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BARNET
LONDON BOROUGH

Colindale
Area Action Plan

Supporting Documents

Strategic Flood Risk Assessment

June 2008

Local Development Framework

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Revision Schedule

Colindale Area Action Plan – Strategic Flood Risk Assessment
Final

Rev	Date	Details	Prepared by	Reviewed by	Approved by
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Glossary

Term	Definition
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Culvert	A channel or pipe that carries water below the level of the ground.
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood plain	Area adjacent to river, coast or estuary that is naturally susceptible to flooding.
Flood storage	A temporary area that stores excess runoff or river flow often ponds or reservoirs.
Fluvial flooding	Flooding by a river or a watercourse.
Freeboard	Height of flood defence crest level (or building level) above designed water level
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Inundation	Flooding
Local Development Framework (LDF)	The core of the updated planning system (introduced by the Planning and Compulsory Purchase Act 2004). The LDF comprises the Local Development Documents, including the development plan documents that expand on policies and provide greater detail. The development plan includes a core strategy, site allocations and a proposals map.
Local Planning Authority	Body that is responsible for controlling planning and development through the planning system.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Overland Flow	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Risk	The probability or likelihood of an event occurring.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Sustainable drainage system	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations meeting their own needs.
1 in 100 year event	Event that on average will occur once every 100 years. Also expressed as an event, which has a 1% probability of occurring in any one year.
1 in 100 year design standard	Flood defence that is designed for an event, which has an annual probability of 1%. In events more severe than this the defence would be expected to fail or to allow flooding.

1 Introduction

1.1 Overview

The London Borough of Barnet is currently producing an Area Action Plan (AAP) for the area of Colindale in association with Urban Practitioners. This document forms the basis for this study, which aims to produce a strategic flood risk assessment for the Colindale AAP in accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25) and identify constraints and formulation of planning policies for the area.

PPS25 requires an assessment of flood risk is carried out at appropriate stages of the planning process. These include a:

- Regional Flood Risk Appraisal (RFRA) to inform the Regional Spatial Strategy;
- Strategic Flood Risk Assessment (SFRA) to inform Local Development Documents and the Local Development Framework;
- Site-specific Flood Risk Assessment (FRA) to accompany planning application as required by the Environment Agency;

This Strategic Flood Risk Assessment aims to provide the London Borough of Barnet with the necessary tools to apply the Sequential Test to the Colindale area and where necessary, provide a sufficient level of information to justify the development of sites through the satisfaction of the Exception Test.

1.2 Study Area

The London Borough of Barnet has a total area of 86.7km^2 with a population of 330,000. Within the borough of Barnet the areas of Barnet Mill Hill East, Colindale and Brent Cross/Cricklewood have been identified by the London Plan as 'Opportunity Areas' to assist in meeting growth targets for housing and employment in the wider area from 2001-2016. Colindale has been identified by the Mayor of London for 10,000 new homes and 500 new jobs by the year 2016.

1.3 Objectives

The objectives of this Flood Risk Assessment for the Colindale AAP are:

- To provide an assessment of the impact of all potential sources of flooding in accordance with PPS25, including an assessment of any future impacts associated with climate change and sea level rise.
- Enable planning policies to be identified to minimise and manage flood risks for the whole of the study area.
- To provide information needed to apply the Sequential Test for identification of land suitable for development on line with the principles of PPS25.
- To allow the London Borough of Barnet to assess the flood risk for specific development proposal sites, thereby setting out the requirements for site specific Flood Risk Assessments (FRAs).

- To enable the London Borough of Barnet to use this FRA as a basis for decision making at the planning application stage.
- Ascertain the acceptability of flood risk in relation to emergency planning capability.
- Where necessary, to provide technical assessments and assistance to demonstrate that development located in flood risk areas are appropriate in line with the requirements of the Exception Test.

1.4 Scope of this document

The Colindale SFRA has been prepared in accordance with PPS25 to inform the preparation of the Area Action Plan for the Colindale area of the London Borough of Barnet. The area is considered suitable for regeneration and growth within the Barnet area.

The time frame requirements of the Colindale AAP are such that the Colindale SFRA has been prepared in advance of the North London SFRA.

The North London Strategic Flood Risk Assessment (SFRA) is currently in draft with completion expected in Autumn 2008. The study area for the SFRA includes the London Boroughs of Barnet, Camden, Enfield, Hackney, Haringey, Islington and Waltham Forest. The North London SFRA is intended to provide an evidence base to the participating London Boroughs as part of the Local Development Framework process and inform their Sequential Test and Exception Test process for future site allocations in accordance with PPS25.

The draft North London SFRA has been supplied and reviewed in order to provide background information for this SFRA for the Colindale AAP.

2 Colindale Area Action Plan

2.1 Background

Colindale is already the focus of two large development schemes at Grahame Park and Beaufort Park where work is underway to build a large number homes to regenerate these areas. These two schemes already have planning permission to build 3440 residential units.

Colindale has been designated as an Opportunity Area in the London Plan with the capacity to deliver 10,000 new homes between 2001-2016. Although not all these new homes have to be provided within the AAP boundary, the focus on development sites in the AAP will therefore be residential with mixed-use sites across the study area.

2.2 Study Area

The suburban housing area of Colindale is located in the London Borough of Barnet in north London. The study area of the Area Action Plan is presented in Figure 1, bordered by Edgware Road to the west and the A1 (M) and West Coast Mainline to the east. The Colindale underground station is located in the centre of the study area.

2.3 Area Action Plan Sites

For the purposes of this SFRA we have assessed the sites identified in the Colindale AAP which originated from the London Borough of Barnet's Local Development Scheme. This includes the previously identified Grahame Park which has planning consent for 3440 units, and the RAF East Camp known as Beaufort Park which has planning consent for 2800 units with potential for further growth. Therefore the AAP aims to identify the sites for the remaining 5000-6000 new homes.

Table 7.1 in Appendix B highlights the main sites identified in the AAP along with proposed land uses, which is presented in Urban Practitioners Drawing No. CAAP/AJM/LUTPlan also contained within Appendix B. The site allocations have also been reproduced within Figure 2.

3 Policy

3.1 Introduction

This chapter provides a summary of both national and regional policies that provide direction and guidance to Local Authorities with respect to flood risk. The information presented in the SFRA should be used by the Boroughs to establish robust policies in relation to flood risk as part of their emerging Local Development Frameworks (LDFs).

3.2 Local Policies

The Unitary Development Plan (UDP) produced in 2006 sets out the policies and proposals for future development and land use in the London Borough of Barnet up to 2016.

Within the current UDP there are three policies which relate to flood risk in the Barnet area, these tend to address the management of new development in relation to flood risk.

Policy ENV9 – Flood Risk Areas
In areas at risk from flooding, new development or intensification of existing development will only be permitted where applicants have properly assessed the flood risk and made arrangements to implement flood prevention measures. The council will seek to ensure this through the use of planning conditions or obligations.

Policy ENV10 – Increased Flood Risk
Development that will generate significant surface water run-off likely to result in increased flood risk, or changes to natural habitats, will not be permitted unless appropriate prevention measures are taken as part of the development.

Policy ENV11 – Drainage Infrastructure
The council will require new developments to include adequate foul and surface water drainage infrastructure and will seek to ensure this through the use of planning conditions or obligations. Wherever this is practicable, the council will require the use of sustainable drainage systems.

3.3 National Policies

Making Space for Water

In 2004 the Government's Making Space for Water strategy set out a new national direction for flood risk management planning in England over the next 20 years. The report recognised the requirement for a holistic approach between the various responsible bodies, including flood defence operating authorities, sewerage undertakers and highways authorities, to achieve sustainable development. The report also highlighted the need for a more integrated approach to urban drainage. The protection of the functional floodplain forms an integral aspiration of the strategy.

In January 2007 details of 15 new pilot studies were released that will aim to identify the causes and consider the most suitable ways to manage urban drainage and reduce future flooding taking climate change into consideration. It is hoped the outcome of these studies will culminate in guidance on how to approach urban flood risk and integrated drainage, which will be released in Autumn 2008.

Amongst several other key drivers[1], the Making Space for Water document intended to improve the manner in which land use planning was undertaken. Since 2004 the particular goals alluded to in this document have been achieved. The Environment Agency's role as a statutory consultee has been extended in areas that are at risk of flooding. In essence, an objection made by the Environment Agency has the same weighting as that of the Boroughs. An integral part of this new direction for flood risk management planning in England was the production of a new Planning Policy Statement (PPS). As discussed within the Making Space for Water document itself, the intention was 'to replace and improve the operational effectiveness of', Planning Policy Guidance Note (PPG) 25. The overriding document PPS25 was released in December 2006 and is discussed below.

Planning Policy Statement 25: Development & Flood Risk

This policy document establishes the national policy for development and flood risk. The overarching aim of PPS25 is to support the Government's objectives for sustainable development. 'The aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas at high risk'. Therefore, PPS25 seeks towards steering of new development to sites of lower flood risk.

