

SALISBURY ROAD
UXBRIDGE

FLOOD RISK ASSESSMENT

MENTMORE INVESTMENTS LLP

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This Flood Risk Assessment was commissioned by Mentmore Investments LLP in May 2014 to investigate the risks and assess the consequences of flooding of the proposed development on Salisbury Road in Uxbridge, Hillingdon.

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Contents

Glossary	1
Executive Summary	2
1 Introduction.....	3
General Information.....	3
Scope of Study	3
2 Site Description.....	4
Location	4
Existing Development.....	5
Topographic Survey	5
Site Visit.....	6
Proposed Development	6
3 Planning Policy and Guidance	7
National Planning Policy Framework.....	7
Local Planning Policy.....	7
London Borough of Hillingdon Preliminary Flood Risk Assessment.....	8
London Borough of Hillingdon Surface Water Management Plan	8
London Borough of Hillingdon Strategic Flood Risk Assessment	8
4 Potential Flooding On Site	9
Historic Information	9
Flood Sources.....	9
Climate Change	12
Structures which may Influence Local Hydraulics	12
Flood Defences.....	12
5 Assessment of Fluvial Flood Risk	13
Modelled Flood Water levels	13
Dry Access	14
Flood Warning Service	14
Floodplain Storage and Compensation.....	14
Consequences of Flooding on Site.....	14
6 Surface Water Management	16
Existing Site Drainage	16
Proposed Surface Water Drainage System	16

7 Summary of Flood Risk Assessment..... 19

8 Conclusions and Recommendations..... 23

Appendix A – Drawings 24

Appendix B – Calculations..... 25

Appendix C – Site Visit Photographs..... 26

List of Figures

Figure 1 – Location of proposed development site	4
Figure 2 – Ground Levels Across the Site	5
Figure 3 – Environment Agency Flood Zone Map	9
Figure 4 – Environment Agency Online Surface Water Flood Map	10

List of Tables

Table 1 – Modelled flood water levels in the River Colne appropriate to this site	13
Table 2 – Environment Agency SUDS hierarchy	18
Table 3 – Summary of Flood Risk Assessment based on the guidelines set out in the NPPF	19

List of Drawings

Drawing 1 – Topographic Survey	24
Drawing 2 – Proposed Development	24
Drawing 3 – EA Flood Zone Map	24
Drawing 4 – Thames Water Sewer Asset Plans	24
Drawing 5 – EA Detailed Flood Outlines	24
Drawing 6 – 1D Node Locations (and accompanying results)	24
Drawing 7 – 2D Node Results	24

GLOSSARY

AOD	Above Ordnance Datum
CDA	Critical Drainage Area
DEFRA	Department for Environment Food and Rural Affairs
EA	Environment Agency
FRA	Flood Risk Assessment
LDF	Local Development Framework
LiDAR	Light Detection And Ranging
LPA	Local Planning Authority
NPPF	National Planning Policy Framework
PFRA	Preliminary Flood Risk Assessment
ReFH	Revitalised FSR/FEH Rainfall-Runoff method
SFRA	Strategic Flood Risk Assessment
SUDS	Sustainable Urban Drainage Systems
SWMP	Surface Water Management Plan

EXECUTIVE SUMMARY

The site is located at the former Trimite paint and coatings factory on Salisbury Road in Uxbridge. The site is currently almost entirely hard-paved. Proposals involve the demolition of the existing buildings and the construction of eight modern industrial units.

The closest river to the site is the River Colne which flows in a southerly direction approximately 150m to the south-west of the site. The Grand Union Canal is located approximately 40m to the east of the site.

The Environment Agency online flood zone map indicates that the site is located partially within Flood Zone 2, with the remainder located in Flood Zone 1. The site is greater than one hectare in area and a full flood risk assessment, including surface water drainage strategy, has therefore been prepared to accompany a planning application for redevelopment.

Since the proposed use represents replacement of the existing use with no increase in vulnerability, and the site is not at any significant risk of flooding, the Sequential Test is satisfied.

Based on the modelled flood water levels provided by the Environment Agency, the entire site would remain dry during the 1% AEP event (including climate change) in either the River Colne, Grand Union Canal or The Culvert. Safe access to the site would be achieved via normal access routes.

The surface-water drainage system as proposed above will prevent an increase in runoff for the 100 year plus climate change event from the existing rate of 691l/s down to 45l/s. This represents a significant reduction in runoff. Surface water will be collected and the 30 year event will be attenuated below ground using a granular sub-base before discharging into local surface water sewers via existing connections. The remaining volume up to the 100 year plus climate change event will be stored above ground on the surface; with a predicted depth of 30mm. Proposals will also reduce the overall volume of runoff which leaves the site. The proposed drainage system is sustainable in nature, requiring little maintenance and ensuring clean discharge without the need for petrol interceptors.

Development proposals as presented represent a significant improvement over the existing site, reducing the rate and volume and improving the quality of the surface-water runoff via sustainable drainage systems. There will be no significant consequences of flooding in the 1% AEP event, including an allowance for climate change and no adverse effects for any neighbouring property.

1 INTRODUCTION

General Information

- 1.1 The site comprises of land located mostly in Flood Zone 1, with part of the site located in Flood Zone 2 according to the Environment Agency's Flood Zone map. In addition, the site is greater than one hectare in area, and a full flood risk assessment including a surface water drainage strategy has therefore been prepared to accompany a planning application for the site.
- 1.2 The site lies partially within Flood Zone 2 and therefore has an annual exceedence probability (AEP) of flooding from rivers and the sea of between 0.1% and 1%. The site is also greater than one hectare and a flood risk assessment is therefore required to support the planning application in accordance with the National Planning Policy Framework (NPPF)¹ and the associated Planning Practice Guidance². A significant emphasis of the assessment is the management of surface water on the site.

Scope of Study

- 1.3 The main objectives of this study are to:
 - assess the risk and implications of flooding on the site from all possible flood sources, including the future risk as a result of projected climate change over the lifetime of the development;
 - assess the impact of the proposed development on flood risk elsewhere, with particular consideration of surface water management on the site;
 - provide a flood risk assessment of the site, compliant with the guidelines set out in the NPPF and the associated Flood Risk and Coastal Change section of the Planning Practice Guidance, to accompany any application for planning permission; and
 - provide advice on the site layout and design that will ensure safe operation of the site in an extreme flood or rainfall event, and avoid causing an unacceptable impact on the risk of flooding elsewhere in the catchment.

1 Communities and Local Government, National Planning Policy Framework, March 2012

2 Communities and Local Government, Planning Practice Guidance: Flood Risk and Coastal Change, March 2014

2 SITE DESCRIPTION

Location

2.1 The 2.9ha. site occupies part of the Sarum Complex Industrial Estate to the south-west of Uxbridge town centre. The site is bound to the west by Arundel Road, to the north by Ashley Road and Cowley Mill Road, to the west by Wallingford Road and other industrial developments, and to the south by Salisbury Road. The Grand Union Canal lies approximately 50m to the east of the development and the River Colne flows approximately 140m to the west of the development. The location of the site relative to surrounding water and geographical features is presented in Figure 1.

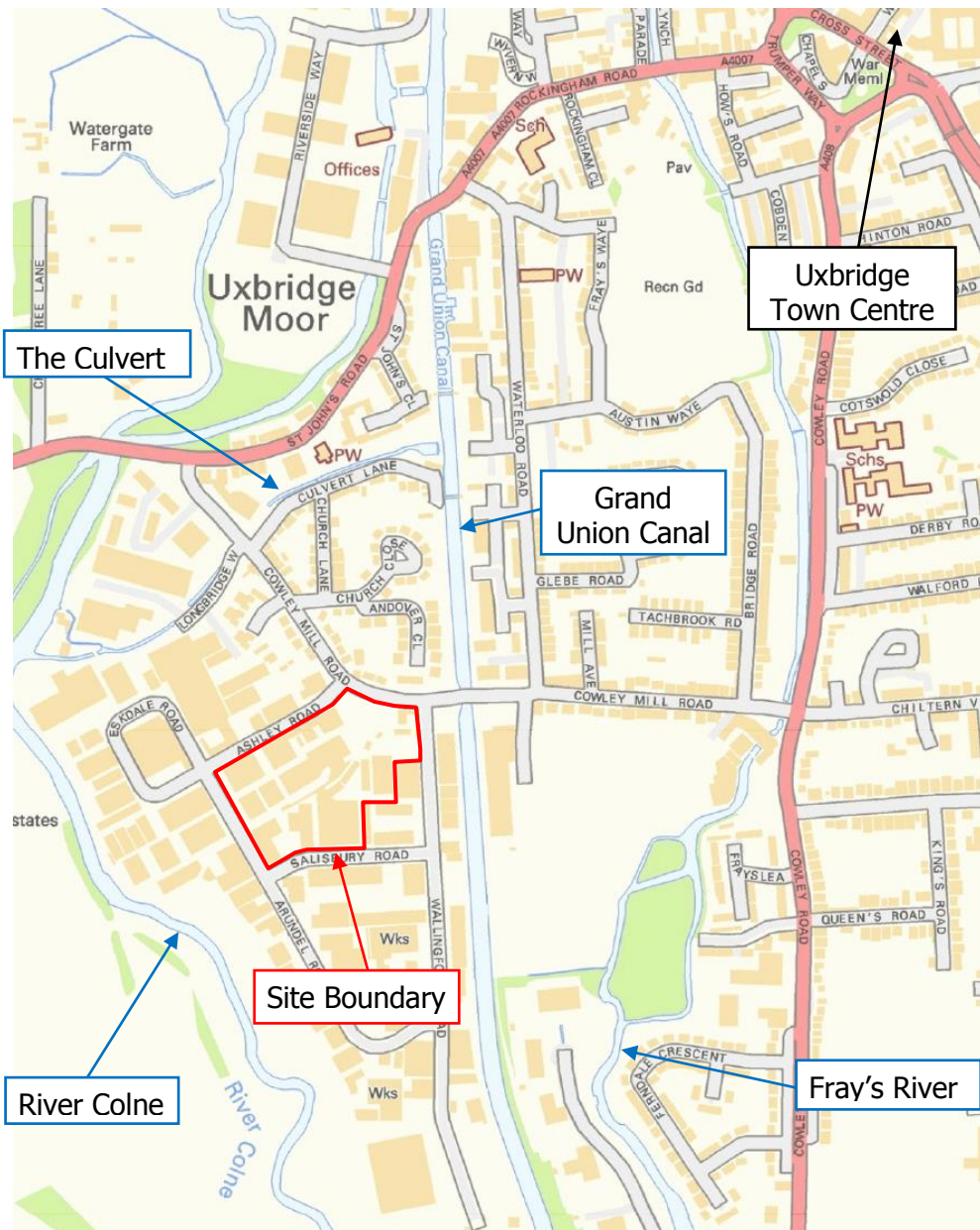


Figure 1 – Location of proposed development site

Existing Development

- 2.2 The site was formerly occupied by the Liquid and Powder Coatings Division of Trimite, a producer of paint and coatings. There are a number of buildings on the site, including warehouses, factory buildings, administration areas and ancillary plant buildings. All existing buildings are due to be demolished. Access to the site is can be gained from either Arundel Road, Ashley Road, Cowley Mill Road or Salisbury Road. The site is comprised almost entirely of hard standing and impermeable surfaces.

Topographic Survey

- 2.3 A topographic survey of the site was undertaken by Sitech Surveying Services in December 2013, and is referenced to Ordnance Datum (AOD) and Ordnance Survey National Grid. The survey has been included as Drawing 1 and includes all land occupied by the former Trimite factory.

