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BARNET
LONDON BOROUGH

Colindale
Area Action Plan

Supporting Documents

Outline Surface Water Management Strategy

June 2009

Local
Development
Framework

Revision Schedule

Outline Surface Water Management Strategy for Colindale AAP - Final Technical Report
June 2009

Rev	Date	Details	Prepared by	Reviewed by	Approved by
01	May 2009	Draft	**Matthew Graham** Principal Consultant	**Damon O'Brien** Technical Director	**Damon O'Brien** Technical Director
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Executive Summary

Background and Aims

Colindale has been identified by the London Plan as an "Opportunity Area" with 10,000 new homes planned by the year 2016. To meet this growth target, 24 development sites covering 102.5 ha have been selected and clustered into 4 "Corridors of Change" by London Borough of Barnet. These sites comprise the Colindale Area Action Plan (AAP).

Colindale is located within the Silk Stream catchment (a tributary of the Brent River), which demonstrates the response to storm rainfall that is expected from an urbanised catchment: a reduction in the hydraulic lag time and time base, as well as an increase in the peak flow over that naturally expected. An aggravating factor is the underlying geology (London Clay) that makes it even more susceptible to short intense rainfall events and restricts the feasibility of infiltration SUDS, making surface water management a challenge to future developers. The catchment has changed significantly over time, from a predominantly rural catchment to a more urbanised catchment. As a result of these land use changes the hydraulic lag time has reduced and this compounded by the underlying soil conditions. Furthermore, historic surface water flooding has been reported within Colindale in 1982, 1992 and more recently in 2007.

Key development areas have been identified in Colindale and hence the need for a Surface Water Management Plan to direct development away from areas at risk from surface water flooding. The results of this study will compliment the SFRA by quantifying the risk of surface water flooding as recommended in Planning Policy Statement (PPPS25) and the Pitt Review.

Scott Wilson was commissioned by Urban Practitioners on behalf of London Borough of Barnet to undertake an Outline Surface Water Management Plan to support the Colindale Area Action Plan (AAP) by providing clear guidance and technical recommendations (based on outline pluvial modelling) to address surface water management over a 25 year appraisal period. This study is also required for the AAP to be in general conformity with the London Plan. The aim is to identify and assess at an early stage of planning:

- any fundamental problems associated with surface water flooding and related to land allocation and/or layout that could impact the current indicative master plan;
- the suitability of a strategic sustainable drainage system, the funding and implementation of which could be secured through Section 106 agreements and added as a priority for developer's contributions.

Methodology

- Data collection through site visits conducted in conjunction with the Environment Agency.
- Data collected from the London Borough of Barnet Highways Drainage Department.
- Data collection and review of historical surface water flooding data held at the British Library, Colindale.
- Two separate types of probabilistic pluvial modelling were undertaking to identify overland flow paths and surface water ponding areas. The outputs from the numerical modelling also helped to support the identification of Critical Drainage Areas.
- Crititial Drainage Areas (CDAs) within the study area were identified by applying an underlying hypothesis that CDAs are characterised by the amount of surface water runoff that drains into the CDA, its topography and hydraulic conditions of the river system, as well as receptors (properties, infrastructure and people) that can be affected by flooding.

Results

This study has shown that most of the land area identified for development in the AAP is at low risk of surface water flooding. Pluvial modelling, confirmed by site surveys and analysis of past flood events from all sources, has enabled the identification of Critical Drainage Areas (CDAs) where flood storage and/or more regular river/highway drainage asset maintenance will be required. This modelling was undertaken using two methods, one of which was undertaken by Imperial College. These CDAs include:

- CDA 1 - The Greenway;
- CDA 2 - Lanacre Avenue between Montrose Avenue and Grahame Park;
- CDA 3 - Colindeep Lane, between Hanover Court and Rushgrove Avenue.

The identification of these CDAs within Colindale, should support the basis of a risk-based maintenance programme for Council highways drainage assets (e.g. gully pots) where clearing works should be carried out at a higher frequency.

Although this study has included the provision of preliminary storage volume requirements based upon the indicative development plans, once the final development plans are confirmed, a detailed drainage study for all four Corridors of Change will need to be undertaken.

This, together with the identification of preferential flow paths and ponding areas through modelling, provides the required evidence base to undertake a detailed surface water management strategy for the Colindale AAP, in terms of high level localisation and initial sizing of source control, conveyance and attenuation SUDS.

A preliminary assessment of the Surface Water Management Train (CIRIA 2005) has also been undertaken. Due to the impermeable nature of the underlying geology, SUDS components are likely to rely mostly on conveyance and storage. This is however subject to confirmation of infiltration capacity at the development stage, as infiltration may still be possible in some areas (such as made ground and alluvium).

Recommendations

In addition to the technical outputs highlighted above, various areas of improvement have been identified and corresponding recommendations have been formulated (See Chapter 7 for detailed recommendations). A brief summary of these recommendations includes:

- Opportunities for river enhancement;
- Opportunities for large-scale rainwater harvesting;
- Opportunities for flood attenuation and storage and improvement of Montrose Park;
- Need for an asset register / centralised drainage database;
- Risk-based approach to drainage maintenance.

