THE FLOOD RISK CONSULTANCY

FLOOD RISK ASSESSMENT

No 101-103 Raleigh Avenue, Hayes

Report No: 2012-057/01

9/21/2012

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Contract

This report describes work commissioned by Kompas Ltd following written instruction from their representative, Ishtiaq Syed dated 21st August 2012. Donna Metcalf of The Flood Risk Consultancy carried out the work.

Disclaimer

This document has been prepared solely as a Flood Risk Assessment for Kompas Ltd. The Flood Risk Consultancy accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

Executive Summary

The proposed development covers a gross area of 0.02 Hectares, and comprises private garden space associated with No101-103 Raleigh Avenue in Hayes, Middlesex.

Proposals incorporate redevelopment to provide a single detached residential unit.

The development area is located wholly within Flood Zone 2 of the Environment Agency Flood Map which is which is defined as land assessed having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.

Flood risk at the application site is identified from fluvial; surface water (pluvial); infrastructure failure; and potentially groundwater.

The primary flood risk is from Yeading Brook, which is located approximately 100 metres to the north of the application site. The watercourse is comprised predominantly of open channel, with no raised flood defences to provide protection to property adjacent to the river bank.

Public open space known as Belmore Playing Fields acts as a formal flood storage area, which is maintained by the Environment Agency; and stores flood water emanating from the watercourse during extreme flood conditions.

The modelled 1 in 100 year plus climate change flood level for the watercourse in line with the development is 29.263mAOD.

Overtopping of the natural river bank during the design flood event is considered likely. The average ground level within the site has been taken as 29.67mAOF for the purposes of this assessment; and is therefore elevated above the flood level within the nearby Yeading Brook.

The estimated 1 in 1000 year flood level within Yeading Brook is 30.093mAOD; and as such under such extreme flood conditions, it is considered probable that the application site will become inundated.

It is therefore concluded that Yeading Brook presents a flood risk to the proposed site.

The existing site is comprised of undeveloped private garden space and is therefore deemed to be 100% permeable.

Using IOH124 to estimate greenfield runoff associated within the existing site, it is estimated that surface water runoff rates are significantly less than 5l/s.

Should surface water runoff from the proposed development be restricted to existing rates, it is considered that owing to the small aperture required to control flow, there is likely to be an increase in flood risk associated with blockage at the flow control structure.

As such it is recommended that flows leaving the site should be restricted to a maximum rate of 5l/s for storms up to and including the 1 in 100 year plus climate change event. Flows in excess of this must be attenuated on-site prior to discharge.

Undertaking an assessment of post development surface water runoff from the site indicates that flows are likely to be less than 5l/s for storms up to and including the 1 in 100 year plus climate change event; and as such it is anticipated that on-site storage will not be required.

However it is highly recommended that this is re-evaluated at the detailed design stage to accommodate any requirements stipulated by the Statutory Authorities, the final development design and runoff likely to be generated by the development.

The hierarchy for disposal of surface water from new development is laid out within Building Regulations Approved Document H (2002) and specifies the following methods in order of preference:

- Infiltration via soakaway or other suitable infiltration device
- Discharge to watercourse
- Discharge to public sewer.

Details of site investigation works undertaken at the site are unknown at this time; however a review of historic borehole logs near to the subject site; along with details provided by the 'Soilscape' map for the area indicates ground conditions are largely unsuitable for infiltration.

As such it is considered that infiltration methods such as soakaways are unsuitable for dispersing surface water into the ground.

The nearest watercourse is Yeading Brook, located approximately 100m to the north of the development site off Raleigh Avenue in Hayes.

It is believed that the public surface water system serving the area within the locality of the site discharges into Yeading Brook; and therefore it is proposed that the plot drainage discharges into a 450mm diameter public surface water sewer located within Lothian Avenue, immediately adjacent to the application site.

An assessment of different SUDs techniques indicates that the following methods may be suitable for inclusion within the drainage strategy for the site:

- Retention – sub-surface storage.
- Wetland – pocket wetland.
- Source Control – green roof technology or rainwater harvesting; and permeable pavements (shallow attenuation).

Further assessment indicates that sub-surface storage is not required. Furthermore lack of space within the development area discounts the feasibility for a pocket wetland.

In order to reduce the volume of surface water leaving the development, it is recommended that rainwater harvesting is considered to enable non-potable re-use such as toilet flushing; with excess flows directed to the receiving public sewer system.

Details obtained from the Soilscape Map and London Borough of Hillingdon SFRA indicates that the application site lies within an area with a risk of groundwater flooding. It is noted however that there are no historical records available which indicate that flooding from this source is problematic within the immediate vicinity of the site.

Recommended measures for inclusion within the development proposals to mitigate against residual flooding include the following:

- Floor Levels to be elevated to a minimum level of 29.863mAOD i.e. 600mm above the 1 in 100 year plus 20% climate change flood level.
- Occupants advised to sign up the Environment Agency's Flood Alert Service.
- Develop and practice a Flood Evacuation Plan.

The implementation of mitigation measures as summarised above will ensure that any risk of flooding at the proposed development may be reduced to an acceptable level.

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1.0 Introduction

1.1 Terms of Reference

This report was commissioned by Kompas Ltd, to support a planning application for a single residential development at the rear of No 101-103 Raleigh Avenue in Hayes, Middlesex. The location of the site is shown on Table 2.

The development site is shown to lie wholly within Zone 2 of the Environment Agency Flood Map; which is defined as land assessed having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.

It is usual for the Agency to raise an objection to development applications within the floodplain or Zone 2 or 3 of the flood map until the question of flood risk has been properly evaluated. The Agency will also object to developments where the total site area is in excess of 1 hectare until suitable consideration has been given to surface water runoff.

1.2 Approach to the Assessment

An initial assessment indicates that the primary source of flood risk at the proposed development is from a fluvial source known as Yeading Brook; with additional flood risk resulting from an increase in surface water runoff following development. As such, it is necessary to investigate the impact of overtopping river banks and pre/post development surface water management issues at the application site. Consideration has also been given to the site flooding from secondary sources such as groundwater; infrastructure failure; overland flow and ponding of localised rainfall within the site.

The requirements for flood risk assessments are generally as set out in the 'Technical Guidance to the National Planning Policy Framework', published in March 2012; and in more detail from the Environment Agency's 'Standing Advice on Flood Risk' available from http://www.environment-agency.gov.uk/reasearch/planning/82584.aspx.

1.3 Sequential & Exceptions Test

As set out in the National Planning Policy Framework, the aim of the Sequential Test is to steer new development to areas at the lowest probability of flooding.

The Flood Zones are the starting point for the sequential approach.

The Environment Agency Flood Map shows the development site to be wholly within Zone 2 of the Environment Agency Flood Map; which is defined as land assessed having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.

Proposals for the application site involve residential development. In accordance with Table 2 'Flood Risk Vulnerability Classification' of the Technical Guidance to the National Planning Policy Framework, residential sites are defined as 'more vulnerable'.

As such, Table 1 overleaf indicates that the proposed development is considered appropriate.

Table 1: Flood Risk Vulnerability and Flood Zone 'Compatibility'[1]

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

✓ Development is appropriate
× Development should not be permitted

[1] Extracted from Table 3 of the Technical Guidance to the National Planning Policy Framework Document (March 2012)

2.0 Details of the Site

2.1 Site Details

Table 2: Development Location

Site Name:	Land r/o No101-103 Raleigh Avenue, Hillingdon.
Purpose of Development:	Residential
Existing Land Use:	Domestic garden
OS NGR:	TQ 108 818
Country:	England
County:	Middlesex
Local Planning Authority:	London Borough of Hillingdon
Internal Drainage Board:	Not Applicable
Other Authority (e.g. British Waterways/ Harbour Authority)	Not Applicable

Location Plan:

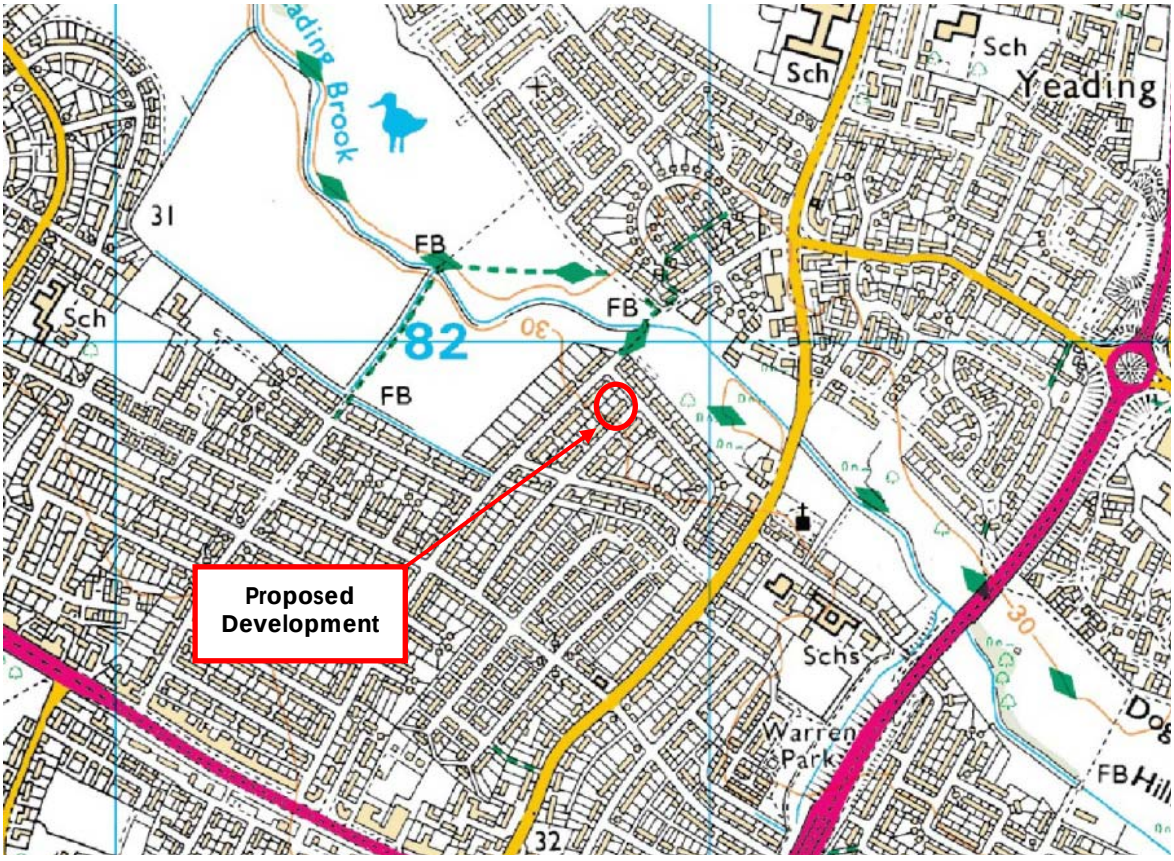


Image produced from the Ordnance Survey Get-a-map service.
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2.2 Site Description

The application site is located to the rear of No101-103 Raleigh Avenue within the Hayes area of the London Borough of Hillingdon.

The total site area covers approximately 0.02 Hectares and presently comprises driveway and garden areas associated with 2No semi-detached residential properties.

The site is surrounded predominantly by an established residential area, approximately 2.5 kilometres to the north east of Central Hayes; and 500 metres to the south west of Yeading.

Public open green space known as Belmore Playing Fields is situated to the north west of the application site; with a watercourse known as Yeading Brook flowing in a south easterly direction at a distance of 100 metres to the north of the development area.

Yeading Brook forms the upper reaches of the River Crane; and becomes the River Crane at Cranford Country Park, 4 kilometres downstream from the proposed development at Raleigh Avenue.

From Ordnance Survey maps of the local area, 2No additional minor watercourses are also identified. The first of these is located approximately 300 metres to the south west of the development; and appears to be part of a land drainage system serving the Belmore Playing Fields site. The second minor watercourse flows in a north easterly direction through the area known as Warren Park.

Figure 2.1: Aerial Photograph of Existing Site Viewed West.



Image courtesy of www.bing.com

Due to the nature of the existing site comprising predominantly of garden space it is surmised that the site is not currently drained via a positive system.

Figure 2.2: NE Boundary of No103 Raleigh Avenue Viewed South along Lothian Avenue



Image courtesy of Google Earth

Unfortunately a topographical survey of the application site is not currently available. However, it is noted that the area surrounding the site is fairly flat in nature.

This is confirmed by sewer record data provided by Thames Water for the area surrounding the site. Information contained within this data set, indicates that the road level at the junction of Raleigh Avenue with Lothian Avenue approximates 29.74mAOD. It is further noted that the road level at the junction of Lothian Avenue with nearby Shakespeare Avenue is 29.60mAOD.

The location of the application site lies between these points and as such, for purposes of assessing the flood risk to the proposed development, an average ground level of 29.67mAOD has been adopted for the site.

2.3 Proposed Development Details

The total area designated for development within the red-line boundary of the site approximates to 0.02 Hectares.

Current development details indicate that a single two-storey residential unit is planned for the site; with associated private garden to the rear; and additional garden space and off street parking at the front of the new property.

Vehicular access into the development will be via Lothian Avenue.

From the latest development plan, provided within Appendix A of this report, it is estimated that the impermeable area i.e. roof and hardstanding area, within the site following completion of the development will be increased to approximately 40% i.e. covering an area of 0.008 Hectare.

3.0 Initial Assessment

3.1 Historical Flooding

3.1.1 British Hydrological Society Flood Event Records

A search on the British Hydrological Society (BHS) Chronology of British Hydrological Events website[2] found no records of flooding within the immediate vicinity of the proposed development at Hayes.

3.1.2 Internet Search

No further information regarding instances of historic flooding within the vicinity of the application site was obtained via an internet search of the London Borough of Hillingdon, and more specifically the Hayes area.

3.1.3 London Borough of Hillingdon Level 1 Strategic Flood Risk Assessment (2008)

The London Borough of Hillingdon's SFRA was undertaken by Scott Wilson in 2008, to support the development of the Local Authority's Local Development Framework (LDF).

A review of the document provided the following information:

'***River Crane:*** *This River has a history of flooding in its lower reaches. The upper reaches, known as the Yeading Brook, flow through considerable lengths of parks and open spaces providing less developed areas for floodwater to be accommodated. Nevertheless a strategic examination of options for sustainable surface water management, taking into account climate change predictions, should be used to influence future development decisions and considerations of the management of the riverside open spaces.'*

'The main historic flooding event that affected the Yeading Brook as listed in the River Crane Flood History Database and form Environment Agency sources are:-

- *September 1958: Yeading Brook overtop in the Delamere Road Area in Hayes;*
- *August 1977: severe flooding inundated and damaged approximately 1200 homes in north-west and south seat London. Within the Yeading Brook area Ruislip Gardens were seriously affected.*
- *Summer 2007: Flooding at Field End Road and Brookside Close. Field End Trash Screen had become blocked by debris and caused the Roxbourne to overtop with flooding affecting 20 properties, 6 of which were flooded internally.*

3.1.4 London Borough of Hillingdon PFRA

A Preliminary Flood Risk Assessment (PFRA) was undertaken by Capita Symonds in 2011 on behalf of the London Borough of Hillingdon to satisfy the legal requirements of the Flood Risk Regulations, 2009, and the EU Floods Directive.

The Flood Risk Regulations (FRR), which came into force on the 10th December 2009, and the Flood & Water Management Act, which gained Royal Assent on the 8th April 2010, forms the basis for the PFRA.

[2] http://www.dundee.ac.uk/geography/cbhe/

The PFRA is a high level screening exercise used to identify areas of significant risk, based on available and readily derivable information, describing both the probability and harmful consequences of past and future flooding.

Hillingdon is at risk from many different sources of flooding including, Main Rivers, Ordinary Watercourses, tidal, surface water runoff, groundwater, sewer flooding and the residual risks associated with artificial water bodies such as canals and reservoirs.

Table 3: Historic Flooding

Main Source of Flooding	Description/Location
Groundwater	Cricket ground on Rickmansworth Road
Groundwater	Property on Links Road, Northwood
Pluvial	West Ruislip Station – standing water in roads at Eastcote & Ruislip.
Pluvial	Ruislip Tube Station – flooding to station following intense rainfall events
Pluvial	Ruislip Manor Tube Station - flooding to station following intense rainfall events
Groundwater	Property on Crossier Way – standing water
Unknown	Civic Centre canteen & underground car park flooded – cars left with water up to window sills
Unknown	Hillingdon Underground Station – flooding throughout flood warning areas
Groundwater	Standing water at property in Windsor Avenue
Groundwater	Standing water at property in Hoppner Road
Pluvial	Heathrow Airport – caused disruption to transport affecting Heathrow. Heathrow Airport can be affected by heavy rain and flights have been cancelled as a consequence.
Unknown	Bedford Road, Clyfford Road & Lea Crescent affected by flooding. Key vulnerable structure – GP surgery.
Unknown	Brunel University affected, some properties on Church Road & Business Park
Unknown	Church Road, Hillingdon – properties affected.
Unknown	Bridge Road, back gardens affected

Although it is advised that the records provided are not exhaustive, no incidents of flooding within the immediate vicinity of the application site at Raleigh Avenue or Lothian Avenue were recorded.

3.1.5 EA Environmental Fact Sheet for Hillingdon (2011)

Fluvial & Tidal Flood Events

'Flooding has occurred in Hillingdon a number of times over the last few years. In the last 10 years events were recorded in 2000, 2001, 2003, 2007 and 2009. These events were fluvial (river) flooding and were mainly located in the south west of the borough around the lower reaches of the River Colne.

In 2009 four areas of Hillingdon were subjected to flooding: the River Pinn, Holme Lodge Ditch, Stanwell Moor Ditch and the Colne Brook. These events were attributed to a variety of causes; river flow exceeding channel capacity, surface water runoff overwhelming the local drainage systems and an obstruction in a culverted channel.