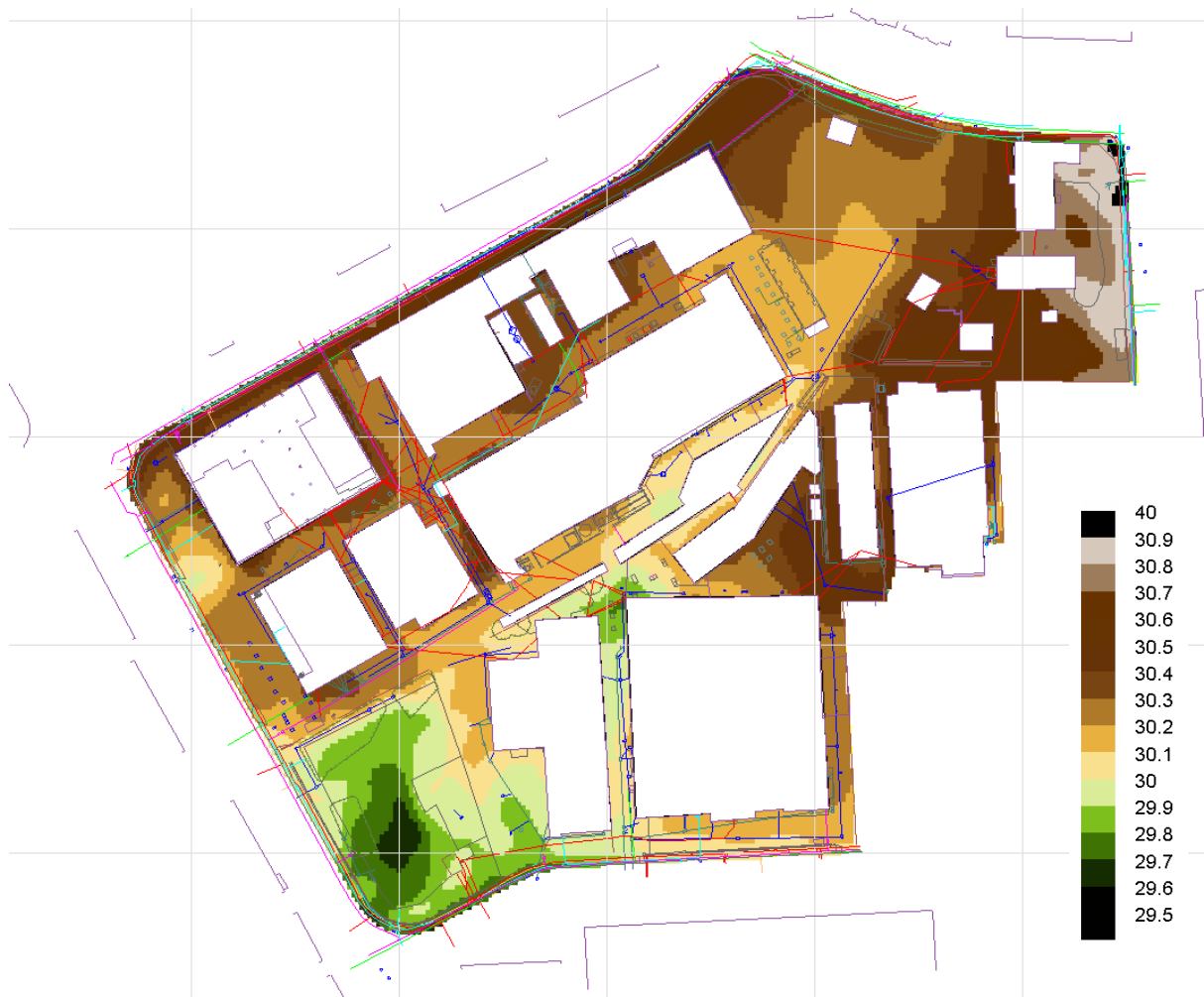


Figure 2 – Ground Levels Across the Site

- 2.4 Ground levels generally fall in a north-east to south-west direction. In addition, there is a slight depression/valley shown to diagonally cross the site towards the River Colne.

- 2.5 The topographic survey identified a number of manholes that were associated with the surface water drainage infrastructure. Not all existing connections to the local sewer network could be proved, and some soakaway features were identified towards the centre of the site.

Site Visit

- 2.6 A site visit was undertaken on 16th May 2014. A selection of photographs taken during the site visit is provided in Appendix C. A number of the existing buildings had been demolished prior to the site visit, and the remainder were in the process of being demolished. The surface water drainage infrastructure that was identified in the topographic survey was confirmed. One of the soakaways at the centre of the site (location) was found to be completely silted up as there was a large area of standing water. This could be partly due to a significant amount of debris and dust blocking the inlets to the drainage network.
- 2.7 The Grand Union Canal was also visited during the site visit. In the vicinity of the site the Grand Union Canal is slightly raised above surrounding ground levels and impounded with embankments. There is a lateral weir to the north of the site from the canal that discharges into the River Colne via a watercourse referred to historically as "The Culvert" (as shown on Figure 1). The River Colne was found to be a fairly natural watercourse in the vicinity of the site where access was available.

Proposed Development

- 2.8 The proposed development layout is illustrated in Drawing 2 and involves the construction of eight warehouse units, which will provide a combined 16,292m² of warehousing.

The drainage infrastructure on the site will be improved and brought in line with the recommendations stated in the London Plan and the Flood Risk and Coastal Change section of the Planning Practice Guidance.

3 PLANNING POLICY AND GUIDANCE

National Planning Policy Framework

- 3.1 The NPPF was released in March 2012 and sets out the Governments' planning policies for England and how these are expected to be applied. The NPPF states that:

"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere."

- 3.2 In addition to the NPPF, online Planning Practice Guidance was released in March 2014 to clarify planning aspects of flood risk management. The Planning Practice Guidance supersedes the Technical Guidance to the NPPF and clarifies which development types are considered appropriate within each flood zone.
- 3.3 The proposed development can be described as 'general industry, storage and distribution' which, according to Table 2 of the Flood Risk and Coastal Change section of the Planning Practice Guidance, is considered to be 'Less Vulnerable'. There will be no change in vulnerability as a result of the development since the previous land use at the site is also considered to be 'Less Vulnerable'. Table 3 of the Flood Risk and Coastal Change section of the Planning Practice Guidance confirms that 'Less Vulnerable' development is compatible within Flood Zone 2.

Local Planning Policy

- 3.4 The London Borough of Hillingdon adopted Part I of its Local Plan³ in November 2012 in accordance with the NPPF. Policy EM6: Flood Risk Management considers the risk of flooding within Hillingdon and sets out the strategic direction for development within the borough. Policy EM6 states that;

"The Council will require new development to be directed away from Flood Zones 2 and 3 in accordance with the principles of the NPPF."

- 3.5 In addition, the Hillingdon Local Plan places an emphasis on the use of sustainable urban drainage systems, stating that;

"The Council will require all development across the borough to use SUDS unless demonstrated that it is not viable".

- 3.6 According to the emerging Part II of the Hillingdon Local Plan⁴, the site is shown to lie within Uxbridge Industrial Estate, which is to be designated as a Preferred Industrial Location.
- 3.7 Being within a London borough, the development is also subject to the requirements of the Mayor of London's strategic plan, 'The London Plan'⁵. Policy 5.13 (Sustainable Drainage) of the London Plan states that:

³ London Borough of Hillingdon (November 2013), *Local Plan Part I: Strategic Policies*.

⁴ London Borough of Hillingdon (September 2013) *Local Plan Part II: Draft Proposed Site Allocations and Designations*.

"Development should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so."

- 3.8 The London Plan Supplementary Planning Guidance⁶ states that the 'Mayor's Priority' is that *"developers should maximise all opportunities to achieve greenfield runoff rates in their developments"*, with a minimum expectation to *"achieve at least 50% attenuation of the site's (prior to re-development) surface water runoff at peak times."* The document also states that *"on previously developed sites, runoff should not be more than three times the calculated greenfield rate."*

London Borough of Hillingdon Preliminary Flood Risk Assessment

- 3.9 A Preliminary Flood Risk Assessment⁷ (PFRA) was completed by Capita Symonds in 2011 as the first step of the responsibility of the London Borough of Hillingdon as a Lead Local Flood Authority (LLFA).
- 3.10 The PFRA considered the historical incidence of flooding in the Borough and also assessed the risk of flooding from fluvial, groundwater and surface water sources.

London Borough of Hillingdon Surface Water Management Plan

- 3.11 A Surface Water Management Plan⁸ (SWMP) was completed in 2013. The SWMP follows on from the PFRA and considers in greater detail the areas where there is a risk of surface water flooding, known as Critical Drainage Areas (CDA). The site is not shown to be located within a critical drainage area.

London Borough of Hillingdon Strategic Flood Risk Assessment

- 3.12 The London Borough of Hillingdon undertook a Strategic Flood Risk Assessment⁹ (SFRA) in November 2008. The outputs of the SFRA have been taken into consideration when undertaking this assessment.

⁵ Greater London Assembly (July 2011), *The London Plan*.

⁶ Mayor of London (April 2014), *Sustainable Design and Construction Supplementary Planning Guidance*.

⁷ Capita Symonds (May 2011), London Borough of Hillingdon Preliminary Flood Risk Assessment.

⁸ Capita Symonds (January 2013), London Borough of Hillingdon Surface Water Management Plan.

⁹ Scott Wilson (November 2008), London Borough of Hillingdon Strategic Flood Risk Assessment.

4 POTENTIAL FLOODING ON SITE

Historic Information

- 4.1 The Environment Agency holds no records of historical incidents of flooding on site from any source. There are no recorded incidents of historic surface water flooding in the vicinity of the site according to the Hillingdon SWMP. In addition, there are no recorded incidents of fluvial or groundwater flooding close to the site.
- 4.2 Between 21 and 50 properties are recorded to have historically internally flood based on Thames Water information reported in the Hillingdon SWMP. These incidents are within the entire four-digit postcode area of the site and no specific locations are provided.

Flood Sources

Flooding from Rivers (Fluvial Flooding)

- 4.3 The site lies in an industrial estate between the River Colne and the Grand Union Canal. In addition, the Fray's River flows in a southerly direction to the east of the Grand Union Canal. Figure 3 shows the Environment Agency online Flood Zone map for the area surrounding the site.

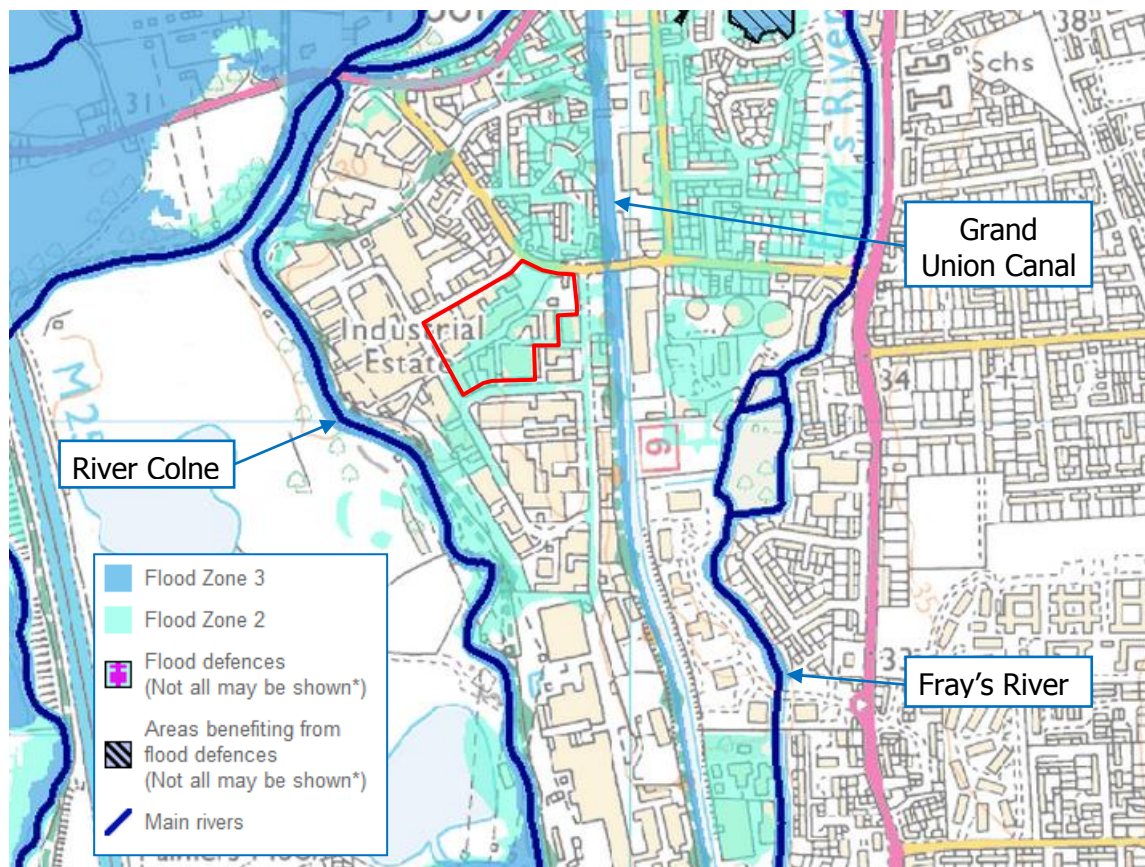


Figure 3 – Environment Agency Flood Zone Map

- 4.4 The floodplain indicated in dark blue is the area that may be affected by the 1% AEP fluvial flooding event, neglecting the influence of any flood defences in the area. This is categorised by the Environment Agency as Flood Zone 3. The light blue colour shows the additional extent of an extreme flood (0.1% probability in any year), and is categorised as Flood Zone 2.
- 4.5 Figure 3 shows the site to lie partially within Flood Zone 1, with the central portion of the site in Flood Zone 2. A detailed flood zone map for the site as provided by the Environment Agency is included in Drawing 3. The impact of fluvial flood risk is discussed further in Chapter 5 of this report.