Planning Policy Statement 25 requires that local councils must do the following, when preparing their Local Development Framework:

1. Allocate all sites in accordance with the 'Sequential Test', reduce the flood risk and ensure that the vulnerability classification of the proposed development is appropriate to the Flood Zone classification;
2. Flood Risk Assessments (FRAs) should be undertaken for all developments within Flood Zones 2 and 3 including when a change of use to a higher vulnerability is proposed. The FRA should assess the risk of flooding to the development and identify options to mitigate the flood risk to the development, site users and surrounding area;
3. FRAs are also required within Flood Zone 1 for all sites greater than 1 hectare, and for all sites (regardless of site area) in areas that suffer from critical drainage problems.
4. Flood risk to development should be assessed for all forms of flooding;
5. Where floodplain storage is removed, the development should provide compensatory storage on a level for level and volume for volume basis to ensure that there is no loss in flood storage capacity.
6. Encourage the management of surface water as close to the source as possible, using appropriate Sustainable Drainage Systems (SuDS) where possible.

The PPS25 document aims to ensure that flood risk is taken into account at all stages in the planning process from the inception of regional and local policy through to individual development control decisions.

The document seeks to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of high risk through the application of the sequential approach and the precautionary principle.

[1] Including coastal erosion, management of water in a rural setting, improved provision of data and research and an improved incorporation of the three pillars of sustainable development (i.e. economic, social and environmental) in risk management activities.

3.4 Regional Policies

London Plan

The Greater London Assembly published the London Plan, Spatial Development Strategy for Greater London in February 2008. The published London Plan has been approved by the Secretary of State and is a statutory development planning document, and covers a period up to 2020. One of the important roles of the Draft RSS is to 'translate strategy into proposals for the provision of new homes'. The plan sets out a strategy for distributing housing numbers amongst the boroughs and for realising and monitoring that development. Colindale provision for additional 'homes' targets 2001- 2016 is 10,000.

Furthermore the London Plan sets out policies pertaining to flood risk that should be considered as part of the development process:-

- Policy 4A.12 Flooding: In reviewing their DPDs, boroughs should carry out strategic flood risk assessments to identify locations suitable for development and those required for flood risk management. Within areas at risk from flooding (Flood Zones) the assessment of flood risk for development proposals should be carried out in line with PPS25.
- Policy 4A.13 Flood risk management: Where development in areas at risk from flooding is permitted, (taking into account the provisions of PPS25), the Mayor will, and boroughs and other agencies should, manage the existing risk of flooding, and the future increased risk and consequences of flooding as a result of climate change, by:
    - *protecting the integrity of existing flood defences*
    - *setting permanent built development back from existing flood defences to allow for the management, maintenance and upgrading of those defences to be undertaken in a sustainable and cost effective way*
    - *incorporating flood resilient design*
    - *establishing flood warning and emergency procedures.*

Opportunities should also be taken to identify and utilise areas for flood risk management, including the creation of new floodplain or the restoration of all or part of the natural floodplain to its original function, as well as using open space in the flood plain for the attenuation of flood water.

The Mayor will, and boroughs and other agencies should, take fully into account the emerging findings of the Thames Estuary 2100 Study, the Regional Flood Risk Appraisal and the Thames Catchment Flood Management Plan.

- Policy 4A.14 Sustainable drainage: The Mayor will, and boroughs should, seek to ensure that surface water run-off is managed as close to its source as possible in line with the following drainage hierarchy:
    - *store rainwater for later use*
    - *use infiltration techniques, such as porous surfaces in non-clay areas*
    - *attenuate rainwater in ponds or open water features for gradual release to a watercourse*
    - *attenuate rainwater by storing in tanks or sealed water features for gradual release to a watercourse*
    - *discharge rainwater direct to a watercourse*

- *discharge rainwater to a surface water drain*
- *discharge rainwater to the combined sewer.*

The use of sustainable urban drainage systems should be promoted for development unless there are practical reasons for not doing so. Such reasons may include the local ground conditions or density of development. In such cases, the developer should seek to manage as much run-off as possible on site and explore sustainable methods of managing the remainder as close as possible to the site.

The Mayor will encourage multi agency collaboration (GLA Group, Environment Agency, Thames Water) to identify sustainable solutions to strategic surface water and combined sewer drainage flooding/overflows.

Developers should aim to achieve greenfield run off from their site through incorporating rainwater harvesting and sustainable drainage. Boroughs should encourage the retention of soft landscaping in front gardens and other means of reducing, or at least not increasing, the amount of hard standing associated with existing homes.

- Policy 4A.15 Rising groundwater: In considering major planning applications in areas where rising groundwater is an existing or potential problem, the Mayor will, and boroughs should, expect reasonable steps to be taken to abstract and use that groundwater. The water may be used for cooling or watering purposes or may be suitable for use within the development or by a water supply company.

The Mayor of London water strategy details these proposals further, Proposal 7 states that: The Mayor will, and the Boroughs should, require new developments (larger than 1,000 m2 or more than 10 dwellings) to manage their surface water runoff so that there is a 50 per cent reduction in the volume and rate of surface water drainage when compared to that of the undeveloped site at peak times.

In the Mayor of London water strategy, Proposal 8 states that: The Mayor will, and the Boroughs should, require new developments (larger than 3,000 m^2 or more than 100 dwellings) to establish separate foul sewer and surface water drains and not to discharge excess surface water into the combined sewer system.

In addition, development should integrate successfully with the water space in terms of use, appearance and physical impact and should in particular:

- Include a mix of uses appropriate to the water space, including public uses and open spaces, to ensure an inclusive accessible and active waterside and ground level frontage;
- Integrate into the public realm, especially in relation to walking and cycling routes and borough open space strategies. Public art will often be appropriate in such locations as well as clear signage, information and lighting to promote the use of waterside spaces by all;
- Incorporate built form that has a human scale of interaction with the street, public spaces and waterside and integrates with existing communities and places;
- Recognise the opportunity to provide landmarks that are of cultural and social significance along the waterways, providing orientation points and pleasing views without causing undue harm to the cohesiveness of the water's edge;
- Relate successfully in terms of scale, materials, colour and richness of detail, not only to direct neighbours but also to buildings on the opposite bank and those seen in the same context with the River Prospects (see Policy 4B.15) or other locally identified views. Such juxtaposition of buildings should take into account river meanders and the impact these can have on how buildings may be seen together;

- Incorporate sustainable design and construction techniques, in particular a precautionary approach to flood risk.

London Plan Supplementary Planning Guidance (2006)

The Mayor of London has also published Supplementary Planning Guidance (SPG) to provide additional information and support the implementation of the London Plan. The SPG sets out 'Essential Standards', which must be met by new developments and 'Preferred Standards' which are desirable, for a number of Sustainable Design and Construction categories.

The SPG includes important requirements regarding water usage and surface water drainage. In particular, the Water Pollution and Flooding category sets the following standards.

Essential Standards

- Use of Sustainable Drainage Systems, wherever practical;
- Achieve 50% attenuation of the undeveloped site's surface water run-off at peak times.

Mayor's Preferred Standard

- Achieve 100% attenuation of the undeveloped site's surface water run-off at peak times.

3.5 Thames Catchment Flood Management Plan (CFMP)

The Thames CFMP was completed in December 2007 and covers the London Borough of Barnet. The Thames CFMP has summarised the future approach to flood risk management into four key messages:

Flood defences cannot be built to protect everything
Current flood defences will be maintained but it is unrealistic to continue to build defences to protect all of the peoples and properties at risk of flooding. The focus should be placed on the consequences of flooding rather than the likelihood of flooding.

Climate change will be the major cause of increased flood risk in the future
The predicted change in weather patterns due to climate change suggests that winter floods will happen more frequently.

The floodplain is our most important asset in managing flood risk
Many floodplains in the Thames region have no flood defences and can serve their natural function of storing water during times of flood. The value of this floodplain needs to be recognised in reducing the impacts of flooding. Improving the effectiveness of the floodplain can reduce flooding to properties both locally and further downstream.

Development and urban regeneration provide a crucial opportunity to manage the risk
The consequences of flooding can be managed through forward planning. By considering the location, layout and the design of the development, flood risk to properties can be reduced. For example, locate more vulnerable properties out of the floodplain, open up urban river corridors to provide more floodplain and make new buildings flood resilient in combination with the use of SuDS.

The Thames CFMP highlights the River Brent catchment, including the Silk Stream as highly developed floodplains with little open space and modified river channels. The following measures are recommended within a strategic action plan:

- Incorporate long-term policies that outline protecting and re-creating river corridors and areas where flooding can happen naturally.
- Identify how sustainable flood risk management can be best aligned to redevelopment plans, to establish solutions that can best offset the impacts of climate change
- PPS25 guidance on managing residual flood risk should be applied through policies in LDFs and SFRAs.
- Develop more practical and accessible advice on flood proofing for homeowners.
- Identify where an integrated approach to drainage provides a tangible benefit to flood risk management to address the frequent, low-order flooding that occurs all over London.