Anticipated Project Benefits

This outline Surface Water Management Strategy will bring the following benefits:

- Clear benefits to the London Borough of Barnet, through
- An improved understanding of surface water flood risk (ponding areas & overland flow paths);
- SUDS guidance to both the Council and Developers;
- Opportunity to improve communication/coordination on future flood incident management.
- Runoff (volumetric) reduction from regeneration areas with complimentary opportunity for water quality improvements (from diffuse sources).
- The surface water flood risk map can be used by the Emergency Planning Team at Barnet and the London Local Resilience Forum (LRF) to inform multi-agency flood plans and emergency procedures as required by the Cabinet Office (COBR) and under the Civil Contingencies Act.
- Clear advantages to the spatial planning system, better decision making based upon clear and available information on surface water flooding (ponding areas and overland flow paths as well as proposed flood risk mitigation measures).
- Shared understanding of flood risk (all sources) despite limitations on sewer flooding data.
- Opportunities for improved communication and clarity to the public.
- Opportunity for coordinated investments across public sector bodies and water company.
- It provides evidence base for Area Action Plan, indicative developer actions and investment plan.

Outstanding key challenges

Throughout the progress of the project, a number of issues could not be resolved, and are listed below. These barriers should be seen as areas of improvement where they include deficiencies, and/or as opportunities to identify the scope for further investigations where critical data gaps are obvious.

- Inability to assess the risks from the sewer network: No sewer data from Thames Water was provided for the purpose of this study, and therefore the contribution of the sewer network to the drainage of the study area could not be fully assessed.
- Uncertainties regarding the actual impact of climate change: Climate change has been taken into account when modelling rainfall routing over Colindale and computing the required storage volumes. However, although climate change is acknowledged as taking place, there is uncertainty regarding the hydrological changes, particularly of extreme short duration events.
- Thames Water was not able to supply information in the required timeframe;

Table of Contents

1 Background & Aims

This Outline Surface Water Management Strategy has been produced to support the Colindale Area Action Plan (AAP) which is currently being prepared by the London Borough of Barnet. Its purpose is to provide clear guidance and a summary of technical recommendations and conclusions to address surface water management over a 25 year planning period. This report covers the following surface water related issues:

- Forms of flooding & surface water flood risk across Colindale;
- Identification of Critical Drainage Areas (CDAs);
- Outline SUDS Strategy for Colindale AAP;
- Tools for sustainable asset management;
- Developer guidance;
- Action plan & policy recommendations.

1.1 Objectives as set out in the Brief

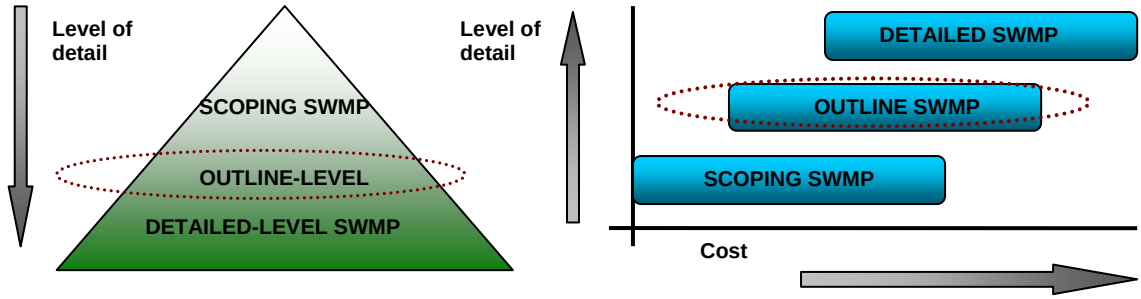
The overall aim of the project is to produce a high level assessment of flood risk from all surface water sources and provide the necessary evidence base for planning policy recommendations to the Council. This draft technical report establishes the methodological foundation for a future Borough-wide or sub-Regional surface water management plan (SWMP). The specific deliverables include the following:

1. Identify Critical Drainage Areas (CDAs);
2. Produce a surface water flood risk map that can be used in conjunction with the SFRA to inform the allocation of land and inform the London Resilience Forum (LRF);
3. Provide detailed data on surface water flooding to inform future updates of the Drain London Draft Scoping Study (February 2009);
4. Provide recommendations for a sustainable drainage strategy for the Colindale AAP;
5. Produce an Outline Surface Water Management Plan (SWMP) for Colindale.