Flooding from the Sea

- 4.6 The site is located approximately 60km west of the mouth of the River Thames. The River Thames remains tidal as far west as Teddington Weir, which at its closest is 16km south east of the site. The site is therefore not at risk of flooding from the sea.

Flooding from the Land

- 4.7 Surface water (or pluvial) flooding results from flood water flowing overland in times of intense rainfall before reaching watercourses or drainage systems. Surface water flooding is generally associated with topographic depressions and natural valleys. Surface water flood modelling has been undertaken as part of the PFRA and SWMP for the London Borough of Hillingdon. The outputs from this modelling, and other datasets, have been combined into the Environment Agency's online surface water flood map. An extract of this map for the site is shown in Figure 4.

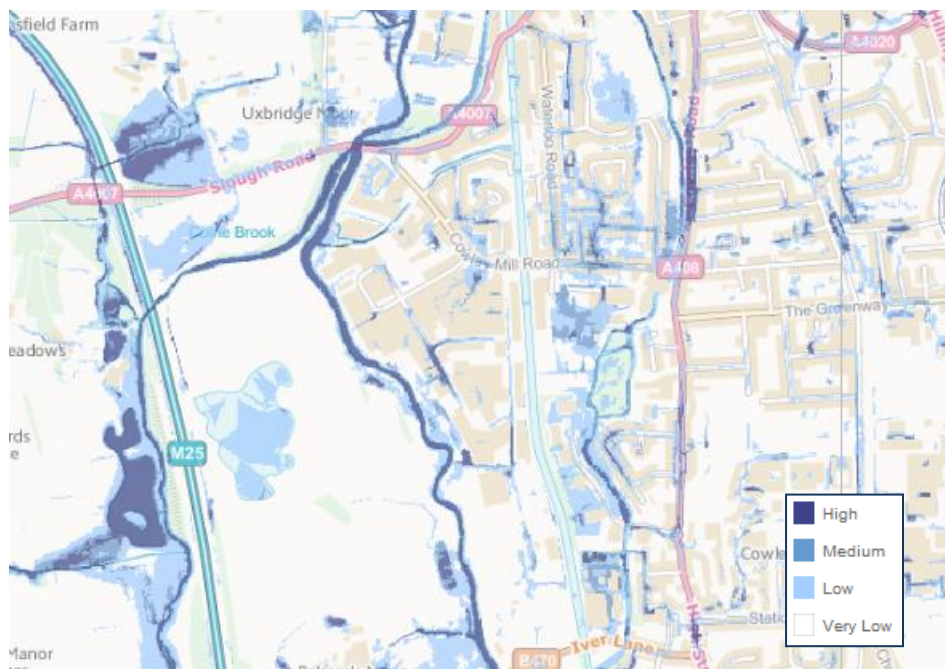


Figure 4 – Environment Agency Online Surface Water Flood Map

- 4.8 There is an area in the northern part of the site that is shown to be at risk of surface water flooding. The site falls generally from north-east to south-west. The modelling methodology for surface water flooding will have included a representation of the existing site buildings. It is considered that, since the density of the buildings on the

existing site was high, there will not have been a flowpath available for surface water within the small drainage catchment to be conveyed onwards towards the south-west, thus causing ponding to the north-east of the site. In reality, surface water will have been able to travel between the buildings and will have been incorporated into the site drainage. This area of surface water ponding is therefore considered to be a function of the existing site layout and is not representative of future surface water flood risk.

- 4.9 The site is not shown to be located within a CDA in the Hillingdon SWMP. Surface water will be actively managed on the site and the risk of flooding from overland flow is therefore considered to be low.

Flooding from Groundwater

- 4.10 The underlying geology at the site, as observed in the Hillingdon SFRA and British Geological Survey (BGS) 1:50,000 mapping, consists of London Clay overlain by Alluvium. London Clay is characterised by low permeability and confines water to lower layers, however the presence of alluvium drift geology and the site's proximity to the River Colne and Fray's River may result in shallow groundwater levels on site. A ground investigation on the site has confirmed this geological succession.
- 4.11 The site is not shown on Environment Agency online mapping to lie within a Source Protection Zone. The Environment Agency classifies the Alluvial deposits as being a Secondary A aquifer. These are defined as permeable layers capable of supporting water supplies at a local rather than strategic level and in some cases forming an important source of base flow to rivers. The London Clay bedrock is classified as unproductive strata.
- 4.12 Groundwater levels were recorded over the site in monitoring wells. Groundwater was encountered and recorded ranging between 1.22m and 1.75m below ground level (bgl), resting within the Made Ground or within the upper alluvial deposits. A BGS borehole to the north indicates a standing water level of approximately 1.70mbgl. The recorded groundwater levels indicate a general north east to south west trend, with shallow groundwater assumed to flow generally towards the River Colne.
- 4.13 The alluvial deposits are assumed to be in hydraulic connectivity with the River Colne, and thus groundwater levels are closely linked to river levels. It is unlikely that groundwater would cause flooding except as a direct result of river flooding.
- 4.14 Finished floor levels will be raised above surrounding ground levels to ensure no flooding of internal areas.

Flooding from Sewers

- 4.15 The Thames Water sewer asset location plan (included as Drawing 4) shows that there is a separate sewer system in this area and that there are surface water sewers located within the majority of the roads surrounding the site. There is a 225mm surface water sewer that commenced at the junction of Arundel Road and Ashley Road, which flows in a southerly direction. There is a lateral connection to this sewer from Salisbury Road, where a 225mm diameter sewer commences at the south-eastern corner of the site. There is shown to be a 450mm diameter surface water sewer along Wallingford Road, which flows in a southerly direction from a 300mm sewer in Cowley Mill Road.

- 4.16 The Hillingdon SWMP identifies that there have been between 21 and 50 historic incidents of internal flooding due to overloaded public sewers in the area surrounding the site. This includes the entire postcode area and individual specific locations are not provided.
- 4.17 The site is not currently considered to be at significant risk of sewer flooding. The proposed drainage system will be designed such that no internal flooding occurs for rainfall events up to and including the critical duration 1% AEP event with an appropriate allowance for climate change. Management of surface water is discussed in more detail in Chapter 6.

Flooding from Artificial Water Bodies

- 4.18 The nearest artificial water body to the site is the Grand Union Canal, which lies 50m to the east of the site in a raised embankment. Although an artificial water body, the canal interacts with the adjacent watercourses and levels in the canal are affected accordingly. As such, flooding from the Grand Union Canal will be discussed in more detail in Chapter 5, in conjunction with fluvial flood risk.
- 4.19 There is shown to be an area at risk of flooding from reservoir failure on the Environment Agency online mapping associated with the failure of Shardloes Reservoir upstream of the site on the River Misbourne (a tributary of the River Colne). The maximum predicted extent of flooding is entirely contained within the channel of the River Colne and it is therefore considered that there is no risk of flooding to the site from reservoir failure.
- 4.20 There are no other artificial water bodies that would constitute a source of flood risk to the site.

Climate Change

- 4.21 The projected impacts of climate change are likely to cause long term variations in the probability and risk of flooding. Risk of flooding from groundwater is likely to be reduced, but risks from other sources are likely to increase. This will affect the site in terms of the likelihood of flooding from rivers and sewers. The impact of climate change is considered in more detail in relevant sections of this report, and has been accounted for in the site design.

Structures which may Influence Local Hydraulics

- 4.22 The River Colne at this location is a complex network of channels and tributaries that interact with the Grand Union Canal and as such, comprises several man-made structures including numerous weirs. All of these structures are assumed to be accounted for in the Environment Agency's hydraulic model of the Lower Colne and are reflected in the modelled flood water levels.

Flood Defences

- 4.23 There are no recorded formal flood defences in the vicinity of the site as shown on the Environment Agency's flood zone map (Figure 3).

5 ASSESSMENT OF FLUVIAL FLOOD RISK

Modelled Flood Water levels

- 5.1 The River Colne (including the Grand Union Canal and the Fray's River) has been hydrologically and hydraulically modelled on behalf of the Environment Agency. The Environment Agency has provided modelled flood levels from the Lower Colne Modelling and Mapping Study 2012 and are assumed to be correct. Detailed modelling outlines for the River Colne model for a range of return periods is provided as Drawing 5. A detailed hydrological study of the River Colne catchment and hydraulic analysis of the River Colne has therefore not been carried out as part of this investigation.

The River Colne

- 5.2 Modelled flood water levels in the River Colne for a range of return periods for all model node locations relevant to this site are shown in Table 1. The locations of the 1D nodes are shown in Drawing 6. Model Node B075 is the closest node to the site and is considered to be the most representative.

Table 1 – Modelled flood water levels in the River Colne appropriate to this site

Node	1% AEP Level (m AOD)	1% AEP + 20% Level (m AOD)	0.1% AEP Level (m AOD)
B077D	29.54	29.66	29.8
B076	29.48	29.59	29.73
B075	29.31	29.43	29.58
B074	29.18	29.32	29.48
B073	29.06	29.19	29.34
B072	28.95	29.09	29.25

- 5.3 Lowest ground levels on the site are approximately 29.6m AOD, higher than the modelled 0.1% AEP flood water level for the River Colne. The flood zone map shown in Figure 3 and the detailed modelling outlines for the River Colne (Drawing 5) confirm that the site is not at risk of flooding from within the channel of the River Colne to the west of the site.

The Grand Union Canal

- 5.4 There are 2D nodes in the Environment Agency hydraulic model to the east of the site within the Grand Union Canal. Drawing 7 shows the results for the 2D nodes, including the Grand Union Canal, for the 1% AEP including a 20% allowance for climate change. Modelled flood water levels within the Grand Union Canal are shown to be 31.79m AOD to the immediate east of the site. The Grand Union Canal is raised above surrounding ground levels along this section and therefore the modelled flood water levels are higher than the ground levels on the site. The detailed modelled flood outlines shown in Drawing X show there to be no overtopping of the canal during the 1% AEP plus climate change flood.
- 5.5 The detailed modelled flood outlines show that the Grand Union Canal will overtop during the 0.1% AEP flood event on the western embankment of the canal, with one

overtopping location to the north of Cowley Mill Road. This is shown to traverse the site from north-east to south-west in line with the extent of Flood Zone 2.

The Culvert

- 5.6 The Culvert is a small channel that connects the Grand Union Canal and the River Colne. Modelled flood water levels from within the channel of The Culvert have been provided by the Environment Agency. Flood water levels for the 1% AEP event including an allowance for climate change range from 30.24m AOD at the inlet to the culvert beneath Cowley Mill Road (CUL12U on Drawing 6) to 29.66m AOD at the confluence of The Culvert and the River Colne. The Culvert is considered to be a sufficient distance away from the site to not constitute a risk of flooding.