A Policy Unit has been developed for the River Brent catchment and the Environment Agency's approach to flood risk management for this type of catchment is outlined below:

- We need long-term adaptation of the urban environment. There are massive opportunities to reduce flood risk through redevelopment. In most areas we need to change the character of the urban area in the floodplain through re-development. It must be resilient and resistant to flooding and result in a layout that re-creates river corridors.
- We are seeking to re-create river corridors through redevelopment so that there is space for the river to flow more naturally and space in the floodplain where water can be attenuated.
- We will be seeking to build flood defences as redevelopment occurs and as part of an overall catchment plan. This is because more attenuation and more space in the river corridors are needed for defences to be sustainable. This is more complex but represents better value for society in the long-run even if it is more costly for the Environment Agency today.
- These areas are very susceptible to rapid flooding from thunderstorms. Emergency response and flood awareness are particularly important.

4 Review of Flood Risk

4.1 Regional Flood Risk Assessment (RFRA)

The Greater London Authority has produced a RFRA to accompany the London Plan. The draft RFRA was issued in June 2007 for informal consultation and is drawn from in this FRA. The purpose of the RFRA is to provide a broad regional understanding of the risk that flooding creates in Greater London, and was undertaken following the stipulation within PPS25. The RFRA is a descriptive document, intended to feed into the Strategic Sustainability Assessment (SSA) and the RSS in order to help determine broad regionally significant locations for development.

The regional appraisal of flood risk concludes that there are five major flood sources- tidal, fluvial, groundwater, surface water and sewer that influence London, however tidal flooding does not effect the London Borough of Barnet.

Future flood risk management options recommended for Barnet comes under the strategic North London sub-region.

The RFRA identifies the following in relation to the London Borough of Barnet:

- River Brent and Silk Stream: The River Brent is identified as being sufficiently defended from flooding. However, localised flooding has been recorded, particularly in upper catchments, one of which is Barnet. The Environment Agency has examined options to address this and recommendations should be incorporated into Local Development Documents to reduce surface water runoff.
- The Colindale Hospital is identified as lying partially within the Silk Stream Floodplain
- The Edgware Hospital is identified as lying wholly within the Silk Stream Floodplain and should carry out a flood risk assessment of present premises to determine necessary mitigation measures to ensure the operation of the hospital in the event of a flood.
- Burnt Oak Tube Station is within the Silk Stream Floodplain

The RFRA provided twenty three strategy recommendations pertaining to the Local Authorities. More specifically the regional policies that should be considered as part of this SFRA in the context of the Borough of Barnet are:-

- **Recommendation 6**: Developments all across London should implement the Drainage Hierarchy set out in Policy 4A.5vii of the FALP.
- **Recommendation 7**: Regeneration and redevelopment of London's fluvial river corridors offer a crucial opportunity to reduce flood risk. Strategic Flood Risk Assessments and policies should focus on making the most of this opportunity through appropriate location, layout and design of development as set out in PPS25 and the Thames Catchment Flood Management Plan. In particular opportunities should be sought to:
    - i. Set back of development from the river edge to enable sustainable and cost effective flood risk management options (FALP Policy 4A.5vi).
    - ii. Ensure that the buildings with residual flood risk are designed to be flood compatible or flood resilient (FALP Policy 4A.5vi).

iii. Use open spaces within developments which have a residual flood risk to act as flood storage areas

- **Recommendation 10:** Organisations responsible for development with large roof areas should investigate providing additional surface water run-off storage (such as BAA at Heathrow) should investigate providing additional surface water run-off storage.
- **Recommendation 20:** All of London's major hospitals, including those not on the above table (i.e. outside floodplains) have large roof, parking and other hard surfaced areas which will generate high volumes of surface water run-off. Opportunities should be taken during refurbishment or extension works to introduce sustainable drainage techniques. This is particularly viable in those hospitals which are set in large grounds.

The document concludes that flood risk is a serious consideration for London. There are many opportunities for new developments within London to actively reduce overall flood risk. This can be achieved through improving the management of surface water and allowing space for the future maintenance and upgrade of flood defences. A range of infrastructure may also be affected by flooding and new facilities should be located considering flood risk.

4.2 Strategic Flood Risk Assessment (SFRA)

The North London SFRA draft was completed in April 2007. This is due for completion later in 2008, so the following information may be subjection to change on finalisation of this report.

Summary of the flood risks for Barnet

The North London SFRA concluded that the main source of flood risk to the London Borough of Barnet was from fluvial flooding from the Dollis Brook, Silk Stream, Pymmes Brook and their associated tributaries.

The Silk Stream is discussed in more detail in the following chapter as this river flows along the southern boundary of the Colindale AAP study area.

The SFRA concludes that surface water flooding in Barnet presents a low to moderate source of flood risk, while sewer flooding is noted as being a low risk. Groundwater flooding was also concluded to be a low risk to the London Borough of Barnet due to the impermeable geology and depth of the local groundwater table.

Policy Recommendations

The North London SFRA identifies a series of draft policy recommendations. These are intended to reflect the national and regional policies identified in the previous chapter. The following lists these under three headings of policy, development control and technical.

Policy

- Incorporation of SFRA findings into the Core Strategy and Development Framework Documents
- The Core Strategy should include a clear policy statement on flood risk in urban areas
- The SFRA should be linked with other Flood Risk Management Strategies
- Flood Risk Guidance should be included in the Area Action Plans with the following recommendations for inclusion:

- Highly vulnerable development should be avoided in the high and medium Flood Zones
- More vulnerable development should not be located on the ground floor
- Flood proofing and flood resilience should be incorporated in the overall design of any development
- Access/egress points and specified refuge points
- Proposals will need to demonstrate emergency planning measures have been taken into account
- Any particular requirements relating to flood risk and specific designations

Development Control

- Development adjacent to flood defences should be set back from defences.
- Appropriate development of urban centres using sequential approach as well as consideration of:
  - Suitability of land uses on the ground floor of more vulnerable development
  - Incorporation of flood proofing and flood resilience measures in design
  - Emergency planning has been incorporated into the development
  - Location and appropriateness of uses
- Flood risk consideration in housing market renewal
- The functional floodplain should be protected from development
- Develop flood risk and design policy
- Develop policy for basement dwellings in Flood Zones 3 and 2
- Consideration of Sustainable Drainage (SuDS) for surface water runoff
- Flood proofing for all new development
- Windfall sites should be considered against flood risk management policy
- Completion of the Sequential and Exception Tests in allocating sites and planning applications
- Location of development types in suitable flood risk areas
- Emergency planning and evacuation route review using SFRA

Technical

- Development of Surface Water Management Plans
- Working in partnership with Environment Agency to share knowledge
- SFRA review in future to update guidance and data.

5 Flood Sources in Colindale

5.1 Fluvial Flooding

Sources

The Silk Stream drains a catchment area of approximately 35km^2 and flows north-west to south-east through the south of the study area, forming the dominant source of fluvial flood risk. Approximately 1.5km downstream of the study area, towards the south western boundary of LB Barnet, the Silk Stream converges with the River Brent at the Brent Reservoir. The River Brent drains the reservoir and flows south to its confluence with the tidal River Thames at Brentford Lock approximately 1.5km upstream of Kew Bridge.

The Silk Stream catchment is highly influenced by urbanisation and low permeability London Clay geology, which is present throughout the area, which both increase the speed at which the catchment responds to rainfall events. As the potential for infiltration into subsoils is low, a large proportion of rainfall is rapidly conveyed into the Silk Stream resulting in a 'flashy' hydrograph profile. This means that there is limited time for flood warning and evacuation procedures to be put into place unless they are triggered by weather forecasting techniques.

Historic Flooding

The Silk Stream catchment has suffered from flooding during the 1990's, in 1992 and 1999. No detailed information regarding the antecedent conditions for these events is available, however the characteristics of the catchment suggest that it is susceptible to short intense rainfall events, which typically occur during the summer period.

Silk Stream Flood Alleviation Scheme

The 1992 Silk Stream flood event acted as a trigger for investment into a catchment wide flood alleviation scheme to reduce the risk of fluvial flooding. The feasibility studies initially considered 32 potential sites for upstream flood storage areas within the catchment, with 6 sites carried forward as the final scheme.

Construction of the 6 flood storage areas is now complete and the flood alleviation scheme is operational, providing an improved standard of flood protection to approximately 750 properties in the Edgware area. The flood storage areas are designed to hold floodwaters in times of heavy rain to prevent the rivers bursting their banks and flooding homes and businesses. The standard of flood protection has been improved to a 1 in 20 year throughout the study area.

The fluvial Flood Zone outlines following construction of the Silk Stream flood alleviation scheme are shown in Figure 4. However in line with PPS25 requirements, the benefits of the scheme as a flood defence structure have been excluded from the mapping used to undertake sequential testing in chapter 6.

Flood Defences

The Environment Agency has provided flood defence data from the National Flood and Coastal Defence Database (NFCDD), which identifies that the Silk Stream channel has an existing standard of protection of 1 in 5 years within the study area. However the North London SFRA comments that the Environment Agency use the 5 year value as a default when no information is available and it is therefore unlikely that

this information is correct. Given that the recent flood alleviation scheme provides a standard of protection of 1 in 20 years, the NFCDD data would appear to be incorrect and in need of updating.

