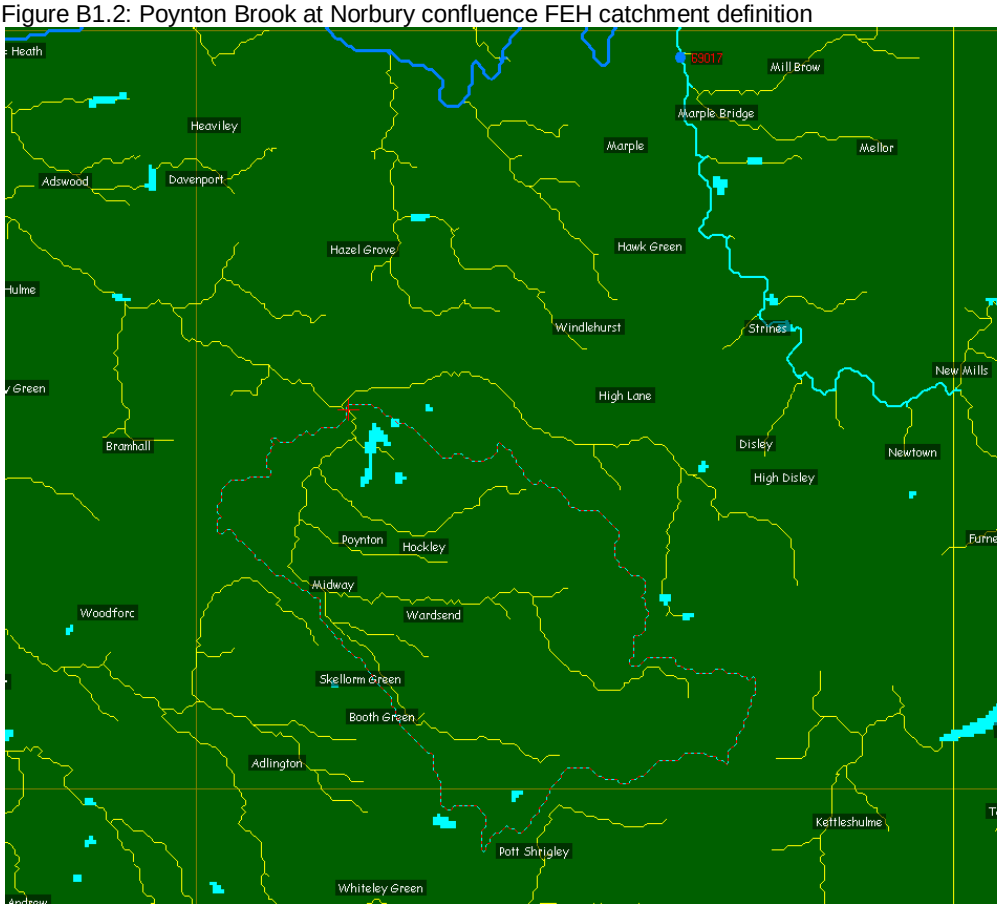
Norbury Brook growth factors and return periods:

Return Period (years)	x_T rural	Adjustment	x_T urban	QT (m^3s^{-1})
2	1	1.00	1.00	5.66
5	1.307	1.00	1.30	7.37
10	1.51	0.99	1.50	8.49
25	1.781	0.99	1.76	9.97
50	1.997	0.99	1.97	11.15
100	2.229	0.98	2.19	12.40

Note that the Generalised Logistic distribution was used to build the growth curve. The calculated 1 in 100 year flow plus 20% allowing for climate change for Norbury Brook is 14.88.

Flow Estimation by the Statistical Approach for Poynton Brook at Norbury Confluence

Figure B1.2: Poynton Brook at Norbury confluence FEH catchment definition



An EA approved, calibrated hydraulic model downstream of this project study area on the Norbury Brook (known as the Micker Brook downstream) provides a verified 1 in 100 year +20% flow of 31 m^3/s (Micker Brook Flood Risk Mapping Study, Final Modelling Report, Faber Maunsell, September 2005). This flow includes the contribution from the Norbury Brook and the inflow from the Poynton Brook as well as additional area contribution associated with a point further downstream the watercourse.

The flow calculation for the Norbury Brook above returns a 1 in 100 year +20% flow of 14.88 m^3/s. The modelled flow for the Poynton Brook upstream of the entry point to the Norbury Brook, calculated below was determined at 14.5 m^3/s.

If the calculated flow for the Norbury Brook (14.88 m^3/s) is subtracted from the calculated flow for the Micker Brook (31 m^3/s) a remainder is left of ~16 m^3/s for the Poynton Brook input. Since this input is downstream of the Poynton Brook calculation of 14.5 m3/s, it is acceptable that 16 m^3/s is used as the Poynton Brook inflow contribution to the Norbury Brook model.

Model Geometry

The modelling software used was InfoWorks RS, which is a one-dimensional, GIS interfaced hydrodynamic routing program based on the ISIS flow engine. The software includes full solutions of open channels, floodplains, embankments and hydraulic structures.

The river cross-section were imported into Infoworks RS and combined with the ground model to provide a robust representation of the watercourse and its floodplains.

The channel roughness is represented by Manning's, 'n' number. An estimate of the channel roughness based on site visits and standard values for the types of vegetation and channel was undertaken. A Manning's 'n' of 0.035 to represent the channel roughness and 0.05 to represent the channel roughness on the banks and floodplains was adopted.

Structures

The bridges along this reach of the Norbury Brook were included within the model and represented by Arch Bridge units in Infoworks RS. Spill units were added to the model to represent flow of water over the bridge deck.

Minor bridges or foot bridges that were well above the expected flood level were taken into account by increasing the roughness coefficients of the river-sections.

Out of bank flow (floodplain)

Out of bank and storage within the floodplain were represented by spills units representing the top of bank connected to floodplain storage units representing the floodplain. The depth-storage relationship of the floodplain areas was calculated using the ground model at depth intervals of 0.1m. Where there were earth bunds, adjacent flood storage areas were adopted and linked by in-line spill units

Flow Boundaries and Event Data

A flow hydrograph representing inflow into Norbury Brook and the intermediate inflow representing Poynton Brook was derived from the hydrological calculations described in hydrology above.

The peak flow for the in-flow into Norbury Brook is 14.9m^3/s and the Poynton Brook 16.0m^3/s. These flows represent a conservative estimate of the 1 in 100 year plus 20% climate change event.

The downstream boundary was normal depth boundary, positioned sufficiently downstream from the point of interaction with the proposed highway so as not to have any significant effect on modelling results.