Dry Access

- 5.7 Based on the modelled flood water levels provided by the Environment Agency, the entire site would remain dry during the 1% AEP event (including climate change) in either the River Colne, Grand Union Canal or The Culvert. Safe, dry pedestrian access would be available from the site via normal access routes or the Grand Union Canal towpath in a southerly direction.

Flood Warning Service

- 5.8 The site falls into an area that benefits from the Environment Agency's free flood warning service. The full Environment Agency flood warning service comprises of four staged warning codes, each indicating the severity of flooding and the level of danger. These are Flood Alert, Flood Warning and Severe Flood Warning and All Clear,. The flood status of an area is updated at 15 minute intervals on the internet and is also available by telephone on a 24 hour Floodline.
- 5.9 The flood warning area within which the site is located is "River Colne at Willowbank including Uxbridge Moor". Occupants of the proposed development should subscribe to Floodline by calling 0345 988 1188 or 0845 988 1188, selecting option 1 and entering Quickdial number **172701**. Subscribers to the flood warning service receive automatic notification of a change in flood status for the area by telephone, text message, email, pager or facsimile.

Floodplain Storage and Compensation

- 5.10 Based on the modelled flood water levels provided by the Environment Agency, the entire site would remain dry during the 1% AEP event (including climate change) in either the River Colne, Grand Union Canal or The Culvert. As a result, the proposed development will not result in a loss of floodplain storage and compensation is not required.

Consequences of Flooding on Site

- 5.11 By virtue of the modelled flood water levels, raised floor levels and high ground levels, the site is expected to remain safe during the 1% AEP event including the effects of

climate change. The economic consequences of flooding on site are therefore expected to be minimal.

6 SURFACE WATER MANAGEMENT

Existing Site Drainage

- 6.1 The site was formerly the Trimite paint and coatings factory and consists almost entirely of hard-paved and impermeable surfaces. The runoff coefficient for the site has been calculated as 0.91 (assuming a runoff coefficient of 0.4 for permeable surfaces and 0.95 for impermeable surfaces).
- 6.2 Surface water is currently collected in a private drainage system and discharged into the local public sewer network. The topographic survey identified some soakaways towards the centre and north-west of the site that could have been used for the disposal of collected surface water. The site visit discovered ponding in the areas of the identified soakaways and it is therefore assumed that the soakaway features have become silted up and have not been taken into account for existing runoff calculations. No provision was made for surface water attenuation and any runoff that could not be accommodated in the drainage network during extreme rainfall events will run off via overland flow routes to the south-west of the site towards the River Colne.
- 6.1 Greenfield runoff rates for the site (excluding climate change) have been calculated using the recommended Institute of Hydrology Report 124 methodology. The resulting runoff was calculated as 15l/s for the 100 year event, assuming a SOIL index of 0.3 and a Standard Average Annual Rainfall (SAAR) of 636mm, and 10.9l/s for the 30 year event.
- 6.2 The site is currently brownfield in nature and it is therefore considered more appropriate to calculate design rainfall intensities using the Wallingford Procedure¹⁰ and calculating resulting runoff using the Modified Rational Method to enable fair comparison of the pre- and post- development cases.
- 6.3 A 1% AEP, 15 minute storm (M5-60 of 20mm and an 'R' value of 0.40) was applied to arrive at a rainfall intensity of 94mm/h. Runoff rates prior to re-development were then calculated and found to be 691l/s for the 100 year event and 535.4l/s for the 3.33% 30 year event.

Proposed Surface Water Drainage System

- 6.4 The proposed surface-water drainage system has been designed in accordance with the NPPF Planning Practice Guidance and the London Plan. As previously described, the London Plan Supplementary Planning Guidance states that the 'Mayor's Priority' is that "*developers should maximise all opportunities to achieve greenfield runoff rates in their developments*", with a minimum expectation to "*achieve at least 50% attenuation of the site's (prior to re-development) surface water runoff at peak times.*" The document also states that "*on previously developed sites, runoff should not be more than three times the calculated greenfield rate.*"

¹⁰ HR Wallingford (2000) The Wallingford Procedure for Europe – Best Practice Guide to urban drainage modelling (CD)

- 6.5 As for the existing state, runoff rates after development have been calculated using the Wallingford Procedure and the Modified Rational Method for the 100 year event. Climate change was accounted for over a 50-year lifespan for commercial developments, through a 20% increase in peak rainfall, resulting in a design rainfall intensity of 133.2mm/h. The 100 year plus climate change, 12.7 minute storm resulted in a runoff rate of 1,003.5l/s.
- 6.6 In order to conform to the Mayor's *minimum expectation* of the London Plan SPG, runoff should be reduced to at least 50% of the site's (prior to re-development) rates. As such, the maximum allowable rate of runoff for the proposed site in a 100 year event would be $(0.5 \times (691.04)) = 345.5\text{l/s}$. Attenuation to this rate of runoff in line with a 50% reduction in runoff would require 484.4m^3 of storage when considering the 100 year plus climate change event. However, the London Plan SPG states that runoff should not be more than three times the calculated greenfield rate, which equates to 45l/s. Surface water storage in the order of $1,270\text{m}^3$ would be required to attenuate to three times the calculated greenfield rate.
- 6.7 The site drainage network is designed to be consistent with the standards for adoptable surface-water systems and to ensure that no surface-water flooding occurs in the 30-year event. Discharge of the site drainage will be via the existing connections in Arundel Road and Salisbury Road, subject to agreement with Thames Water.
- 6.8 For the proposed development with a 30-year runoff, attenuation to three times the greenfield rate of 45l/s would require 912m^3 of on-site attenuation. This will be provided in the form of a granular sub-base beneath roads and car parking, providing both storage and treatment of runoff prior to discharging into the local sewer network. The total area of yard space is approximately $11,920\text{m}^2$. Assuming a void ratio of 0.3, the depth of granular sub-base required to provide sufficient storage is 255mm. This is considered to be an acceptable minimum and can be incorporated into the detailed drainage design by suppliers such as Marshalls.
- 6.9 The remaining storage for the events up to the 1% AEP plus climate change runoff (an additional 358m^3) will be provided by allowing yard areas of the site to flood to a shallow depth while still containing all storage on site. Assuming an even distribution, this corresponds to flooding of 30mm.
- 6.10 Minimum floor slab levels of the warehousing units will be raised a minimum of 150mm above surrounding ground levels within the yards such that no internal areas of buildings will be flooded. The yards will have a fall away from the buildings into drainage collection infrastructure.
- 6.11 When considered in the context of the DEFRA guidance on the flood hazards, this level of surface-water flooding presents no significant risk to life and there will be no internal flooding of buildings. As such, there will be no significant social or economic consequences of flooding resulting from the 100 year (including 20% climate change) rainfall event.

Sustainable Drainage Principles

- 6.12 The aim of Sustainable Urban Drainage Systems (SUDS) is to emulate natural processes with the result that watercourses and storage areas receive the hydrological profiles under which they evolved, and that water quality in local ecosystems is

protected or improved. The best practice guide states that a sustainable drainage system will¹¹:

- reduce the impact of additional urbanisation on the frequency and size of floods;
- protect or enhance river and groundwater quality;
- be sympathetic to the needs of the local environment and community; and
- encourage natural groundwater recharge

6.13 Table 2 represents the preferred SUDS hierarchy as specified by the Environment Agency. The use of living roofs for large warehouse buildings are impractical due to the additional structural constraints. Ponds are also not practical for this site as the depth to the outfall is so shallow. The use of filter strips, swales and soakaways are not appropriate for this site due to the potential pollution on the site and the possibility of potentially shallow groundwater levels.

6.14 The use of a granular sub-base in combination with permeable surfaces as proposed represents a Sustainable Drainage System which will reduce the size and frequency of runoff. It obviates the need for petrol interceptors and ensures a clean discharge from the site. It may be possible to allow infiltration into the ground from the granular sub-base subject to infiltration testing at detailed design stage.

Table 2 – Environment Agency SUDS hierarchy

<i>Most Sustainable</i>	<i>SUDS technique</i>	<i>Flood Reduction</i>	<i>Pollution Reduction</i>	<i>Landscape & Wildlife Benefit</i>
↑	Living roofs	✓	✓	✓
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration devices - soakaways - infiltration trenches and basins	✓	✓	✓
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviers	✓	✓	
Least Sustainable	Tanked systems - over-sized pipes/tanks - storms cells	✓		

¹¹ CIRIA C523 – Sustainable Urban Drainage Systems – Best Practice Manual

7 SUMMARY OF FLOOD RISK ASSESSMENT

7.1 Table 3 illustrates the points which should be addressed for all development sites greater than 1 hectare in size, as defined in FRA Guidance Note 1 (March 2007).

Table 3 – Summary of Flood Risk Assessment based on the guidelines set out in the NPPF

Requirement	Assessment
1. Development description and location	
1a. Location plan of the site at an appropriate scale.	Figure 1 shows the location of the site, geographical features and the nearby watercourses.
1b. Vulnerability classifications of the proposed types of development as provided in the NPPF and Planning Practice Guidance.	The proposed development includes commercial, and therefore is classified as 'Less Vulnerable'.
1c. Land use allocations for the site in the local plan, including whether an SFRA has been used as a guide for the Sequential Test in developing the Local Development Documents.	The Borough is covered by the Hillingdon Strategic Flood Risk Assessment, which will inform land use allocations in the development of Phase II of the Hillingdon Local Plan.
1d. Evidence that the Exception Test has been satisfied with reference to pages 2 and 3 of the technical guidance document to the NPPF.	As the site is located in Flood Zone 2, the Exception Test is not required.
2. Definition of the flood hazard	
2a. Identification of potential sources of flooding which may affect the site.	The site lies between the Grand Union Canal and the River Colne and is potentially at risk from fluvial flooding. Due to its size, the surface water runoff volumes from the site are high, and must be managed to avoid creating a risk to the site and/or increasing flood risk elsewhere. All other potential sources of flooding are considered negligible.
2b. An appraisal of each hazard, the mechanisms that could lead to a flood occurring and the pathways that flood water would take to, and across, the site. Details of any historical flood events which may have affected the site.	The Environment Agency holds no record of the site having flooded in the past from any source. This analysis and the SFRA show that the site is not expected to flood in the 1% AEP fluvial event. Detailed drainage design will ensure that the probability of flooding from surface water will be less than 1% (including an allowance for climate change) as specified in the NPPF.

Requirement	Assessment
2c. A description of existing surface water infrastructure on the site.	Surface water currently discharges without attenuation into the public sewer, and unrestricted overland flow routes. There are also some soakaway features located on the site to discharge collected surface water into the underlying Alluvium.
3. Probability	
3a. The Flood Zone the site lies in, as per Table 1 of the technical guidance document to the NPPF.	The site lies partially in Flood Zone 2, with the remainder in Flood Zone 1.
3b. Consideration of a Strategic Flood Risk Assessment covering the site.	The site is covered by the Hillingdon SFRA. The SFRA shows that the site is unlikely to flood in the 1% AEP event and there are no other known sources of flooding. There is no significant flood hazard associated with the site.
3c. Probability of the site flooding taking into account the contents of the SFRA and the site-specific flood risk assessment, including a description of any existing flood defences or alleviation measures, structures which may influence local hydraulics, and details of modelling carried out to define the degree of flood risk.	The probability of flooding is less than 1% in any year over the 50-year lifetime of the development.
3d. Existing rates and volumes of runoff generated by the site for a range of annual probability events where appropriate.	The current runoff characteristics of the site were determined using the Modified Rational Method to obtain an estimate of the current and proposed rates of runoff. The 1% AEP, 15 minute rainfall event results in existing rate of 691.04l/s. Greenfield runoff rates for the site have been calculated using the IoH124 methodology as 15l/s for the 1% AEP event.
4. Climate change	
4a. Assessment of climate change and its impact on probabilities of flooding. The assessment should ensure that the development meets an acceptable standard of flood defence for the design life of the development as per the NPPF.	The Environment Agency have provided levels in the River Colne and The Culvert for a range of return periods and including climate change until the year 2085.