Model Data

The Environment Agency has provided additional modelling data produced in 2006, throughout the design of the flood alleviation scheme. The model was originally constructed at a strategy study level, to assist with design works and was not configured to estimate site specific flood levels.

However the Environment Agency has provided the information for use in this study as it forms the most up-to-date information currently available. It is understood that the previous Flood Zone extents for the study area were produced using broad scale JFlow models, therefore the 2006 modelling, utilising ISIS software provides more detailed information for use in this assessment.

Flood extents have been provided for both the 'pre-scheme' and 'post-scheme' scenarios for the 1 in 25 year, 1 in 100 year and 1 in 100 year with climate change flood events. The 1 in 1000 year 'undefended' flood extent has also been provided to represent the 'pre-scheme' scenario, however this has not been made available for the 'post-scheme' scenario. Modelled flood levels have been provided for the 'post-scheme' scenario which are presented in Figure 7. As discussed further in section 8.3 these levels should be used when carrying out site specific FRAs.

PPS25 Flood Zones

PPS25 requires definition of four Flood Zones to determine the appropriateness of proposed development uses through the application of the Sequential Test. These are:

Table 5.1: Fluvial Flood Zone Definitions (as defined in PPS25, Table D.1)

Flood Zone	Definition	Probability of Flooding
Flood Zone 1	At risk from flood event greater than the 1 in 1000 year event (greater than 0.1% annual probability of flooding each year)	Low Probability
Flood Zone 2	At risk from flood event between the 1 in 100 and 1 in 1000 year event (between 1% and 0.1% annual probability of flooding each year)	Medium Probability
Flood Zone 3a	At risk from flood event less than or equal to the 1 in 100 year event (greater than 1% annual probability of flooding each year)	High Probability
Flood Zone 3b	At risk from a flood event less than or equal to the 1 in 20 year event or otherwise agreed between the Local Planning Authority and the Environment Agency (greater than 5% annual probability of flooding each year)	Functional Floodplain

PPS25 states that the Flood Zones should not take into account the affects of any flood defences or flood management infrastructure for Flood Zones 1, 2 and 3a. However Flood Zone 3b, the functional floodplain, should be determined considering the effects of defences and other flood risk management infrastructure. The functional floodplain relates only to river and coastal flooding, it does not include areas at risk of flooding solely from other sources of flooding (e.g., surface water, sewers). The benefits of the flood alleviation scheme can therefore not be taken into account when defining Flood Zones 1, 2 and 3a.

Climate Change

The Flood Zones should be defined considering the effects of climate change. For fluvial systems, PPS25 requires an increase of 20% in peak flows to be used when mapping climate change Flood Zones up to 2115. However the Environment Agency's modelling work within the study area only considered a climate change scenario for the 1 in 100 year flood event, i.e. climate change scenarios were not completed for the 1 in 25 or 1 in 1000 year flood events. No appropriate flood outlines are therefore available to define FZ2 and FZ3b with climate change. It is recommended that further modelling studies of the Silk Stream should consider climate change for these events.

Data Sources used to Map Colindale Flood Zones

Table 5.2 identifies the sources of data used to map the fluvial Flood Zones required by PPS25. The mapping has been produced from flood outlines supplied by the Environment Agency.

Table 5.2: Fluvial Flood Zone Mapping Data Sources

Scenario		Silk Stream
Current Flood Zones (2008)	**FZ 2**	1 in 1000 year 'undefended scenario' outline
	FZ 3a	Silk Stream FAS 'pre-scheme' 100 year outline
	FZ 3b	Silk Stream FAS 'post-scheme' 25 year outline
Climate Change Flood Zones (2108)	**FZ 2**	No appropriate outline available
	FZ 3a	Silk Stream FAS 'pre-scheme' 100 year plus climate change outline
	FZ 3b	No appropriate outline available

The current Flood Zones have been prepared using the best available information and following the precautionary principle as detailed throughout PPS25, demonstrated through use of the 1 in 25 year flood outline to map the functional floodplain in absence of the 1 in 20 year data. As the functional floodplain should take into account the effect of flood defences, the 'post-scheme' model flood outlines have been used to define Flood Zone 3b. However the 'pre-scheme' outlines have been used to define Flood Zones 2 and 3a.

Mapping

The extent of the fluvial Flood Zones, excluding the benefits of the Silk Stream flood alleviation scheme for the Colindale AAP study area are presented in the Flood Zone Map (Figure 3). These have been produced using the best available data from appropriate hydraulic models throughout the study area, as shown in Table 5.2.

5.2 Tidal

There are no sources for tidal flooding in the London Borough of Barnet so this flood source is not investigated further in this report.

5.3 Overland Flow/ Surface Water

Overland flow / surface water flooding typically arises as a result of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. It can run quickly off land and result in localised flooding.

As the majority of the study area is heavily developed, overland flow typically tends to occur when surface water cannot enter overloaded drainage systems during significant rainfall events. This problem is exacerbated by areas of steep, impermeable topography which can generate significant volumes of run-off during heavy rainfall events.

The study area is urbanised and underlain by impermeable London Clay as shown in Figure 8, which indicates limited potential for infiltration of precipitation. This increases the risk of significant overland flow during heavy rainfall events therefore to provide further information regarding surface water flood risk, the topography of the study area has been analysed. LiDAR data has been provided by the Environment Agency which has been used to construct a Digital terrain Model (DTM) of the study area which is presented in Figure 2.

The LiDAR has been queried to determine the angle of the ground throughout the study area, and the results compiled to form a colour coded slope grid, presented in Figure 5. The slope grid identifies the variation in gradient across the study area, which can be analysed alongside the topographic data in Figure 6 to identify local low points where ponding of surface water could potentially occur. The slope grid provides an indication of the overall terrain however it should be noted that in reality, specific flow paths may vary due to the absence or presence of flow barriers on the ground.

As shown in Figure 5 localised areas of steeper sloping terrain are mainly located along the railway embankments, with the only significant area of steep ground located in the south west of the study area within the LB Brent. It is unlikely that the railway embankments and localised areas of steep ground would generate significant volumes of run-off.

However the steep ground within LB Brent could potentially generate significant overland flow. Examination of the LiDAR topography shows that any overland flow from this area would potentially flow north towards Site No.s 23 & 24.

Further investigation into off-site surface water flow routes will therefore be required when undertaking site specific FRAs for Site No.s 23 & 24. This should include consideration of the impact of the built environment on overland flow routes and any necessary mitigation measures on the site.

The risk of flooding from surface water run-off is therefore considered to be moderate in the south west of the study area and low throughout the remaining study area. Despite the current low risk classification, this is predicted to increase with climate change, therefore new development should be viewed as an opportunity to reduce surface water flood risk throughout the study area. Sustainable Drainage Systems (SuDS) mimic natural drainage patterns by controlling water at source and storing water to reduce flood risk throughout the drainage catchment, which are discussed further in section 8.5.

5.4 Groundwater Flooding

The Environment Agency has provided borehole data as a GIS layer containing groundwater levels throughout the study area, however these records have only been collated since January 2004. A borehole was located in the Colindale area and this shows a depth of groundwater at 40 metres below ground level. These have been mapped for the Colindale study area in Figure 6.

Groundwater flooding is usually associated with chalk and limestone catchments that allow groundwater to rise to the surface through the permeable subsoil following long periods of wet weather. However Colindale is underlain by impermeable London Clay, which would prevent any groundwater located within the underlying chalk from rising and causing flooding above ground. The risk of groundwater flooding throughout the study area is therefore considered to be low.

5.5 Sewer Flooding

Records of sewer flooding were obtained for the North London SFRA from Thames Water through a query of their DG5 registers between August 1997 and August 2007. In order to fulfil statutory commitments set by OFWAT, water companies must maintain verifiable records of sewer flooding, which is achieved through their DG5 registers. Water companies are required to record flooding arising from public foul, combined or surface water sewers and identify where properties suffered internal or external flooding.

The data provided by the water companies is limited to postcode data, resulting in the coverage of relatively large areas by comparatively limited and isolated recorded flood events. The data also only covers the last ten years of record.

In addition, the records of flooding do not account for the affect of any capital works designed to alleviate flooding. In areas exposed to frequent flooding from overloaded sewers, water companies will typically undertake alleviation works to reduce the severity and/or frequency of the flood events.

The sewer flooding data provided did not include any recorded flooding incidents within the study area therefore the risk of sewer flooding is considered to be low.

5.6 Artificial Sources / Infrastructure Failure

Artificial sources of flooding can include reservoirs, canals and lakes where water is retained above natural ground level. There are no artificial sources within the Colindale study area therefore this flood source is not considered further in this report.