The heavy urbanisation of London's catchments mean many areas are susceptible to surface water flooding, which is exacerbated by poor or inadequate drainage systems.'

3.2 Sources of Flooding

Table 4: Possible Flooding Mechanisms

Source/Pathway	Significant?	Comment/Reason
Fluvial	Yes	Yeading Brook; Minor Watercourses
Canal	No	Grand Union Canal
Tidal/Coastal	No	Nearby watercourses are non-tidal at the location of the application site
Reservoir	Yes	Yeading West FSA; Charville Lane FSA[3]
Pluvial (urban drainage)	Yes	Surface water management issues to be addressed
Groundwater	No	
Overland flow	No	Low-lying ground with relatively flat topography
Blockage	Yes	Existing footbridge; Yeading Lane Bridge;
Infrastructure failure	Yes	Existing footbridge; Yeading Lane Bridge
Rainfall Ponding	No	No significantly depressed ground levels at the site.

There are numerous sources of potential flood risk identified at the proposed development, and it is necessary to assess the probability of flooding emanating from each source.

The primary flood risk to the proposed development is fluvial from Yeading Brook. The watercourse is predominantly open channel in nature and therefore it is considered necessary to determine flood water levels at the site for the desired return periods emanating from this source.

There are 2No minor tributaries which flow into Yeading brook near to the proposed development at Raleigh Avenue. It is considered that the Yeading brook is however the primary source of fluvial flood risk to the site and therefore for the purposes of this assessment the minor tributaries have not been considered further.

Secondary sources of flooding such as the Grand Union Canal; Yeading west and Charville Lane Flood Storage Areas; surface water runoff; groundwater; blockage and infrastructure failure have also been identified and considered further.

Yeading Brook is located approximately 100 metres to the north of the application site, and forms the upper reach if the River Crane.

The watercourse is classified as 'Main River, and the Environment Agency have provided modelled flood level data for to assist in the assessment of flood risk at the proposed development from this potential flood mechanism.

The watercourse is predominantly open channel in nature, with a footbridge crossing between Greenway and Shakespeare Avenue immediately to the north of the development site; and a major road crossing at Yeading Lane approximately 300 metres downstream of the site. It is understood that there are no formal flood defences along the route of each watercourse and as such the flood mechanisms of overtopping, blockage and infrastructure failure will require further consideration.

[3] FSA = Flood Storage Area

Flooding may occur as a result of any impoundment structure (such as a dam, sluice or raised bank) being overtopped or failing. This can cause significant threat to life and property as flooding can occur very quickly with little warning and can result in deep fast flowing floodwaters.

This risk comes primarily from the Grand Union Canal, situated approximately 1.6 kilometres to the south east of the development site.

'Broad canals' like the Grand Union Canal at Hayes do not pose a direct flood risk as they are controlled water bodies with regulated flows. However, there are residual risks associated with lower probability events such as overtopping and/or the breaching of embankments.

The residual risk associated with canals is unknown as it depends on a number of factors including, the source of water into the canal, materials used within the canal embankments and the condition of those embankments. The risk of flooding is limited due to continued maintenance by the Canal & River Trust (formerly British Waterways) and the controlled volume of water within an impounded length. However, if an event occurs the consequences can be quite high, especially if people or properties are situated directly below the breached length.

It is noted that the length of canal in line with the proposed development is not elevated; and as such the residual impact of flooding at the application site caused by overtopping or structural failure is considered to be low. As such, further assessment of this flood source is not considered to be necessary.

Yeading West and Charville Lane FSA's or Flood Storage Areas are only operational during flood events within Yeading Brook and are therefore not considered to represent 'true' reservoirs within the Hayes area. These flood storage areas are managed by the Environment Agency.

The Environment Agency Reservoir Flood Map illustrated below in Figure 3.1, illustrates the largest area that might be flooded if the flood storage area were to fail and release the water it is designed to hold during a flood event. The application site is located at the outer edge of the area likely to be affected by flooding from this source. The impact of such flooding has been investigated further within Section 4.2 of this report.

It is considered that following development, the impermeable area within the site will be increased, and as such, further investigation regarding pre and post development surface water management issues will need to be addressed within this assessment.

Figure 4 from the SFRA provides details of flood sources other than fluvial which impact the London Borough of Hillingdon. It is noted that whilst there are a number of locations within the Borough which are shown to be vulnerable to groundwater flooding; the area within the vicinity of the proposed development at Hayes is considered to have a low risk of flooding from this source. As such, groundwater flooding has not been considered further within this report.

Figure 3.1: Environment Agency Map – Risk of Flooding from Reservoirs

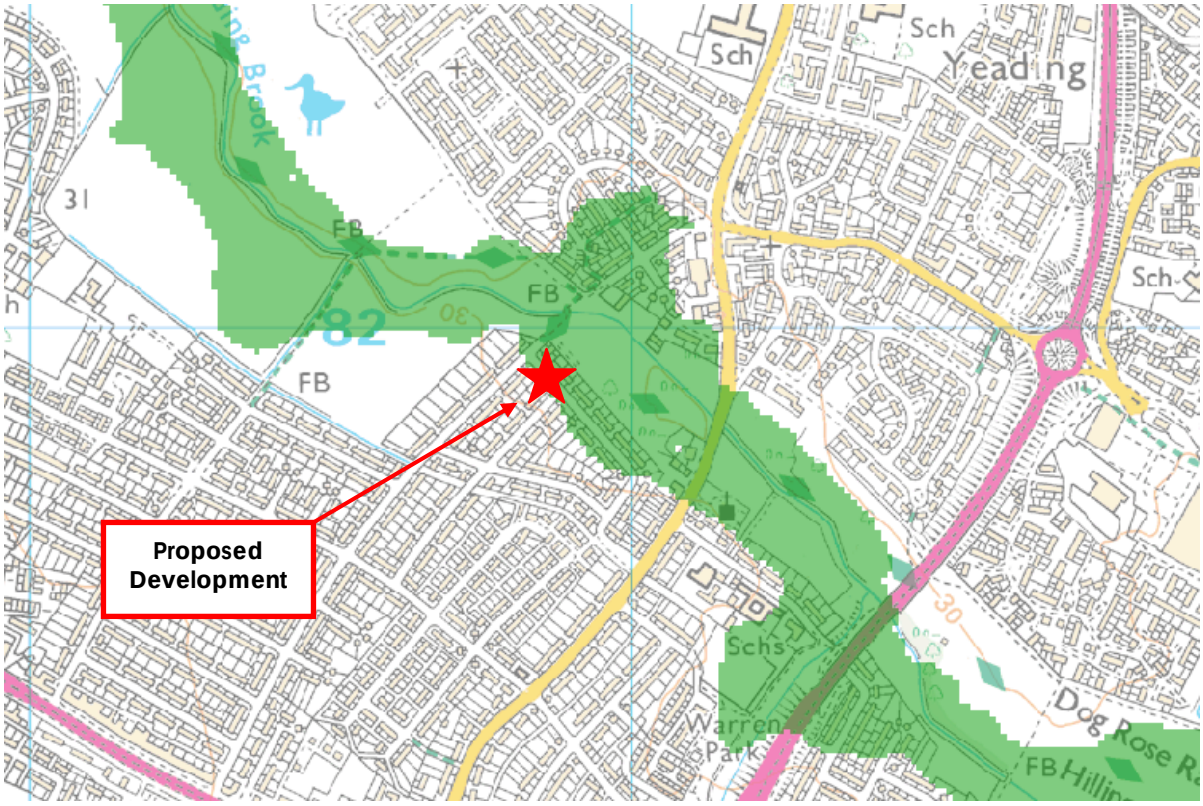


Image from www.environment-agency.gov.uk

4.0 Quantitative Flood Risk Assessment

4.1 National Planning Policy Framework

4.1.1 Environment Agency FRA Requirements: More Vulnerable Development within Flood Zone 2 (Sites <1 Hectare)

The Environment Agency's Standing Advice with regard to residential development within Flood Zone 2 is as follows:

- Ground floor levels to be set at a minimum of (whichever is the higher):
  - 300mm above the general ground level of the site OR
  - 600mm above the 1 in 100 year (1% AEP) fluvial flood level; or 1 in 200 year (0.5% AEP) tidal flood level in any year, including an allowance for climate change.
  - Basement rooms are to have unimpeded access internally to an upper floor level.
- In order to deliver safe development, for single storey buildings or subdivisions with no access to higher floors, users of the development must have access to a safe refuge set above the 1 in 1000 year (0.1% AEP) fluvial flood level, including an allowance for climate change.
- Management of Surface Water
  - Surface Water runoff will be controlled to ensure no flooding of property and no increase in surface water runoff from the site to a watercourse or receiving water body compared to the existing pre-application runoff rate in a 1 in 100 year storm event, plus an appropriate allowance for climate change.
  - Meets the requirements of Approved Document Part H of the Building Regulations 2000.
- Flood resilience/resistance and emergency escape measures/procedures have been incorporated where possible. This applies to any part of the building (e.g. basements) that are situated below the 1 in 100 year (1% AEP) fluvial flood level; or 1 in 200 year (0.5% AEP) tidal flood level in any year, including an allowance for climate change.

4.2 Fluvial: Yeading Brook

4.2.1 General

The Yeading Brook flows into the Borough of Hillingdon from the east through two principal branches, known as the East arm and West arm.

The East arm enters Hillingdon through a long culvert at Field End Road before emerging to the southwest of Victoria Retail Park. It flows in a south-westerly direction for 3.6 kilometres through South Ruislip, and then west along the southern boundary of Northolt Aerodrome before its confluence with the West arm.

The West arm enters Hillingdon through Ruislip recreation ground and flows in parallel with the East arm in a south-westerly direction for 5 kilometres, curving round the northern and western boundary of Northolt Aerodrome, before its confluence with the Ickenham Stream to the south. It then flows for 1.7 kilometres through rural pasture before its confluence with the East arm.

The main branch of the watercourse flows south for 7.6 kilometres passing through green open space to the southeast of Yeading and the easterly edge of Hayes.

Of this 7.6 kilometre length, the Yeading Brook travels in parallel with the Grand Union Canal for 2.5 kilometres before flowing under an Aqueduct becoming the River Crane at Cranford Park.

At the A312 road the Hayes Bypass Channel splits off from the Yeading Brook flowing down a manmade concrete channel in a southerly direction for 2km before entering a 0.5km culvert and then rejoining the Yeading Brook.

The Hayes Bypass Channel provides flood relief to properties on the western floodplain area.

There are two large flood storage reservoirs on the Yeading Brook which provide storage capacity up to the 1 in 50 year standard. The first of these is located just off the A40 opposite RAF Northolt at NGR 509420, 184410.

The second of these, Charville Lane Flood Storage Area, is located at the end of Charville Lane at NGR 509740, 183900.

It is understood that there are no formal flood defences situated along the banks of Yeading Brook. As such, to adequately assess the flood risk to the application site from this source, only overtopping of the natural river bank will need to be investigated further.

4.2.2 Modelled Flood Level Data

Extracts from the River Crane Mapping Study produced by Halcrow in 2008 relevant to the location of the proposed development site have been provided by the Environment Agency; and presented within Appendix B of this report.

From this information it was determined that the flood level data for Node Reference Y744 would provide the best point of reference due to its location relative to the proposed development site. The modelled data for this node is tabulated below.

Table 5: Modelled Flood Data for Node Ref Y744

Return Period	Modelled Flood Level (mAOD)
1 in 5 year	29.008
1 in 20 year	29.099
1 in 50 year	29.156
1 in 100 year	29.190
1 in 100 year + 20%	29.263
1 in 1000 year	30.093

4.2.3 Overtopping (1 in 100 year plus 20% climate change event)

The average ground level within the existing development site has been taken as 29.67mAOD. Using the information tabulated above, the water level within Yeading Brook during the 1 in 100 year plus climate change flood event is 29.263mAOD. The site is therefore elevated approximately 0.4 metres above the predicted flood level.

In conclusion, the site is elevated above the 1 in 100 year plus climate change flood level; and is therefore situated outside of Flood Zone 3; and concurs with the Environment Agency Flood Map.

4.2.4 Overtopping (Extreme 1 in 1000 year event)

Comparing the modelled flood level for the extreme 1 in 1000 year event i.e. 30.093mAOD, indicates that under such flood conditions within Yeading Brook, the application site will become inundated to a depth approximating 0.42 metres.

4.2.5 Infrastructure Failure: Blockage or Collapse at Structures Spanning Yeading Brook

During flood conditions there is the potential for debris to enter open channel sections of the watercourse, and be washed downstream. An accumulation of debris at bridges and culverted sections of the watercourse may lead to blockages within structures located along the channel, causing flood water to backup.

Similarly should the existing bridges spanning Yeading Brook fail, i.e. the existing footbridge between Greenways and Shakespeare Avenue or the road bridge at Yeading Road; the capacity of the enclosed section of watercourse is likely to be greatly reduced, which again is likely to cause flood water to backup within the channel upstream from either bridge crossing.

As such, it is considered likely that the extent of flooding within the local vicinity of either structure will be exacerbated in the event of severe blockage or structural collapse.

It is noted that Yeading Brook is designated as 'Main River' and therefore the Environment Agency are responsible for managing flood risk along the watercourse.

The Environment Agency undertakes an annual programme of maintenance, which may include the following activities:

- Maintaining flood barriers & pumping stations
- Clearing grills and removing obstructions from rivers
- Controlling aquatic weeds within rivers
- Managing grass, trees and bushes on flood embankments
- Inspection and repair of flood defence structures

An extract from the Environment Agency's routine maintenance programme for 2012-13 at Hayes includes the following:

'This system includes the River Crane, loops and tributaries from Yeading to the Hospital Bridge roundabout at Whitton. We manage vegetation growth on the Yeading Brook from Yeading to Cranford Park, and remove obstructions that would increase flood risk.'

As such, blockage or structural collapse at along the route of Yeading Brook is therefore considered to have a relatively low probability.

4.2.6 Conclusion

It is concluded that Yeading Brook presents a medium flood risk to the application site off Raleigh Avenue in Hayes.

4.3 Surface Water Runoff

4.3.1 General

The gross area of the site approximates to 0.02 Hectares and is considered to be 100% permeable as the site is currently undeveloped.

As such, surface water discharge rates from the proposed development will be restricted to greenfield runoff rates.

Development plans for the site comprise a single residential unit, with private garden space and off-street parking.

4.3.2 Greenfield Runoff Rates

In accordance with the CIRIA C697 SUDS Manual, greenfield runoff at the existing site has been estimated using IOH124 'Flood Estimation for Small Catchments', for a range of probabilities and tabulated below.

Table 6: IOH124 Greenfield Runoff Calculations: Existing

Return Period	Q_{RURAL} Area = 50Ha (l/s)	Hydrometric Area	Runoff Area = 50Ha (l/s)	Runoff from Existing Site (l/s)
1 in 2 year	263	6	231	0.09
1 in 30 year			594	0.24
1 in 100 year			839	0.34

In accordance with standard industry practice, outflow from the proposed development is normally limited using a flow control such as a hydrobrake or similar device, to the estimated peak 1 in 2 year greenfield runoff rate, in this case estimated to be approximately 0.09l/s.

The small size of aperture required to restrict surface water runoff leaving the site to such a low flow rate is considered to increase the risk of surface flooding due to blockage.

Therefore in order to reduce this secondary flood risk to an appropriate level, it is proposed that the surface water discharge rate for flow leaving the development site is limited to a maximum of 5l/s.

It is proposed that surface water discharge from the proposed development will be discharged into an existing 450mm diameter public surface water sewer located within Lothian Avenue.

Surface water runoff rates leaving the development in excess of 5l/s will need to be attenuated on-site prior to discharge.

Thames Water; the Environment Agency and the London Borough of Hillingdon will request that the proposed 1 in 2 year plus climate change surface water runoff can be maintained and also insist that the 1 in 30 year plus climate change event is not allowed to flood the surface; hence surface water must remain within the pipes, manholes, and storage systems.

It is usual that the 1 in 100 year plus climate change event will be allowed to flood the surface, but water will not be permitted to enter the proposed building within the site.

Additionally, flooding resulting from the 1 in 100 year plus climate change rainfall event must also be retained within the development boundary and not be allowed to migrate to adjacent properties.

4.3.3 Disposal of Surface Water: The Hierarchy

The hierarchy for disposal of surface water from new development is outlined within The Building Regulations Approved Document H (2002) and specifies the following methods in order of preference:

- Infiltration via soakaway or other suitable infiltration device
- Discharge to watercourse
- Discharge to public sewer.

i. Infiltration

A site investigation report for the proposed development is not currently available. Therefore in order to assess the potential suitability for infiltration methods to dispose of surface water from the development, an examination of the general ground conditions within the surrounding area was undertaken.

Catchment wide data for the site was obtained from the FEH CD-ROM (V3.0), which indicates that the SPRHOST (Standard Percentage Runoff) for the site has a value of 50.4%.

Through experience, this value is considered generally to represent ground which is likely to be unsuitable for the dissipation of surface water flows into the ground.

To further investigate, a review of historical borehole logs taken near to the proposed development, from the British Geological Society records indicates that ground within the vicinity of the development is predominantly comprised of silty clays to significant depth.

Information from the National Soil Resource Institute: www.landis.org.uk/soilscapes, associated with Cranfield University, details the development area as being situated on loamy soils with naturally high groundwater.

In conclusion ground conditions generally indicate that infiltration methods are unsuitable for inclusion within the proposed drainage strategy for the development.

A copy of the borehole logs and 'Soilscape' map which have been reviewed is provided within Appendix E of this report.

ii. Watercourse & Public Sewer

The nearest watercourse is Yeading Brook, located approximately 100m to the north of the development site.

It is believed that the public surface water drainage system serving the area currently discharges into the watercourse.