Sensitivity testing

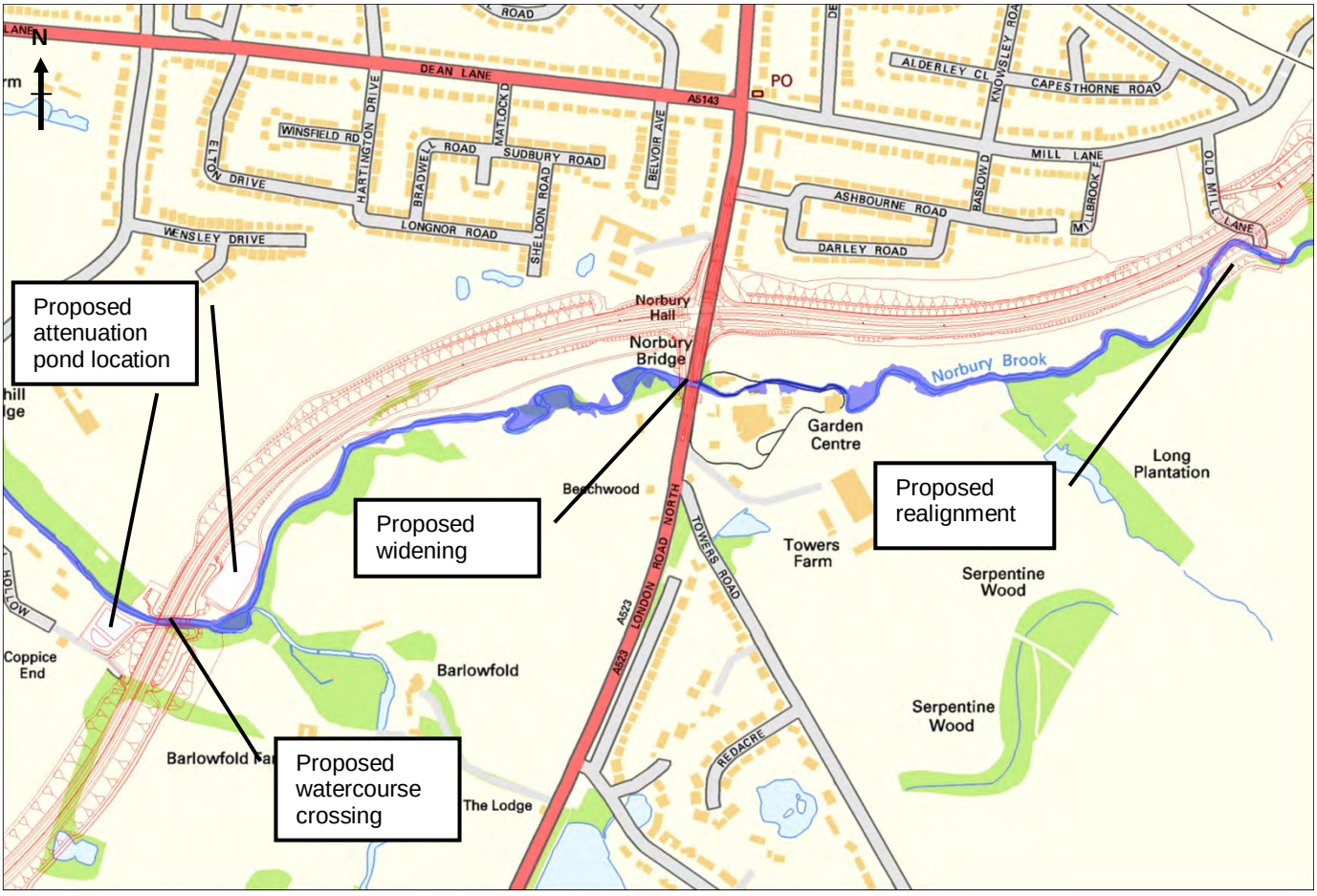
As there is no measured flow and level data for the Norbury Brook for calibration a sensitivity test of the key parameters was undertaken to ensure that the model provides a robust model of Norbury Brook. Checks were also undertaken of parameters of calibrated models of nearby watercourses and review against EA's flood maps.

B2 Modelling Results

Base Case (existing flood risk)

Figure B.2.1 shows a plan of the modelled flood extents of Norbury Brook for the 1 in 100 year plus climate change event, along a 2km length of the proposed highway. The model results show that the 1 in 100 year plus 20% climate change event is contained within the Norbury Brook and its primary floodplain and there are no areas of extensive flooding.

Figure B2.1: Flood extent map of the Norbury Brook (1 in 100 year +20%)



 Not to scale.

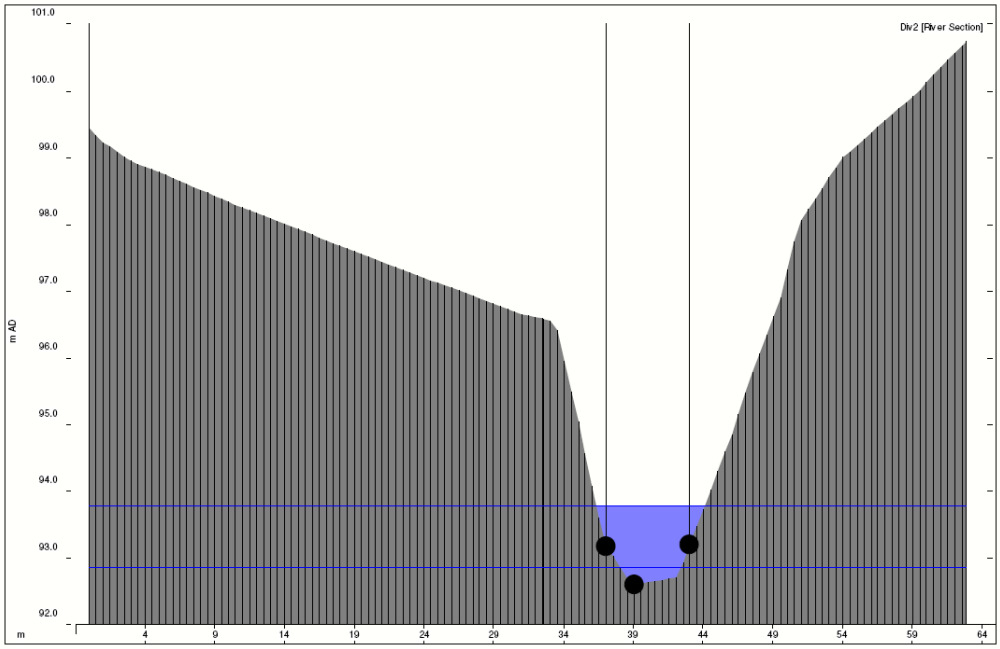
Key:

Approximate Proposed Highway Works

Modelled 1 in 100 year plus 20% climate change flood extent

Figure B2.2 below shows the river section (Chainage 8830m), where the highway alignment is almost parallel to the stream and where the proposed realignment is located. The vertical alignment of the highway is approximately 98.0 mAOD whereas the 1 in 100 year flood level is 93.7 mAOD, this indicates that there is no flood risk to the proposed highway.