Requirement	Assessment
5. Detailed development proposals	
5a. Details of the proposed development, reference to relevant drawings, and including the assessment of vulnerability classification in Table 2 of the technical guidance document to the NPPF.	Proposals involve the construction of eight industrial warehousing units, which have a combined plan area of approximately 1.62ha.
5b. Demonstration of how land-uses most sensitive to flood damage have been placed within the site that are at least risk of flooding.	The site is not expected to flood in the 1% AEP fluvial event, including an allowance for climate change.
6. Flood risk management measures	
6a. Description of proposed flood defences, alleviation or protection measures, including surface water attenuation facilities and SUDS, as well as access and egress arrangements.	No flood defences are proposed as the site levels are above modelled flood water levels. Surface water runoff will be attenuated using sustainable drainage systems, specifically a granular drainage blanket beneath the roads and car parking areas. Safe and dry access will be achieved via normal access routes in the 1% AEP event, including an allowance for climate change.
7. Off-site impacts	
7a. An assessment of the impact on third-party land, including mitigation measures, floodplain compensation, details of post development modelling, and an assessment of the impact on geomorphology of local watercourses.	The site is not expected to flood in a 1% AEP event including climate change and the development is not expected to impede flood flows or displace floodwater. There will be no significant impact on the fluvial morphology of the local watercourses as a result of the proposed development. There will be no adverse impacts on third-party landowners as a result of the proposed development.
7b. Evidence that the drainage of the site will not result in an increase in the peak rate or volumes of runoff generated by the site.	Surface water runoff rates for the existing, proposed and greenfield site conditions were calculated using the Modified Rational Method, with design rainfall events estimated using the Wallingford Procedure, as agreed with the Environment Agency. Analysis of the resultant runoff hydrographs was used to determine the amount of storage required to limit runoff to less than three times equivalent greenfield rates over a range of return periods, as presented in detail in Chapter 6 of this report.

Requirement	Assessment
8. Residual risks	
8a. Flood-related residual risks on the developed site, including potential event exceedence for on-site drainage systems, or site-specific flood protection measures to be implemented on site.	Residual risks of flooding are extremely low. Exceedence of on-site drainage systems will result in shallow flooding of external areas for a short time, but internal areas will remain dry. The Flood zone 2 classification indicates that part of the site may be subject to flooding in the 0.1% AEP event.
8b. Management of risks over the lifetime of the development, including flood warning and evacuation procedures, and an assessment of the potential economic, social and environmental consequences of a flood event occurring.	The environmental, social and economic consequences resulting from the proposed development during flood events will be negligible, since the site is not expected to flood, and surface water will be managed such that discharge rates will decrease following development.

8 CONCLUSIONS AND RECOMMENDATIONS

- 8.1 The site is located at the former Trimite paint and coatings factory on Salisbury Road in Uxbridge. The site is currently almost entirely hard-paved. Proposals involve the demolition of the existing buildings and the construction of approximately 16,292m² of warehouse floorspace. The development will provide a series of modern industrial units.
- 8.2 The closest river to the site is the River Colne which flows in a southerly direction approximately 150m to the south-west of the site. The Grand Union Canal is located approximately 40m to the east of the site.
- 8.3 The Environment Agency online flood zone map indicates that the site is located partially within Flood Zone 2, with the remainder located in Flood Zone 1. The modelled flood water levels for the River Colne indicate an approximate flood level of 29.43m AOD for the 1% AEP plus 20% climate change event. The topographic survey of site indicates ground levels on site are higher than the modelled flood water levels for the 1% AEP plus 20% climate change event. Flooding on the site during an extreme event (0.1% AEP) is predicted due to overtopping of the embankment of the Grand Union Canal to the north-east of the site.
- 8.4 Since the proposed use represents replacement of the existing use with no increase in vulnerability, and the site is not at any significant risk of flooding, the Sequential Test is satisfied.
- 8.5 Based on the modelled flood water levels provided by the Environment Agency, the entire site would remain dry during a 1% AEP event (including climate change) in either the River Colne, Grand Union Canal or The Culvert. Safe access to the site would be achieved via normal access routes. There is no need for any form of floodplain compensation.
- 8.6 The surface-water drainage system as proposed above will prevent an increase in runoff for the 100 year plus climate change event from the existing rate of 691l/s down to 45l/s. This represents a significant reduction in runoff. Surface water will be collected and the 30 year event will be attenuated below ground using a granular sub-base before discharging into local surface water sewers via existing connections. The remaining volume up to the 100 year plus climate change event will be stored above ground on the surface; with a predicted depth of 30mm. Proposals will also reduce the overall volume of runoff which leaves the site. The proposed drainage system is sustainable in nature, requiring little maintenance and ensuring clean discharge without the need for petrol interceptors.
- 8.7 As a result of the development proposals and specifically the provisions made in the surface water drainage strategy, development proposals will help to reduce the impacts of flooding in the area and will result in significant benefits for the wider community. There will be no significant impact on the fluvial morphology of the local watercourses as a result of the proposed development. There will be no adverse impacts on third-party landowners as a result of the proposed development.

APPENDIX A – DRAWINGS

Drawing 1 – Topographic Survey

Sitech Surveying Solutions Drawing No 6353-8093-13

Topographic survey, with levels referenced to Ordnance Survey datum.

Drawing 2 – Proposed Development

Mentmore Investments LLP Drawing Number 2013/1176/A148

Proposed development at Trimite Site UB8 2SD.

Drawing 3 – EA Flood Zone Map

Environment Agency Map – Project Ref: NET/042015/JH

This Flood Zone map shows the Flood Zones 1, 2 and 3.

Drawing 4 – Thames Water Sewer Asset Plans

Drawing No. 2013 2641816

This drawing shows the sewer plans related to the site (with accompanying key and manhole information).

Drawing 5 – EA Detailed Flood Outlines

Environment Agency Map – Project Ref: NET/042015/JH

This Map shows the flood outlines from the 2012 Lower Colne Modelling and Mapping Study.

Drawing 6 – 1D Node Locations (and accompanying results)

Environment Agency Map – Project Ref: NET/042015/JH

This map shows the 1D node locations and the attached results table.

Drawing 7 – 2D Node Results

Environment Agency Map – Project Ref: NET/042015/JH

This map shows the modelled flood water levels at the 2D node locations for the 100 year plus climate change event.

Unit 1
21419ft2
2750ft2 Mezzanine
office space
total 24169ft2
yard 19144ft2

Unit 2
15649ft2 ground floor
2325ft2 mezzanine
office space
Total 17974ft2
yard 15923ft2

Unit 3
22626ft2
2200ft2 mezzanine
office space
total 24826ft2
yard 19500ft2

Unit 4
70676ft2
70676ft2 mezzanine
yard 28503ft2

Unit 5
12917ft2
1200ft2 mezzanine
office space
total 14117ft2
yard 10460ft2

Unit 6
10000ft2
1000ft2 mezzanine
office space
total 11000ft2
yard 12540ft2

Unit 7
12080ft2
1200ft2 mezzanine
office space
total 13280ft2
yard 11786ft2

unit 8
10000ft2
1000ft2 mezzanine
office space
total 11000ft2
yard 10441ft2

Total size plot 1 and 2
72135 ft2 = 1.656 acre



1 Main warehouse layout
1 : 1250

Mentmore Investments LLP
Beechbarn Farm
The Ridgeway, Enfield
EN2 8AF

07789 515816

0208 248 3051

No.	Description	Date
R1	Altered units 5, 6 and 7	14/3/14
R2	Altered Layout 1 & 2	17/3/14

Mentmore Investments
LLP
Trimite Site UB8 2SD

Main Warehouse Layout

Project number 2013/1176

Date 17/09/2013

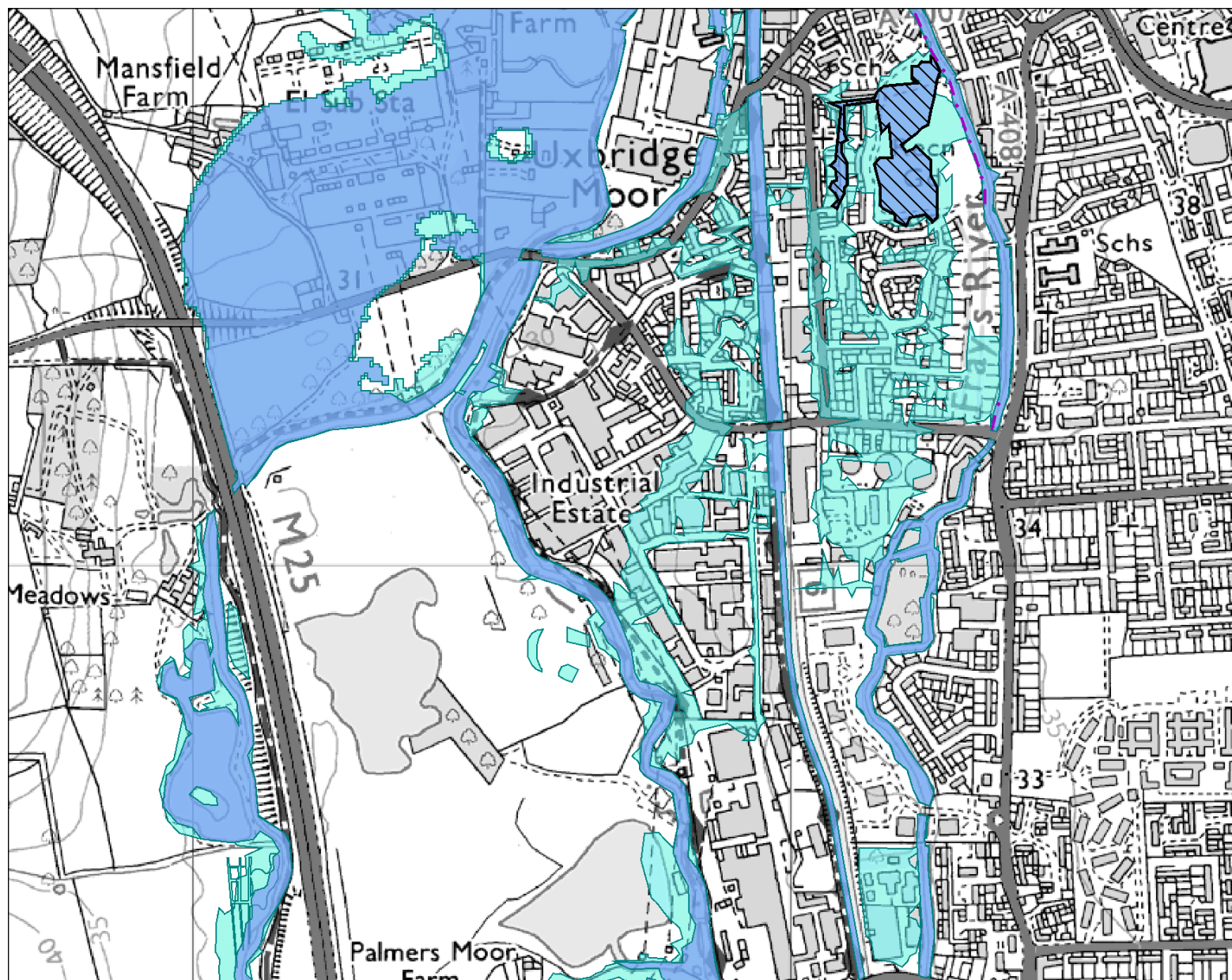
Drawn by db

Checked by hk

A148

Scale 1 : 1250

Flood map centred on MIDDLESEX, UB8 2SD created 28/05/2014 Ref:NET/042015/JH



Scale 1:10,001



Flood Map for Planning (Rivers and Sea)

- Flood Map - Defences
- Areas Benefiting from Flood Defences
- Flood Map - Flood Storage Areas
- Flood Map - Flood Zone 3
- Flood Map - Flood Zone 2