It is considered impractical to provide a new outfall to the watercourse solely to serve a single residential dwelling; and as such it is proposed that surface water from the development will discharge to Yeading Brook indirectly via the public surface water system near to the development.

4.3.4 Attenuation Requirements

Following development, the impermeable area within the site will be increased.

Details provided by Kompas Ltd indicate that roof and hardstanding areas within the proposed development will cover an area of 0.008 Hectares i.e. 40% of the gross development area.

Using the Wallingford Procedure Modified Rational Method storage volumes for the 1 in 2 year, 30 year, 100 year plus climate change events have been calculated and tabulated below. The allowable discharge rate from the proposed development has been set to a maximum of 5l/s.

Table 7: Indicative Volume of Attenuation: Proposed Development

Return Period	Storage Volume (l/s)
1 in 2 year + 20% climate change	0
1 in 30 year + 20% climate change	0
1 in 100 year + 20% climate change	0

The calculations indicate that following development, the increased impermeable area is not sufficient to generate surface water runoff rates in excess of 5l/s for storm events up to and including the 1 in 100 year plus climate change event.

As such it is anticipated that on-site attenuation of flows will not be required.

It is noted that the storage volumes provided are indicative only at this stage and should be recalculated during the detailed design stage to reflect planning conditions imposed by the Statutory Authorities i.e. the agreed allowable discharge from the site; the final development layout proposals; and the extent of impermeable areas and runoff to be generated.

4.3.5 Sustainable Urban Drainage Systems (SUDS)

The Environment Agency requires that surface water runoff should be controlled as near to its source as possible, through a sustainable drainage approach to surface water management (SUDs). This approach involves using a range of techniques such as soakaways and swales to reduce flood risk by attenuating the rate and quantity of surface water runoff from a site.

A suitability matrix has been used to quickly identify SUDS techniques which may be investigated further for incorporation into the surface water management system for the proposed development. The results from the analysis are summarised below and in more detail within Table 8 overleaf, and Appendix H of this report:

- Retention – sub-surface storage.
- Wetland – pocket wetland.
- Source Control – green roof technology or rainwater harvesting; and permeable pavements (shallow attenuation).

On further investigation, attenuation of surface water flows is deemed unlikely to be required; and as such sub-surface storage and permeable pavements have been disregarded.

Furthermore due to the potential for shallow groundwater and overall lack of space, the implementation of a pocket wetland to serve a single residential dwelling has also been disregarded.

It is considered unlikely, from a practical perspective that green roof technology will be incorporated into the architectural design for the new dwelling; and therefore in order to reduce the volume of surface water leaving the development, to pre-development rates it is recommended that that rainwater harvesting is considered. This SUDs method will enable non-potable re-use such as toilet flushing; with excess flows directed to the receiving public surface water sewer located within Lothian Avenue.

Table 8: SUDS Techniques and Suitability of Use

Method	Description	Potential for use at site
Filter drains	Drainage trench filled with gravel and provided with a pipe	Potentially shallow groundwater; and limited available space within the proposed site.
Swales	Shallow grass ditch	Potentially shallow groundwater; and limited available space within the proposed site.
Permeable surfaces	Pavement surfaces that allow water to pass through into underlying storage in sub base e.g. permeable concrete block paving or porous asphalt.	Ground conditions indicate poor permeability for infiltration.
Ponds and basins	Open areas that are used to store and treat rainwater. Ponds are permanent bodies of water and basins are generally dry and occasionally store water.	Limited availability of space - unsuitable.
Green roofs	Roof system that is vegetated with plants (note sedum plants rather than grass so no mowing is required)	Suitability dependant on the architect's design – rainwater harvesting considered a more practical option.
Rainwater Harvesting	Rainwater re-use to provide a non-potable water supply	Will enable a reduction in post development surface water runoff volume to leave the site to predevelopment levels.
Infiltration devices	Methods that allow rainwater to soak into the ground, e.g. soakaways.	Ground conditions indicate poor permeability for infiltration.
Storage tanks	Underground tanks that temporarily store water in the drainage system.	Attenuation of flows unlikely to be required at this site.

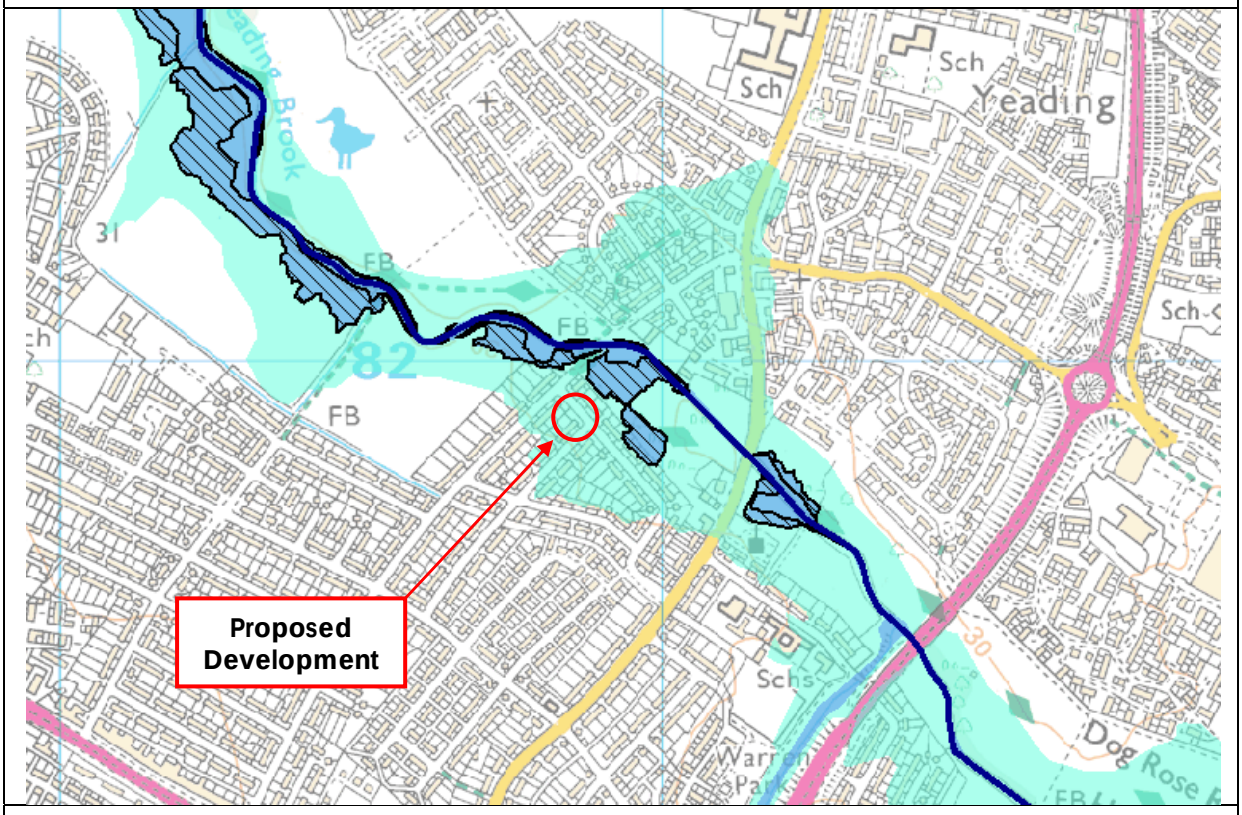
5.0 Mitigation Measures

5.1 The Environment Agency Flood Map

The Environment Agency flood zone map indicates that the site lies within Flood Zone 2 of the Environment Agency Flood Map (version 2.8.2 which is which is defined as land assessed having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.

An extract of the Environment Agency flood map at the development site is provided in Figure 5.1 below.

Figure 5.1: Environment Agency Flood Map



Source: Environment Agency website (http://www.environment-agency.gov.uk)

- Flooding from rivers or sea without defences (Flood Zone 3)
- Extent of extreme flood (Flood Zone 2)
- Flood defences
- Areas benefiting from flood defences
- Main rivers

5.2 FFL's and Land Raising

The average ground level within the site is estimated to be 29.67mAOD; and is therefore elevated approximately 0.4 metres above the modelled 1 in 100 year plus climate change flood level within Yeading Brook.

It is usual practice to ensure that finished ground floor levels within new residential dwellings are set at a minimum of 600mm above the 1 in 100 year plus climate change flood level i.e. 29.263mAOD + 0.6m = 29.863mAOD; in order to provide a suitable freeboard.

5.3 Access and Egress

The access and egress point from the development is located outside of Flood Zone 3; and therefore occupants and visitors to the majority of the proposed properties will be able to safely leave the site during normal flood conditions within the nearby watercourse.

However under extreme flood conditions, i.e. t he 1 in 1000 year event access to the front of the proposed property along Lothian Avenue may be compromised; and therefore it is recommended that the occupants of the proposed dwelling are advised to sign up to receive flood warnings from the Environment Agency and devise a flood evacuation plan, to ensure that they are able to move safely away from Flood Zone 2 if required to do so.

5.4 Compensatory Flood Storage

The proposed development to the rear of No101-103 Raleigh Avenue is considered to lie outside of the 1 in 100 year plus climate change flood zone associated with Yeading Brook.

As such compensatory flood storage volumes will not need to be provided at the site.

5.5 Flood Warning

The location of the proposed development is covered by the Environment Agency's Flood Warnings Direct Service.

This is a free service which enables the Environment Agency to send a direct message when flooding is expected and may affect the property. Flood warnings are designed to provide residents the time to prepare for flooding. Flood warnings can be sent by telephone, mobile, email, SMS text message or fax.

The Environment Agency also provides the **Floodline 0845 988 1188** service, where occupants can listen to recorded flood warning information for the area or speak to an operator for advice 24 hours a day.

Should a flood event reach the level where the development is at risk of inundation, then the Environment Agency will issue a Severe Flood Warning.

5.6 Evacuation Plan

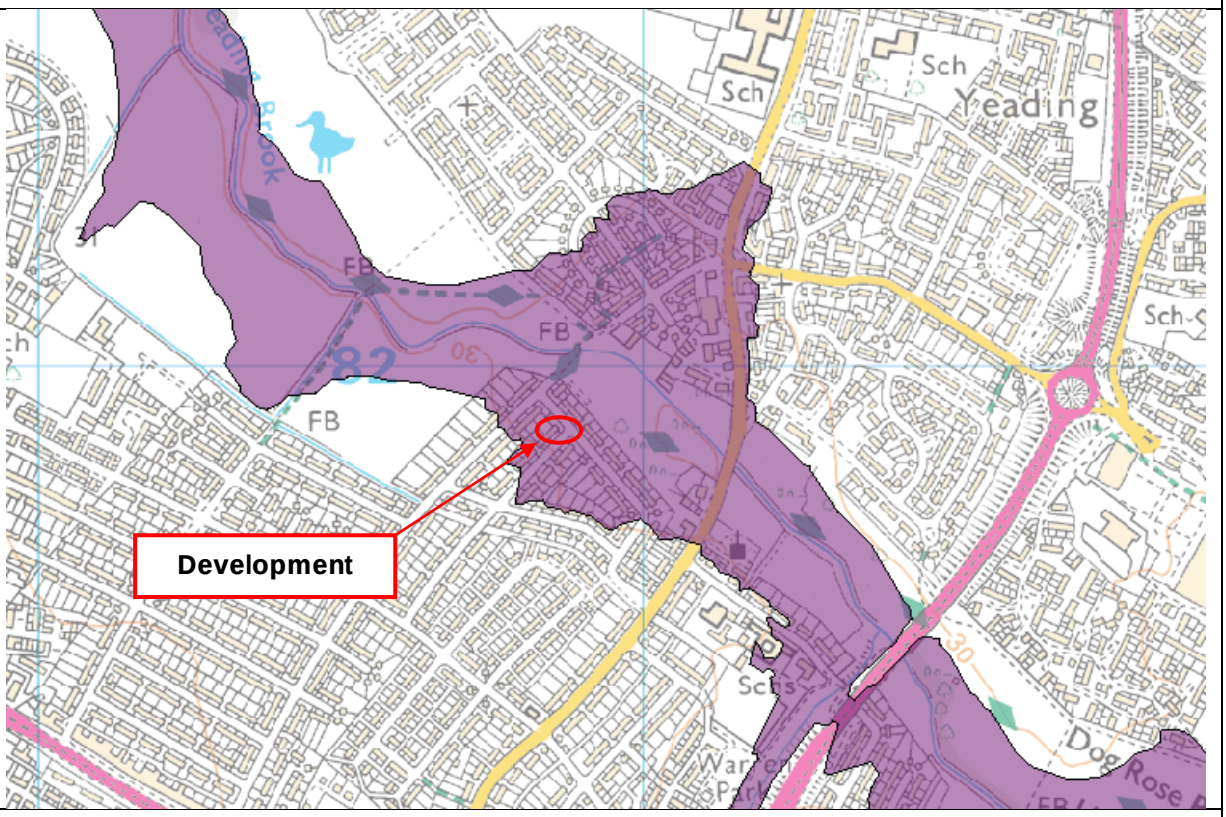
For health and safety reasons there is a preference to evacuate, as failure to do so, would put the residents and others (e.g. rescuers) at risk of injury. Therefore, it is highly recommended that the residents are advised to devise a flood warning and evacuation plan from the site to a safe area away from Yeading Brook, should a severe flood warning be issued by the Environment Agency.

The residents of the new development should be made aware of the potential for flooding from the watercourse.

It is noted that during evacuation, the residents should be directed in a south westerly away from the river.

Practical advice is available from the Environment Agency publication titled 'What to do before, during and after a flood', which can be downloaded from the Environment Agency website: http://publications.environment-agency.gov.uk/PDF/FLHO1110BTFK-E-E.pdf

Figure 5.2: Environment Agency Flood Warning Coverage Map



Source: Environment Agency website (http://www.environment-agency.gov.uk/subjects/flood)

6.0 Conclusions & Recommendations

The development is shown to be wholly located within Flood Zone 2 of the Environment Agency Flood Map.

The primary source of flood risk to the development is identified to be from Yeading Brook which is located approximately 100 metres to the north of the site.

The 1 in 100 year plus 20% climate change flood level for Yeading Brook in line with the development is given as 29.263mAOD. Undertaking a comparison of the flood data against local level information confirms that the application site is likely to become inundated during extreme flood conditions within the watercourse.

In conclusion Yeading Brook presents a flood risk to the proposed development to the rear of No101-103 Raleigh Avenue in Hayes, Middlesex.

Recommended measures for inclusion within the development proposals to mitigate against residual flooding include the following:

- Floor Levels to be elevated to a minimum level of 29.863mAOD i.e. 600mm above the 1 in 100 year plus 20% climate change flood level.
- EA Flood Warnings Direct – Prospective occupants are advised to sign up the Environment Agency's free Flood warnings Direct Service.
- Develop and practice a Flood Evacuation Plan.

Secondary sources of flooding have been identified from groundwater; an increase in surface water runoff from the site, resulting from an increase in impermeable area; and infrastructure failure.

Following assessment, these additional flood sources are deemed to present a low risk of flooding at the application site.

The existing site is classed as 'greenfield' development, and covers a gross area of 0.02 Hectares.

Proposals for development within the site include the provision of a single residential dwelling with private garden space and off-street parking.

Following development the roof and hardstanding areas within the site will be increased to 0.008m^3 or 40% of the total site area.

Using IOH124 it is estimated that existing greenfield runoff rates from the site are significantly less than 5l/s; as such it is recommended that flow leaving the development must not exceed 5l/s for storms up to and including the 1 in 30 year plus climate change event.

The hierarchy for disposal of surface water from new development is outlined within The Building Regulations Approved Document H (2002) and specifies the following methods in order of preference:

- Infiltration via soakaway or other suitable infiltration device
- Discharge to watercourse
- Discharge to public sewer.

Site investigation data for the development is currently unavailable; and therefore an examination of the general ground conditions within the surrounding area was undertaken.

Historical borehole logs indicate that the area comprises silty clays. A review of the 'Soilscape' map for the area containing the site indicates ground comprising loamy soils with naturally high groundwater.

It is therefore concluded that infiltration methods are unlikely to be viable for inclusion within a drainage strategy for the development.

As such it is proposed that surface water is discharged into the nearby Yeading brook via an existing 450mm diameter public surface water sewer which is located within Lothian Avenue adjacent to the site.

In order to minimise the effect of residual flooding within the proposed development, the implementation of mitigation measures as described throughout the assessment report should reduce flood risk to an appropriate level.

APPENDICES

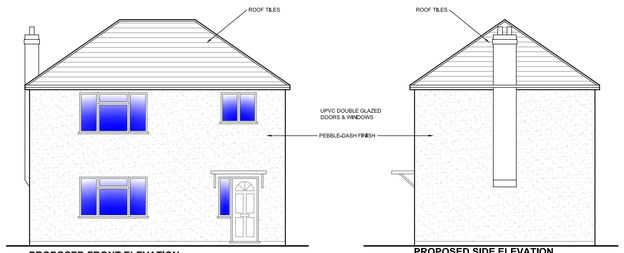
Appendix A: - Proposed Development Plans

KOMPAS WILL NOT BE RESPONSIBLE FOR THE CONTRACT AFTER HAVING OBTAINED PLANNING PERMISSION AND/ OR BUILDING REGULATION APPROVALS AND THAT THERE CAN BE NO GUARANTEE THAT PLANNING PERMISSION OR BUILDING REGULATION WILL BE OBTAINED. ANY WORKS WHICH ARE STARTED BEFORE APPROVALS WILL BE AT OWNERS RISK. NO RESPONSIBILITY WILL BE TAKEN FOR WORKS WHICH ARE UNFORESEEN AND FOR ANY SUBSEQUENT ALTERATIONS MADE WHICH ARE BEYOND THE CONTROL OF THE AGENT.