1.2 Overview of Methodology

The Outline SWMP focuses on identifying flood risk sources and quantifying the risk of surface water flooding, an appreciation of how this can mitigated through sustainable design and engineering, the likely causes and benefits, and a set of recommendations for future management strategies, including any further detailed work required. For the purposes of quantification, we have used two separate pluvial modelling packages. The Outline-level SWMP will deliver a Plan suitable for use in master planning and as the supporting evidence base for wider planning objectives, including Local Development Documents and Local Development Frameworks, see Figure 1a below:

Figure 1a - Hierarchy of SWMPs



Our methodology for an Outline SWMP follows the draft Defra guidance on Surface Water Management Plans[1], as per Figure 1b, below:

Figure 1b - Outline SWMP stages

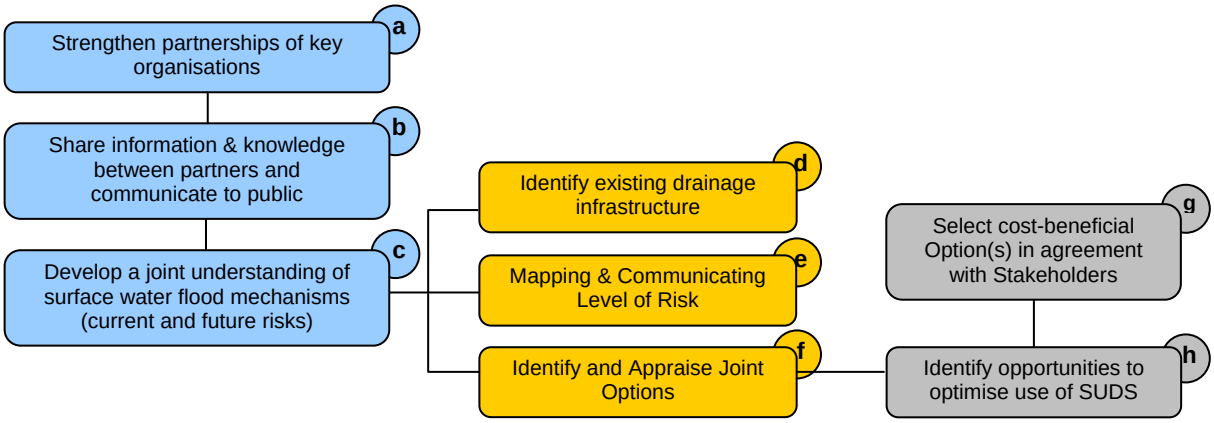
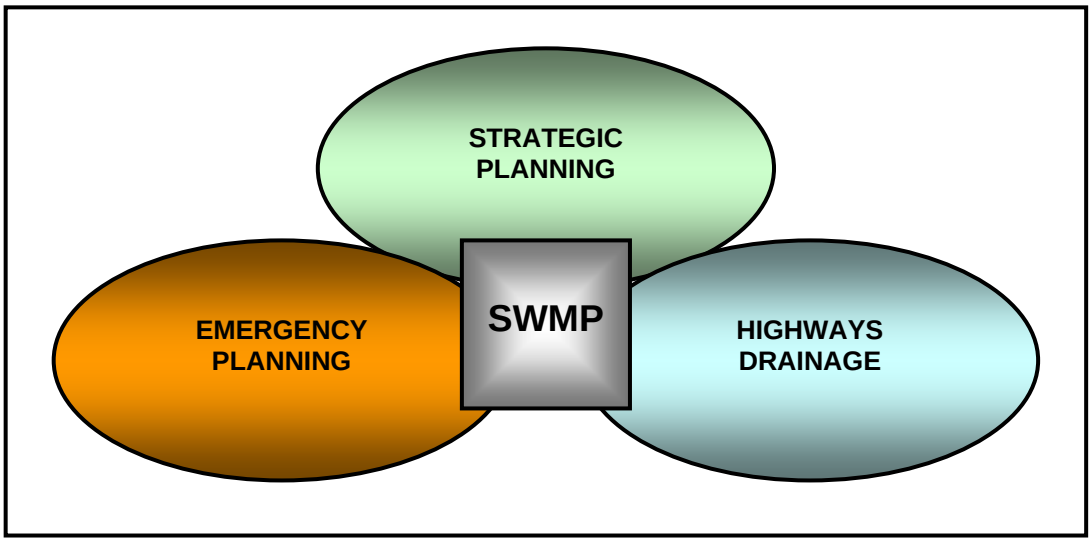


Figure 1c - Surface Water Management Plans (a Local Authority perspective)



[1] Defra - *Surface Water Management Plan Technical Guidance*, February 2009

1.3 Policy & Drivers

The primary driver for this study is the scale, extent and number of new major developments which have been put forward in the Area Action Plan as well as comments raised by the Greater London Authority regarding the need to assess surface water flood risk and strategic SUDS solutions. Other drivers include:

- Pitt Review & Government Response (December 2008);
- EU Floods Directive (2007);
- EU Water Framework Directive (2000);
- Defra-led National Indicator 188 (Planning to Adapt to Climate Change) & 189 (Flood & Coastal Erosion Risk Management);
- Civil Contingencies Act (2004);
- Making Space for Water (MSfW) – March 2005;
- London Plan (2004);
- Thames CFMP (& Brent Policy Unit) - 2008;
- North London River Restoration Strategy (2007).