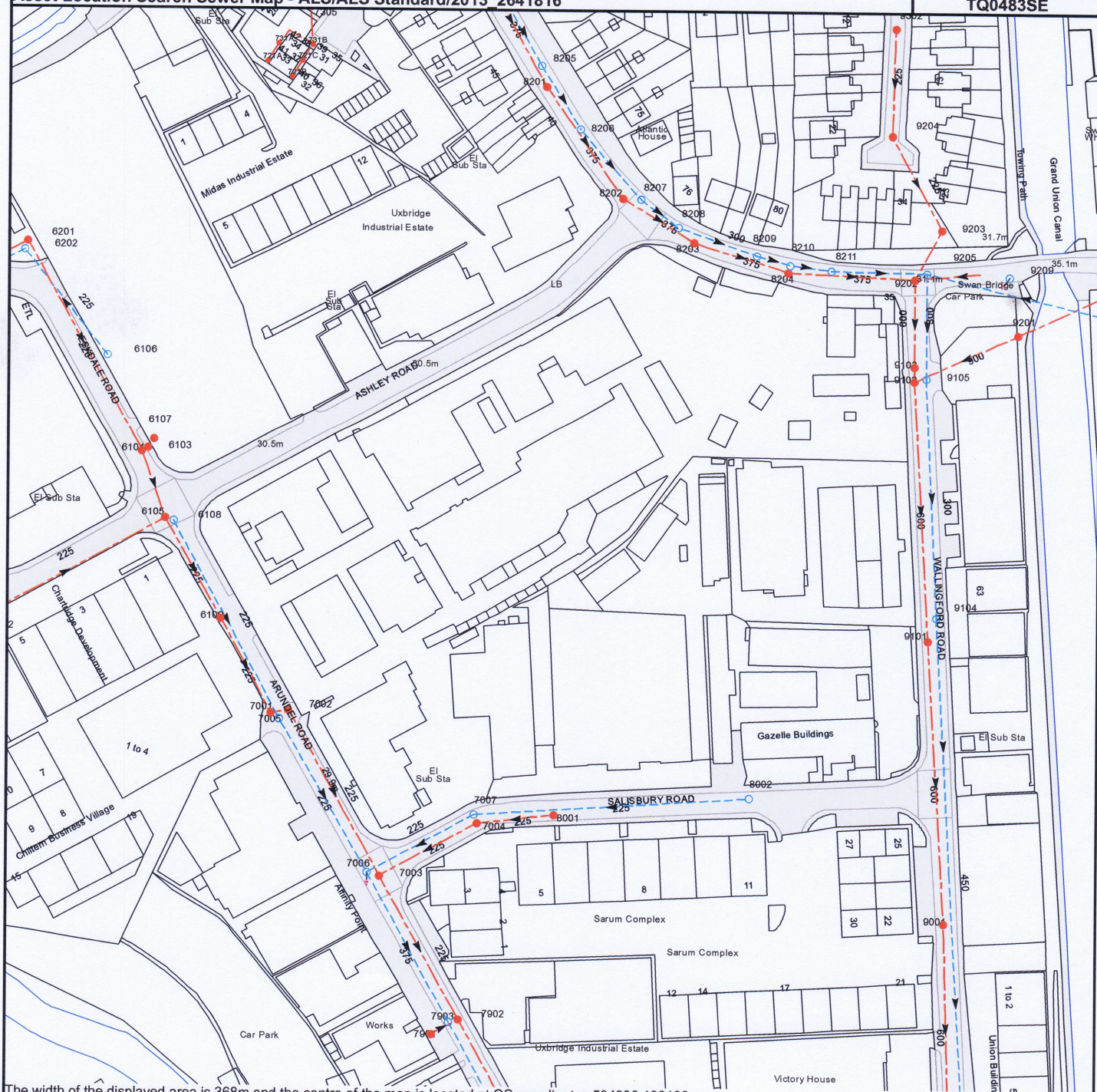
Flood Map for Planning (Rivers and Sea) (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:

- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

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The width of the displayed area is 368m and the centre of the map is located at OS coordinates 504806,183133

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Based on the Ordnance Survey Map with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
9209	n/a	n/a
9201	n/a	n/a
8205	n/a	n/a
8201	n/a	n/a
8206	n/a	n/a
8202	n/a	n/a
8207	n/a	n/a
8208	n/a	n/a
8203	n/a	n/a
8209	n/a	n/a
8204	n/a	n/a
8210	n/a	n/a
8211	n/a	n/a
9204	30.78	29.39
9302	30.62	29.64
9203	n/a	n/a
6202	30.79	29.64
6201	30.79	29.24
721A	n/a	n/a
731A	n/a	n/a
721B	n/a	n/a
721C	n/a	n/a
731B	n/a	n/a
7004	29.79	28.54
7007	29.77	28.68
8001	29.87	28.57
8002	30.15	28.85
7005	30.04	28.7
7001	30.05	28.6
7002	n/a	n/a
9101	30.58	28.19
6109	30.14	28.63
9104	30.58	28.98
6108	30.53	28.89
6105	30.56	28.78
6104	n/a	n/a
6103	30.56	29
6107	n/a	n/a
9102	30.93	28.38
9105	30.9	29.2
9103	30.94	28.39
6106	n/a	n/a
9202	n/a	n/a
9205	n/a	n/a
7901	29.59	28.59
7903	29.43	28.28
7902	29.45	28.24
9001	30.27	27.98
7003	29.63	28.45
7006	29.64	28.53
The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.		



ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

	Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.		
	Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.		
	Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.		
	Trunk Surface Water		Trunk Foul
	Storm Relief		Trunk Combined
	Vent Pipe		Bio-solids (Sludge)
	Proposed Thames Surface Water Sewer		Proposed Thames Water Foul Sewer
	Gallery		Foul Rising Main
	Surface Water Rising Main		Combined Rising Main
	Sludge Rising Main		Proposed Thames Water Rising Main
	Vacuum		

Notes:

- 1) All levels associated with the plans are to Ordnance Datum Newlyn.
- 2) All measurements on the plans are metric.
- 3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
- 4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
- 5) 'na' or '0' on a manhole level indicates that data is unavailable.

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

	Air Valve
	Dam Chase
	Fitting
	Meter
	Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

	Control Valve
	Drop Pipe
	Ancillary
	Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol. Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

	Outfall
	Undefined End
	Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

	Public/Private Pumping Station
	Change of characteristic indicator (C.O.C.I.)
	Invert Level
	Summit

Areas

Lines denoting areas of underground surveys, etc.

	Agreement
	Operational Site
	Chamber
	Tunnel
	Conduit Bridge

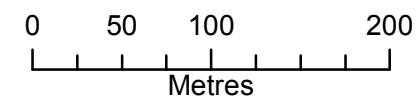
Other Sewer Types (Not Operated or Maintained by Thames Water)

	Foul Sewer		Surface Water Sewer
	Combined Sewer		Gully
	Culverted Watercourse		Proposed
			Abandoned Sewer

- 6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.



Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX



Legend

— Main Rivers

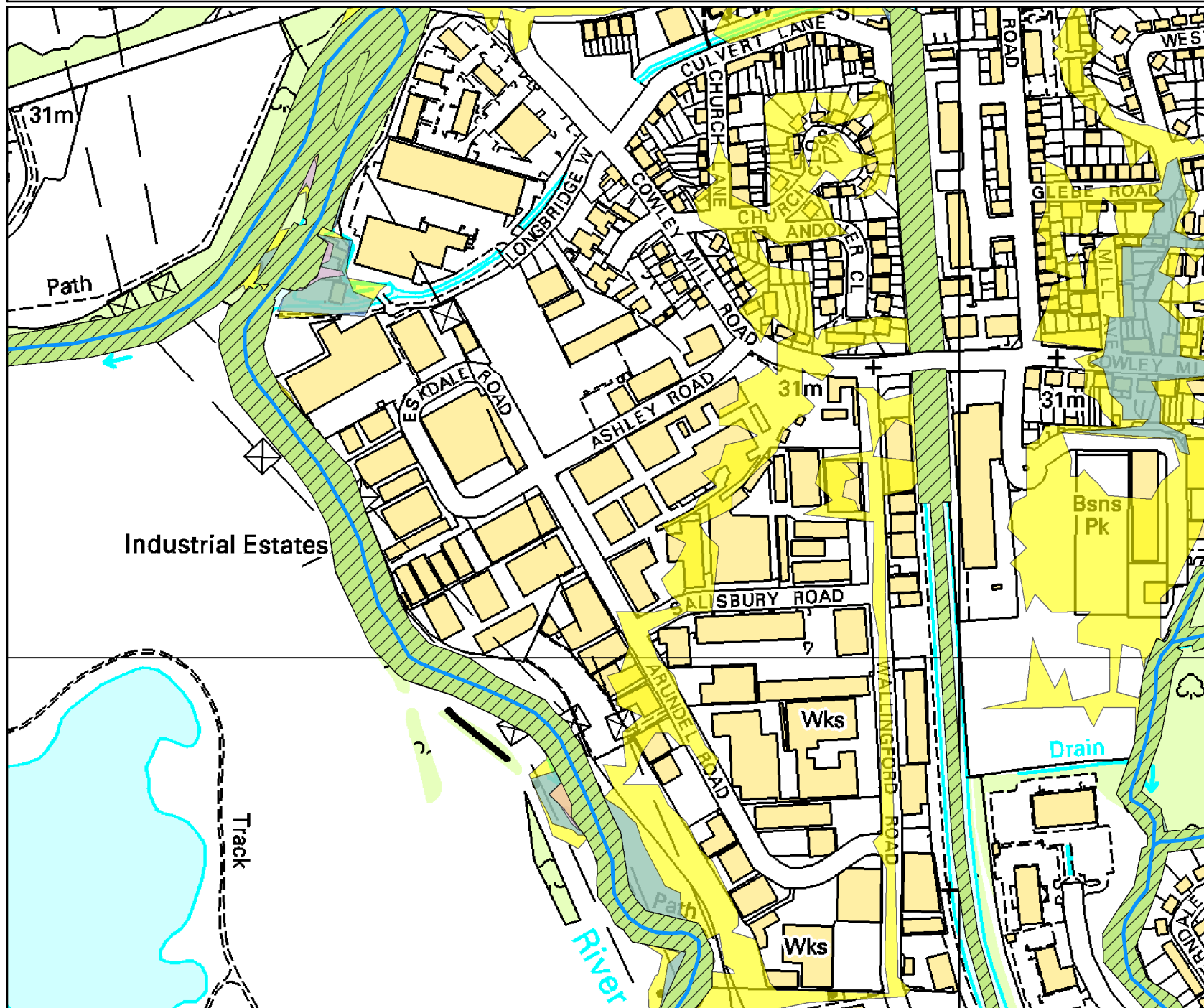
Defended Flood Outlines

- 1 in 5 (20%) Defended
- 1 in 20 (5%) Defended
- 1 in 50 (2%) Defended
- 1 in 100 (1%) Defended
- 1 in 100+20% (*CC) Defended
- 1 in 1000 (0.1%) Defended

The data in this map has been extracted from the Lower Colne Modelling and Mapping Study (Mott MacDonald 2012).

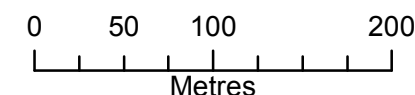
This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences.