NOTES

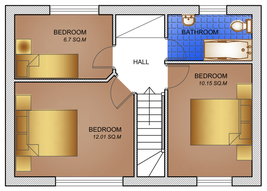


PROPOSED GROUND FLOOR

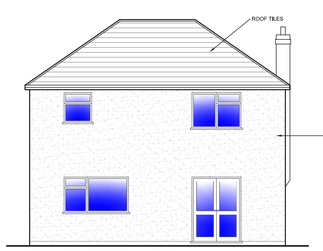


PROPOSED FRONT ELEVATION

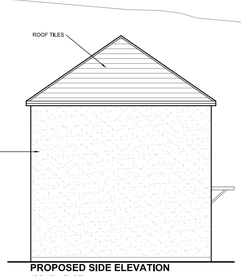
PROPOSED SIDE ELEVATION
(NORTH-WEST)



PROPOSED FIRST FLOOR

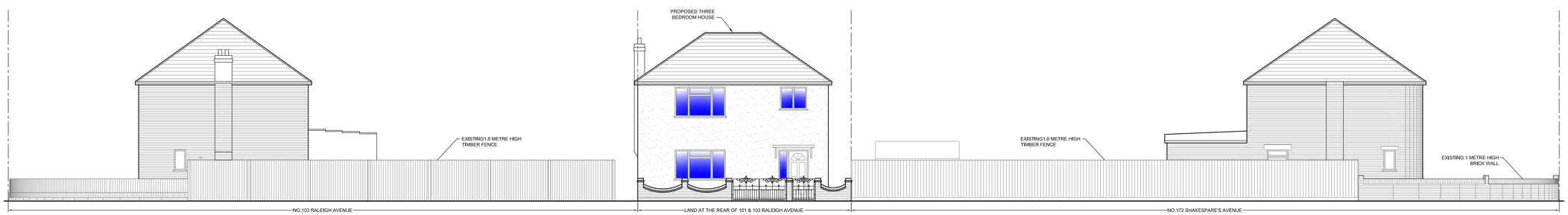


PROPOSED REAR ELEVATION

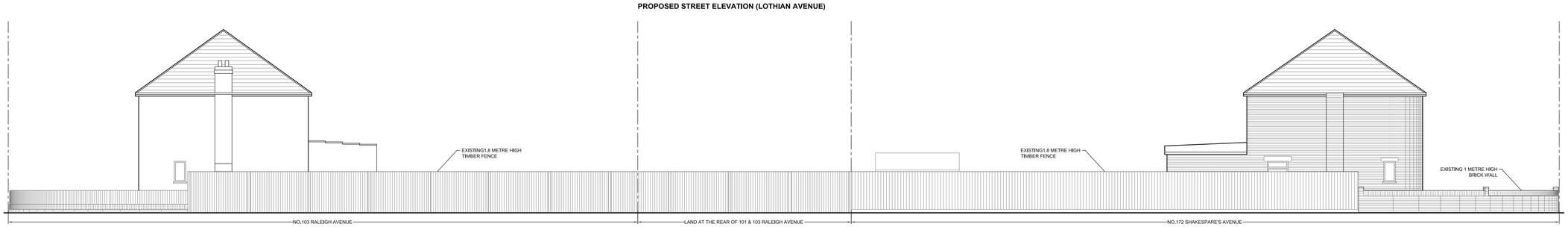


PROPOSED SIDE ELEVATION
(SOUTH-EAST)

M 1:100
0 1 2 3 4 5 6 7 8 9 10 [m]



PROPOSED STREET ELEVATION (LOTHIAN AVENUE)



EXISTING STREET ELEVATION (LOTHIAN AVENUE)

SITE AREA = 192 SQ.M

PROPOSED 3 BEDROOM HOUSE

FLOOR AREA	=82 SQ.M
PROPOSED AMENITY SPACE	=130 SQ.M
PROPOSED PARKING SPACE	= 1

A	SCALE BAR ADDED	10.08.2012
	REVISIONS	DATE

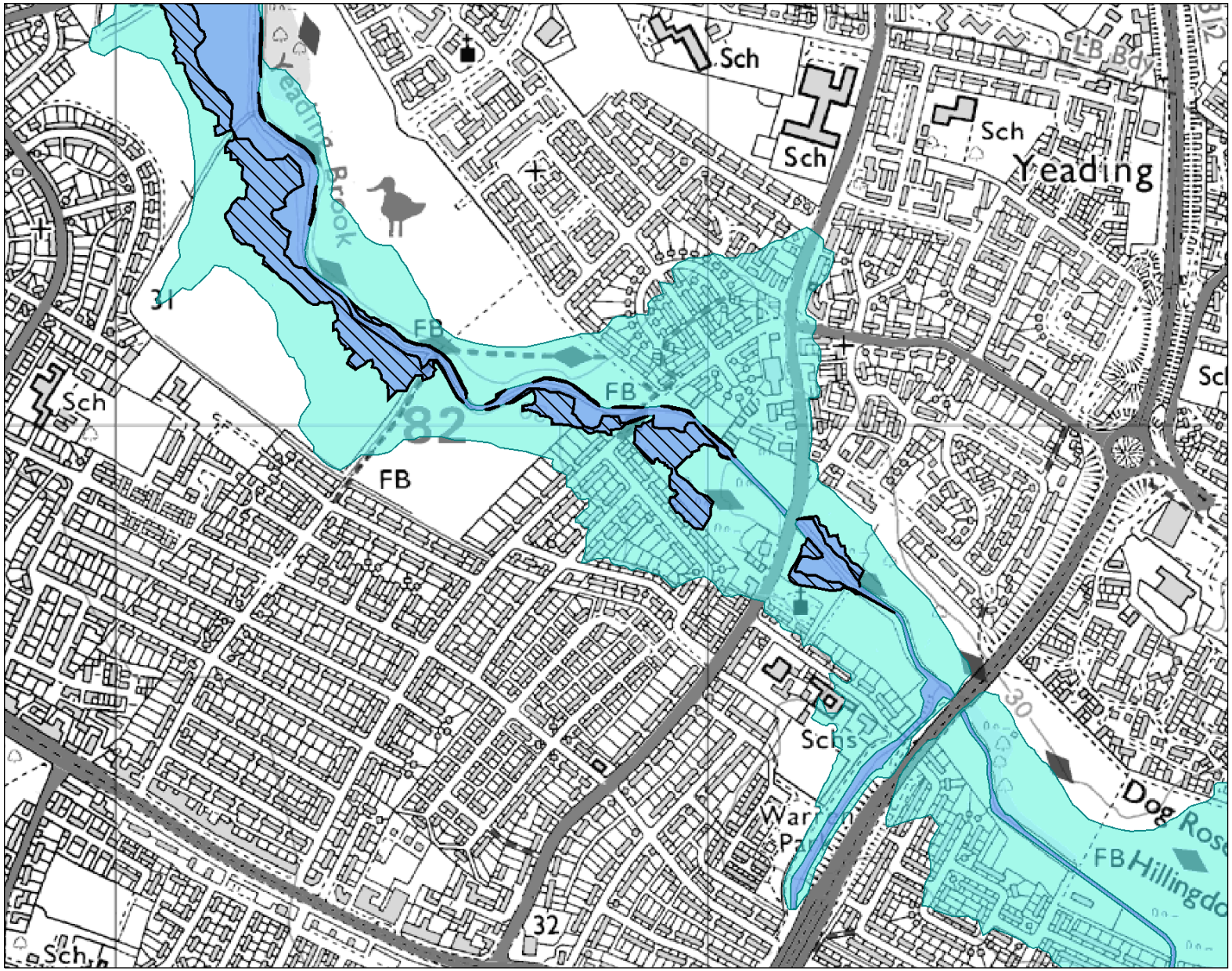
Kompas Limited
16 ELECTRIC PARADE
SEVEN KINGS ROAD
ILFORD, ESSEX. IG3 8BY
PH : 020 8590 0002
FAX : 020 8599 3773
www.kompas.uk.com
Info@kompas.uk.com

© PLANNING ISSUE

PROJECT	PROPOSED ERECTION OF A NEW THREE BEDROOM HOUSE AT THE REAR OF 101 & 103 RALEIGH AVENUE, LONDON. UB4 0EF
DRAWING	EXISTING AND PROPOSED PLANS AND ELEVATIONS
CLIENT	MR. R S THAND
DATE	JULY 2012
SCALE	1:100 @A1
DRG NO.	KOM/374-1
REVISIONS	

Appendix B: - Environment Agency Flood Data

Flood map centred on 510848, 181898 created 12 September 2012 - NE32092BC.



Environment Agency

Scale 1:10,001

N
W E
S

- 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 Areas (assuming no defences)

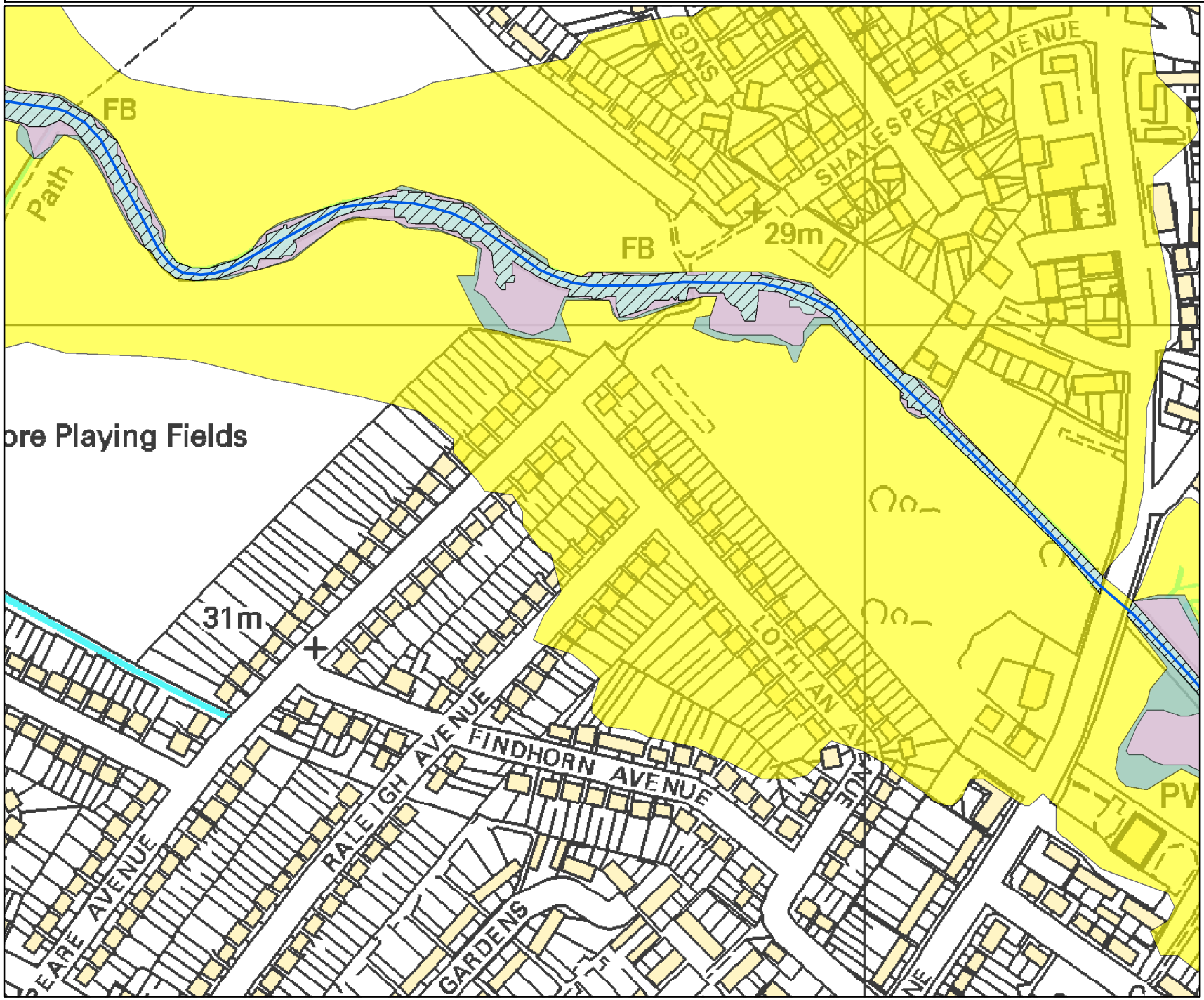
Flood Zone 3 shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

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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Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Detailed FRA map centred on 510848, 181898 created 12 September 2012 - NE32092BC.



Environment Agency

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

0 45 90 180
Metres

Legend

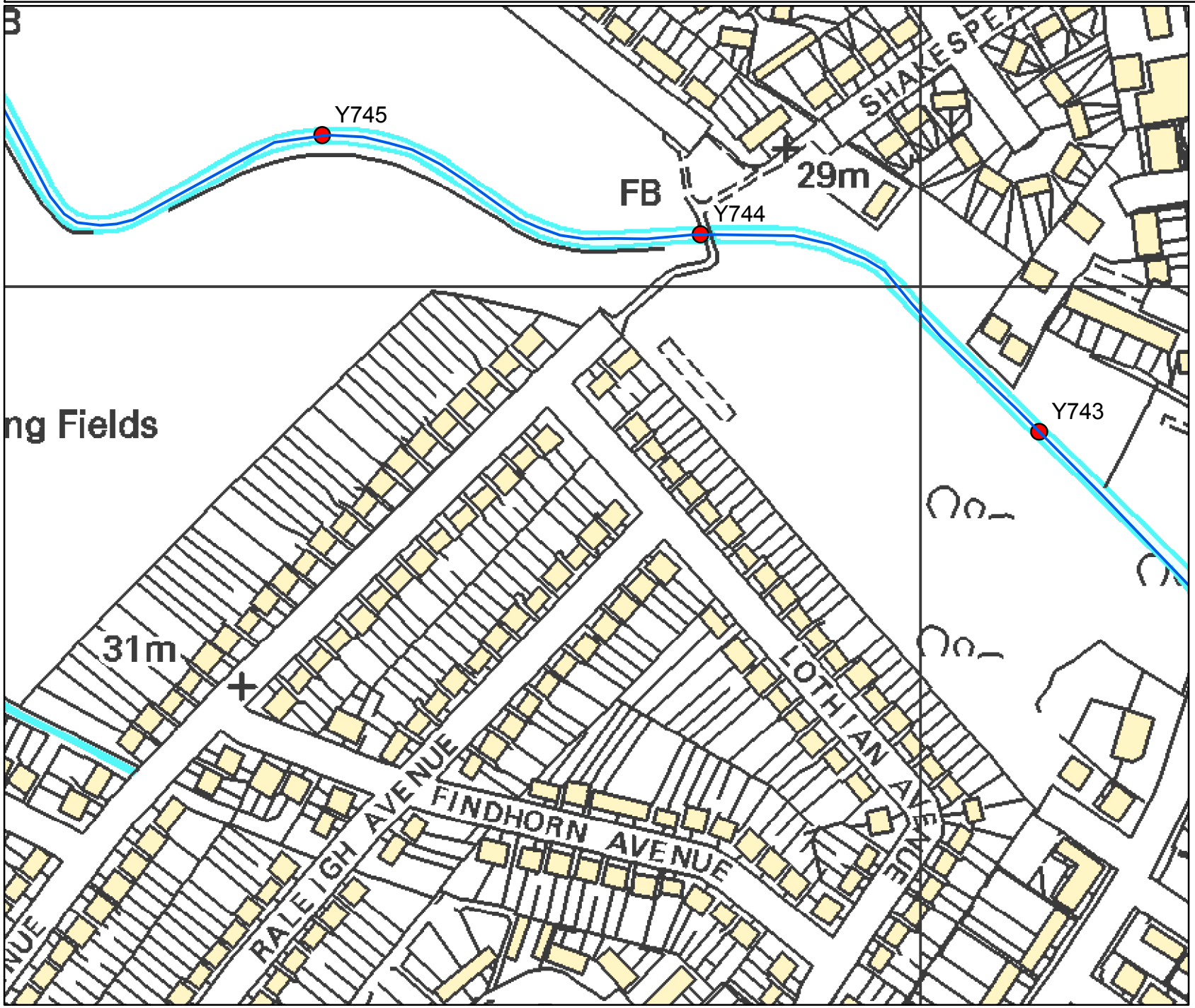
- Main river
- 1 in 5 (20%) Defended
- 1 in 10 (10%) Defended
- 1 in 100 (1%) Defended
- 1 in 100+20% (*CC) Defended
- 1 in 1000 (0.1%) Defended

The data in this map has been extracted from the Brent Mapping Study (Hyder, 2011). 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
South East (North East Thames Area)

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Detailed FRA map centred on 510848, 181898 created 12 September 2012 - NE32092BC.



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

0 35 70 140
Metres

Legend

- Main river
- Node Results

The data in this map has been extracted from the River Crane Mapping Study (Halcrow 2008).
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:
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Environment Agency ref: NE32092BC

The following information has been extracted from the River Crane Mapping Study (Halcrow 2008)

Caution:
The modelled flood levels and extents are appropriate for catchment wide strategic flood risk mapping. However, for more detailed flood risk assessment it is recommended that each of the underlying flood mapping, hydraulic modelling and hydrological assumptions are re-evaluated to determine the appropriateness in a more detailed analysis.