Figure B2.2: River section at chainage 8830m



Proposed Realignment of Norbury Brook

The Norbury Brook is a steep incised river valley, the risk of fluvial flooding is considered low. The proposed highway includes one bridged crossing and a realignment of the Norbury Brook in one location, shown in Figure B2.1 above and Figure B2.3 below.

Proposed Realignment

At Chainage 8830m, the horizontal alignment of the highway runs arallel but above the brook. The length of this section was considered too great to bridge, therefore the proposal includes rea gnment of the brook to a more southerly alignment (Figure B2.3).

Figure B2.3: Proposed realignment at CH. 8830m.

Contains Ordnance Survey data © Crown copyright and database right 2013. Not to scale.

Post Development Scenario

The existing (base case) modelling was used as a basis for analysing the impact of the proposed re-alignment. The in-flows to the model remain the same as the base case and to ensure a conservative estimate of flood risk the 1 in 100 year +20% (climate change) event has been modelled.

Changes were made to the geometry to the model, river channel cross-sections were added to the model to represent the proposed re-alignment, the size and shape of the channel cross-sections were consistent with the existing sections, the length of the channel was decreased to represent the channel realignment.

In terms of changes in peak stage (maximum water level), the 'Proposed Realignment' modelling with channel re-alignment showed no significant increase either at the location of the proposed realignment, or in the upstream and downstream reach. The peak stage is slightly reduced at most model cross-sections in the vicinity of the realignment, with a maximum increase of 0.01m just upstream, this is considered within the normal modelling tolerances and not significant.

In terms of changes in peak flow, the 'Proposed' modelling also showed no significant increases either at the location of the proposed realignment, or in the upstream and downstream reach. A small increase of 0.01 m^3/s occurs at a cross-section downstream of the proposed crossing, again within the normal modelling tolerances and not considered significant.

Flood Mapping was produced for the 'Existing' and the 'Proposed Realignment' cases using InfoWorks RS to demonstrate visually that there is no increase in flood extent as a result of the proposed road, and associated realignment/crossing. In the vicinity of the proposed realignment, there is little or no change in the flood extent between the 'Existing' case and 'Proposed Realignment' case, other than at the realignment itself.

Proposed Structures

As indicated on the plan in Appendix A1, there are two proposed structures which will cross Norbury Brook – a widening of Norbury Bridge at the junction with the A523 Macclesfield Road and a road bridge carrying the proposed highway over the brook to the east of Woodford Road and, both downstream of the proposed realignment.

During the detailed design stage these structures will be designed to have no impact on the flood extents or the brook itself, with further modelling checks being undertaken as necessary to ensure the design is appropriate. Detailed modelling of the proposed

structures was not therefore undertaken at this stage. The requirements for design of these structures in relation to the flow and flood extents of Norbury Brook are discussed in Section 6.

Conclusion

The ‘Existing’ and ‘Proposed Realignment’ models of Norbury Brook were developed in InfoWorks RS, they have been reviewed and updated where necessary to ensure they reflect the existing case, and the latest proposed road design respectively.

Results from the model runs showed no significant increases in peak flow or stage (water level) at either the location of the proposed realignment, or in the reaches upstream and downstream of the realignment. The mapping of the flood extents shows no detectable change in flood extent, other than at the realignment itself. It is therefore concluded that the proposed realignment does not cause an increase in flood risk from Norbury Brook and the proposed route is not affected by flooding during the 1 in100 year plus climate change event.

Appendix C – Culverting Assessment

C1 Determination of Culverting Requirements

C2 Culvert Sizing

C3 WinDes Greenfield Runoff Calculation

C4 Proposed Culvert Schedule

C1 Determination of Culverting Requirements

Along the route of the proposed A6 to Manchester Airport scheme, a number of existing drains or small watercourses which will be bisected by the proposed highway have been identified. At these points it may be necessary to culvert the watercourse/drain beneath the proposed highway in order to maintain the flow.

AECOM has assessed the requirements for treatment of these small watercourses and drains on a case-by-case basis and undertaken initial sizing of proposed culverts.

All locations discussed are indicated on the Route Plan within Appendix A1 of the Flood Risk Assessment (AECOM, 2012).

Approach

It was agreed with the Environment Agency (EA) that a 'case-by-case' approach to the treatment of small watercourses/drain and potential culvert locations is required.

The recommendations on whether a culvert is required has been based on assessment of the upstream catchment and likely flow, inspection of existing conditions on site, assessment of proposed conditions, and a pragmatic evaluation of the most appropriate treatment for each location. The recommendations are made from a flood risk perspective only, and further assessment by the Environmental Consultant (Mouchel) and discussion with the appropriate LLFA is required in order to determine if a culvert is required or not.

At all locations the final requirement for culverting should be agreed with the LLFA based on the assessment of the Environmental Consultant and the Engineers.

Inspection of Watercourses

During the site walkover most of the watercourses/drains were visited to confirm their location, size and inspect the current condition. Photographs from the site walkover are included in **Appendix A2**.

Where a location could not be accessed during the site visit, our assessment has been undertaken with reference to OS mapping, UU sewer records, and aerial photography.

Assessment

The following pages detail the results of the assessment at each identified potential culvert location. The figures over the following pages should be read with the following key.

Key to Figures 8 - 14:


Approximate Proposed Highway Works

Watercourse

Minor watercourse/Drain

Direction of Flow (From inspection on site or based on topography)