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Partnerships & Strategic Overview,
Hertfordshire & North London





Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX



Legend

— Main Rivers

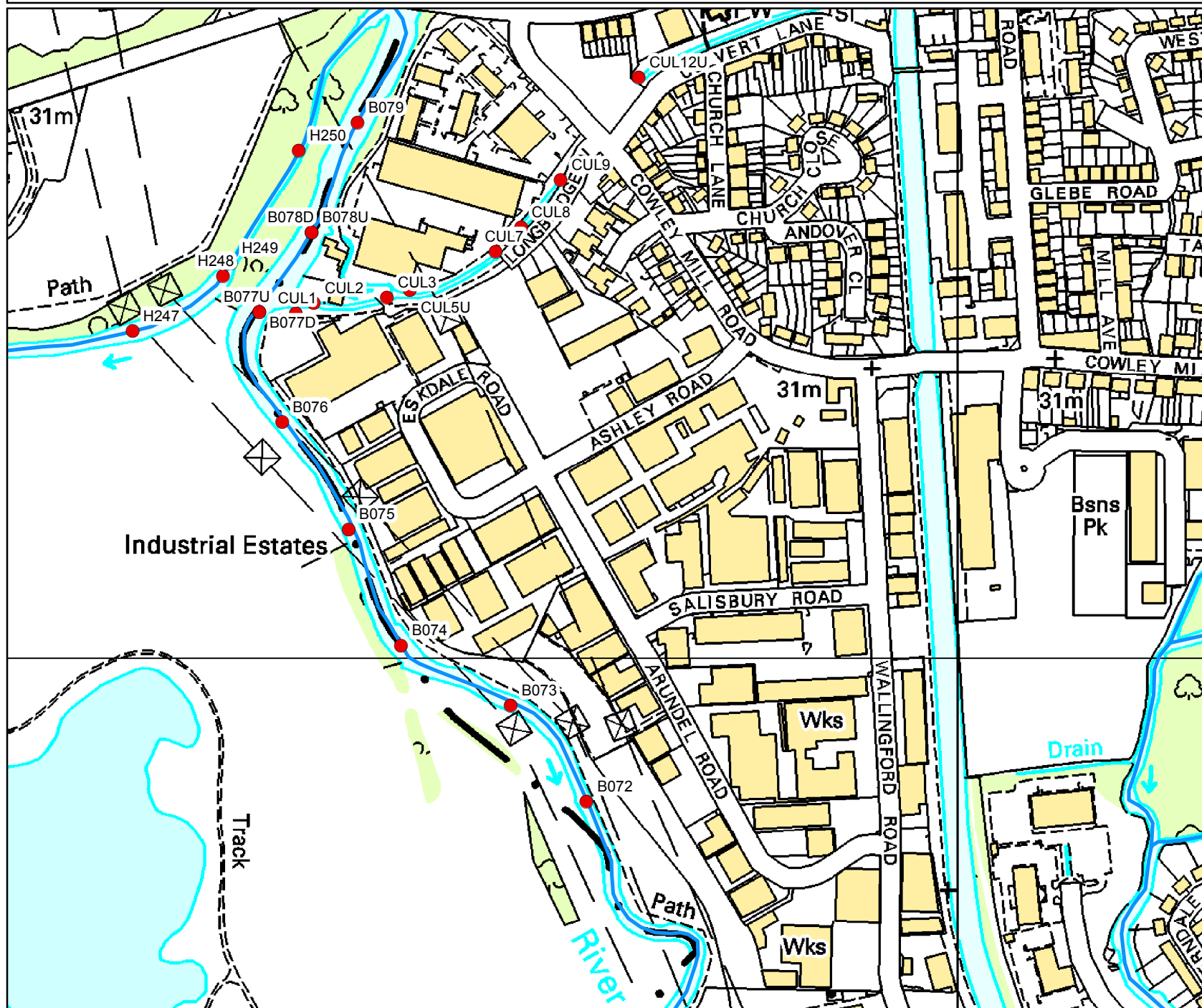
1D Node Results

● 1D Nodes

The data in this map has been extracted from the Lower Colne Modelling and Mapping Study (Mott MacDonald 2012).

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences.

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London



Environment Agency ref: NET/042015/JH

The data in this map has been extracted from the Lower Colne Modelling and Mapping Study (Mott MacDonald 2012).

All flood levels are given in metres Above Ordnance Datum (mAOD)

All flows are given in cubic metres per second (cumecs)

MODELLED FLOOD LEVEL

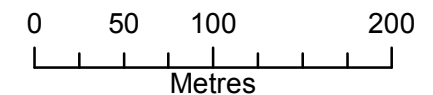
Node Label	Easting	Northing	Return Period							
			2 yr	5 yr	10 yr	20 yr	50 yr	100 yr	100 yr + 20%	1000 yr
B072	504710	182887	28.38	28.56	28.66	28.75	28.86	28.95	29.09	29.25
B073	504651	182962	28.52	28.68	28.78	28.87	28.98	29.06	29.19	29.34
B074	504565	183009	28.64	28.80	28.90	28.99	29.10	29.18	29.32	29.48
B075	504524	183100	28.80	28.95	29.04	29.13	29.23	29.31	29.43	29.58
B076	504472	183184	29.00	29.14	29.22	29.30	29.40	29.48	29.59	29.73
B077D	504454	183270	29.05	29.19	29.28	29.36	29.46	29.54	29.66	29.80
B077U	504454	183270	29.05	29.19	29.28	29.36	29.46	29.54	29.66	29.80
B078D	504495	183332	29.07	29.22	29.30	29.39	29.49	29.56	29.69	29.83
B078U	504495	183332	29.07	29.22	29.30	29.39	29.49	29.56	29.69	29.83
B079	504531	183418	29.09	29.24	29.33	29.42	29.52	29.60	29.73	29.88
CUL1	504483	183269	29.05	29.19	29.28	29.36	29.46	29.54	29.66	29.80
CUL12U	504751	183453	29.97	30.04	30.08	30.12	30.15	30.18	30.24	30.33
CUL2	504497	183277	29.06	29.20	29.28	29.37	29.47	29.54	29.66	29.80
CUL3	504554	183281	29.14	29.27	29.34	29.42	29.51	29.57	29.68	29.82
CUL5U	504572	183287	29.17	29.31	29.39	29.47	29.57	29.65	29.76	29.88
CUL7	504639	183317	29.39	29.49	29.56	29.62	29.69	29.76	29.84	29.91
CUL8	504659	183336	29.45	29.55	29.61	29.68	29.75	29.81	29.89	29.98
CUL9	504690	183373	29.62	29.71	29.76	29.81	29.87	29.92	30.00	30.09
H247	504355	183255	29.09	29.24	29.33	29.41	29.52	29.59	29.72	29.86
H248	504426	183298	29.09	29.24	29.33	29.41	29.52	29.60	29.73	29.86
H249	504432	183308	29.09	29.24	29.33	29.42	29.52	29.60	29.73	29.86
H250	504485	183396	29.10	29.25	29.34	29.43	29.53	29.61	29.74	29.88

MODELLED FLOWS

Node Label	Easting	Northing	Return Period							
			2 yr	5 yr	10 yr	20 yr	50 yr	100 yr	100 yr + 20%	1000 yr
B072	504710	182887	7.73	10.13	11.62	13.11	15.02	16.50	18.58	20.89
B073	504651	182962	7.73	10.13	11.62	13.11	15.02	16.52	19.31	22.92
B074	504565	183009	7.73	10.13	11.62	13.11	15.02	16.52	19.31	22.92
B075	504524	183100	7.73	10.13	11.62	13.11	15.02	16.52	19.31	22.93
B076	504472	183184	7.73	10.13	11.62	13.11	15.02	16.52	19.31	22.92
B077D	504454	183270	7.73	10.13	11.62	13.11	15.02	16.52	19.31	22.93
B077U	504454	183270	5.78	7.67	8.86	10.09	11.74	13.05	15.67	19.05
B078D	504495	183332	5.78	7.67	8.86	10.09	11.75	13.03	15.32	17.71
B078U	504495	183332	4.92	6.70	7.85	9.02	10.62	11.90	14.28	16.86
B079	504531	183418	4.93	6.70	7.85	9.02	10.62	11.90	13.96	15.15
CUL1	504483	183269	1.96	2.46	2.76	3.02	3.28	3.49	3.73	3.88
CUL12U	504751	183453	2.83	3.44	3.78	4.10	4.41	4.65	5.19	6.08
CUL2	504497	183277	1.96	2.46	2.76	3.02	3.27	3.49	3.68	3.68
CUL3	504554	183281	1.96	2.46	2.76	3.02	3.28	3.49	3.68	3.68
CUL5U	504572	183287	2.83	3.44	3.78	4.10	4.41	4.65	4.83	4.83
CUL7	504639	183317	2.83	3.44	3.78	4.10	4.40	4.65	5.19	6.08
CUL8	504659	183336	2.83	3.44	3.78	4.10	4.40	4.65	5.19	6.08
CUL9	504690	183373	2.83	3.44	3.78	4.10	4.41	4.65	5.19	6.08
H247	504355	183255	2.17	2.88	3.38	3.90	4.64	5.23	6.38	8.04
H248	504426	183298	2.17	2.88	3.38	3.90	4.65	5.23	6.38	8.03
H249	504432	183308	2.17	2.88	3.38	3.90	4.64	5.23	6.38	8.04
H250	504485	183396	2.17	2.88	3.38	3.90	4.51	5.04	6.36	8.68



Environment Agency
2 Bishops Square Business Park
St Albans Road West
Hatfield
Hertfordshire
AL10 9EX



Legend

Main Rivers

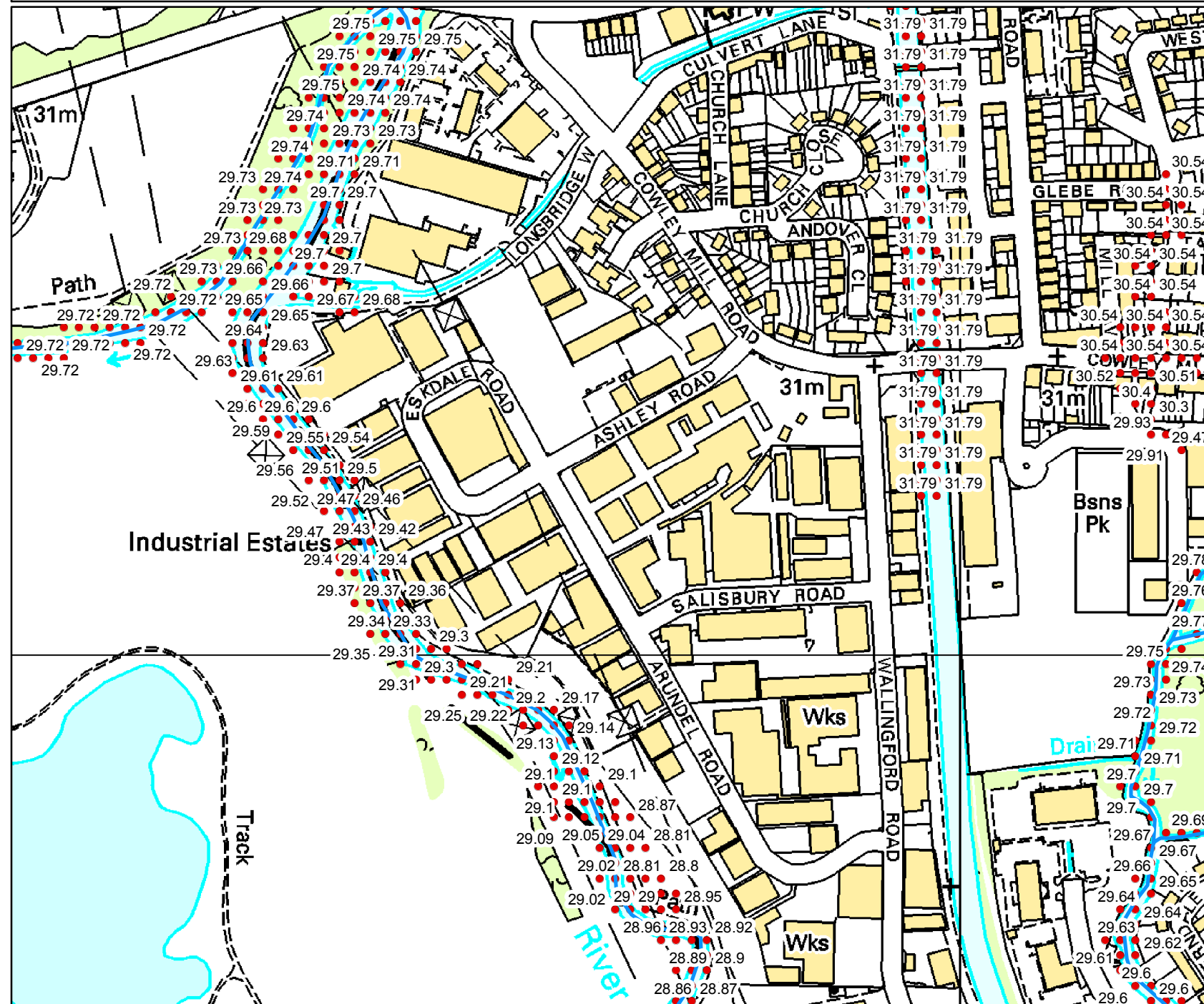
2D Node Results

1 in 100+20% (*CC) Defended

The data in this map has been extracted from the Lower Colne Modelling and Mapping Study (Mott MacDonald 2012).