5.7 Summary

Table 5.3 Summary of Flood Sources to the Colindale AAP

Flood Source	Significance to the Colindale AAP
Fluvial	Silk Stream – associated Flood Zones
Tidal	None present – No risk
Surface Water / Overland Flow	Steep topography – Moderate risk in southwest study area; Low risk elsewhere
Groundwater	Water levels 40 m bgl – Low risk
Sewer flooding	No records – Low risk
Artificial Sources/Infrastructure Failure	None present – No risk

6 The Sequential Approach

PPS25 requires that the four Flood Zones are identified for the purposes of completing the Sequential Test without the inclusion of flood defences (as shown in Figure 3). The Flood Zones mapped for the purposes of this study show that much of the Colindale AAP study area resides within Flood Zone 1. The Flood Zones 2 and 3 identified around the southern perimeter of the study area are associated with the Silk Stream and have a medium to high probability of flooding. As previously discussed within this report, the Flood Zones only relate to fluvial and tidal sources, so for the Colindale area this flood risk only concerns fluvial sources.

6.1 Background

In accordance with PPS25 a sequential approach is required by Local Planning Authorities to steer development away from areas affected by flood risk through the application of the 'Sequential Test' to future land allocations.

Under PPS25 development is only permissible in areas at risk of flooding where it can be demonstrated that there are no reasonably available sites in areas of lower risk and that the benefits outweigh the risks from flooding i.e. the development must pass the Exception Test.

Where there are no reasonably available sites in Flood Zone 1, decision makers should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2, applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should decision makers consider sites in Flood Zone 3, taking into account flood risk vulnerability and applying the Exception Test where necessary.

6.2 Sequential Test in Colindale

The Sequential Test should ideally be applied throughout the London Borough of Barnet on their preferred options sites as part of their Local Development Framework, however, this SFRA has been produced to support the Colindale AAP so the Sequential Test analysis has only been completed for this localised study area. The North London SFRA will expand on the findings of this SFRA for the entire borough to enable the wider Sequential Test to be completed.

A Sequential Test approach has been adopted to each of the sites identified by the Area Action Plan. Information was provided on the existing development, site boundary extents and proposed development uses for each of the sites.

The Sequential Test table for the Colindale AAP sites identify the suitability of the proposed land uses. Furthermore the tables identify the Flood Zones, vulnerability of proposed use and where the Exception Test may be required.

6.3 Flood Zones and Vulnerability

Planning Policy Statement 25 classifies developments according to their vulnerability. Five vulnerability classifications are defined, these are:

- Essential Infrastructure;

- Highly Vulnerable;
- More Vulnerable;
- Less Vulnerable, and
- Water Compatible.

Full definitions are provided in Table D.2 of PPS25 including the types of development that fall under these classifications (reproduced as Table 6.2).

PPS25 also stipulates where the differing types of vulnerable development may be appropriate based on flood risk. This is presented in Table D.3 of PPS25, which is reproduced below.

Table 6.1:PPS25 Table D3 Flood Risk Vulnerability and Flood Zone 'Compatibility' (DCLG, 2006)

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test Required	✓	✓
	3A	Exception Test Required	✓	✗	Exception Test Required	✓
	3B	Exception Test Required	✓	✗	✗	✗

✓ – Development is appropriate ✗ – Development should not be permitted

Table 6.2: Flood Risk Vulnerability Classification (from PPS25, Appendix D, Table D2)

ESSENTIAL INFRASTRUCTURE	• Essential transport infrastructure (including mass evacuation routes), which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
HIGHLY VULNERABLE	• Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent.
MORE VULNERABLE	• Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
LESS VULNERABLE	• Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in 'more vulnerable'; and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment plants. • Sewage treatment plants (if adequate pollution control measures are in place).
WATER-COMPATIBLE DEVELOPMENT	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel workings. • Docks, marinas and wharves. • Navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

6.4 Colindale AAP Sequential Test

Background

Colindale presents a clear regeneration opportunity: while the borough is relatively affluent, the ward of Colindale displays significant levels of deprivation across multiple aspects, while the Super Output Areas (ODPM, 2004) associated with Grahame Park are some of the most deprived in the Borough. These levels of deprivation are clearly visible in its poor public realm, and compounded by the low quality housing in which many residents live.

LB Barnet's corporate strategy, 'The Three Strands Approach' establishes Colindale as one of three strategic opportunity areas for high quality sustainable growth. Colindale's future as a strategic employment and housing location will be a key element of the Borough's long-term economic and social sustainability, but this will only be achieved if development is accompanied by appropriate community and transport infrastructure. Furthermore, The London Plan (February 2008) identifies Colindale as an Opportunity Area with the potential for a minimum of 10,000 new homes and 500 new jobs.

Colindale Area Action Plan Framework

The Colindale AAP was identified as a priority in LB Barnet's Local Development Scheme. The Borough's approach to the LDS was supported by the Greater London Authority, in particular in concentrating on adopting the emerging Replacement Unitary Development Plan as soon as practicable and the provision of two AAPs for Colindale and Mill Hill East, along with a Joint Waste Development Plan Document with its adjoining London Boroughs.

A significant amount of new housing and employment is proposed as part of this growth. Fundamental to its delivery will be a coordinated approach to addressing local transportation issues to manage and enhance access to and from the area. An AAP is proposed for Colindale to provide a planning framework for the significant amount of change proposed throughout the area. The Plan will provide a vision, strategy and delivery mechanism for realising comprehensive and well planned redevelopment. This will ensure that the necessary infrastructure to facilitate regeneration is considered in a holistic and sustainable manner. The AAP will also provide certainty and opportunities for private sector investment by giving direction, focus and development potential.

In the context of the major changes already underway in Colindale and the new London Plan policy framework there are a series of other key sites that are likely to come forward for redevelopment. In order to ensure these sites come forward for redevelopment in a coordinated and phased way, a policy framework will emerge through the various stages of Area Action Plan preparation. Without an appropriate planning response, incremental and uncoordinated development could result in missed opportunities to holistically address key physical, environmental and socio-economic infrastructure issues, which will be key to achieving mixed sustainable communities and high quality development.

Redevelopment Sites

Through the redevelopment of Grahame Park, Beaufort Park and other known housing commitments, there are already several thousand new dwellings approved for the Colindale area. However, other key sites including Colindale Hospital, Middlesex University, the Peel Centre and sites on Edgware Road have previously been identified as potential development sites due to their strategic location, brownfield status, and for some due to the fact that their use is no longer required. These sites will be key in delivering the identified target of 10,000 new homes.

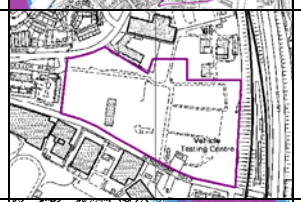
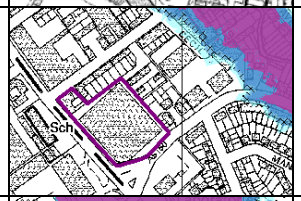
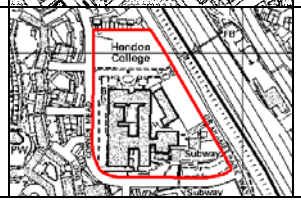
Private sector investment is already building a momentum for change in Colindale. St George is already developing a new residential quarter at Beaufort Park, and Fairview New Homes has purchased the former Colindale Hospital site and will be developing proposals for a new residential-led mixed use area, with the station as a key focus. Other key public and private sector partners are also developing proposals for key sites in Colindale.

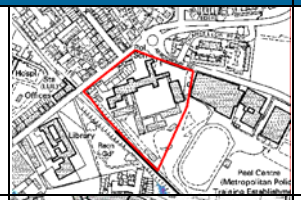
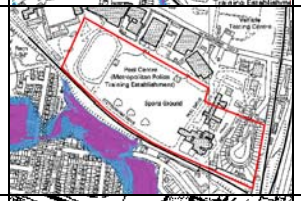
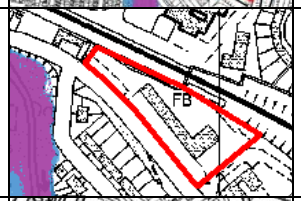
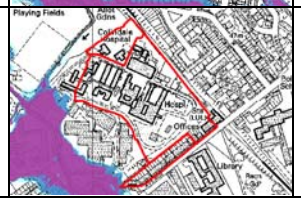
It is important that the principles of sustainability provide the foundations for growth and change in Colindale. The type and layout of housing developments, the provision of infrastructure and services to them and their detailed design and specification will be vital, and will depend to a large extent on the environmental and planning standards placed on new development proposals to ensure the highest environmental standards are achieved.