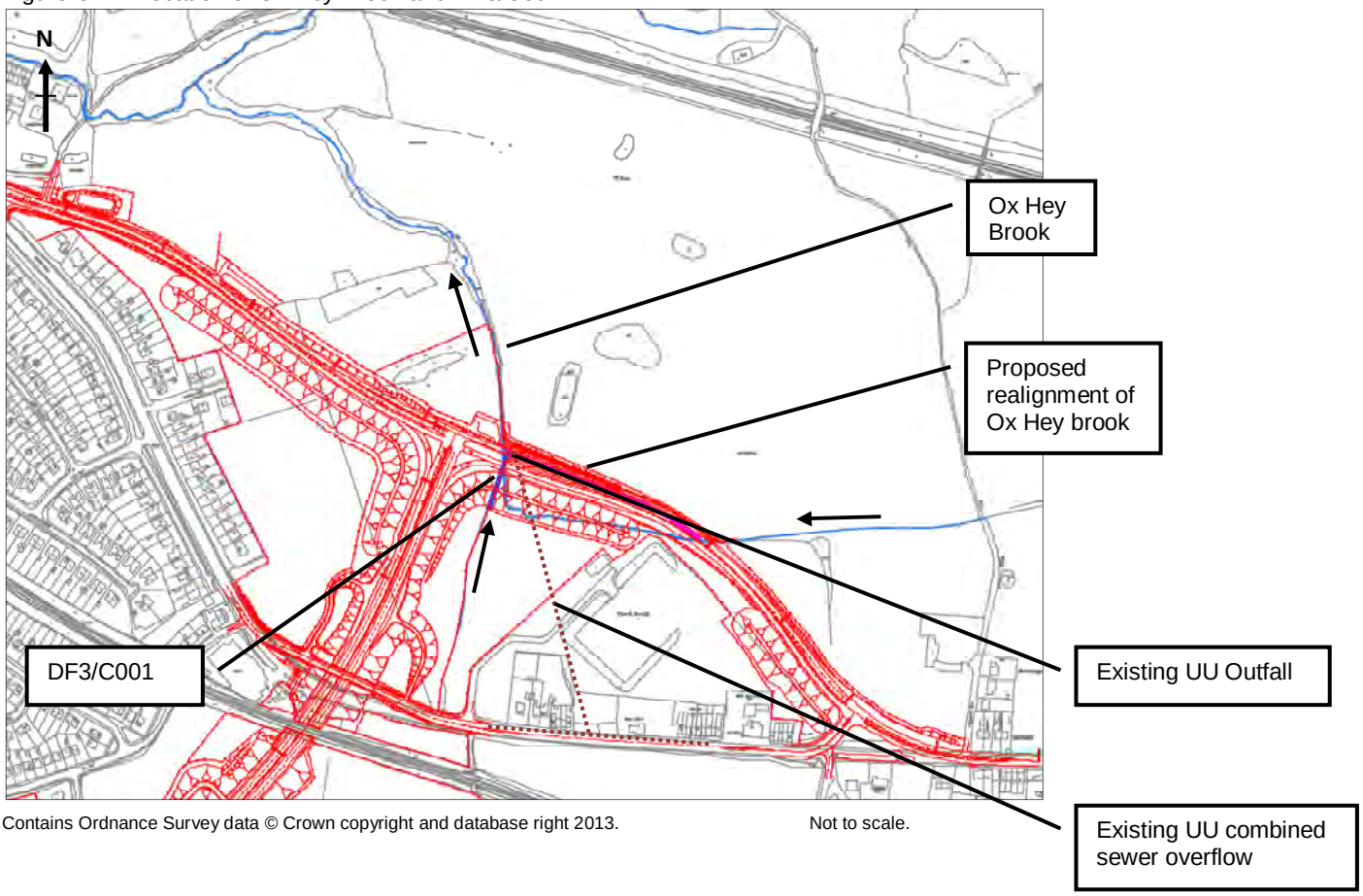
Proposed Realignment

Potential Proposed Culvert

Ox-Hey Brook and DF3/C001

A possible land drain does exists to the west of an existing UU combined public sewer outfall between the A6 and Ox-Hey Brook. This may require culverting; the location of the potential culvert is shown in Figure C1.1. Inspection of this land drain on site was not possible during the site walkover. Its existence and importance should be confirmed during detailed design.

Figure C1.1: Location of Ox Hey Brook and DF3/C001.

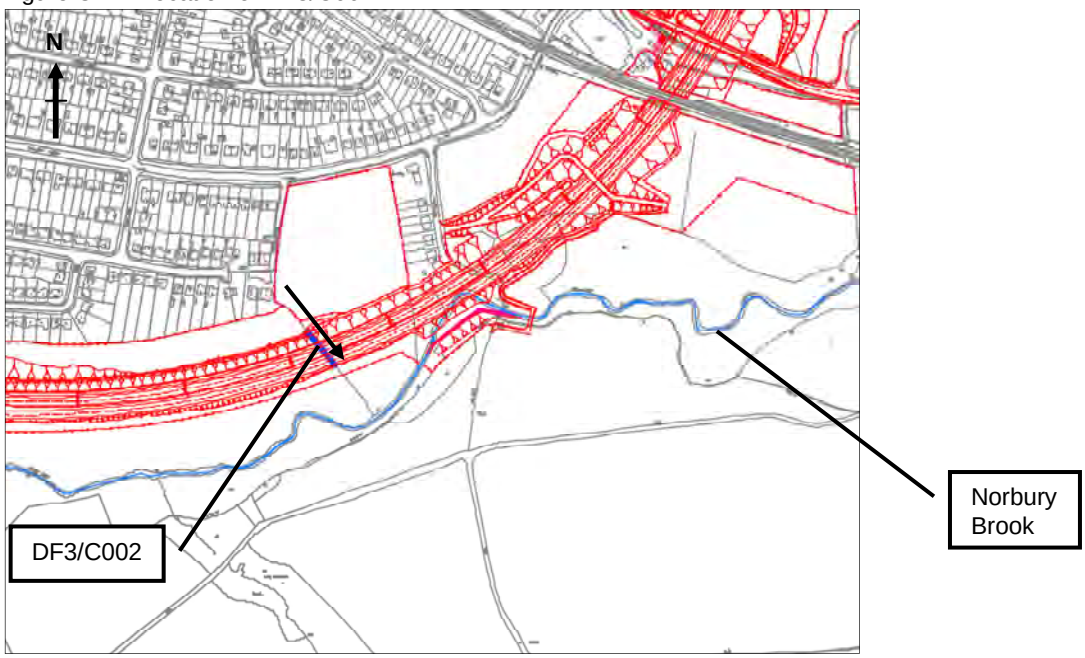


 Not to scale.

DF3/C002

To the west of the proposed realignment of Norbury Brook, a potential land drain has been identified down the hillside to Norbury Brook as shown in Figure C1.2. From inspection on site from the opposite side of Norbury Brook (see photographs in Appendix A2), and study of OS and aerial maps, no defined channel is visible in this location and only a tree line is visible on the hillside. As there is no defined channel and only a relatively small greenfield area surrounding this location, it is unlikely that the flow which could be conveyed by any drain in this location would be significantly great to warrant culverting, and therefore it is suggested any runoff following this line down the hillside could be picked up by the earthworks drainage of the proposed scheme without any detrimental impact.

Figure C1.2: Location of DF3/C002.



 Not to scale.

DF3/C003

Further west, a potential land drain has been identified down the hillside along the tree line from Wensley Drive to Norbury Brook as indicated in Figure C1.3. The site could not be accessed during the walkover, but no tributary at this location is noted in the previous Norbury Brook modelling study and OS mapping does not indicate the presence of a drain at this location. Further work on site is required to establish the presence of drain, but it is suggested that a culvert at this location may not be necessary and any runoff following this line down the hillside could potentially be picked up by the earthworks drainage of the proposed scheme without any detrimental impact.

Figure C1.3: Location of DF3/C003.