1.4 Consultation, data collection and review

Data was collected through several on-site field visits (including one with the Environment Agency River Inspector) and through a review of technical data obtained from Key Stakeholders (Thames Water, Greater London Authority and the Environment Agency). The following is a summary of documents reviewed when undertaking this study:

Table 1 - Data collected and main data gaps

Stakeholder organisation	Data collected	Data gaps
Environment Agency	► Catchment Flood Management Plans (CFMPs) North London SFRA ► LiDAR data ► Flow data, Silk Stream ► River Maintenance Program	● Maps of Areas at Risk of Surface Water Flooding ●Catchment boundaries, Culverts data ● Updated data from NFCDD on asset conditon ● Rainfall data
Thames Water	►Historic data on sewer flooding to 3-digit post code.	● Drainage Area Plans (+ Network model) ● Combined/Storm Sewer models or asset data ● Continuous and intermittent discharges ● Groundwater level from water supply boreholes
Met Office	None	Rainfall data and frequency analyses
Barnet Council	► SFRA for Colindale ►Maintenance regime (Barnet Highways Department) ► Historic flood event data (high level)	● Details of maintenance regime ● Locations and number of asset failures ● Historic surface water and groundwater flooding events data

2 Study Area

The Colindale Area Action Plan, located within the London Borough of Barnet, comprises approximately 200 hectares of which approximately 102 hectares have been earmarked for re-development.

See Figure 2 – showing location of study area as well as adjoining Council boundaries, below.

2.1 Summary of regeneration proposals for Colindale Area Action Plan

The London Borough of Barnet has identified Colindale as one of the largest growth areas in the Borough with approximately 10,000 new homes planned. A brief summary of the proposed regeneration is described in detail in the draft Colindale Area Action Plan which sets out the four (4) regeneration corridors, known as Corridors of Change, as follows:

1. Colindale Avenue, comprising development sites 6, 9, 10, 12 & 13 and a total area of 14.25 hectares.
2. Aerodrome Road, comprising development sites 2, 7, 8, 11, 14 and a total area of 28.5 hectares.
3. Edgware Road, comprising development sites 3, 4, 15-24 and a total area of 19.65 hectares.
4. Grahame Park, comprising development sites 1 & 5 and a total area of 40.1 hectares.

Excerpt from Colindale AAP indicating the locations of the four Corridors of Change

2.2 Description of key characteristics of the study area

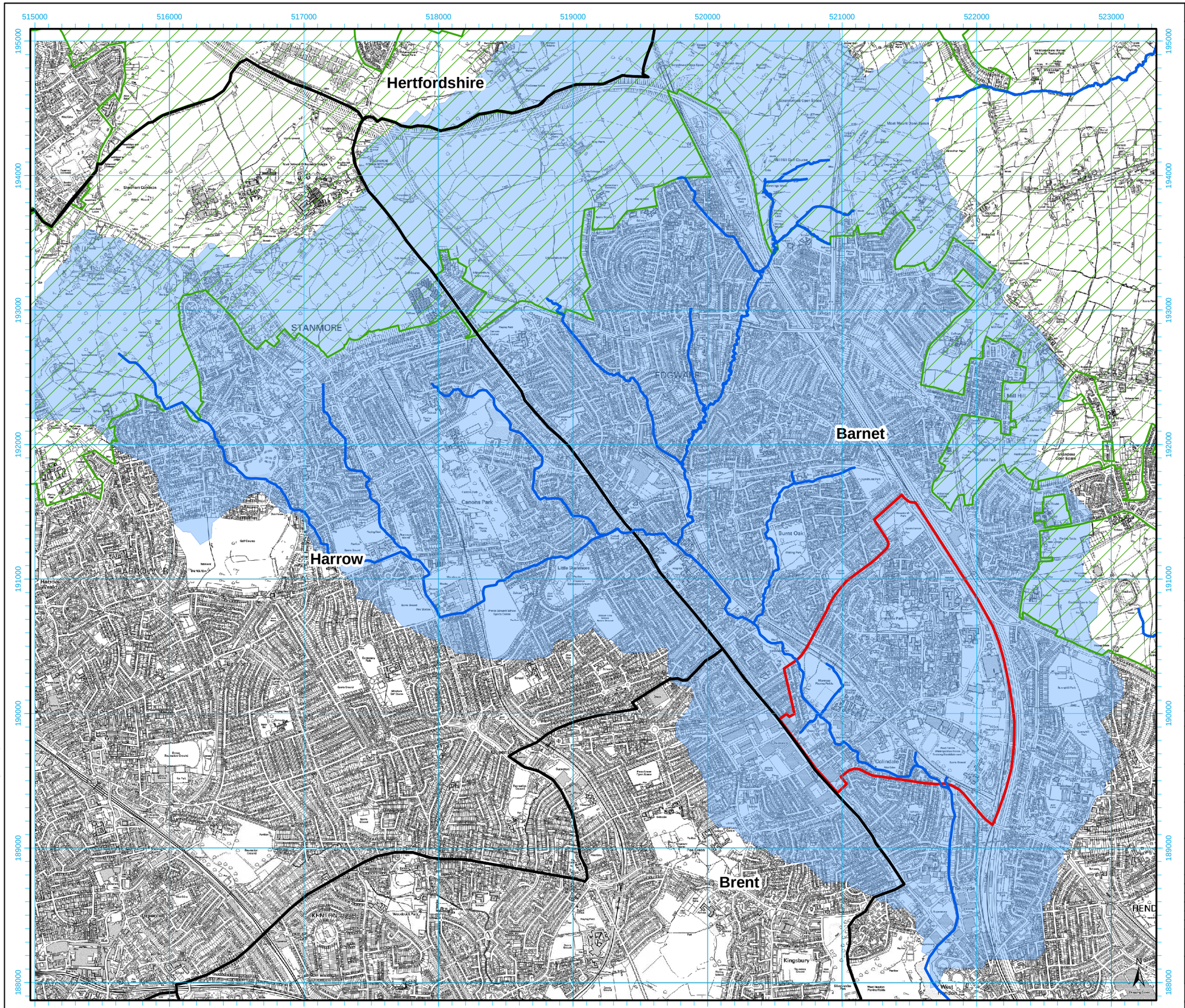
The Silk Stream, a tributary of the river Brent, drains a catchment of 32 km^2. The River Brent joins the River Thames on the Tideway at Brentford. The catchment is predominantly urban with suburban areas in the upper catchment (see Figure 2). The underlying geology is London Clay. As shown in Table 2 below, the Silk Stream catchment mostly lies within the London Borough of Barnet, but also receives contributions from areas located in the London Boroughs of Harrow, Brent and from Hertfordshire.