This model has been designed for catchment wide flood risk mapping. It should be noted that it was not created to produce flood levels for specific development sites within the catchment. Modelled outlines take into account catchment wide defences.

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London



APPENDIX B – CALCULATIONS

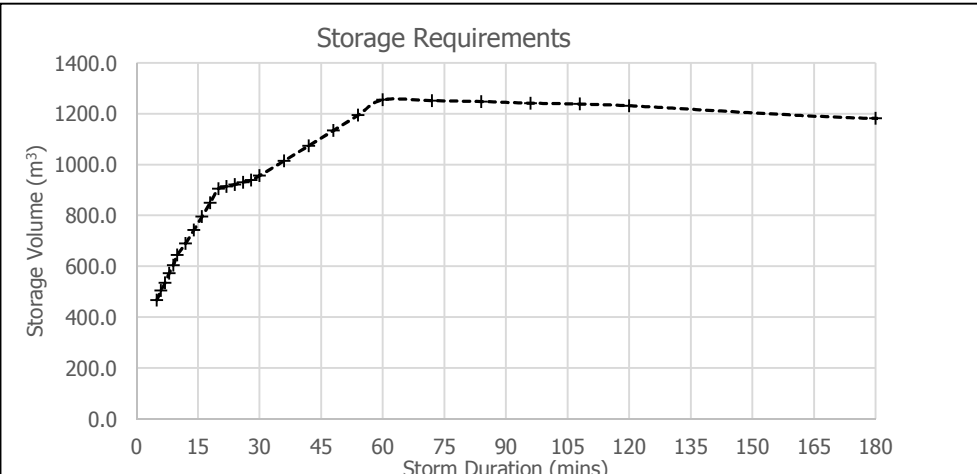
- Greenfield Runoff Estimation for Site
- Calculations for Wallingford Procedure and Modified Rational Method

Date Printed: 05/06/2014

Wallingford Procedure : Existing Peak Runoff			14059	Salisbury Road, Uxbridge	
			Calculations By: JL	Checked By: TC	Date: 30/05/2014
Site Characteristics					
Catchment Area	AREA	ha	2.9		
Approximate Longest Drainage Path	L	m	100		
Difference in Ground Levels	ΔH	m	0.3		
Slope	Slope (S)		1: 333		
Permeable Surfaces (Rational Method runoff coefficient = 0.4)		ha	7%		
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)		ha	93%		
Area Weighted Rational Method Runoff Coefficient			0.912		
Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)					
60minute, 5 year return period rainfall	M5-60	mm	20		
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40		
Time of Concentration					
Recommended Tc Method:		SCS: Sheet Flow			
Tc Method Choice:		SCS: Sheet Flow			
Sheet Flow					
Surface Description	Tarmac or Asphalt (Broken or Rough)				
Slope	Shallow				
Roughness Coefficient (Manning's n)	0.016				
Flow Length, L	m	100			
M2-24hr	mm	29.47			
Land Slope	m/m	0.00300			
Tc	hr	0.25			
Time of Concentration	T _c	min	15.0		
Critical Storm Duration (minimum 5min)	T _{crit}	min	15.0		
Critical Storm Rainfall and Runoff					
Z1 _{TC}	0.61 *Wallingford Procedure Figure 3.6				Discharge Rate Q = 2.78CiA
M5-T _{crit}	12.1				
C	0.912069				
	Return Period (years)	Z2*	Depth (mm)	Intensity (mm/hr)	Discharge Rate l/s
	1	0.61	7.4	29.7	218.49
	2	0.79	9.6	38.4	282.54
	10	1.23	14.9	59.4	436.97
	30	1.50	18.2	72.8	535.42
	50	1.67	20.2	80.8	594.25
	100	1.94	23.5	94.0	691.04
*Wallingford Procedure Table 3.2					

Wallingford Procedure : Developed Peak Runoff			14059	Salisbury Road, Uxbridge	
			Calculations By: JL	Checked By: TC Date: 30/05/2014	
Site Characteristics					
Catchment Area	AREA	ha	2.9		
Approximate Longest Drainage Path	L	m	100		
Difference in Ground Levels	ΔH	m	0.3		
Slope	Slope (S)		1: 333		
Permeable Surfaces (Rational Method runoff coefficient = 0.4)		ha	3%		
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)		ha	97%		
Area Weighted Rational Method Runoff Coefficient			0.93		
Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)					
60minute, 5 year return period rainfall	M5-60	mm	20		
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40		
Time of Concentration					
Recommended Tc Method:	SCS: Sheet Flow				
Tc Method Choice:	SCS: Sheet Flow				
Sheet Flow					
Surface Description	Tarmac or Asphalt (smooth)				
Slope	Shallow				
Roughness Coefficient (Manning's n)			0.013		
Flow Length, L	m		100		
M2-24hr	mm		29.47		
Land Slope	m/m		0.00300		
Tc	hr		0.21		
Time of Concentration	T_c	min	12.7		
Critical Storm Duration (minimum 5min)	T_{crit}	min	12.7		
Critical Storm Rainfall and Runoff					
Z1 _{TC}	0.61 *Wallingford Procedure Figure 3.6			Discharge Rate Q = 2.78CiA	
M5-T _{crit}	12.1				
C	0.93				
	Return Period (years)	Z2*	Depth (mm)	Intensity (mm/hr)	Discharge Rate l/s
	1	0.61	7.4	35.1	264.41
	2	0.79	9.6	45.4	341.92
	10	1.23	14.9	70.2	528.81
	30	1.50	18.2	86.0	647.95
	50	1.67	20.2	95.4	719.15
	100	1.94	23.5	111.0	836.28
	100 (+20%)	1.94	23.5	133.2	1003.53
*Wallingford Procedure Table 3.2					

Modified Rational Method Storage Calculator		14059	Salisbury Road, Uxbridge
		Calculations By: JL	Checked By: TC Date: 30/05/2014
Site Parameters			
Catchment Area	AREA	ha	2.9
Approximate Longest Drainage Path	L	m	100
Difference in Ground Levels	ΔH	m	0.3
Slope	Slope (S)		1: 333
Permeable Surfaces (Rational Method runoff coefficient = 0.4)		ha	3%
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)		ha	97%
Area Weighted Rational Method Runoff Coefficient			0.93
Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)			
60minute, 5 year return period rainfall	M5-60	mm	20
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40
Time of Concentration	T_c	min	12.7
Maximum Storm Runoff Storage Volume (modified rational method)			
T_d	20.0	min	
Z_{1-TD}	0.70 *Wallingford Procedure Figure 3.6		
$M5-T_d$	14.0	mm	
C	0.93		
Z_{2-100}	1.97 *Wallingford Procedure Table 3.2		
M_{100-T_d}	27.6	mm	
Intensity	82.9	mm/hr	
Q_d	624.8	l/s	
$Q_{d,climate\ change}$	812.3	l/s	
$Q_{limiting\ discharge}$	345.5	l/s	
Maximum storage required			484.5
The graph, titled 'Storage Requirements', plots Storage Volume in cubic meters (m³) on the y-axis (0.0 to 600.0) against Storm Duration in minutes on the x-axis (0 to 180). The curve starts at approximately 280 m³ at 5 minutes, rises to a peak of 484.5 m³ at 20 minutes, and then gradually declines, reaching 0 m³ at approximately 75 minutes. The data points are marked with 'x' symbols.			

Modified Rational Method Storage Calculator			14059	Salisbury Road, Uxbridge
			Calculations By: JL	Checked By: TC
			Date: 30/05/2014	
Site Parameters				
Catchment Area	AREA	ha	2.9	
Approximate Longest Drainage Path	L	m	100	
Difference in Ground Levels	ΔH	m	0.3	
Slope	Slope (S)		1: 333	
Permeable Surfaces (Rational Method runoff coefficient = 0.4)		ha	3%	
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)		ha	97%	
Area Weighted Rational Method Runoff Coefficient			0.93	
Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)				
60minute, 5 year return period rainfall	M5-60	mm	20	
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40	
Time of Concentration	T_c	min	12.7	
Maximum Storm Runoff Storage Volume (modified rational method)				
T_d	255.0	min		
Z_{1T_D}	1.40 *Wallingford Procedure Figure 3.6			
$M5-T_d$	28.0	mm		
C	0.93			
$Z_{2_{100}}$	1.99 *Wallingford Procedure Table 3.2			
$M_{100}-T_d$	55.8	mm		
Intensity	13.1	mm/hr		
Q_d	99.0	l/s		
$Q_{d,climate\ change}$	128.7	l/s		
$Q_{limiting\ discharge}$	45.0	l/s		
Maximum storage required			m³	1269.6
Storage Requirements 				

Modified Rational Method Storage Calculator		14059	Salisbury Road, Uxbridge																														
		Calculations By: JL	Checked By: TC Date: 30/05/2014																														
Site Parameters																																	
Catchment Area	AREA	ha	2.9																														
Approximate Longest Drainage Path	L	m	100																														
Difference in Ground Levels	ΔH	m	0.3																														
Slope	Slope (S)		1: 333																														
Permeable Surfaces (Rational Method runoff coefficient = 0.4)		ha	3%																														
Impermeable Surfaces (Rational Method runoff coefficient = 0.95)		ha	97%																														
Area Weighted Rational Method Runoff Coefficient			0.93																														
Site parameters from The Wallingford Procedure for Europe: Best Practice Guide to urban drainage modelling, HR Wallingford, July 2000 (CD)																																	
60minute, 5 year return period rainfall	M5-60	mm	20																														
Ratio of M5-60 to 2day, 5 year return period rainfall	r	-	0.40																														
Time of Concentration	T_c	min	12.7																														
Maximum Storm Runoff Storage Volume (modified rational method)																																	
T_d	60.0	min																															
Z_{1T_D}	1.00	*Wallingford Procedure Figure 3.6																															
$M5-T_d$	20.0	mm																															
C	0.93																																
Z_{230}	1.54	*Wallingford Procedure Table 3.2																															
$M30-T_d$	30.9	mm																															
Intensity	30.9	mm/hr																															
Q_d	232.6	l/s																															
$Q_{d,climate\ change}$	302.4	l/s																															
$Q_{limiting\ discharge}$	45.0	l/s																															
Maximum storage required			m³																														
			912.1																														
Storage Requirements The graph plots Storage Volume (m³) on the Y-axis (0.0 to 1400.0) against Storm Duration (mins) on the X-axis (0 to 180). The data points show a rapid increase in storage volume for durations up to 60 minutes, after which the volume levels off and slightly decreases. <table border="1"> <caption>Approximate data points from the Storage Requirements graph</caption> <thead> <tr> <th>Storm Duration (mins)</th> <th>Storage Volume (m³)</th> </tr> </thead> <tbody> <tr><td>10</td><td>450</td></tr> <tr><td>15</td><td>650</td></tr> <tr><td>20</td><td>850</td></tr> <tr><td>30</td><td>950</td></tr> <tr><td>45</td><td>1100</td></tr> <tr><td>60</td><td>1250</td></tr> <tr><td>75</td><td>1230</td></tr> <tr><td>90</td><td>1220</td></tr> <tr><td>105</td><td>1210</td></tr> <tr><td>120</td><td>1200</td></tr> <tr><td>135</td><td>1190</td></tr> <tr><td>150</td><td>1180</td></tr> <tr><td>165</td><td>1170</td></tr> <tr><td>180</td><td>1160</td></tr> </tbody> </table>				Storm Duration (mins)	Storage Volume (m³)	10	450	15	650	20	850	30	950	45	1100	60	1250	75	1230	90	1220	105	1210	120	1200	135	1190	150	1180	165	1170	180	1160
Storm Duration (mins)	Storage Volume (m³)																																
10	450																																
15	650																																
20	850																																
30	950																																
45	1100																																
60	1250																																
75	1230																																
90	1220																																
105	1210																																
120	1200																																
135	1190																																
150	1180																																
165	1170																																
180	1160																																

APPENDIX C – SITE VISIT PHOTOGRAPHS



Grand Union Canal towpath to the east of the site looking south



Lateral weir from Grand Union Canal to The Culvert looking west



River Colne at Cowley Mill Road bridge looking south



Surface water ponding on site at location of surveyed soakaway



Silt in location of previous ponding on the site