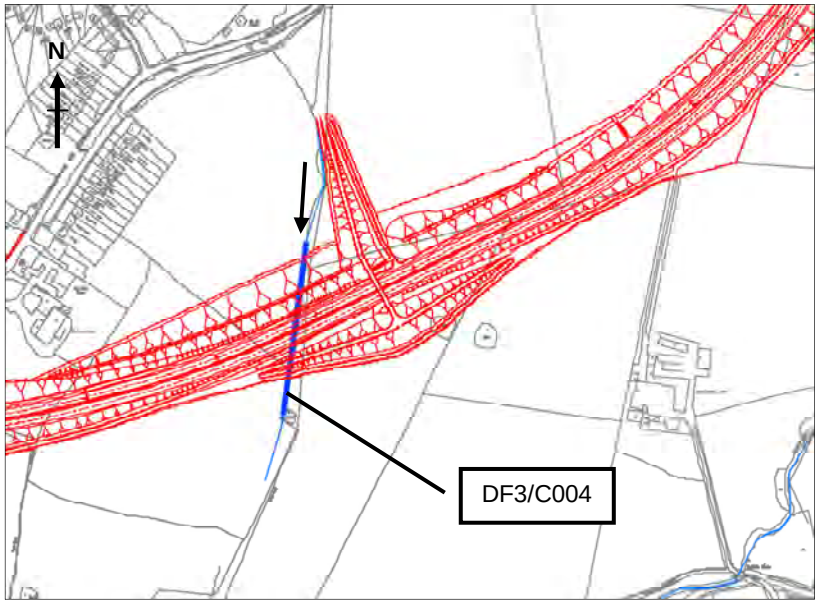
 Not to scale.

DF3/C004

In this location to the south east of Woodford Road a land drain was identified during the site walkover, as indicated in Figure C1.4. The drain does not appear to have a notable source, only a field drain which becomes more defined as it falls down the hill. The existing drain ends at a pond.

As the bottom end and function of the drain would be lost following the construction of the new highway, it is suggested that A culvert at this location may not be necessary as any flow in the drain on the north of the highway (down the hillside towards the highway) could potentially be picked up by the earthworks drainage of the proposed scheme without any detrimental impact. However, the ecological requirements of the existing pond will require consideration in this decision.

Figure C1.4: Location of DF3/C004.



 Not to scale.

DF3/C005 and DF3/C006

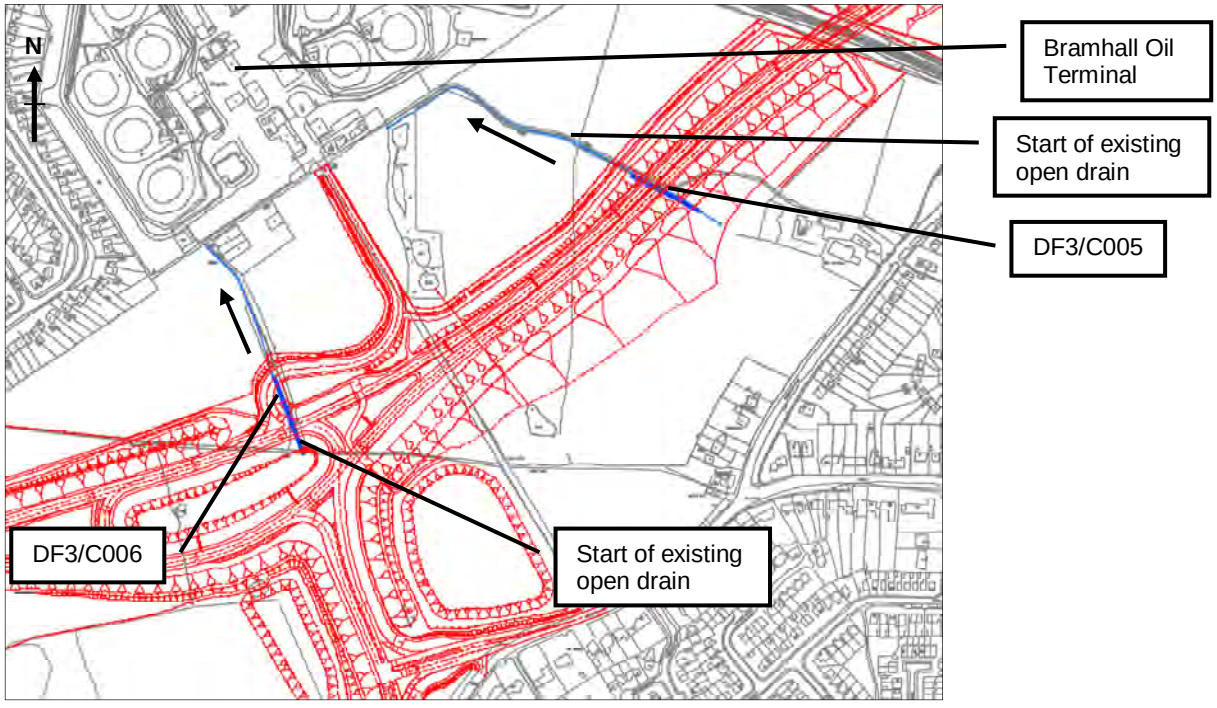
At these potential culvert locations, land drains have been positively identified during the site walkover. They are located to the north west of Woodford Road, between Woodford Road and the Bramhall Oil Terminal as shown in Figure C1.6.

At the potential location of DF3/C005 no drain is present on the surface, but a small drain is visible to the north east of this location which may be piped beneath the footprint of the proposed highway. The drain here flows from a pipe (estimated 150mm diameter) into a ditch for approximately 20m, and back into a pipe. Only a small flow was observed in the ditch during the site visit. This drain appears to be nothing more than a land drain and is unlikely to require culverting as no upstream open section has been identified. The piped land draining which feeds the ditch should be protected during construction of the new highway or picked up by the earthworks drainage to ensure its function is maintained.

At the potential location of DF3/C006 there is a defined but small watercourse along a field boundary, which begins from a number of pipe outfalls at a location which is within the footprint of the proposed highway. The present watercourse flows in open channel towards the oil terminal for approximately 30m before flowing into a culvert. No open sections of drain or watercourse upstream of this watercourse have been identified, therefore it is suggested that culverting may be inappropriate in this location.

The piped land drainage which feeds the ditch could be protected and extended to the new head of the culvert (outside of the highway footprint) to ensure its function is maintained and the flow in the watercourse remains the same. Alternatively, if a culvert was required to preserve the full length of the existing open channel, the piped outfalls would be within the culvert.

Figure C1.6: Location of DF3/C005 and DF3/C006.



 Not to scale.