Table 2 – Local Authority administrative areas contributing to the Silk Stream catchment

Administrative area	Area contributing to the Silk Stream catchment	
	km^2	%
Barnet	20.83	64.3%
Brent	1.30	4.0%
Harrow	9.24	28.5%
Hertfordshire	1.02	3.2%
Total Silk Stream	**32.39**	**100.0%**

Table 3 - Physical catchment characteristics

Characteristic	Data
Study area (Colindale AAP area)	Approximately 200 ha
Area of proposed development sites (Corridors of Change)	102.5 ha
Silk Stream catchment area (sq km)	32.39
Total length of watercourse (in study area)	1.75 km
Lowest point (in study area)	37.9m
Highest point (in study area)	92.1m
Average Annual Rainfall (mm) - FEH CD-ROM	699



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Legend

- Silk Stream & Tributaries
- Borough Boundaries
- Greenbelt
- Colindale AAP - Study Area
- Silk Stream Catchment (FEH)

NOTES

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: COLINDALE AAP

SURFACE WATER MANAGEMENT STRATEGY

Drawing Title: SILK STREAM CATCHMENT & ADMINISTRATIVE BOUNDARIES

Scale at A3	1:27,000		
Drawn	TB	Approved	MG
Stage 1 check	Stage 2 check	Originated	Date

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Drawing Number: **FIGURE 2** Rev

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3 Sources of flood risk

Surface water flooding includes four primary flood sources according to the *Surface Water Management Plan Technical Guidance* February 2009, as described below:

- Flooding from small open channels and culverted urban watercourses which receive most of their flow from inside the urban area;
- Sewer flooding; flooding which occurs when the capacity of the underground network systems is exceeded, resulting in flooding inside and outside of buildings. Normal discharge of sewers and drains through outfalls may be impeded by high water levels in receiving waters;
- Groundwater flooding; flooding which occurs when groundwater rises to the surface through permeable subsoil following long periods of wet weather;
- Pluvial flooding; flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse, or cannot enter because the network at capacity.