All flood levels are given in metres Above Ordnance Datum (mAOD)
All flows are given in cubic metres per second (cumecs)

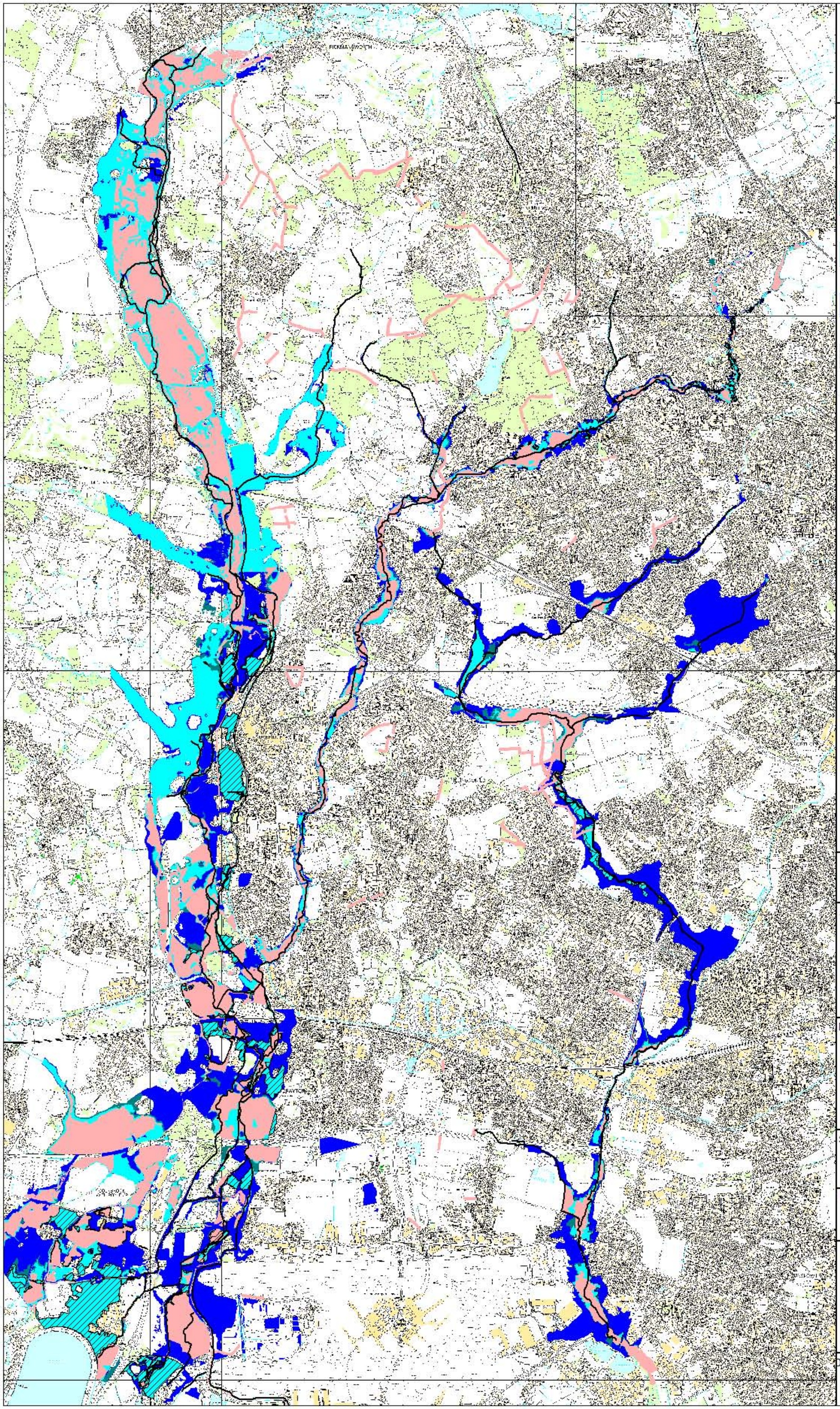
MODELLED FLOOD LEVEL

			Return Period					
Node Label	**Easting**	**Northing**	**5 yr**	**20 yr**	**50 yr**	**100 yr**	**100yr + 20%**	**1000yr**
Y745	510720.09	182070.13	29.096	29.187	29.24	29.275	29.355	30.117
Y744	510896.97	182025.17	29.008	29.099	29.156	29.19	29.263	30.093
Y743	511055.06	181932.06	28.901	28.994	29.057	29.096	29.162	30.058

MODELLED FLOWS

			Return Period					
Node Label	**Easting**	**Northing**	**5 yr**	**20 yr**	**50 yr**	**100 yr**	**100yr + 20%**	**1000yr**
Y745	510720.09	182070.13	10.919	12.183	12.947	13.548	14.959	48.281
Y744	510896.97	182025.17	10.923	12.192	12.956	13.557	14.966	47.55
Y743	511055.06	181932.06	10.928	12.203	12.969	13.57	14.975	46.949

Appendix C: -London Borough of Hillingdon SFRA Maps



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Legend

- Flood Zone 3b
- Flood Zone 3a
- Flood Zone 3a + Climate Change
- Flood Zone 2
- Areas Benefiting from Defences
- Main River

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Scott Wilson

GD0100031673 2006

Drawing Status

FINAL

Job Title

London Borough of Hillingdon SFRA

Drawing Title

Fluvial Sources of Flood Risk

Scale at A3

1:50000

Drawn	Approved
MK	JR

Scott Wilson

Drawing Number

Figure 3

RICKMANSWORTH
WATFORD RURAL CP
NORTHWOOD
CHALFONT ST PETER CP
GERRARDS CROSS
GERRARDS CROSS CP
DENHAM CP
RUISLIP
PINNER
FULMER CP
UXBRIDGE
NORTHOLT
HILLINGDON LB
HILLINGDON
WEXHAM CP
IVER CP
HAYES
IVER
SOUTHALL
YIEWSLEY
WEST DRAYTON
COLNBROOK WITH POYLE CP
HORTON CP
Heathrow Airport London
HOUNSLOW LB
HOUNSLOW
WRAYSBURY CP
FELTHAM
East Bedfont

FINAL

LONDON BOROUGH OF HILLINGDON SFRA

OTHER SOURCES OF FLOOD RISK

- London Borough of Hillingdon
- Groundwater Flooding
- Artificial Water Bodies
- Area of high relief possibly susceptible to overland flow

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Scott Wilson 0200100331672 2007

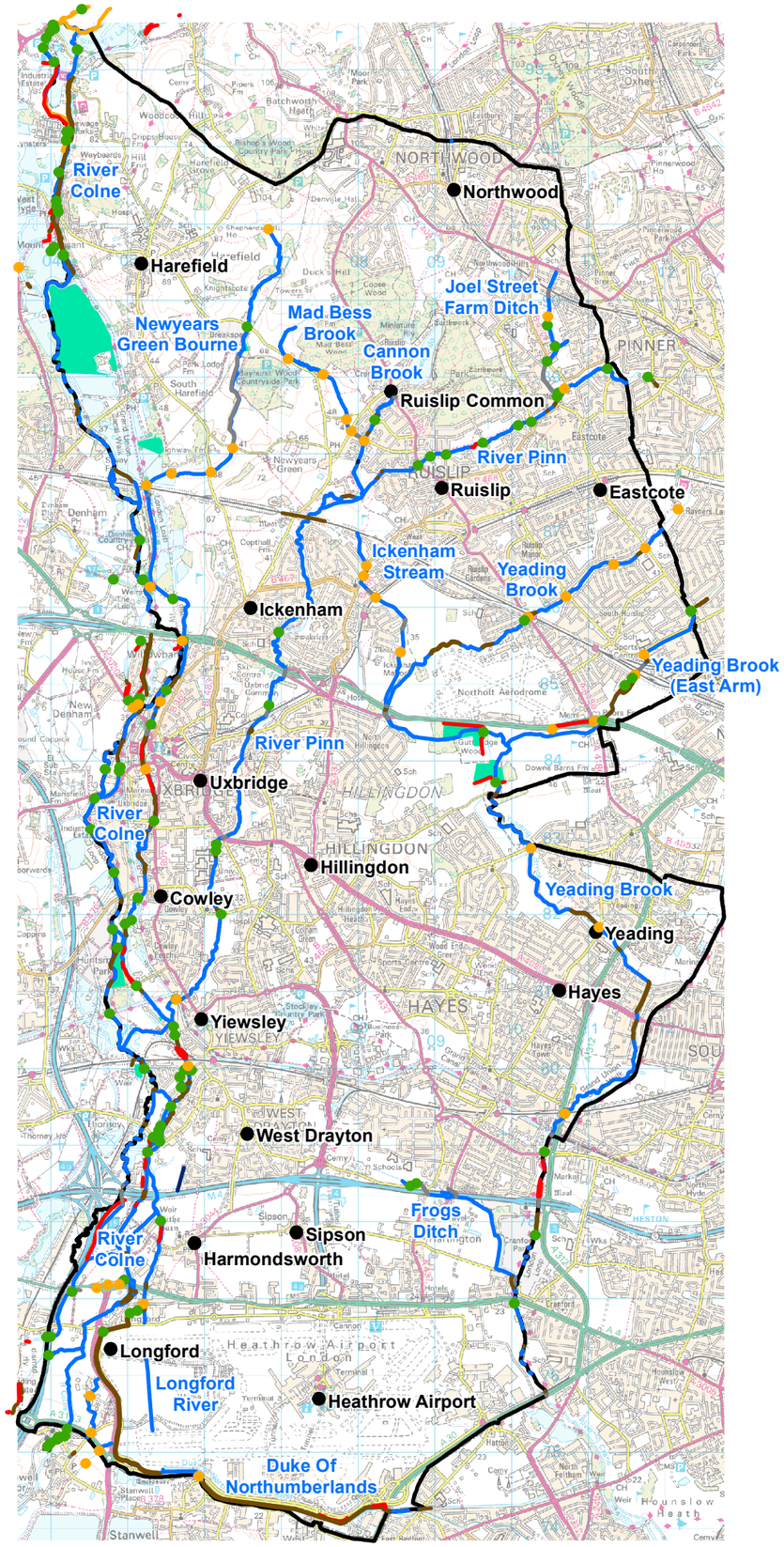
FIGURE 4

Scale (A1): 1:10,000

TD | HR

Scott Wilson
Scott House
Basingstoke
Hampshire, RG21 4JG
Tel 01256 310200
Fax 01256 310201
www.scottwilson.com

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE IN RESPECT WHICH IT WRITTEN CHEKED/CKD SHALL BE USED



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

NOTES

- Towns
- Main Watercourses
- Hillingdon District Boundary
- Culverted Channel
- Flood Defence Structure
- Culverted Channel
- Flood Defence Structure
- Maintained Channel
- Non-Flood Defence Structure
- Raised Defence (man-made)
- Flood Storage Area

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Scott Wilson GD0100031673 2006

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: LONDON BOROUGH OF HILLINGDON SFRA

Drawing Title: NFCDD

Scale at A3: 1:75,000

Drawn	Approved	Stage 1 check	Stage 2 check	Originated	Date
TD	HR				

Scott Wilson
Scott House
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Hampshire, RG21 4JG
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Drawing Number: **FIGURE 5**

Rev

N

Plot Date: 12th November 2007
Filepath: K:\D_Hillingdon_SFRA\ArcGIS\MXD's\Final Figures\Figure 5 NFCDD.mxd

Appendix D: - Thames Water Record Plans

Asset Location Search

Thames Water Property Searches
12 Vastern Road
READING
RG1 8DB

Search address supplied
101
Raleigh Avenue
Hayes
UB4 0EF

Your reference Raleigh_01
Our reference ALS/ALS Standard/2012_2318280

Search date 19 September 2012

You are now able to order your Asset Location Search requests online by visiting
www.thameswater-propertysearches.co.uk

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0845 070 9148
E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Asset Location Search

Search address supplied: 101, Raleigh Avenue, Hayes, UB4 0EF

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

This search provides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0845 070 9148, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk
Web: www.thameswater-propertysearches.co.uk

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0845 070 9148

E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Asset Location Search

Waste Water Services

Please provide a copy extract from the public sewer map.

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an ‘as constructed’ record. It is recommended these details be checked with the developer.

Clean Water Services

Please provide a copy extract from the public water main map.

With regard to the fresh water supply, this site falls within the boundary of another water company. For more information, please redirect your enquiry to the following address:

Veolia Water
Tamblin Way
Hatfield

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0845 070 9148

E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Asset Location Search

AL10 9EZ
Tel: 0845 7823333
Fax: 01707 277104

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Payment for this Search

A charge will be added to your suppliers account.

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0845 070 9148

E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Asset Location Search

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk

Should you require any further information regarding budget estimates, diversions or stopping up notices then please contact:

DevCon Team
Asset Investment
Thames Water
Maple Lodge STW
Denham Way
Rickmansworth
Hertfordshire
WD3 9SQ

Tel: 01923 898 072
Email: devcon.team@thameswater.co.uk

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0845 070 9148

E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Asset Location Search

Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

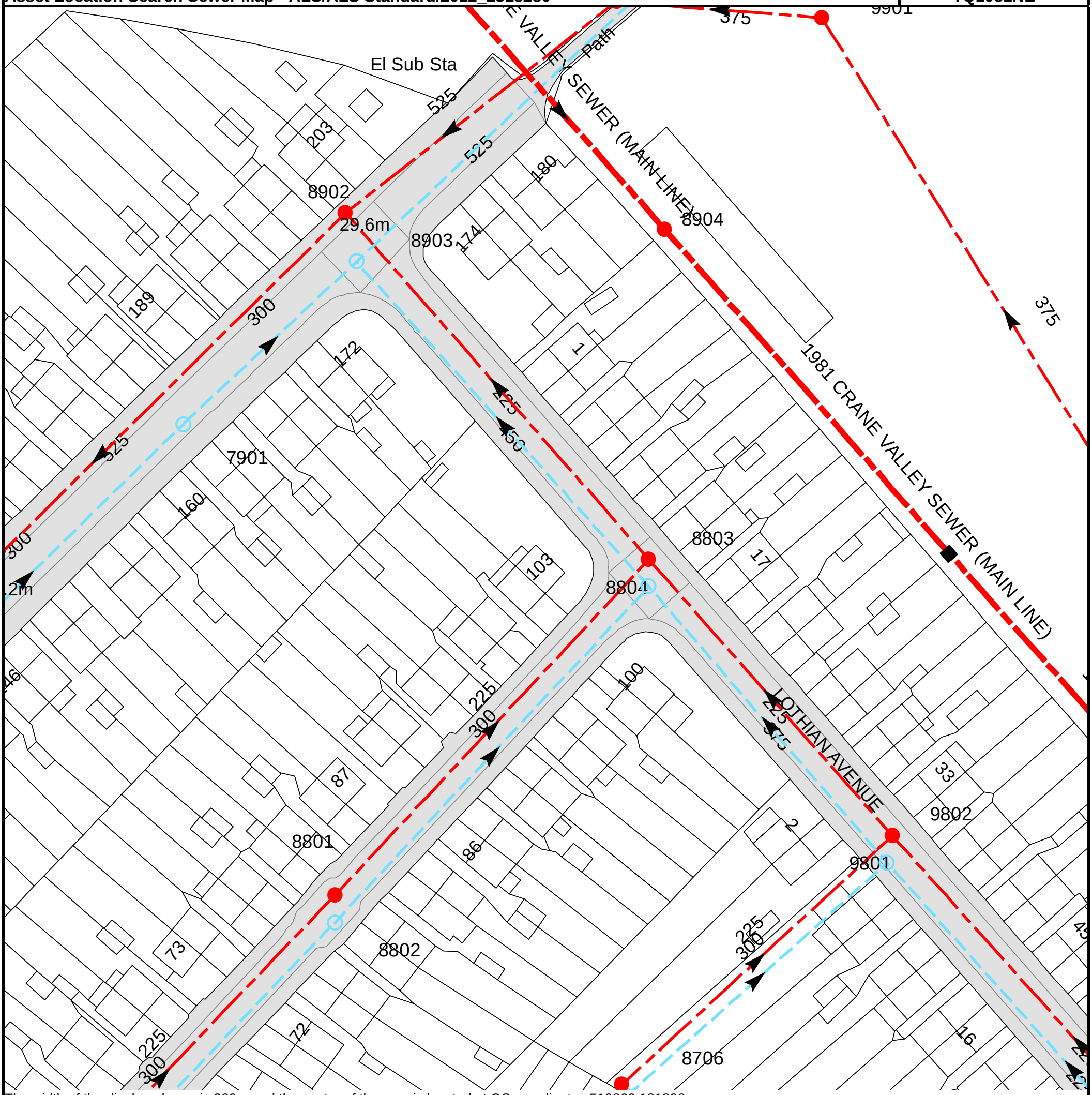
DX 151280 Slough 13

T 0845 070 9148

E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Asset Location Search Sewer Map - ALS/ALS Standard/2012_2318280 | **TQ1081NE**



The width of the displayed area is 200m and the centre of the map is located at OS coordinates 510860,181898

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. WU298557 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
8803	29.76	28.37
8804	29.72	26.38
8904	29.34	20.88
9901	29.63	25.64
9802	29.41	28.55
9801	29.42	26.95
8706	n/a	n/a
7901	29.85	28.45
8802	29.94	28.81
8801	29.93	28.08
8903	29.59	28.11
-	-	-
8902	29.61	25.4

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

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
- Gulley
- Culverted Watercourse
- Proposed
- Abandoned Sewer

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.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. 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.

Search Code

IMPORTANT CONSUMER PROTECTION INFORMATION

This search has been produced by Thames Water Property Searches, Clearwater Court, Vastern Road, Reading RG1 8DB, which is registered with the Property Codes Compliance Board (PCCB) as a subscriber to the Search Code. The PCCB independently monitors how registered search firms maintain compliance with the Code.

The Search Code:

- provides protection for homebuyers, sellers, estate agents, conveyancers and mortgage lenders who rely on the information included in property search reports undertaken by subscribers on residential and commercial property within the United Kingdom
- sets out minimum standards which firms compiling and selling search reports have to meet
- promotes the best practise and quality standards within the industry for the benefit of consumers and property professionals
- enables consumers and property professionals to have confidence in firms which subscribe to the code, their products and services.

By giving you this information, the search firm is confirming that they keep to the principles of the Code. This provides important protection for you.