C2 Culvert Sizing

The correct sizing of any culverts beneath the highway is necessary to ensure continuity of flow in land drains/watercourses, thereby ensuring there is no increase in flood risk caused by the development. As discussed in Appendix C1, it is suggested that culverts may not be required at all locations identified. This has been determined from a flood risk perspective, however it is recognised that some culverts may be required for ecology proposes, to allow natural habitats to remain connected. Theoretical culvert sizes have therefore been determined for all locations.

There are a number of considerations which need to be taken into account when establishing the appropriate culvert size for each location. In addition to the need to pass the required design flow unrestricted, further requirements may include: Ecological considerations such as provision of wildlife ledges and provision of a naturalised bed; Access requirements for maintenance through the culvert or upstream and downstream of the culvert; and buildability considerations.

It has been recognised by all parties that appropriate culvert sizing will be an iterative process, taking into account hydrology, ecology, access and buildability, which will include input from the LLFA, the highway designers and the Environmental Consultant.

This section describes the methodology by which the initial culvert sizing has been carried out.

Calculation of Design Flow

Estimation of Catchment Size

Catchment size for each watercourse/drain has been estimated from the topographical information supplied by SMBC.

Climate Change

The NPPF requires climate change to be taken into account. As detailed in Section 2.2 of the FRA, an allowance of an additional 20% on rainfall intensity has been applied during culvert sizing process.

Runoff Calculation

As supported by the EA, the existing runoff rates from the greenfield areas of the route have been calculated based on the methodology set out in Institute of Hydrology Report No. 124 Flood Estimation for Small Catchments (the IoH124 method). This methodology calculates greenfield runoff rates based on the site area, soil type and annual rainfall based on the location of the Site within the United Kingdom. This method is based on the formula:

$$QBA_{Rrural} = 0.00108.AREA^{0.89}.SAAR^{1.17}.SOIL^{2.17}$$

where: AREA = Area (km^2)

SAAR = Average Annual Rainfall (mm) - Obtained from Wallingford Maps

SOIL = Soil Index - Obtained from Wallingford Maps

The IoH124 method is generally applicable to catchments over 50 hectares. The Interim Code of Practice for SUDS recommends that for catchments of less than 50 hectares, a 50 hectare figure is used to calculate runoff, and the result linearly interpolated for the actual area. The greenfield runoff rate for the rural parts of the route has been estimated using the Microdrainage WinDes computer package. The results of the calculation for a 50ha site are included in Appendix C3. Interpolating these results gives the following runoff rate for the 1 in 100 year return period:

$Q_{100\ rural}$ = 11.63 l/s/ha

From this the 100 year plus 20% climate change runoff rate can also be calculated as:

$Q_{120\ rural}$ = 13.95 l/s/ha

These runoff rates have been applied to the greenfield catchment areas to determine the design flow rate for each of the rural culvert locations.

Ecological Requirements

Ecological requirements may include such measures as provision of wildlife ledges, provision of a natural bed. The final culvert size should include for the recommendation of the Environmental Consultant on these matters.

During the initial sizing, provision has been made for a 150mm depth of natural bed, as recommended by the EA.

Initial Culvert Sizing

Based on the guidelines set out by the Environmental Consultant, the EA, and with reference to the CIRIA document C687 Design and Maintenance of Culverts, the following general 'rules' have been applied to arrive at the appropriate initial culvert size for each location:

- Culvert shall be sized to allow the free passage of the 1:100 year +20% flow event;
- Minimum culvert size shall be 600mm diameter to mitigate against potential blockage;
- Culverts under significant embankments will have a minimum diameter of 1000mm to allow access for maintenance;
- The culvert invert is to be set below the bed level by around 25% of the pipe diameter or not less than 150m to allow a natural bed to be reinstated, 300mm has been applied to box culverts;
- All sizes to be based on available pre-cast pipes or box units.
- No multi-pipe culverts to be specified;
- A freeboard shall be provided above the design flood level of either 25% of the pipe diameter for pipes of diameter up to 1200mm, or 300mm for larger culverts and box culverts;
- Once the appropriate size has been determined on this basis, the 'next size up' has been selected to allow for the cross sectional area lost to provision of mammal ledges.

The initial culvert schedule is included in Appendix C4.

Development of Culvert Schedule and Final Culvert Sizing

The initial culvert sizing and draft culvert schedule is to be reviewed by the Environmental Consultant, LLFA and highway designer to determine where larger culverts may be required or where culverts may be omitted based on the information in Appendix C1. The initial culvert sizing is intended as a guide to the required minimum culvert size at each location from a hydraulic perspective.

Final culvert sizing at detailed design will be subject to full hydraulic design and may include the provision of additional measures such as trash screens and/or grilles, access through the culvert, and any ecological requirements. Culverting will also be subject to obtaining Land Drainage Consent form the LLFA as set out in Section 6.1 of the FRA.

IH 124 Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	50.000	Urban	0.000
SAAR (mm)	860	Region Number	Region 10

Results	**l/s**
QBAR Rural	279.5
QBAR Urban	279.5
Q100 years	581.3
Q1 year	243.1
Q2 years	260.3
Q5 years	332.6
Q10 years	385.7
Q20 years	439.4
Q25 years	458.3
Q30 years	473.8
Q50 years	517.0
Q100 years	581.3
Q200 years	659.6
Q250 years	684.7
Q1000 years	849.6

SEMMMS A6 to Manchester Airport
Initial Proposed Culvert Schedule
June 2013

Produced by: Matthew Wilson, Engineer
Checked by: John Bolton, Associate Director

THIS SCHEDULE SETS OUT THE MINIMUM CULVERTING REQUIREMENTS, BASED ON THE INVESTIGATIONS AND INITIAL SIZING CALCULATIONS UNDERTAKEN FOR THIS STUDY. THE SIZING REQUIREMENTS SHOULD BE REVISITED BASED ON ANY FURTHER RECCOMENDATIONS OR REQUIRMENTS OF THE ENVIRONMENTAL CONSULTANT AND THE ENVIRONMENT AGENCY BEFORE THE FINAL CULVERT REQUIREMENTS AND SIZES ARE CONFIRMED AT DETAILED DESIGN.