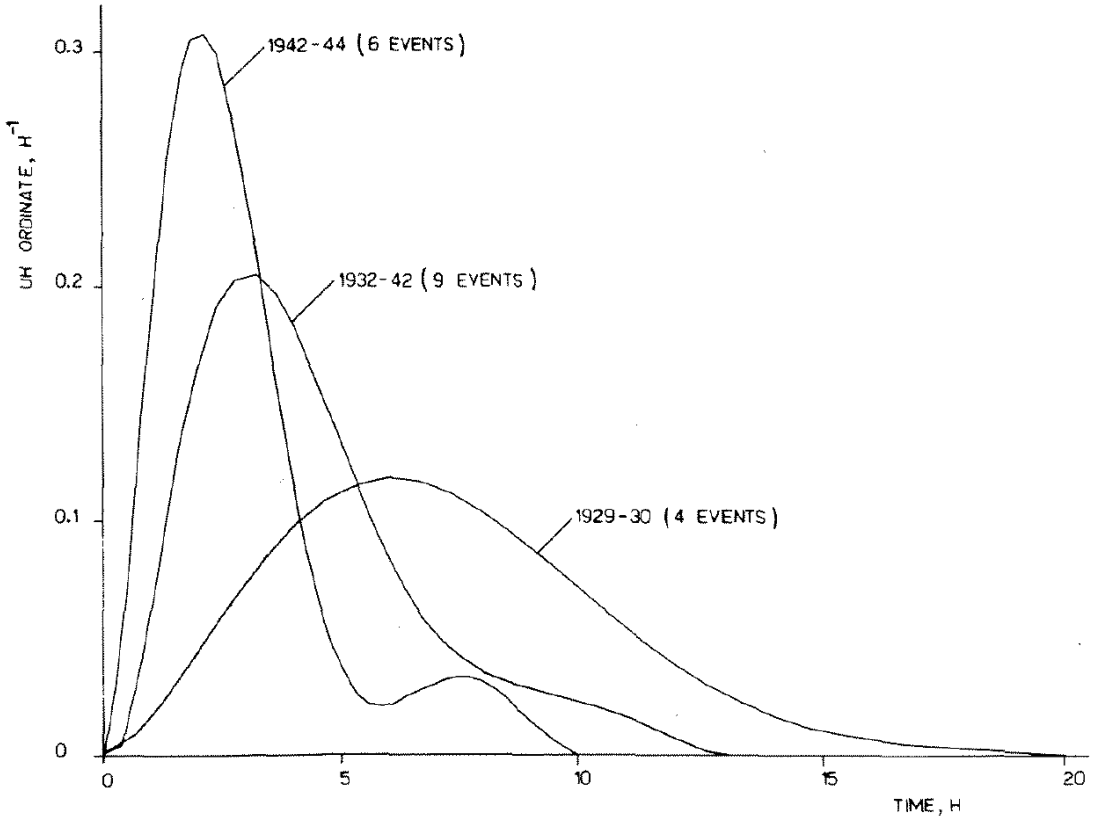
3.1 Hydrology

3.1.1 Catchment characteristics and history

The Silk Stream catchment was predominantly rural until the early 1920s, and then experienced extensive urbanisation between 1920 and 1940. From 1955 to about 1970, development was concentrated mainly in small pockets of rural area within the existing urbanisation, which raised the proportion of impervious area to approximately 25%[2]. As a result of development, the Silk Stream catchment experienced a significant change in its response to storm rainfall between 1929 and 1944 (see Figure 3 below), displaying all the features expected from an urbanising catchment: a reduction in the hydraulic lag time and time base, as well as an increase in the peak flow as the urban area developed.

[2] M.J. Hall, 1978. *The effect of urbanization on storm runoff from two catchment areas in North London*, IAHS Pulication N^0 123, pp.144-152.

Figure 3 - One-hour unit hydrographs for the Silk Stream at Colindeep Lane (M.J. Hall, 1978)



The key characteristics of the Silk Stream catchment are displayed in Table 4 below.

Table 4 - Main catchment descriptors from the FEH CD-ROM Version 2

Catchment Descriptors	
Catchment drainage area	32.39 km^2
Index of catchment steepness	40.3 m/km
Longest drainage path	11.36 km
Index of proportion of time that soils are wet	0.29
1961-1990 standard-period average annual rainfall	684 mm
1941-1970 standard-period average annual rainfall	699 mm
FEH index of fractional urban extent for 1990	0.3171

3.1.2 Rainfall gauging and telemetry sites

There are no rainfall gauging stations within the study area. The closest rainfall gauging station is located in Mill Hill Cemetery, some 1.5 km north-east of the study area.

The Environment Agency manages a flow gauging station at Colindeep Lane. Daily-averaged flow data is available between 1973 and 2006 and 15 minute-averaged flow data is available for 2007-2008.

3.1.3 Fluvial hydraulic structures along the Silk Stream

There are a number of hydraulic structures (weirs and bridges) along the channel within the Colindale study area. Whilst weirs aim to maintain a minimum water level during drought periods, bridges represent a constriction of the cross section, restricting the channel's capacity during major storm events. The consequence of reduced channel conveyance is increased water levels upstream which can reduce the capacity of the sewer system to discharge to rivers (e.g., Silk Stream).

From the modelled flood water levels in the Silk Stream, the bridges generating the most significant head losses for all modelled return periods (thus representing the most critical areal constriction) have been identified:

- Bridge at Montrose Playing Fields, immediately upstream of the confluence with the Tramway Ditch;
- Bridge at Sheaveshill Avenue;
- Bridge at Colindeep Lane.

These bridge intersections logically correspond to areas of known fluvial flood risk. A long profile of the Silk Stream bed levels (and its main two tributaries within the study area, based on LiDAR data), as well as the 1 in 100 year flood levels, are presented in Figure 4 below, highlighting bridges intersections and corresponding head losses. In addition, this long profile should be used as an indicative guide to identify suitable locations for new discharge points from the development sites, as high water levels in the Silk Stream may impede discharge from storage ponds.