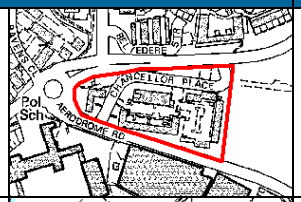
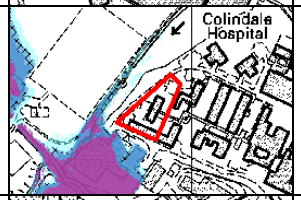
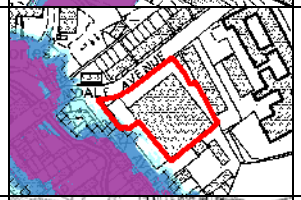
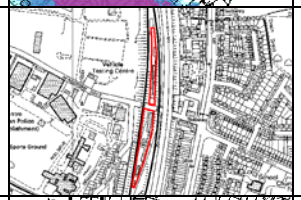
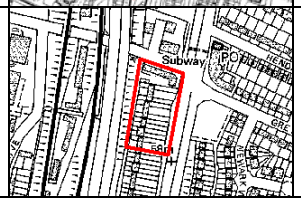
Sequential Testing

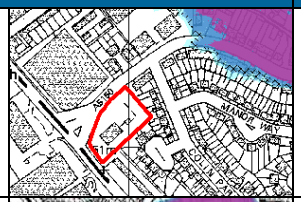
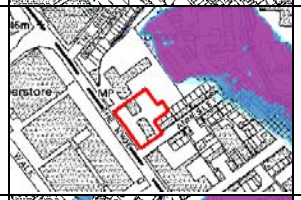
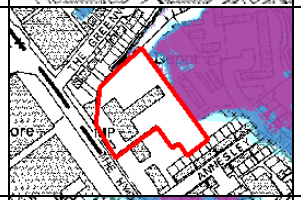
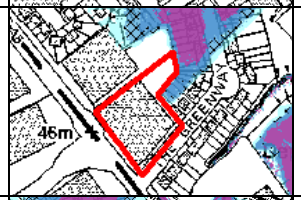
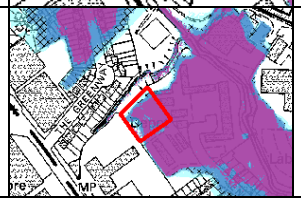
The Colindale AAP sites and proposed land uses contained in Appendix C have been sequentially tested, by comparing the proposed development vulnerability and Flood Zone classification for each site. This process confirms whether the proposed development is compatible with the PPS25 Sequential Test and the results are presented within Table 6.3 overleaf, which also includes guidance regarding the focus for future site specific FRAs.

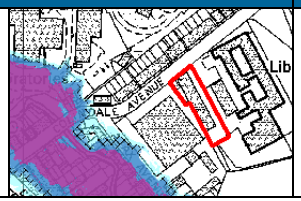
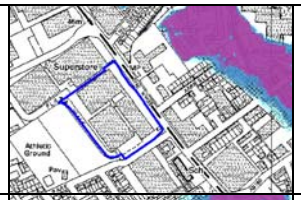
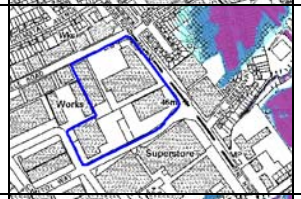
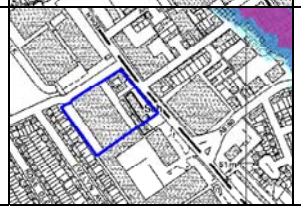
Table 6.3: Colindale AAP Sites Sequential Test (sites and proposed use taken from Table 7.1 Appendix B)

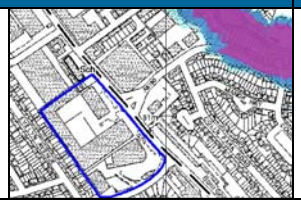
Site No	Site Name	Flood Zone		Proposed Use	Vulnerability	Sequential Test Compatible?	FRA Focus
Sites in Barnet							
1	Grahame Park (Lanacre Avenue)	FZ1		Residential-led mixed use (Neighbourhood centre)	More vulnerable	✓	Surface water drainage
2	Beaufort Park (Aerodrome Avenue)	FZ1		Residential-led mixed use (Neighbourhood centre)	More vulnerable	✓	Surface water drainage
3	Zenith House (Edgware Road)	FZ1		Residential, restaurant, bar	More vulnerable	✓	Surface water drainage
4	Former National Grid/Kidstop Premises (Edgware Road)	FZ1		Residential, B1 use (375m^2)	More vulnerable	✓	Surface water drainage
5	Barnet College (Grahame Park Way)	FZ1		Residential, primary school	More vulnerable	✓	Surface water drainage

Site No	Site Name	Flood Zone		Proposed Use	Vulnerability	Sequential Test Compatible?	FRA Focus
6	Peel Centre East (Colindale Ave/ Aerodrome Road)	FZ1		Residential-led mixed use	More vulnerable	✓	Surface water drainage
7	Peel Centre West (Aerodrome Road)	FZ1		Residential, employment, primary school	More vulnerable	✓	Surface water drainage
8	Farrow House (Colindeep Lane)	FZ1		Employment	Less vulnerable	✓	Surface water drainage
9	British Library (Colindale Avenue)	FZ1		Residential-led mixed use (likely retail, retain employment no.s)	More vulnerable	✓	Surface water drainage
10	Colindale Hospital (including frontage & Phase 2)	FZ1		Residential-led mixed use, Barnet College (50 parking spaces)	More vulnerable	✓	Investigate Montrose Playing fields ditch (Phase 2 site) Close proximity to Flood Zones therefore compare Silk Stream flood levels with topography to confirm flood extents (Frontage site) Surface water drainage

Site No	Site Name	Flood Zone		Proposed Use	Vulnerability	Sequential Test Compatible?	FRA Focus
11	Middlesex University Halls (Grahame Park Way)	FZ1		Student accommodation-led (2000 beds - 50 staff) mixed use	More vulnerable	✓	Surface water drainage
12	National Blood Service expansion site	FZ1		National Blood Service expansion (employment)	Less vulnerable	✓	Close proximity to Flood Zones therefore compare Silk Stream flood levels with topography to confirm flood extents Surface water drainage
13	Brent Works (Colindale Avenue)	FZ1		Residential	More vulnerable	✓	Close proximity to Flood Zones therefore compare Silk Stream flood levels with topography to confirm flood extents Surface water drainage
14	Land between railway line (Aerodrome Road)	FZ1		Employment	Less vulnerable	✓	Surface water drainage
15	Site along Watford Way	FZ1		Residential	More vulnerable	✓	Surface water drainage

Site No	Site Name	Flood Zone		Proposed Use	Vulnerability	Sequential Test Compatible?	FRA Focus
16	McDonalds Site (Edgware Road)	FZ1		Residential-led mixed use	More vulnerable	✓	Surface water drainage
17	Burger King & Eyeland Site (Edgware Road)	FZ1		Residential-led mixed use	More vulnerable	✓	Surface water drainage
18	Merit House (Edgware Road)	FZ1		Residential, office (presume existing office use remains)	More vulnerable	✓	Close proximity to Flood Zones therefore compare Silk Stream flood levels with topography to confirm flood extents Surface water drainage
19	Green Point (Edgware Road/The Greenway)	FZ1		Residential-led mixed use	More vulnerable	✓	Close proximity to Flood Zones therefore compare Silk Stream flood levels with topography to confirm flood extents Surface water drainage
-	Former Electricity Board Land site	FZ3B		Unknown	Unknown	✗	Functional floodplain – only water compatible development appropriate or essential infrastructure (subject to Exception Test)

Site No	Site Name	Flood Zone		Proposed Use	Vulnerability	Sequential Test Compatible?	FRA Focus
-	Land in between British Library and Brent Works	FZ1		Employment units and 2 houses	More vulnerable	✓	No FRA required (site area < 0.5Ha and no. of dwellings< 10) However surface water assessment should be encouraged
Sites in Brent							
20	Oriental City (Edgware Road)	FZ1		Retail, residential, primary school	More vulnerable	✓	Surface water drainage
21	Capitol Way (Edgware Road)	FZ1		Residential-led mixed use	More vulnerable	✓	Surface water drainage
22	Asda Site (Edgware Road)	FZ1		Asda, residential	More vulnerable	✓	Surface water drainage
23	Sarema House (Edgware Road)	FZ1		Residential, workspaces, primary school	More vulnerable	✓	Overland flow from steep topography to the south Surface water drainage

Site No	Site Name	Flood Zone		Proposed Use	Vulnerability	Sequential Test Compatible?	FRA Focus
24	Retail Park (Edgware Road)	FZ1		Retail, residential	More vulnerable	✓	Overland flow from steep topography to the south Surface water drainage

6.5 Implications of Climate Change on the Sequential Test

Modelled flood outlines have been provided for the 1 in 100 year event plus climate change, which has been used to assess the potential impact on climate change in relation to the Colindale AAP. The climate change flood extent is presented within Figure 3. The extent of Flood Zone 3a with climate change is similar to the existing Flood Zone 3a, with a slight extension generally shown.

However the increased climate change Flood Zone does not have a significant impact on the sites considered in the Colindale AAP Sequential Test, and the summary contained in Table 6.3 remains correct.

A climate change flood outline is not available for Flood Zone 2 therefore is has not been possible to consider the impact of climate change for the 1 in 1000 year flood event. The extent of the Flood Zone 2 with climate change is likely to extend further than it does at present into Flood Zone 1. This is likely to affect sites on the periphery of the existing Flood Zone 2 boundary.