To be read in conjuction with SEMMMS A6 to Manchester Airport Flood Risk Assessment

Location/Name	Approximate Chainage to centre (m)	Draiange Network Ref	Urban / Rurual Catchment	Approximate coordinates at centre		Approximate Culvert length (m)		Culvert Width (mm)		Proposed Height (mm)	Proposed Shape	Upstream Invert Level (where survey data available)	Estimated 100 yr+20% flow (l/s)	100yr+20% flow depth (mm)	Access required through culvert? (Y/N)	Acccess up-stream (ped/veh)	Access downstream (ped/veh)	Lead Local Flood Authority	Comments
				Easting	Northing	Existing	Proposed	Approximate Existing	Proposed										
East of A6 junction, tributary of Ox Hey Brook within Hazel Grove Golf Course	0	DF3/C001	Rural	393546	385891	N/A	60	N/A	600	600	Circular	TBC	45.92	129	TBC *	TBC	TBC	SMBC	May not require culverting. Refer to FRA Section 8.
Land drain south of Millbrook Fold, tributary of Norbury Brook	8980	DF3/C002	Rural	393020	385426	N/A	100	N/A	600	600	Circular	TBC	10.89	31	TBC *	TBC	TBC	SMBC	May not require culverting. Refer to FRA Section 8.
Land drain to east of Chester Road, tributary of Norbury Brook	10000	DF3/C003	Rural	392037	385250	N/A	80	N/A	600	600	Circular	TBC	72.71	204	TBC *	TBC	TBC	SMBC	May not require culverting. Refer to FRA Section 8.
Woodford Road to Lower Park Road Culvert, land drain	11090	DF3/C004	Rural	391247	384480	N/A	165	N/A	750	750	Circular	TBC	132.16	234	TBC *	TBC	TBC	CEC	May not require culverting. Refer to FRA Section 8.
Un-named watercourse	12150	DF3/C005	Rural	390292	384075	N/A	120	N/A	675	675	Circular	TBC	92.39	199	TBC *	TBC	TBC	SMBC	May not require culverting. Refer to FRA Section 8.
Un-named watercourse	12555	DF3/C006	Rural	390061	383901	N/A	155	N/A	900	900	Circular	TBC	224.69	295	TBC *	TBC	TBC	SMBC	May not require culverting. Refer to FRA Section 8.
						Total	680												

Notes
Estimated flows based on IoH Report 124 methodology as agreed with the Environment Agency.
All initial culvert sizes subject to review by the highway designer, environmental consultant, and EA.
All final culvert details and sizes to be formally agreed with the Environment Agency.
Estimated capacities based on 1:1000 slope
* Minimum size to be 1200mm diameter where access is required through the culvert for maintainence

Appendix D – Local Planning Policy Review

D1 Stockport Metropolitan Borough Council

D2 Cheshire East Council

D3 Manchester City Council

D1 Stockport Metropolitan Borough Council (SMBC)

SMBC have adopted the Stockport Local Development Framework (LDF) Core Strategy Development Plan Documents, meaning that the current policies used to manage development in this area are those set out in the Core Strategy along with some policies of the former Unitary Development Plan (UDP) which have been retained.

Development Management Policy SD-6 of the Core Strategy Development Plan Documents- Adapting to the Impacts of Climate Change – sets out the requirement that all development on 'greenfield' land must not increase the rate of surface water runoff. The policy notes that development on 'brownfield' land will be subject to implementation of a reduction in the rate of surface water runoff by 50%. The policy states the construction of hardstanding should utilise permeable paving or drain to alternative SUDS.

Development Management Policy SIE-3 - Protecting, Safeguarding and Enhancing the Environment – states that all development will be expected to comply with the approach set out in current national planning policy and again notes that SUDS should be implemented for areas of hardstanding.

Saved policy EP1.7 of the UDP states that *"the Council will not permit development, including the raising of land, where it would: (i) be at risk from flooding; (ii) increase the risk of flooding elsewhere; (iii) hinder future access to watercourses for maintenance purposes; (iv) cause loss of the natural floodplain; (v) result in extensive culverting; (vi) affect the integrity of existing flood defences; or (vii) significantly increase surface water run-off unless the applicant can demonstrate that satisfactory and sustainable measures will be implemented to overcome the adverse effects. All development which is likely to have an impact on drainage patterns should incorporate, as far as is practicable, sustainable drainage systems taking account of current Government advice."*

The SMBC Supplementary Planning Document on Sustainable Design and Construction (November 2010) notes that excess surface water and flooding is an issue which requires consideration in development and promotes the use of SUDS. The SFRA notes that all developments on greenfield land should reduce runoff to the greenfield runoff rate, including consideration of climate change.

D2 Cheshire East Council (CEC)

CEC replaced Macclesfield Borough Council as the local authority for the area in 2009. Some of the planning documents produced by the previous council have been adopted by the new council and are still valid.

CEC are in the process of developing a Core Strategy which will guide planning decisions in the area. Until this is completed, the saved policies of the Macclesfield Local Plan are valid. The following relevant polices have been identified.

Policy DC17 Water Resources states that *"development will not normally be allowed which would: 1Be in areas liable to flooding; 2 Cause loss of access to watercourses for future maintenance; 3 Cause loss of natural flood plai; 4 Lead to inadequate surface run-off provision; 5 Result in the extensive culverting of watercourses; 6 Affect the integrity of fluvial defence.*

Policy DC18 Water Resources states that *"where appropriate, development should incorporate sustainable urban drainage systems to bring about a reduction in flood risk."*

D3 Manchester City Council (MCC)

MCC have adopted the LDF Core Strategy Development Plan Documents, meaning that the current policies used to manage development in this area are those set out in the Core Strategy along with some policies of the former UDP which have been retained.

Policy EN 14 of the Core Strategy confirms that development should be directed away from areas at risk of flooding and that it should take account of all sources of flooding identified in the SFRA (See Section 2.2.3.2). It notes that development should minimise surface water runoff, with particular regard to development in any Critical Drainage Area (CDA) where the proposals should have regard to the runoff rates set out in the SFRA.

The Supplementary Planning Document (SPD) Guide to Development in Manchester – Supplementary Planning Guidance (April 2007), which was adopted as part of the LDF, requires that SUDS be included in developments where possible and the amount of impermeable area minimised.

Surface Water Flooding and Critical Drainage Areas

The Manchester City, Salford City and Trafford Councils Level 2 Hybrid Strategic Flood Risk Assessment (SFRA) identifies Critical Drainage Areas (CDA) within Manchester, Salford and Trafford. CDAs are, by definition, areas which are in Flood Zone 1 but have critical drainage problems associated with them. These areas are particularly sensitive to any increase in the rate and volume of surface water runoff from new development, and specific drainage requirements are proposed in these areas to help reduce the risk of surface water flooding.

Within the MCC boundary, the proposed route is located in the Manchester and Trafford South CDA, meaning that particular attention and due consideration must be given to surface water drainage of the proposed development. With regard to this CDA in the study area, the SFRA notes that the CDA has a number of *"dispersed surface water hotspots",* the largest of which is around Wythenshawe and Baguley and is closely linked to the flow route of Baguley Brook (and Brownley Brook).

The SFRA User Guide states that an FRA for a development in a CDA should *"demonstrate that new development is not at risk from flooding from existing drainage systems or potential overland flow routes. It should also demonstrate that the development will not adversely affect existing flooding conditions by the use of appropriate mitigation measures. The FRA should define and address the constraints that will govern the design of the drainage system and layout of the development site".*

The SFRA User Guide recommends that for new development there should be an aim to reduce runoff, to a rate agreed between the developer, the EA, and MCC. A target reduction of at least 50% is suggested for brownfield sites with an aim to reduce the runoff to greenfield rates.