The Code's core principles

Firms which subscribe to the Search Code will:

- display the Search Code logo prominently on their search reports
- act with integrity and carry out work with due skill, care and diligence
- at all times maintain adequate and appropriate insurance to protect consumers
- conduct business in an honest, fair and professional manner
- handle complaints speedily and fairly
- ensure that products and services comply with industry registration rules and standards and relevant laws
- monitor their compliance with the Code

Complaints

If you have a query or complaint about your search, you should raise it directly with the search firm, and if appropriate ask for any complaint to be considered under their formal internal complaints procedure. If you remain dissatisfied with the firm's final response, after your complaint has been formally considered, or if the firm has exceeded the response timescales, you may refer your complaint for consideration under The Property Ombudsman scheme (TPOs). The Ombudsman can award compensation of up to £5,000 to you if he finds that you have suffered actual loss as a result of your search provider failing to keep to the Code.

Please note that all queries or complaints regarding your search should be directed to your search provider in the first instance, not to TPOs or to the PCCB.

TPOs Contact Details

The Property Ombudsman scheme
Milford House
43-55 Milford Street
Salisbury
Wiltshire SP1 2BP
Tel: 01722 333306
Fax: 01722 332296
Email: admin@tpos.co.uk

You can get more information about the PCCB from www.propertycodes.org.uk

PLEASE ASK YOUR SEARCH PROVIDER IF YOU WOULD LIKE A COPY OF THE SEARCH CODE

Appendix E: - Historic Borehole Logs & 'Soilscape' Map

PAGE: 4

DATE: 31.10.96

LOCATION

MARSHALL DRIVE - HAYES

BOREHOLE 3

DESCRIPTION	REDUCED LEVEL m	DEPTH m	LEGEND	SAMPLE TYPE	SAMPLE DEPTH	THICKNESS m	SPT N	REMARKS
TOPSOIL Dry light brown gravelly SILT		0.00 0.20				0.20		
				D	0.50	0.90		-1454/3 / 0.5D
Firm brown very gravelly CLAY		1.10		D	1.10	0.80		-1454/3 / 1.1D
Firm brown grey mottled very silty CLAY		1.90		U100	2.00	1.90		-1454/3 / 2.0U
				U100	3.00			-1454/3 / 3.0U
Stiff brown slightly sandy silty CLAY		3.80		U100	4.00	2.45		-1454/3 / 4.0U
				U100	5.00			-1454/3 / 5.0U
				U100	6.00			-1454/3 / 6.0U
Very stiff dark grey silty CLAY with selenite crystals and some fossils at 9.0m.		6.25		U100	7.00	3.75		-1454/3 / 7.0U
				U100	8.00			-1454/3 / 8.0U
				U100	9.50			-1454/3 / 9.5U
		10.00						-Borehole remained dry

TERRAMECH INVESTIGATIONS LIMITED
183 LONG LANE TILEHURST READING

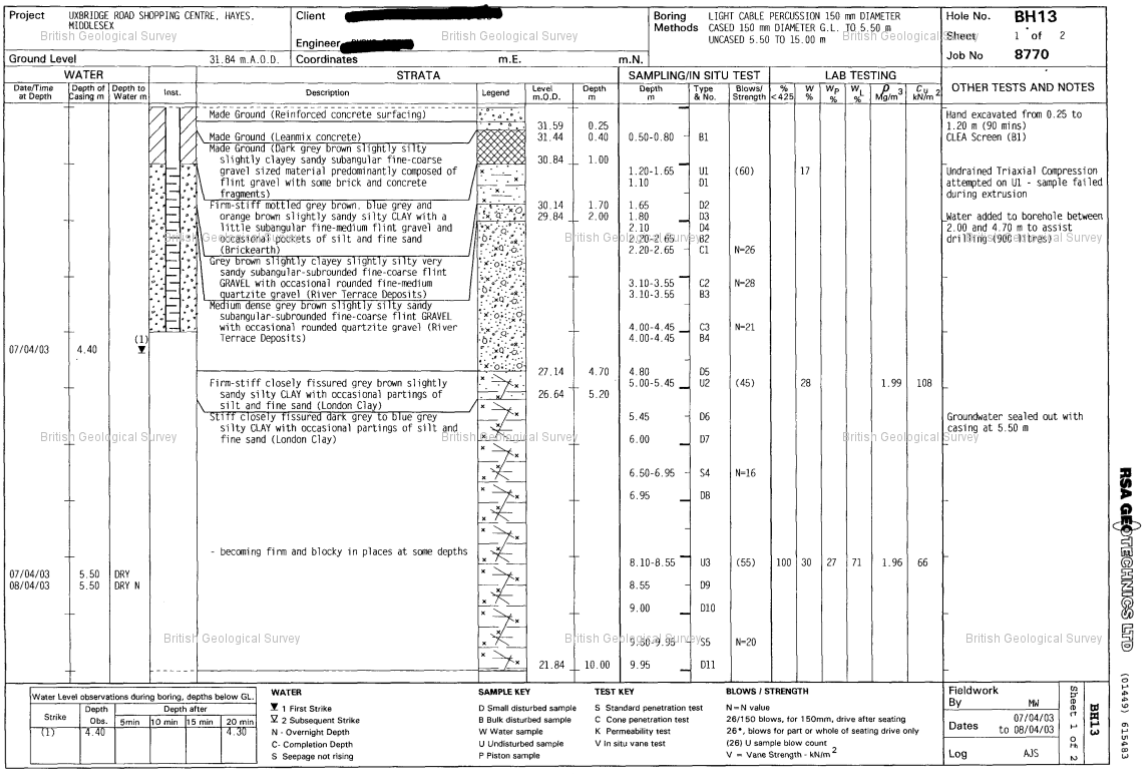
REMARKS:

U100=100mm dia. UNDISTURBED SAMPLE U38=38mm dia. UNDISTURBED SAMPLE D=SMALL DISTURBED SAMPLE
B=BULK SAMPLE W=WATER SAMPLE SPT=STANDARD PENETRATION TEST CPT=CONE PENETRATION TEST

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Report an issue with this borehole

<< < Prev Page 1 of 3 Next > >>



Project: UXBRIDGE ROAD SHOPPING CENTRE, HAYES, MIDDLESEX
Client: [redacted]
Engineer: [redacted]
Ground Level: 31.84 m A.O.D.
Coordinates: m.E. m.N.
Boring Methods: LIGHT CABLE PERCUSSION 150 mm DIAMETER CASED 150 mm DIAMETER G.L. TO 5.50 m UNCASED 5.50 TO 15.00 m
Hole No. BH13
Sheet 1 of 2
Job No 8770

Date/Time at Depth	Depth of Casing m	Depth to Water m	Inst.	Description	Legend	Level m.O.D.	Depth m	Sampling/In Situ Test: Depth m	Type & No.	Blows/ Strength	Lab Testing: % <425	W %	W_P %	W_L %	ρ Mg/m^3	C_u kN/m^2	Other Tests and Notes
				Made Ground (Reinforced concrete surfacing)		31.59	0.25										Hand excavated from 0.25 to 1.20 m (90 mins) CLEA Screen (B1)
				Made Ground (Leanmix concrete)		31.44	0.40	0.50-0.80	B1								
				Made Ground (Dark grey brown slightly silty slightly clayey sandy subangular fine-coarse gravel sized material predominantly composed of flint gravel with some brick and concrete fragments)		30.84	1.00	1.20-1.65 1.10	U1 D1	(60)		17					Undrained Triaxial Compression attempted on U1 - sample failed during extrusion
				Firm-stiff mottled grey brown, blue grey and orange brown slightly sandy silty CLAY with a little subangular fine-medium flint gravel and occasional pockets of silt and fine sand (Brickearth)		30.14 29.84	1.70 2.00	1.65 1.80 2.10 2.20-2.65	D2 D3 D4 U2								Water added to borehole between 2.00 and 4.70 m to assist drilling (900 litres)
				Grey brown slightly clayey slightly silty very sandy subangular-subrounded fine-coarse flint GRAVEL with occasional rounded fine-medium quartzite gravel (River Terrace Deposits)				2.20-2.65	C1	N=26							
				Medium dense grey brown slightly silty sandy subangular-subrounded fine-coarse flint GRAVEL with occasional rounded quartzite gravel (River Terrace Deposits)				3.10-3.55 3.10-3.55	C2 B3	N=28							
07/04/03	4.40	(1) ▼						4.00-4.45 4.00-4.45	C3 B4	N=21							
				Firm-stiff closely fissured grey brown slightly sandy silty CLAY with occasional partings of silt and fine sand (London Clay)		27.14 26.64	4.70 5.20	4.80 5.00-5.45	D5 U2	(45)		28			1.99	108	
				Stiff closely fissured dark grey to blue grey silty CLAY with occasional partings of silt and fine sand (London Clay)				5.45 6.00	D6 D7								Groundwater sealed out with casing at 5.50 m
								6.50-6.95 6.95	S4 D8	N=16							
				- becoming firm and blocky in places at some depths				8.10-8.55	U3	(55)	100	30	27	71	1.96	66	
07/04/03 08/04/03	5.50 5.50	DRY DRY N						8.55 9.00	D9 D10								
								9.50-9.95	S5	N=20							
						21.84	10.00	9.95	D11								

Water Level observations during boring, depths below GL.

Strike	Depth Obs.	Depth after 5min	10 min	15 min	20 min
(1)	4.40				4.30

WATER
▼ 1 First Strike
▽ 2 Subsequent Strike
N - Overnight Depth
C- Completion Depth
S Seepage not rising

SAMPLE KEY
D Small disturbed sample
B Bulk disturbed sample
W Water sample
U Undisturbed sample
P Piston sample

TEST KEY
S Standard penetration test
C Cone penetration test
K Permeability test
V In situ vane test

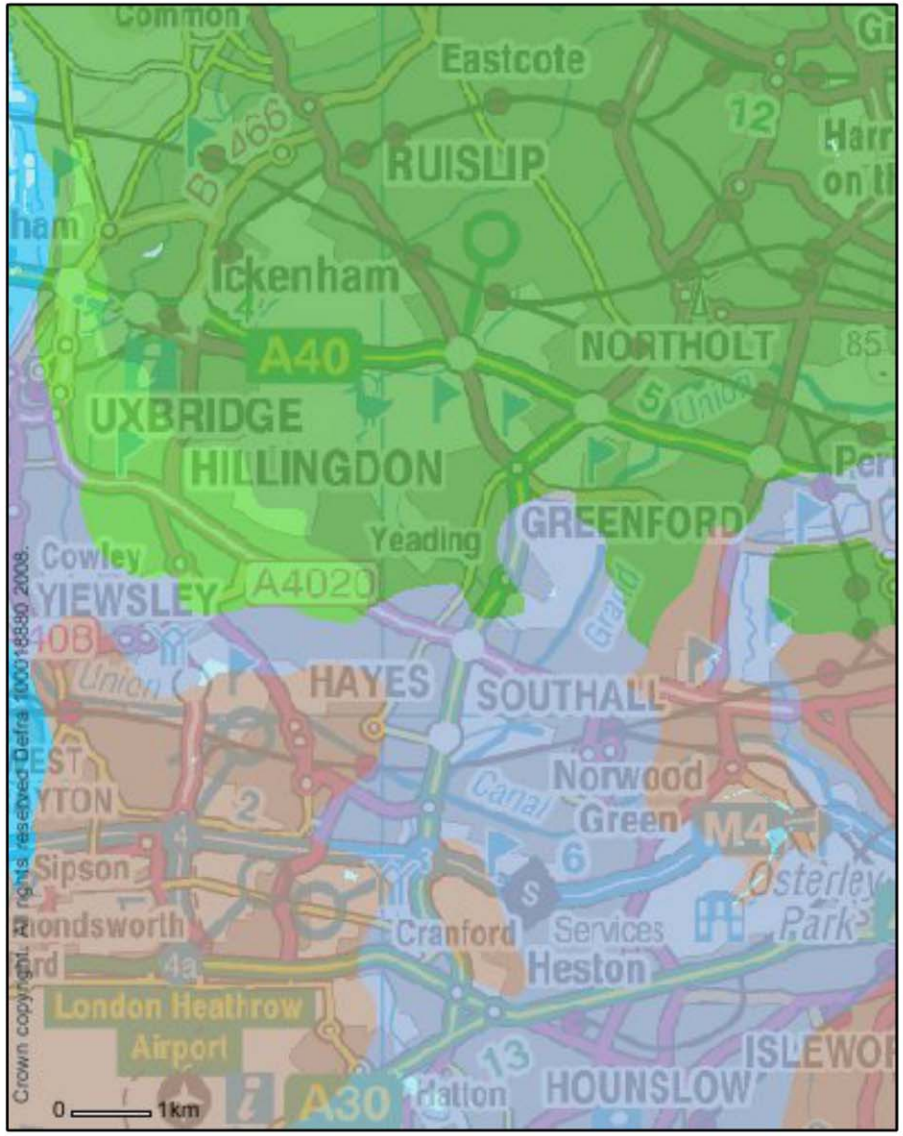
BLOWS / STRENGTH
N = N value
26/150 blows, for 150mm, drive after seating
26*, blows for part or whole of seating drive only
(26) U sample blow count
V = Vane Strength - kN/m^2

Fieldwork By MW
Dates 07/04/03 to 08/04/03
Log AJS
Sheet 1 of 2
BH13

RSA GEOTECHNICS LTD (01449) 615433

Soilscapes Viewer Report

National Soil Resources Institute



SELECTED SOILSCAPE:

Loamy soils with naturally high groundwater

HABITATS:
Wet acid meadows and woodland

LANDCOVER:
Arable grassland and woodland

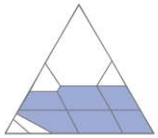
DRAINAGE:
Naturally wet



FERTILITY:
Low



TEXTURE:
Loamy



COVERAGE:
England: 1.7%
Wales: 0.1%
E&W: 1.5%

© National Soil Resources Institute, Cranfield University, 2008. The information and map contained within this report may not be used for commercial purposes.

Soilscapes is a 1:250,000 scale, simplified soils dataset covering England and Wales. It was created from the more detailed National Soil Map (NATMAPvector) with the purpose of effectively communicating a general understanding of the variations which occur between soil types, and how soils effect the environment.

SOILS DATA LEASE
www.landis.org.uk
phone: +44 (0)1234 75 2978
nsridata@cranfield.ac.uk

GENERAL ENQUIRIES
www.silsoe.cranfield.ac.uk/nsri
phone: +44 (0)1234 75 2978
nsri@cranfield.ac.uk

sponsored by defra

Appendix F: - IOH124 Greenfield Runoff Calculations

INSTITUTE OF HYDROLOGY REPORT 124
FLOOD ESTIMATION ON SMALL CATCHMENTS

This spreadsheet is suitable for estimating design flows on small rural catchments (less than 25 km^2) using the IH Report 124 equation for QBAR plus the FSR regional growth curves. Rural can be taken as meaning URBAN less than 0.05, or equivalently URBEX

Key

	User Input
	Header (do not change)
	Formula cell (do not change)

Step 1: Enter catchment descriptors and calculate QBAR

AREA	From FEH CD-ROM	0.5	km2
SAAR4170	From FEH CD-ROM	662	mm
SOIL	From FSR WRAP maps	0.504	Enter fraction of catchment covered by each WRAP class:

1	2	3	4	5
				1

QBAR	0.263	m3/s

Step 2: Use a FSR regional growth curve to estimate design flows

Choose your region from the map. Enter a number, or I for Ireland or GB for Great Britain	6

Return period	Design flow (m^3/s)	Specific runoff (l/s/ha)
2	#N/A	#N/A
2.33	#N/A	#N/A
5	#N/A	#N/A
10	#N/A	#N/A
20	#N/A	#N/A
25	#N/A	#N/A
30	#N/A	#N/A
50	#N/A	#N/A
75	#N/A	#N/A
100	#N/A	#N/A
150	#N/A	#N/A
200	#N/A	#N/A



FSR growth curves

	u		0.82	0.84	0.84	0.8	0.79	0.77	0.77	0.78	0.84	0.85	0.8	0.87
	alpha		0.22	0.18	0.27	0.25	0.26	0.28	0.28	0.28	0.23	0.21	0.24	0.21
	k		-0.2	-0.3	0.00001	-0.175	-0.325	-0.25	-0.25	-0.1	-0.1	-0.1	-0.2	-0.05
	Hydrometric areas in regions		**1-16, 97, 104-108**	**88-**	**17-21, 77-87**	**22-27**	**28,54**	**29-35**	**36-44, 101**	**Same as 6**	**45-53**	**55-67,102**	**68-76**	

Row	Return period	RV	1	2	3	4	5	6	7	8	9	10	GB	I
2	2	0.367	0.90	0.91	0.94	0.89	0.89	0.88	0.88	0.88	0.93	0.93	0.89	0.95
3	2.33	0.579	0.95	0.95	1.00	0.95	0.96	0.94	0.94	0.95	0.98	0.98	0.95	0.99
4	5	1.500	1.20	1.11	1.24	1.23	1.29	1.28	1.28	1.23	1.21	1.19	1.22	1.20
5	10	2.250	1.45	1.42	1.45	1.49	1.65	1.62	1.62	1.49	1.42	1.38	1.48	1.37
6	20	2.970	1.71	1.70	1.64	1.77	2.09	2.00	2.00	1.75	1.64	1.58	1.77	1.54
7	25	3.199	1.81	1.81	1.70	1.87	2.25	2.14	2.14	1.84	1.71	1.64	1.88	1.60
8	30	3.384	1.88	1.90	1.75	1.95	2.39	2.26	2.26	1.91	1.77	1.70	1.96	1.64
9	50	3.902	2.12	2.17	1.89	2.20	2.83	2.62	2.62	2.12	1.94	1.85	2.22	1.77
10	75	4.311	2.33	2.43	2.00	2.41	3.24	2.94	2.94	2.29	2.08	1.98	2.44	1.88
11	100	4.600	2.48	2.63	2.08	2.57	3.56	3.19	3.19	2.42	2.18	2.08	2.61	1.96
12	150	5.007	2.71	2.93	2.19	2.80	4.06	3.57	3.57	2.60	2.33	2.21	2.87	2.06
13	200	5.296	2.89	3.18	2.27	2.98	4.46	3.86	3.86	2.74	2.45	2.32	3.06	2.14