3.1.4 Analysis of flow data

Figure 5 below uses daily-averaged flow records, from which monthly maximums were averaged per season (January to March / April to June / July to September / October to December) and ranked from the wettest to the driest year. This indicates that even though autumn and winter remain, as expected, the wettest months throughout the period of record, the highest peak flows are observed during summer.

Figure 4 - Long profile of the Silk Stream

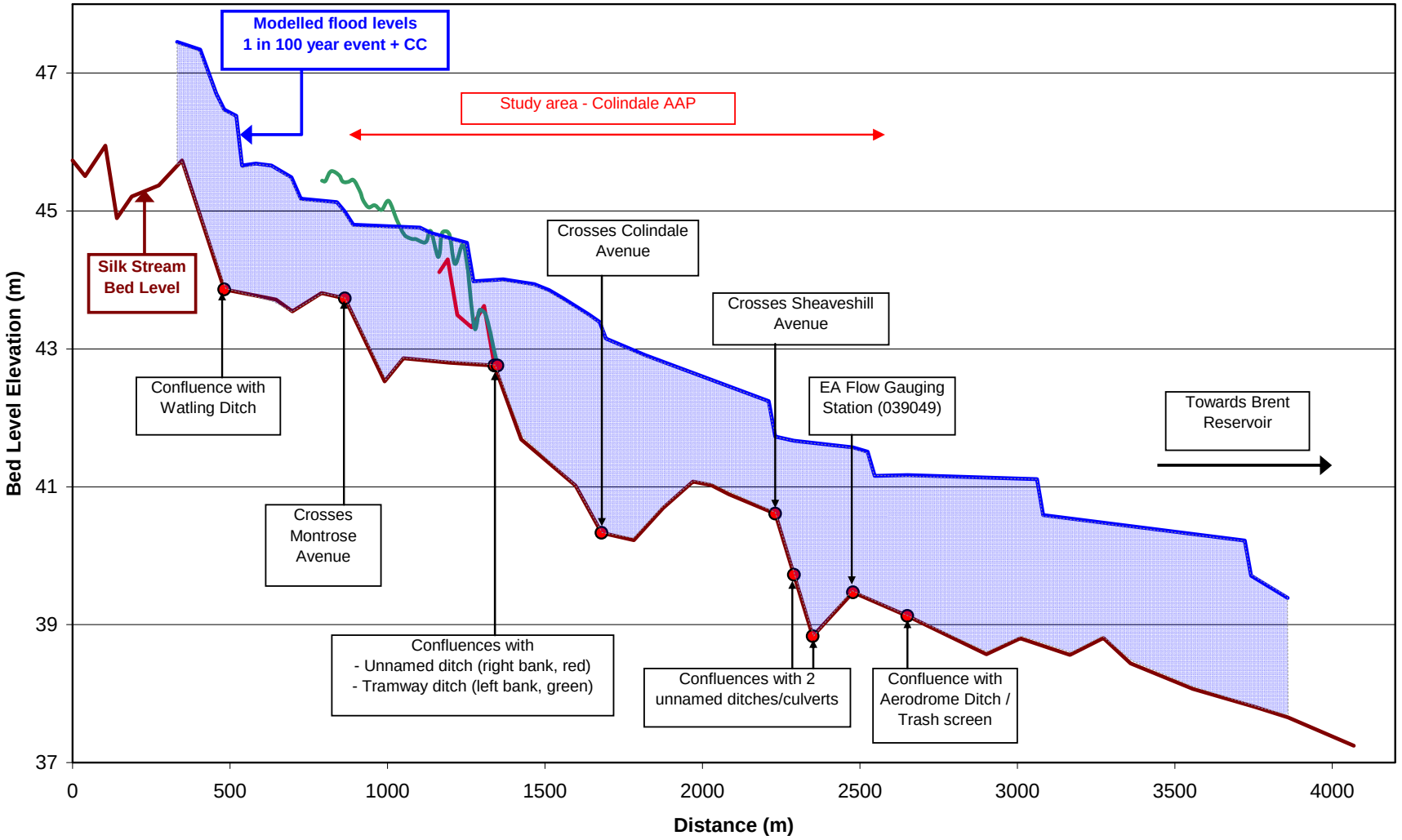
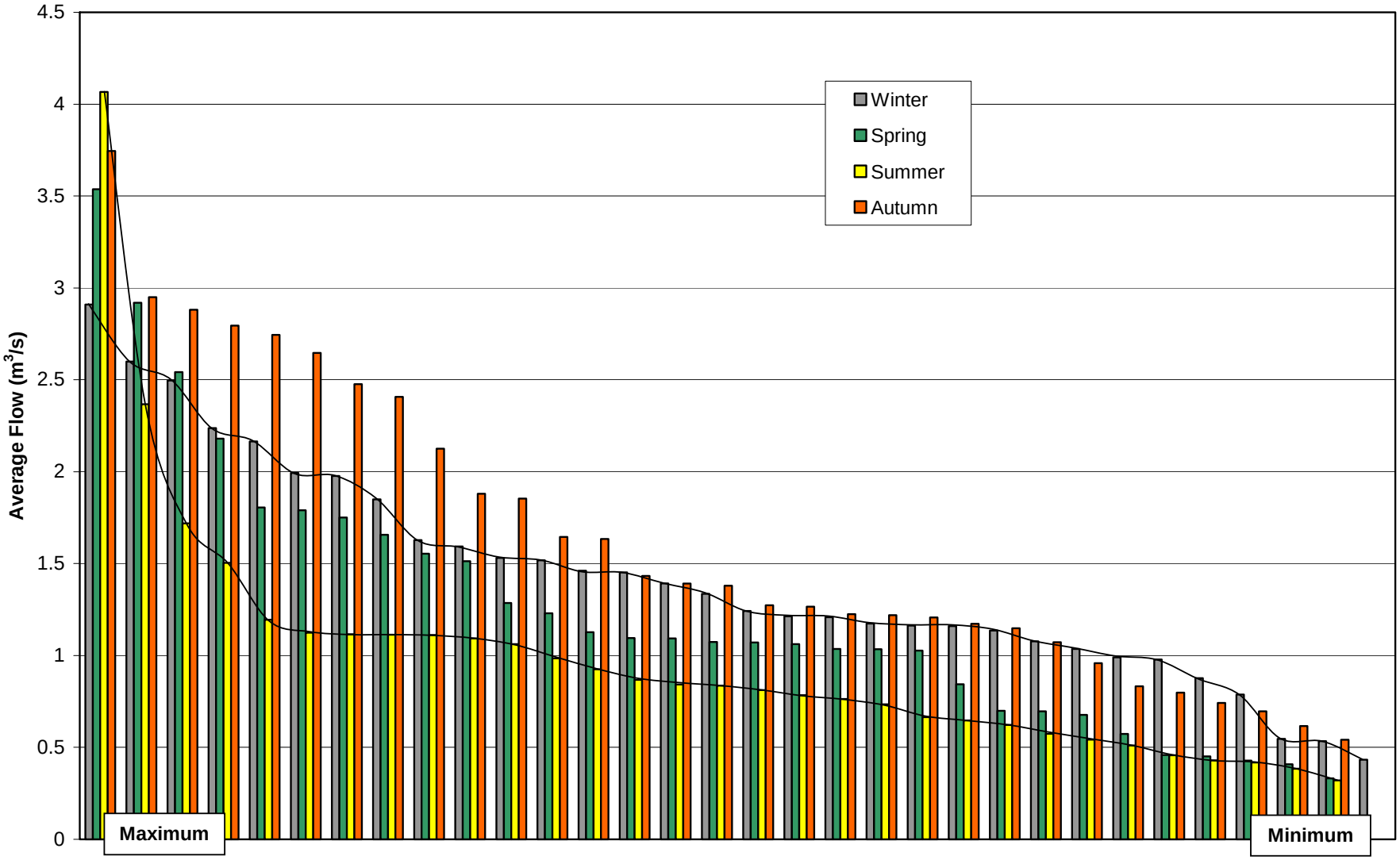