Appendix E – Consultation Summary

E1 Environment Agency

E2 Stockport Metropolitan Borough Council

E3 Cheshire East Council

E4 Manchester City Council

E5 Bramhall Oil Terminal

E6 United Utilities

E1 Environment Agency

An information request was sent to the EA on 18th April 2011 detailing a number of key points for discussion and questions relating to flood risk and the proposed highway. A meeting was held with the EA on 19th April 2011 to discuss the issues surrounding drainage and flood risk in which a number of the points were addressed. The following pertinent points were noted during the discussion with the EA:

- With regards to the east of the route (near the A6), the EA would prefer some of this to be drained to the Ox Hey Brook or Threaplehurst Brook to the north east, in order to follow the natural watercourse catchments;
- For the proposed realignment of Ox Hey Brook, the EA noted that the capacity must be maintained by the realignment. Detailed design must consider the ecological requirements also.
- Assessment of greenfield runoff rate using the method described in the Institute of Hydrology (IoH) Report 124 is appropriate;
- The EA expressed a preference for ponds as attenuation and treatment for highway drainage, rather than below ground tanks;
- The EA stated that all culverts should be sized to pass the 1 in 100 year flow plus an appropriate allowance for climate change. The Environmental Consultant for the scheme (Mouchel) is to confirm the requirements for additional capacity or details for ecological purposes following the initial culvert sizing. It was recognised that this is likely to be an iterative process to arrive at a suitable culvert size at each location;
- For the proposed realignment of Norbury Brook, flood risk will be informed by the previous hydraulic modelling (once reviewed and accepted by the EA). The realignment will require further consideration at detailed design in terms of the ecological requirements;
- AECOM outlined the proposal to drain part of the proposed highway into the existing A555 drainage with appropriate attenuation and storage so as not to adversely impact on the existing drainage. The EA were satisfied with this approach;
- The EA confirmed that the small amount of works to the existing highway in Flood Zone 2 at the A555/A34 roundabout is not considered to represent a significant impact on the flood plain and is acceptable;
- It was agreed that Gatley Brook (to the north of the proposed route near Styal Road) is not a desirable outfall location due to its distance from the proposed highway (in terms of both construction cost and ecological disturbance) and the size of watercourse at this location which was reported to be very small;
- AECOM noted that the western extent of the proposed highway is within the Trafford and South Manchester Critical Drainage Area (as defined in the local SFRA). The EA confirmed that for development on brownfield sites, the proposals should seek to reduce the runoff rate.

Following the meeting, the EA also provided a formal response to the information request which stated the following:

- The approach to surface water management discussed in the meeting of 19th April 2011 is acceptable in principle;
- The catchments outlined at the meeting of 19th April 2011 'appeared acceptable' and the EA will advise on specific requirements for consent applications having received more detail;
- Acceptability of any proposal to discharge surface water by infiltration will be dependent the vulnerability of the groundwater in the area and the treatment that the runoff is subject to before infiltration;
- Any proposed culvert must pass the 1 in 100 year plus climate change flow and should provide appropriate connectivity for any protected species. The ecological consultant should inform the design of the culverts and the EA can provide more detail on the specific requirements at each location when they receive more detailed information;
- Ox Hey Brook is not a Main River and not a Critical Ordinary Watercourse. There is no EA hydraulic model of the watercourse and the EA have no record of flooding from the watercourse at this location.
- Ox Hey Brook should be diverted in an open channel and the diverted watercourse should not increase flood risk elsewhere;
- Any realignment of Norbury Brook should be in-keeping with the surrounding area and ensure there is no increase in flood risk upstream or downstream.
- The EA have no historical records of flooding along the proposed highway route.

During further discussions with the EA it was established that it is acceptable for the assessment of flow in small watercourses for culvert sizing, to be undertaken using a simplified method such as the IoH Report 124 method. The final proposals for culverting

will need to be agreed with the appropriate Lead Local Flood Authority (LLFA) who will be responsible for issuing consents for such works.

The EA were also asked to review the previous hydraulic modelling of the realignment of Norbury Brook which it was agreed is to be used to inform this assessment (as detailed in Appendix B). Having reviewed the original modelling and further evidence submitted by AECOM, the EA confirmed that the modelling work is acceptable in principle.

E2 Stockport Metropolitan Borough Council (SMBC)

SMBC Engineers were asked to review the proposals for the scheme and comment on: Existing flooding incidents which may be affected or affect the proposed scheme; Proposals for treatment of small watercourses and drains; and requirements for access where culverting of small watercourses and drains was proposed.

SMBC reported only that having studied the information available to them on known drainage issues, the only location at which there may be an existing problem is adjacent to the A6 at Hazel Grove. No specific details of these existing problems were confirmed.

E3 Cheshire East Council (CEC)

CEC Engineers were asked to review the proposals for the scheme and comment on: Existing flooding incidents which may be affected or affect the proposed scheme; Proposals for treatment of small watercourses and drains; and requirements for access where culverting of small watercourses and drains was proposed.

CEC noted that they are not familiar with the land drainage in the vicinity of the scheme and not aware of any flooding, as they would only become aware of any land drainage issue if there was an impact on the existing highway.

E4 Manchester City Council (MCC)

MCC Engineers were asked to review the proposals for the scheme and comment on any existing flooding incidents which may be affected or affect the proposed scheme.

MCC noted that the Manchester, Salford and Trafford SFRA may include information relevant to our request and noted that beyond what is contained in the SFRA they are not aware of any further land drains, watercourses, or culverted watercourses crossing the proposed route which have not been identified. With regards to flooding problems in the vicinity of the route MCC noted they were not aware of any incidents beyond what is contained in the SFRA, but that arrangements relating to the monitoring of locally significant flood events are still developing.

E5 Bramhall Oil Terminal

AECOM and the Client conducted a further site visit on 10th May 2011 to discuss the proposals with the operator of the oil terminal to the north of Chester Road. The following pertinent points were noted:

- There are two field drains to the south of the terminal which both flow into pipes before entering the terminal land.
- From here these become part of the terminals surface water drainage system and flow around the terminal before being discharged via an oil separator into a UU sewer. In the event that the UU system is over capacity the terminal's surface water system can spill into the nearby watercourse (to the north east of the terminal). The terminal has consent for these discharges.
- In extreme conditions there is the potential for the sewer and watercourse to back up and cause flooding within the terminal. This has reportedly happened once in the last 25 years.

E6 United Utilities

The highway design team have undertaken consultation with UU regarding requirements for realignment and protection of existing public sewers and water mains.

The drainage designers have undertaken consultation with United Utilities regarding potential discharges to the public sewers near to the western extent of the proposed highway from Styal Road to Manchester Airport.