Appendix G: - Modified Rational Method: Surface Water Storage Volume Calculations

Modified Rational Method

Length (m)	15	m
Area (ha)	0.008	Ha
Max Height	29.7	mAOD
Min Height	29.7	mAOD
DeltaH	0.0	
Slope (%)	0.27	
Te (mins)	15.32	mins
ARF	1.000	
SAAR	662.000	mm
UCWI	65	mm
PIMP	100.0	%
SOIL	0.50	
Percentage Runoff PR	79.87	
DEEPSTOR	1.34	

Cv	0.7987	
Cr	1.3	
allowable outflow		
2 year	0.005	m^3/s

m3

Storage	RT years	Storage
	2 + 20% cc	-4

Return Period **flood** **2 + 20% cc** years
Post Development **Rainfall** **2** years

Rainfall Duration (hours)	Rainfall Duration (days)	Rainfall Depth (mm)	20% increase	Effective Depth (mm)	Rainfall Intensity (mm/hr)	FLOW (l/s)	FLOW (l/s/ha)	RUN-OFF		Allowable Outflow (m^3)	Difference (m^3)
								FLOW (m^3)	RAIN (m^3)		
0.25	0.010	7.07	8.484	8.8	28.3	0.7	81.6	1	1	4.50	-4
0.5	0.021	9.32	11.184	11.6	18.6	0.4	53.8	1	1	9.00	-8
0.75	0.031	10.85	13.02	13.5	14.5	0.3	41.8	1	1	13.50	-12
1	0.042	12.03	14.436	15.0	12.0	0.3	34.7	1	1	18.00	-17
1.25	0.052	13.02	15.624	16.2	10.4	0.2	30.1	1	1	22.50	-21
1.5	0.063	13.87	16.644	17.3	9.2	0.2	26.7	1	1	27.00	-26
1.75	0.073	14.62	17.544	18.2	8.4	0.2	24.1	1	1	31.50	-30
2	0.083	15.3	18.36	19.1	7.7	0.2	22.1	1	2	36.00	-34
2.25	0.094	15.91	19.092	19.8	7.1	0.2	20.4	1	2	40.50	-39
2.5	0.104	16.48	19.776	20.5	6.6	0.2	19.0	1	2	45.00	-43
2.75	0.115	17.01	20.412	21.2	6.2	0.1	17.9	1	2	49.50	-48
3	0.125	17.51	21.012	21.8	5.8	0.1	16.8	1	2	54.00	-52
3.25	0.135	17.98	21.576	22.4	5.5	0.1	16.0	1	2	58.50	-57
3.5	0.146	18.42	22.104	23.0	5.3	0.1	15.2	2	2	63.00	-61
3.75	0.156	18.84	22.608	23.5	5.0	0.1	14.5	2	2	67.50	-66
4	0.167	19.24	23.088	24.0	4.8	0.1	13.9	2	2	72.00	-70
4.25	0.177	19.62	23.544	24.4	4.6	0.1	13.3	2	2	76.50	-75
4.5	0.188	19.99	23.988	24.9	4.4	0.1	12.8	2	2	81.00	-79
4.75	0.198	20.34	24.408	25.3	4.3	0.1	12.4	2	2	85.50	-83
5	0.208	20.68	24.816	25.8	4.1	0.1	11.9	2	2	90.00	-88
5.25	0.219	21	25.2	26.2	4.0	0.1	11.5	2	2	94.50	-92
5.5	0.229	21.32	25.584	26.6	3.9	0.1	11.2	2	2	99.00	-97
5.75	0.240	21.62	25.944	26.9	3.8	0.1	10.9	2	2	103.50	-101
6	0.250	21.92	26.304	27.3	3.7	0.1	10.5	2	2	108.00	-106
6.25	0.260	22.21	26.652	27.7	3.6	0.1	10.3	2	2	112.50	-110
6.5	0.271	22.49	26.988	28.0	3.5	0.1	10.0	2	2	117.00	-115
6.75	0.281	22.76	27.312	28.4	3.4	0.1	9.7	2	2	121.50	-119
7	0.292	23.02	27.624	28.7	3.3	0.1	9.5	2	2	126.00	-124
7.25	0.302	23.28	27.936	29.0	3.2	0.1	9.3	2	2	130.50	-128
7.5	0.313	23.53	28.236	29.3	3.1	0.1	9.1	2	2	135.00	-133
7.75	0.323	23.78	28.536	29.6	3.1	0.1	8.9	2	2	139.50	-137
8	0.333	24.02	28.824	29.9	3.0	0.1	8.7	2	2	144.00	-142
8.25	0.344	24.25	29.1	30.2	2.9	0.1	8.5	2	2	148.50	-146
8.5	0.354	24.48	29.376	30.5	2.9	0.1	8.3	2	2	153.00	-151
8.75	0.365	24.7	29.64	30.8	2.8	0.1	8.1	2	2	157.50	-155
9	0.375	24.92	29.904	31.0	2.8	0.1	8.0	2	2	162.00	-160
9.25	0.385	25.14	30.168	31.3	2.7	0.1	7.8	2	3	166.50	-164
9.5	0.396	25.35	30.42	31.6	2.7	0.1	7.7	2	3	171.00	-168
9.75	0.406	25.56	30.672	31.8	2.6	0.1	7.6	2	3	175.50	-173
10	0.417	25.76	30.912	32.1	2.6	0.1	7.4	2	3	180.00	-177

Modified Rational Method

Length (m)	15	m
Area (ha)	0.008	Ha
Max Height	29.7	mAOD
Min Height	29.7	mAOD
DeltaH	0.0	
Slope (%)	0.27	
Te (mins)	15.32	mins
ARF	1.000	
SAAR	662.000	mm
UCWI	65	mm
PIMP	100.0	%
SOIL	0.50	
Percentage Runoff PR	79.87	
DEEPSTOR	1.34	

Cv	0.7987	
Cr	1.3	
allowable outflow		
30 year	0.005	m^3/s

m3

Storage	RT years	Storage
	30 +20% cc	-2

Return Period flood **30 + 20% cc** years years
Post Development Rainfall **50** years years

Rainfall Duration (hours)	Rainfall Duration (days)	Rainfall Depth (mm)	20% increase	Effective Depth (mm)	Rainfall Intensity (mm/hr)	FLOW (l/s)	FLOW (l/s/ha)	RUN-OFF		Allowable Outflow (m^3)	Difference (m^3)
								FLOW (m^3)	RAIN (m^3)		
0.25	0.010	24.08	28.896	30.0	96.3	2.2	278.0	2	2	4.50	-2
0.5	0.021	29.83	35.796	37.2	59.7	1.4	172.2	2	3	9.00	-6
0.75	0.031	33.45	40.14	41.7	44.6	1.0	128.7	3	3	13.50	-10
1	0.042	36.14	43.368	45.0	36.1	0.8	104.3	3	4	18.00	-14
1.25	0.052	38.31	45.972	47.7	30.6	0.7	88.5	3	4	22.50	-19
1.5	0.063	40.14	48.168	50.0	26.8	0.6	77.2	3	4	27.00	-23
1.75	0.073	41.73	50.076	52.0	23.8	0.6	68.8	3	4	31.50	-27
2	0.083	43.14	51.768	53.8	21.6	0.5	62.3	4	4	36.00	-32
2.25	0.094	44.4	53.28	55.3	19.7	0.5	57.0	4	4	40.50	-36
2.5	0.104	45.56	54.672	56.8	18.2	0.4	52.6	4	5	45.00	-40
2.75	0.115	46.62	55.944	58.1	17.0	0.4	48.9	4	5	49.50	-45
3	0.125	47.6	57.12	59.3	15.9	0.4	45.8	4	5	54.00	-49
3.25	0.135	48.51	58.212	60.4	14.9	0.3	43.1	4	5	58.50	-54
3.5	0.146	49.37	59.244	61.5	14.1	0.3	40.7	4	5	63.00	-58
3.75	0.156	50.18	60.216	62.5	13.4	0.3	38.6	4	5	67.50	-62
4	0.167	50.95	61.14	63.5	12.7	0.3	36.8	4	5	72.00	-67
4.25	0.177	51.67	62.004	64.4	12.2	0.3	35.1	4	5	76.50	-71
4.5	0.188	52.36	62.832	65.2	11.6	0.3	33.6	4	5	81.00	-76
4.75	0.198	53.02	63.624	66.1	11.2	0.3	32.2	4	5	85.50	-80
5	0.208	53.66	64.392	66.9	10.7	0.2	31.0	4	5	90.00	-85
5.25	0.219	54.26	65.112	67.6	10.3	0.2	29.8	5	5	94.50	-89
5.5	0.229	54.85	65.82	68.3	10.0	0.2	28.8	5	5	99.00	-94
5.75	0.240	55.41	66.492	69.0	9.6	0.2	27.8	5	6	103.50	-98
6	0.250	55.95	67.14	69.7	9.3	0.2	26.9	5	6	108.00	-102
6.25	0.260	56.47	67.764	70.4	9.0	0.2	26.1	5	6	112.50	-107
6.5	0.271	56.98	68.376	71.0	8.8	0.2	25.3	5	6	117.00	-111
6.75	0.281	57.47	68.964	71.6	8.5	0.2	24.6	5	6	121.50	-116
7	0.292	57.94	69.528	72.2	8.3	0.2	23.9	5	6	126.00	-120
7.25	0.302	58.4	70.08	72.8	8.1	0.2	23.3	5	6	130.50	-125
7.5	0.313	58.85	70.62	73.3	7.8	0.2	22.6	5	6	135.00	-129
7.75	0.323	59.29	71.148	73.9	7.7	0.2	22.1	5	6	139.50	-134
8	0.333	59.71	71.652	74.4	7.5	0.2	21.5	5	6	144.00	-138
8.25	0.344	60.13	72.156	74.9	7.3	0.2	21.0	5	6	148.50	-143
8.5	0.354	60.53	72.636	75.4	7.1	0.2	20.6	5	6	153.00	-147
8.75	0.365	60.93	73.116	75.9	7.0	0.2	20.1	5	6	157.50	-151
9	0.375	61.31	73.572	76.4	6.8	0.2	19.7	5	6	162.00	-156
9.25	0.385	61.69	74.028	76.9	6.7	0.2	19.3	5	6	166.50	-160
9.5	0.396	62.06	74.472	77.3	6.5	0.2	18.9	5	6	171.00	-165
9.75	0.406	62.42	74.904	77.8	6.4	0.1	18.5	5	6	175.50	-169
10	0.417	62.77	75.324	78.2	6.3	0.1	18.1	5	6	180.00	-174
10.25	0.427	63.11	75.732	78.6	6.2	0.1	17.8	5	6	184.50	-178
10.5	0.438	63.45	76.14	79.1	6.0	0.1	17.4	5	6	189.00	-183
10.75	0.448	63.78	76.536	79.5	5.9	0.1	17.1	5	6	193.50	-187
11	0.458	64.11	76.932	79.9	5.8	0.1	16.8	5	6	198.00	-192
11.25	0.469	64.43	77.316	80.3	5.7	0.1	16.5	5	6	202.50	-196
11.5	0.479	64.74	77.688	80.7	5.6	0.1	16.2	5	6	207.00	-201
11.75	0.490	65.05	78.06	81.1	5.5	0.1	16.0	5	6	211.50	-205
12	0.500	65.35	78.42	81.4	5.4	0.1	15.7	5	7	216.00	-209
12.25	0.510	65.7	78.84	81.9	5.4	0.1	15.5	5	7	220.50	-214
12.5	0.521	66.05	79.26	82.3	5.3	0.1	15.3	5	7	225.00	-218
12.75	0.531	66.39	79.668	82.7	5.2	0.1	15.0	6	7	229.50	-223
13	0.542	66.72	80.064	83.1	5.1	0.1	14.8	6	7	234.00	-227
13.25	0.552	67.05	80.46	83.5	5.1	0.1	14.6	6	7	238.50	-232
13.5	0.563	67.37	80.844	83.9	5.0	0.1	14.4	6	7	243.00	-236
13.75	0.573	67.69	81.228	84.3	4.9	0.1	14.2	6	7	247.50	-241
14	0.583	68	81.6	84.7	4.9	0.1	14.0	6	7	252.00	-245
14.25	0.594	68.31	81.972	85.1	4.8	0.1	13.8	6	7	256.50	-250
14.5	0.604	68.62	82.344	85.5	4.7	0.1	13.7	6	7	261.00	-254
14.75	0.615	68.92	82.704	85.9	4.7	0.1	13.5	6	7	265.50	-259
15	0.625	69.22	83.064	86.2	4.6	0.1	13.3	6	7	270.00	-263

Modified Rational Method

Length (m)	15	m
Area (ha)	0.008	Ha
Max Height	29.7	mAOD
Min Height	29.7	mAOD
DeltaH	0.0	
Slope (%)	0.27	
Te (mins)	15.32	mins
ARF	1.000	
SAAR	662.000	mm
UCWI	65	mm
PIMP	100.0	%
SOIL	0.50	
Percentage Runoff PR	79.87	
DEEPSTOR	1.34	

Cv	0.7987	
Cr	1.3	
allowable outflow		
100 year	0.005	m^3/s

m3

Storage	RT years	Storage
	100 + 20% cc	-1

Return Period flood 100 + 20% cc years
Post Development Rainfall 140 years

Rainfall Duration (hours)	Rainfall Duration (days)	Rainfall Depth (mm)	20% increase	Effective Depth (mm)	Rainfall Intensity (mm/hr)	FLOW (l/s)	FLOW (l/s/ha)	RUN-OFF FLOW (m^3)	RUN-OFF RAIN (m^3)	Allowable Outflow (m^3)	Difference (m^3)
0.25	0.010	34.49	41.388	43.0	138.0	3.2	398.2	3	3	4.50	-1
0.5	0.021	41.94	50.328	52.3	83.9	1.9	242.1	3	4	9.00	-5
0.75	0.031	46.52	55.824	58.0	62.0	1.4	179.0	4	5	13.50	-9
1	0.042	49.89	59.868	62.2	49.9	1.2	144.0	4	5	18.00	-13
1.25	0.052	52.57	63.084	65.5	42.1	1.0	121.4	4	5	22.50	-17
1.5	0.063	54.82	65.784	68.3	36.5	0.8	105.5	5	5	27.00	-22
1.75	0.073	56.75	68.1	70.7	32.4	0.7	93.6	5	6	31.50	-26
2	0.083	58.46	70.152	72.8	29.2	0.7	84.4	5	6	36.00	-30
2.25	0.094	59.98	71.976	74.7	26.7	0.6	76.9	5	6	40.50	-35
2.5	0.104	61.37	73.644	76.5	24.5	0.6	70.9	5	6	45.00	-39
2.75	0.115	62.63	75.156	78.0	22.8	0.5	65.7	5	6	49.50	-43
3	0.125	63.81	76.572	79.5	21.3	0.5	61.4	5	6	54.00	-48
3.25	0.135	64.89	77.868	80.9	20.0	0.5	57.6	5	6	58.50	-52
3.5	0.146	65.91	79.092	82.1	18.8	0.4	54.4	5	7	63.00	-56
3.75	0.156	66.87	80.244	83.3	17.8	0.4	51.5	6	7	67.50	-61
4	0.167	67.77	81.324	84.4	16.9	0.4	48.9	6	7	72.00	-65
4.25	0.177	68.63	82.356	85.5	16.1	0.4	46.6	6	7	76.50	-70
4.5	0.188	69.44	83.328	86.5	15.4	0.4	44.5	6	7	81.00	-74
4.75	0.198	70.22	84.264	87.5	14.8	0.3	42.7	6	7	85.50	-79
5	0.208	70.96	85.152	88.4	14.2	0.3	41.0	6	7	90.00	-83
5.25	0.219	71.66	85.992	89.3	13.6	0.3	39.4	6	7	94.50	-87
5.5	0.229	72.34	86.808	90.1	13.2	0.3	38.0	6	7	99.00	-92
5.75	0.240	73	87.6	91.0	12.7	0.3	36.6	6	7	103.50	-96
6	0.250	73.63	88.356	91.7	12.3	0.3	35.4	6	7	108.00	-101
6.25	0.260	74.24	89.088	92.5	11.9	0.3	34.3	6	7	112.50	-105
6.5	0.271	74.82	89.784	93.2	11.5	0.3	33.2	6	7	117.00	-110
6.75	0.281	75.39	90.468	93.9	11.2	0.3	32.2	6	8	121.50	-114
7	0.292	75.94	91.128	94.6	10.8	0.3	31.3	6	8	126.00	-118
7.25	0.302	76.47	91.764	95.3	10.5	0.2	30.4	6	8	130.50	-123
7.5	0.313	76.99	92.388	95.9	10.3	0.2	29.6	6	8	135.00	-127
7.75	0.323	77.5	93	96.6	10.0	0.2	28.9	6	8	139.50	-132
8	0.333	77.98	93.576	97.2	9.7	0.2	28.1	6	8	144.00	-136
8.25	0.344	78.46	94.152	97.8	9.5	0.2	27.5	7	8	148.50	-141
8.5	0.354	78.93	94.716	98.3	9.3	0.2	26.8	7	8	153.00	-145
8.75	0.365	79.38	95.256	98.9	9.1	0.2	26.2	7	8	157.50	-150
9	0.375	79.82	95.784	99.5	8.9	0.2	25.6	7	8	162.00	-154
9.25	0.385	80.25	96.3	100.0	8.7	0.2	25.0	7	8	166.50	-159
9.5	0.396	80.67	96.804	100.5	8.5	0.2	24.5	7	8	171.00	-163
9.75	0.406	81.08	97.296	101.0	8.3	0.2	24.0	7	8	175.50	-167
10	0.417	81.49	97.788	101.5	8.1	0.2	23.5	7	8	180.00	-172
10.25	0.427	81.88	98.256	102.0	8.0	0.2	23.1	7	8	184.50	-176
10.5	0.438	82.27	98.724	102.5	7.8	0.2	22.6	7	8	189.00	-181
10.75	0.448	82.65	99.18	103.0	7.7	0.2	22.2	7	8	193.50	-185
11	0.458	83.02	99.624	103.4	7.5	0.2	21.8	7	8	198.00	-190
11.25	0.469	83.38	100.056	103.9	7.4	0.2	21.4	7	8	202.50	-194
11.5	0.479	83.74	100.488	104.3	7.3	0.2	21.0	7	8	207.00	-199
11.75	0.490	84.09	100.908	104.8	7.2	0.2	20.7	7	8	211.50	-203
12	0.500	84.43	101.316	105.2	7.0	0.2	20.3	7	8	216.00	-208
12.25	0.510	84.84	101.808	105.7	6.9	0.2	20.0	7	8	220.50	-212
12.5	0.521	85.24	102.288	106.2	6.8	0.2	19.7	7	8	225.00	-217
12.75	0.531	85.63	102.756	106.7	6.7	0.2	19.4	7	9	229.50	-221
13	0.542	86.01	103.212	107.2	6.6	0.2	19.1	7	9	234.00	-225
13.25	0.552	86.39	103.668	107.6	6.5	0.2	18.8	7	9	238.50	-230
13.5	0.563	86.77	104.124	108.1	6.4	0.1	18.6	7	9	243.00	-234
13.75	0.573	87.13	104.556	108.6	6.3	0.1	18.3	7	9	247.50	-239
14	0.583	87.5	105	109.0	6.3	0.1	18.0	7	9	252.00	-243
14.25	0.594	87.85	105.42	109.5	6.2	0.1	17.8	7	9	256.50	-248
14.5	0.604	88.21	105.852	109.9	6.1	0.1	17.6	7	9	261.00	-252
14.75	0.615	88.55	106.26	110.3	6.0	0.1	17.3	7	9	265.50	-257
15	0.625	88.9	106.68	110.8	5.9	0.1	17.1	7	9	270.00	-261
15.25	0.635	89.23	107.076	111.2	5.9	0.1	16.9	7	9	274.50	-266
15.5	0.646	89.57	107.484	111.6	5.8	0.1	16.7	7	9	279.00	-270
15.75	0.656	89.9	107.88	112.0	5.7	0.1	16.5	7	9	283.50	-275
16	0.667	90.22	108.264	112.4	5.6	0.1	16.3	8	9	288.00	-279
16.25	0.677	90.54	108.648	112.8	5.6	0.1	16.1	8	9	292.50	-283
16.5	0.688	90.86	109.032	113.2	5.5	0.1	15.9	8	9	297.00	-288
16.75	0.698	91.17	109.404	113.6	5.4	0.1	15.7	8	9	301.50	-292
17	0.708	91.48	109.776	114.0	5.4	0.1	15.5	8	9	306.00	-297