The impact of this change on the Sequential Test is only really significant for Highly Vulnerable uses where in Flood Zone 2 where the Exception Test would need to be applied. As there are no Highly Vulnerable uses proposed within the Colindale AAP this impact would be considered as minimal.

7 The Exception Test

7.1 Background

After application of the Sequential Test, if it is found to be impossible for an allocation or development to be located in a lower flood risk zone, then it may be possible to apply the Exception Test at the site specific level, providing the development is consistent with the wider sustainability objectives of the area.

The Sequential Testing that has been carried out for the Colindale AAP sites indicates that proposed land uses are appropriate for the site's Flood Zone, with the exception the Former Electricity Board site. Based on the current information this is therefore the only site which may require application of the Exception Test.

7.2 Application

The Exception Test consists of three sections which are detailed below. All of these sections are required to be passed before it could be deemed that a development would be appropriate within the Flood Zone.

Part A – Wider Sustainability to the Community

It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by the SFRA where one has been prepared. If the DPD has reached the 'submission' stage (Figure 4 of PPS12; Local Development Frameworks) the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal.

- The site should be scored against the sustainability criteria of the Sustainability Appraisal.
- Where a development fails to score positively against the SA the London Borough of Barnet could consider planning conditions or Section 106 Agreements.

Part B – Redevelopment of Previously Developed Land

The development must be on developable previously developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously developed land.

Planning Policy Statement 3: Housing defines previously developed land as:

'Previously-developed land is that which is or was occupied by a permanent structure, including the curtilage of the developed land and any associated fixed surface infrastructure.'

The definition includes defence buildings, but excludes:

- Land that is or has been occupied by agricultural or forestry buildings.
- Land that has been developed for minerals extraction or waste disposal by landfill purposes where provision for restoration has been made through development control procedures.
- Land in built-up areas such as parks, recreation grounds and allotments, which, although it may feature paths, pavilions and other buildings, has not been previously developed.

- Land that was previously-developed but where the remains of the permanent structure or fixed surface structure have blended into the landscape in the process of time (to the extent that it can reasonably be considered as part of the natural surroundings).

There is no presumption that land that is previously-developed is necessarily suitable for housing development nor that the whole of the curtilage should be developed.

Part C – Safe from Flood Risk

A FRA must demonstrate that the development will be safe, without increasing food risk elsewhere, and, where possible, will reduce flood risk overall. The PPS25 Practice Guide provides details on the definition of 'safe' in Chapter 6 – Risk Management by Design, and Chapter 7 – Residual Risk.

A minimum requirement of the definition of 'safe' should be:

- Dry access for more and highly vulnerable uses;
- Dry escape for residential dwellings should be up to the 1 in 100 year flood event taking into account climate change; and
- Preferably dry for other uses such as educational establishments and less vulnerable land use classifications.

However the definition of safe should be clarified and agreed between the London Borough of Barnet and the Environment Agency and may require additional considerations depending on the precise nature of the proposed development and flood risk on a site by site basis.

It is recommended that the London Borough of Barnet complete Table 7.1 overleaf to assist in identification of possible development locations that may require Exception Testing.

Table 7.1 Sites for Application of the Exception Test ***(copy as necessary)***

SITE	FLOOD ZONE (FROM FIGURE 3 FLOOD ZONE MAP)	DEVELOPMENT VULNERABILITY	EXCEPTION TEST		
			PART A	PART B	PART C
		Essential Infrastructure / Water Compatible / Highly / More / Less	Wider Sustainability	Brownfield Land (Y/N)	Safe ?
Example	Flood Zone 3a	More Vulnerable	• Close proximity to transport infrastructure • Upgrading/improving • Intensification to reduce pressure for Green belt review	• Development of brownfield site assists LPA to satisfy government targets	• Need to be assessed in further detail for site specific context • Emergency Plan developed which highlights availability of suitable access and egress with regard to timing of flooding

8 Flood Risk Assessment Guidance

8.1 Requirement for an FRA

When informing developers of the requirements of a flood risk assessment for a development site, consideration should be given to the position of the development relative to flood sources, the vulnerability of the proposed development and its scale.

In any one of the following situations a Flood Risk Assessment would be required with a planning application:

- The development site is located in Flood Zone 2 or 3;
- The proposed development comprises 5 or more residential dwellings and/or the site area is greater than 0.5 hectares (even if the site is located in Flood Zone 1). This is to ensure surface water generated by the site is managed in a sustainable manner and does not increase the burden on existing infrastructure and/or flood risk to neighbouring property;
- The floor space of proposed non-residential development is greater than 1000m² or the site area is greater than 1 hectare;
- The development site is located in an area known to have experienced flooding problems from any flood source; and,
- The development is located within 20m of any watercourse regardless of Flood Zone classification.

8.2 FRA Content

Annex E of PPS25 presents the minimum requirements for flood risk assessment. These include:

- Considering the risk of flooding arising from the development in addition to the risk of flooding to the development;
- Identifying and quantifying the vulnerability of the development to flooding from different sources and identify potential flood risk reduction measures;
- Assessments of the remaining 'residual' risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular development;
- The vulnerability of those that could occupy and use the development, taking account of the Sequential and Exception Tests and the vulnerability classification, including arrangements for safe access;
- Considering how the ability of water to soak into the ground may change with development, along with how the proposed layout of development may affect drainage systems; and
- Fully account for current climate change scenarios and their effect on flood zoning and risk.

8.3 FRA Model Data

The Environment Agency has provided modelled flood levels from the Silk Stream flood alleviation project to represent the 'post-scheme' scenario, which are presented within Figure 7. These flood levels should be used when carrying out site specific FRAs, in order to take into account the impact of the alleviation scheme.

The Environment Agency has confirmed that the Silk Stream model is the most up to date and accurate source of flood levels which is currently available for the study area, however the model was originally constructed for a strategy study and not to estimate site specific flood levels. It therefore may be necessary to carry out additional modelling of the Silk Stream to improve the quality of flood level data during site specific FRAs. It is recommended that the Environment Agency is consulted on a site by site basis to confirm whether additional modelling will be required.

8.4 Access and Egress

Safe access and egress is required to enable the evacuation of people from the development, provide the emergency services with access to the development during times of flood and enable flood defence authorities to carry out any necessary duties during periods of flood.

Dry access and egress will be available for all sites located within Flood Zone 1. Therefore the only site which will potentially have access and egress problems is the Former Electricity Board site. Should LB Barnet decide to explore application of the Exception Test for this site, detailed investigation into access routes will be required.

'Safe' access/egress route is a route that is safe for use by occupiers without the intervention of the emergency services or others. For developments located in areas at flood risk the Environment Agency consider 'safe' access/egress to be in accordance with 'FRA Guidance for new Developments FD 2320' (Joint DEFRA and EA document) the requirements for safe access and egress from new developments are as follows in order of preference:

- Safe, dry route for people and vehicles;
- Safe, dry route for people;
- If a dry route for people is not possible, a route for people where the flood hazard (in terms of depth and velocity of flooding) is low and should not cause risk to people (hydraulic model data should be used to determine this);
- If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles.

8.5 Mitigation Measures

With the exception of the Former Electricity Board site, all sites within the Colindale AAP pass the Sequential Test and can be located within Flood Zone 1 i.e. in areas at low risk of flooding. The key mitigation measure for these site specific FRAs will therefore be surface water management through the use of SuDS where appropriate.

Although not relevant to the majority of the sites within the Colindale AAP, additional information is also provided regarding requirements for finished floor levels, floodplain compensation and flood warning and evacuation when developing in higher flood risk areas, such as Flood Zones 2 and 3.

SuDS

Traditionally, built developments have utilised piped drainage systems to manage surface water and convey surface water run-off away from developed areas as quickly as possible. Typically these systems connect to the public sewer system for treatment and/or disposal to local watercourses. Whilst this approach rapidly transfers surface water from developed areas, the alteration of natural drainage processes can potentially impact on downstream areas by increasing flood risk and reducing water quality.

SuDS techniques can be used to reduce the rate and volume and improve the water quality of surface water discharges from sites to the receiving environment (i.e. natural watercourses or public sewers etc). Various SuDS techniques are available and operate under two main principles:

- Infiltration, and;
- Attenuation.

Due consideration should be given to appropriate SuDS techniques throughout preparation and development of the overall drainage strategy for individual development sites. A ground investigation will be required in order to determine whether infiltration techniques are feasible or whether attenuation techniques are more appropriate.

The British Geological Survey (BGS) 1:50,000 Geological mapping has initially been reviewed which shows that the solid geology throughout the study area is impermeable London Clay (Figure 8) overlying the Chalk aquifer. The Clay layer varies in thickness but is approximately 50m thick throughout the majority of the study area. Alluvium is also present along the Silk Stream floodplain, which typically consists of silty clays, sands and gravels which are also typically impermeable.

Although the solid geology of the study area is impermeable it is possible that layers of permeable drift deposits such as sands and gravels overlay the Clay layer. Within such areas infiltration based drainage methods may prove more feasible, depending on the thickness of the strata. On site intrusive investigations will therefore be required to determine ground conditions on site including soakage tests to gauge potential infiltration rates.

Further additional information is included in Appendix C regarding the geology of the study area and examples of potential SuDS techniques. New development should be viewed as an opportunity to reduce surface water flood risk by achieving the Mayor of London's 'essential' or 'preferred' standard for 50% and 100% attenuation of surface water run-off respectively. The redevelopment of large sites such as Grahame Park, Beaufort House and the Peel Centre in line with the Mayor's standards will actively reduce surface water flood risk.

Finished Floor Levels

Where developing in flood risk areas is unavoidable, the most accepted method of mitigating flood risk is to ensure habitable floor levels are raised above the maximum flood water level including a freeboard allowance. This can substantially reduce the damage to property and significantly reduce the risk of injury and fatalities.

In areas of minimal floodwater depth, raising finished floor levels can usually be accommodated in building design. In areas where a substantial depth of floodwater is expected properties can incorporate a garage, utility area or public space on the ground floor with habitable areas above.

Flood Compensation Storage

Where developing in flood risk areas the total volume of storage within the floodplain must be maintained to ensure that development does not increase flood levels upstream and/or downstream of the site. Floodplain compensation will therefore be required on a level for level and volume for volume basis to ensure the shape of the hydrograph is not altered, this will involve lowering areas of land which are currently outside of the floodplain to compensate for the volume lost due to the development.

When considering requirements for floodplain compensation, the 1 in 100 year plus climate change flood levels should be used including for the effect of flood defence structures, specifically the Silk Stream flood alleviation scheme.

Functional Floodplain

The functional floodplain, referred to as Flood Zone 3b is defined by the 1 in 20 year flood extent and comprises land where water has to flow or is stored in times of flood. PPS25 recommends that policy aims for the functional floodplain should seek to reduce the overall level of flood risk in the area to and relocate development to land with a lower probability of flooding. However the PPS25 Practice Guide recognises that whilst only new water compatible development should be located in the functional floodplain, it is likely that some existing development will already be located within areas of Flood Zone 3b.

When previously developed sites with Flood Zone 3b become available for redevelopment, in an ideal world they should be returned to greenfield uses e.g. recreational areas or green open space incorporating wildlife habitat creation. However it is appreciated that there is often pressure upon Local Planning Authorities to retain valuable developed land, based on their obligations to meet the growth targets set out in the London Plan. The PPS25 Practice Guide recognises this and states that existing infrastructure or solid buildings within Flood Zone 3b will not normally be defined as functional floodplain.

Assuming that the Environment Agency agree that the specific existing infrastructure and solid buildings are not considered to form functional floodplain then it may be possible to redevelop sites within the functional floodplain provided that the footprint of the proposed development is not greater than the existing footprint and it can be demonstrated that the site will be safe for future users throughout the design life of the development, including for the effects of climate change.

It is anticipated that it will be challenging to meet these requirements as this is likely to require raised finished floor levels and access & egress routes, whilst ensuring that there is no net loss of floodplain storage volume on a level for level basis. It may be more appropriate to retain existing ground levels and provide lower vulnerability uses such as car parking at ground flood levels with habitable uses above and provide access via walkways that will not reduce floodplain storage.

It should be reiterated that in line with the PPS25 sequential approach, it is recommended that the Former Electricity Board site is not brought forward for significant built development, and it should ideally be returned to greenfield use. However should LB Barnet wish to promote the site for development a feasibility study should be commissioned to determine whether this is likely to be possible based on the requirements discussed above and expanded within PPS25 and the Practice Guide.

Flood Warning and Evacuation Plans

Flood Warning and Emergency Procedures tend to form part of a higher level emergency management plans for the wider area including information such as repair procedures, evacuation routes, refuge areas flood warning dissemination and responsibilities.

When applying the Sequential Test to determine the type of development that may be appropriate in the district, the type of flood warning procedure that exists and the time between the flood warning and the flood peak should be analysed.

9 Policy Recommendations

National and local policies have been reviewed against the local flood risk issues in order to formulate appropriate policies to be taken forward for the Colindale AAP.

9.1 Flood Mitigation

- Surface water flooding should be investigated in detail as part of FRAs for all developments, and comprehensive surface water runoff calculations undertaken. On site intrusive investigations will be required to determine potential for infiltration based SuDS.
- All flood risk assessments and sustainable drainage design should consider the impacts of climate change for the lifetime of the development, both on the site and downstream.
- Surface water discharge rates from new developments must not increase following redevelopment, including an allowance for climate change. The Mayor of London's requirements for attenuation must be adhered to.

9.2 Development Control

- The Council should ensure new development in an area known to suffer surface water flooding does not increase the discharge to the existing drainage system either though restricting site discharge rates and/or through capital contributions to improvements works of the existing drainage infrastructure.
- Ensure that proposed developments can be accommodated by the existing infrastructure provision. Where a development cannot be met by current resources, ensure that the phasing of development is in tandem with infrastructure investment.

9.3 Environmental

- Consider the potential benefits an appropriately designed Sustainable Drainage System could have for the biodiversity, amenity value, water quality and resource value of a development and/or surrounding area.
- Consider the vulnerability and importance of local ecological resources when determining the suitability of drainage strategies/SuDS.

10 Conclusions and Recommendations

10.1 Conclusions

Scott Wilson has been commissioned to undertake a Strategic Flood Risk Assessment for the Colindale Area Action Plan area, located in LB Barnet. This study has considered all sources of flood risk throughout the area in relation to the allocation sites identified in LB Barnet's Local Development Scheme.

This study has investigated tidal, fluvial, groundwater, sewer and surface water flooding sources, however there are no tidal flood sources and no sewer flooding records have been identified within the study area. The main source of fluvial flood risk is the Silk Stream, which follows the southern boundary of the AAP study area.

There are no formal flood defences in the Colindale area, however the Silk Stream flood alleviation scheme was recently completed, which provides flood storage upstream of the study area. The Flood Zones have been mapped with and without the benefits of the flood alleviation scheme, which demonstrates that the scheme has a minimal impact on the Flood Zone extents within the Colindale area.

The study area is urbanised and underlain by impermeable London Clay hence there is limited potential for infiltration and an increased risk of surface water flooding. Topographic data analysis has been undertaken to provide additional information and highlight specific areas at risk. The analysis indicates that the south west of the study area has an increased risk from surface water flows originating on surrounding high ground. Surface water flooding should therefore be the main focus for site specific flood risk assessments in this area. Infiltration SuDS are unlikely to prove feasible given the underlying geology, therefore attenuation and retention SuDS would be more suitable.

The PPS25 Sequential Test has been considered for each of the identified Colindale AAP sites and proposed development vulnerabilities. With the exception of the Former Electricity Board site, which is an optional additional site, all other sites are located wholly in Flood Zone 1 and their intended development uses are considered compatible with PPS25 guidance and the Sequential Test.

Should the additional Former Electricity Board site be required for future development a feasibility study should initially be carried out to determine development potential of the site. Based on PPS25 it is likely that only water compatible uses or essential infrastructure would be permitted, subject to compliance with the requirements of the PPS25 Exception Test. The site is dominated by functional floodplain, and as such an ideal future use could be as additional green space to provide improved flood storage capacity within the study area.

Sites 10, 12, 13, 18 and 19 are located in close proximity to the existing Flood Zones, therefore whilst they pass the Sequential Test, their site specific flood risk assessments should consider a detailed topographic assessment and comparison of flood levels with proposed finished floor levels as a pragmatic precautionary approach.

10.2 Recommendations

Flood Risk Assessments

The majority of sites identified within the Colindale AAP require site specific flood risk assessments. It has been identified in this study that the main focus of these assessments should be on surface water flooding. In some areas where the site lies on the floodplain extent, detailed comparisons should be made to ensure finished floor levels are above predicted flood levels.

Should the Former Electricity Board site be developed, this will require a detailed flood risk assessment and consideration of the site layout to ensure all vulnerable uses are located in areas of lower flood risk. It is likely that the Exception Test would be required for this site.

Surface Water Strategy

The proposed increase in development in this area will intensify surface water runoff in areas previously considered permeable. To ensure there is no increase in flood risk downstream it is essential surface water flood risk is considered and managed on a strategic scale. The Mayors Plan requires a 50% reduction in surface water from future developments, however infiltration SuDS are not feasible in this area making surface water management more of a challenge to future developers. Therefore it may be prudent to undertake a surface water strategy for the Colindale AAP sites to assess the suitability of a strategic SuDS scheme that could be used to facilitate attenuation for the AAP masterplan area.

London Borough of Barnet SFRA

The North London SFRA which includes the London Borough of Barnet was in draft at the time of production of this report. Therefore on completion of this study the Colindale AAP SFRA should be reviewed. Updated modelling and mapping of the Flood Zone Maps should be incorporated into future revisions of this document where they are undertaken.