Appendix H: - SUDs Matrix

SUDS SUITABILITY MATRIX ADAPTED FROM CIRIA REPORT C697 'THE MANUAL FOR SUDS'

Matrix Selections		Land Use								Site Characteristics												Community & Environmental				Quantity & Quality Performances									
																										Water Quality Treatment Potential					Hydraulic Control				
SUDS Group	Technique	Low Density	Residential	Local Roads	Commercial	Hotspots	Construction Site	Brownfield	Contaminated Land	Soil		Area Draining to Single SUDS Component		Minimum depth to Water Table		Site Slope		Available Head		Available Space		Maintenance	Community Acceptability	Cost	Habitat Creation Potential	Total Suspended Solids Removal	Heavy Metals Removal	Nutrient (Phosphorous, Nitrogen) Removal	Bacteria Removal (*)	Capacity to treat Fine Suspended Sediments & Dissolved Pollutants	Runoff Volume Reduction	0.5 (1/2yr)	Suitability for Flow Rate Control (probability) 0.1 - 0.03 (10/30yr)	0.01 (100 yr)
										Impermeable	Permeable	0 – 2 ha	> 2 ha	0 – 1 m	> 1 m	0 – 5 %	> 5 %	0 – 1 m	1 – 2 m	Low	High													
Retention	Retention Pond	Y	Y	Y[1]	Y[2]	Y[2]	Y[3]	Y	Y[2]	Y	Y[1]	Y	Y[5]	Y	Y[3]	Y	Y	Y	Y	N	Y	M	H *	M	H	H	M	M	M	L	H	H	H
	Sub-surface Storage	Y	Y	Y	Y	Y	Y[3]	Y	Y	Y	Y	Y	Y[5]	Y	Y	Y	Y	Y	Y	Y	Y	L	H *	M	L	L	L	L	L	L	H	H	H
Wetland	Shallow Wetland	Y	Y	Y[1]	Y[2]	Y[2]	N	Y	Y[2]	Y[2]	Y[4]	Y[4]	Y[6]	Y[2]	Y[2]	Y	N	Y	Y	N	Y	H	H *	H	H	H	M	H	M	H	L	H	M	L
	Extended Detention Wetland	Y	Y	Y[1]	Y[2]	Y[2]	N	Y	Y[2]	Y[2]	Y[4]	Y[4]	Y[6]	Y[2]	Y[2]	Y	N	Y	Y	N	Y	H	H *	H	H	H	M	H	M	H	L	H	M	L
	Pond/ Wetland	Y	Y	Y[1]	Y[2]	Y[2]	N	Y	Y[2]	Y[2]	Y[4]	Y[4]	Y[6]	Y[2]	Y[2]	Y	N	Y	Y	N	Y	H	H *	H	H	H	M	H	M	H	L	H	M	L
	Pocket Wetland	Y	Y	Y[1]	Y[2]	Y[2]	N	Y	Y[2]	Y[2]	Y[4]	Y[4]	N	Y[2]	Y[2]	Y	N	Y	Y	Y	Y	H	M *	H	H	H	M	H	M	H	L	H	M	L
	Submerged Gravel Wetland	Y	Y	Y[1]	Y[2]	Y[2]	N	Y	Y[2]	Y[2]	Y[4]	Y[4]	Y[6]	Y[2]	Y[2]	Y	N	Y	Y	N	Y	M	L	H	M	H	M	H	M	H	L	H	M	L
	Wetland Channel	Y	Y	Y[1]	Y[2]	Y[2]	N	Y	Y[2]	Y[2]	Y[4]	Y[4]	Y[6]	Y[2]	Y[2]	Y	N	Y	Y	N	Y	H	H *	H	H	H	M	H	M	H	L	H	M	L
Infiltration	Infiltration Trench	Y	Y	Y[1]	Y[2]	N	N	Y	Y[4]	N	Y	Y	N	N	Y	Y	Y	Y	N	Y	Y	L	M *	L	L	H	H	H	M	H	H	H	H	L
	Infiltration Basin	Y	Y	Y[1]	Y[2]	N	N	Y	Y[4]	N	Y	Y	Y[5]	N	Y	Y	Y	Y	N	N	Y	M	H *	L	M	H	H	H	M	H	H	H	H	H
	Soakaway	Y	Y	Y[1]	Y[2]	N	N	Y	Y[4]	N	Y	Y	N	N	Y	Y	Y	Y	N	Y	Y	L	M	M	L	H	H	H	M	H	H	H	H	L
Filtration	Surface Sand Filter	N	Y	Y[1]	Y[2]	Y[2]	N	Y	Y[2]	Y	Y	Y	Y[5]	N	Y	Y	N	N	Y	N	Y	M	L	H	M	H	H	H	M	H	L	H	M	L
	Sub-surface Sand Filter	N	Y	Y[1]	Y[2]	Y[2]	N	Y	Y[2]	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	M	L	H	L	H	H	H	M	H	L	H	M	L
	Perimeter Sand Filter	N	N	Y[1]	Y[2]	Y[2]	N	Y	Y[2]	Y	Y	Y	N	N	Y	Y	N	Y	Y	Y	Y	M	L	H	L	H	H	H	M	H	L	H	M	L
	Bioretention/ Filter Strip	Y	Y	Y[1]	Y[2]	Y[2]	N	Y	Y[2]	Y	Y	Y	N	N	Y	Y	N	Y	Y	N	Y	H	H	M	H	H	H	H	M	H	L	H	M	L
	Filter Trench	Y	Y	Y[1]	Y[2]	Y[2]	N	Y	Y[2]	Y	Y[1]	Y	N	N	Y	Y	N	Y	Y	Y	Y	M	M	M	L	H	H	H	M	H	L	H	H	L
Detention	Detention Basin	Y	Y	Y[1]	Y[2]	Y[1,2]	Y[3]	Y	Y[2]	Y	Y[1]	Y	Y[5]	N	Y	Y	Y	N	Y	N	Y	L	H *	L	M	M	M	L	L	L	L	H	H	H
Open Channels	Conveyance Swale	Y	Y	Y[1]	Y[2]	Y[2]	Y[3]	Y	Y[2]	Y	Y	Y	N	N	Y	Y	N[3]	Y	N	N	Y	L	M *	L	M	H	M	M	M	H	M	H	H	H
	Enhanced Dry Swale	Y	Y	Y[1]	Y[2]	Y[2]	Y[3]	Y	Y[2]	Y	Y	Y	N	N	Y	Y	N[3]	Y	N	N	Y	L	M *	M	M	H	H	H	M	H	M	H	H	H
	Enhanced Wet Swale	Y	Y	Y[1]	Y[2]	Y[1]	Y[3]	Y	Y[2]	Y[2]	Y[4]	Y	N	Y	Y	Y	N[3]	Y	N	N	Y	M	M *	M	H	H	H	M	H	H	L	H	H	H
Source Control	Green Roof	Y	Y	N	Y[2]	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	H	H	H	H	n/a	n/a	n/a	n/a	H	H	H	H	L
	Rain Water Harvesting	Y	Y	N	Y[2]	N	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y				H	M *	H	L	M	L	L	L	n/a	M	M	H	L
	Permeable Pavements	Y	Y	N	Y[2]	Y[1]	N	Y	Y[2]	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	M	M	M	L	H	H	H	H	H	H	H	H	L

Y:Yes N:No

[1] May require two treatment train stages, depending on type and intensity of road use and receiving water sensitivity

[2] May require three treatment rain stages, depending on receiving watercourse sensitivity

[3] Will require draw-down rehabilitation following construction activities, prior to use as a permanent drainage system

[4] providing designs prevent mobilisation of contamination

Y:Yes N:No

[1] With liner

[2] With surface baseflow

[3] Unless follows contours

[4] With liner constant surface baseflow, or high ground water table

[5] Possible, but not recommended (implies appropriate management train not in place)

[6] Where high flows are diverted around SUDS component.

H: High
M: Medium
L: Low

* There may be some public safety concerns associated with open water that require address at design stage

* Limited Data Available

n/a: not applicable

H: High Potential
M: Medium Potential
L: Low Potential

Appendix I: - EA Standing Advice: More Vulnerable Development in Flood Zone 2

More Vulnerable development up to 1ha in size (excludes non-residential extension with a footprint of less than 250sq. metres or a domestic extension) in Flood Zone 2

Applications for planning permission should be accompanied by a completed form. An electronic version can be submitted by 'printing' it to a PDF writer.

The guidance on this sheet concerning Flood Risk Assessment requirements should also be applied to applications for Change Of Use within this category. Note - the Sequential Test does not apply to Change of Use applications. This advice is not applicable to development proposals for landfill/waste facilities & holiday/short-let caravans in this Flood Zone.

Sequential Test requirements

The Sequential Test is applied by the Local Planning Authority (LPA) to planning applications within this category. Details of the sequential test are set out in paragraph 101 of the NPPF.

FRA requirements

Planning applications must be accompanied by a Flood Risk Assessment (FRA). We recommend the FRA meets the requirements set out in the table below. All flood management measures will need to be supported by plans and drawings that form part of the FRA. The requirement for a FRA is set out in the NPPF in paragraphs 103 and 104 and footnote 20.

We recommend that Table 1.0 is completed by the applicant as part of the FRA submission. The standing advice help pages[1] provide guidance to help the applicant through this process. Plans may need to be amended and/or application withdrawn if the detail provided in the table does not meet the requirements as set out.

The following sections are to be completed by the applicant and checked by the LPA:

Site address & development description:	Land r/o No101-103 Raleigh Avenue, Hayes, Middlesex UB4 0EF
Print Name:	Donna Metcalf on behalf of Kompas Ltd
Signature:	
Date:	21/09/12

Continued...

[1]The help pages are available to see on the Environment Agency website www.environment-agency.gov.uk on the flood risk standing advice pages.

Table 1.0

More vulnerable development up to 1ha in size (excludes Non-residential extension with a footprint of less than 250 sq. metres or a domestic extension) in Flood Zone 2 (Does not apply to sites used for holiday or short-let caravans and camping, or landfill and waste management sites. For these proposals please refer to FRA Guidance note 3).

Flood risk to building/occupants. **Information to be provided by the applicant as part of the Flood Risk Assessment**	**Applicant to provide level information in the boxes below**	**Criteria to be used by LPA in assessing the Flood Risk Assessment**
Flood level for the 1 in 100 annual probability river flood (1%); or 1 in 200 annual probability sea flood (0.5%) in any year (including an allowance for climate change) in relation to Ordnance Datum[2] [1] (Newlyn)	29.263mAOD	In order to deliver safe development, we strongly advise the following - Ground floor levels to be set at a minimum of whichever is the higher of: • 300mm above the general ground level of the site OR • 600mm above the 1 in 100 annual probability river flood (1%); or 1 in 200 annual probability sea flood (0.5%) in any year (including an allowance for climate change). • Basement rooms to have unimpeded access internally to an upper level. **LPA's role:** Ensure that the level information has been provided and the standards set out above have been met.
Average ground level of the site in relation to Ordnance Datum (Newlyn)	29.670mAOD	
Finished floor level of lowest habitable room in relation to Ordnance Datum (Newlyn)	29.863mAOD (proposed)	
1 in 1000 annual probability (0.1%) in any year flood level including an allowance for climate change where this information is available.	30.093mAOD	In order to deliver safe development, we strongly advise the following - For single storey buildings or ground floor subdivisions with no access to higher floors, users of the development have access to a refuge set above the 1 in 1000 annual probability (0.1%) in any year flood level including an allowance for climate change. **LPA's role:** Ensure that the provision of a safe refuge for **single storey** buildings complies with the above information. To achieve these standards floor levels should be raised. Note: For buildings with more than one storey in this category upper floors can be considered safe refuge

Continued…

[2] Ordnance Datum or the abbreviation 'OD' is the mean level of the sea at Newlyn in Cornwall from which heights above sea level are taken.
The contour lines on Ordnance Survey maps measure heights above OD for example, though these are not accurate enough for a flood risk assessment.

Table 1.0 (Continued)

Applicant is to provide confirmation that the requirements below have been met	Applicant to indicate compliance in the box below. Enter 'yes' or 'no'	LPA should satisfy themselves with regard to the comments below.
Management of surface water Applicant is to indicate that surface water will be managed in accordance with the following standards: • Specific requirements for managing surface water set out in an adopted Strategic Flood Risk Assessment and/or Surface Water Management Plan produced by the Local Planning Authority. • Surface water run-off will be controlled to ensure no flooding of property and no increase in surface water run-off from the site to a watercourse or receiving water body compared to the existing pre-application run-off rate in a 1 in 100 year storm event (1% chance in any one year) plus an appropriate allowance for climate change (Flood risk Practice Guide paragraphs 5.51 and 5.54) • Meets the requirements of Approved Document Part H of Building Regulations 2000.	Yes	**LPA's role:** Look for assurance from the applicant that surface water will be managed in accordance with the requirements opposite. Seek assurance if not already provided. Cross check the planning application with the Local Plan . Consultation with the local authority Building Control department is recommended. Paragraph 103 of NPPF states that LPAs should in determining planning applications give priority to the use of SuDS. **Note**: Strategic options for surface water management should be used wherever available. Options such as this would be identified as part of the SFRA for inclusion within in the Local Plan. Building regulation requirements alone are not appropriate for areas with critical drainage problems.
Flood resilience and resistance Applicant is to indicate that flood resilience/ resistance and emergency escape measures/ procedures have been incorporated where possible. This applies to any part of the building (e. g. basements), that are situated below the 1 in 100 annual probability river flood (1%); or 1 in 200 annual probability sea flood (0.5%) level in any year (including an allowance for climate change).	N/A	**LPA's role:** Look for assurance from the applicant that resilience/resistance and evacuation procedures have been addressed in accordance with the requirements opposite. Seek assurance if not already provided. Cross check the planning application with the Local Plan. Consultation with the local authority Building Control (flood resilience/ resistance) and Emergency Planning (evacuation) department is recommended.
Other sources of flooding (not rivers or the sea) Applicant is to indicate that the SFRA has been referred to and that the recommendations regarding other sources of flooding have been incorporated into the application. If no SFRA is available and flood risk from other sources is present, guidance should be sought from the organisations listed in the help pages under the heading `other sources of flooding'.	Yes	**LPA's role:** Look for assurance from the applicant that the SFRA has been referred to (where available) and that mitigation for flooding from other sources has been provided where necessary.

Note on flood level information: Flood Level information should be obtained by the applicant first from the SFRA, or if not available, from the Environment Agency. Where the applicant is unable to obtain the information from either of these sources the LPA should consult the Environment Agency for an individual consultation response.

End of comment