Figure 5 - Maximum Monthly Flow at Colindeep Lane - Ranked Seasonal Average (1974 to 2008)



3.2 Fluvial (small open channel and culverted watercourses)

Method of Assessment

Given that the focus of this Outline SWMP is primarily targeted at understanding urban flooding and how it may affect future development proposals in Colindale, this section presents a brief summary of existing fluvial data only. Fluvial flooding is not the main focus of a SWMP as this is satisfactorily covered in the SFRA. However, fluvial flooding and river levels could have an impact on discharge from the proposed development.

We have not undertaken an analysis of the Environment Agency's hydrodynamic river model for the Silk Stream or its tributaries.

3.2.1 Fluvial flood history in the Silk Stream

Data collected and reviewed from the River Brent Flood Risk Management Strategy (EA) indicated that there are 1,257 properties at risk of flooding from a 1% annual probability event (1 in 100 year) in the Upper Silk Stream Catchment and 780 properties at risk from a 1% event in the Lower Silk Stream Catchment. The Colindale Area Action Plan is situated within the Lower Silk Stream Catchment.

As part of this study we have conducted a detailed desk study associated with the flood history in Colindale. From newspaper records the Silk Stream flooded in 1982 & 1992. More recently, the Silk Stream flooded in July 2007, details as follows:

- 1982 – Flooded areas included: Burrell Close and nearby roads, Springwood Estate and shops in Hale Lane. Stanmore Broadway was affected (reported water depth, 18 inches), as well as the basement of WHSmith (reported water depth, 6 feet). The flooding was a combination of surface water, sewage and the Silk Stream overtopping its banks at the upstream end of Rushgrove Park.
- September 1992 – A total of 293 properties were affected in the Edgware area.

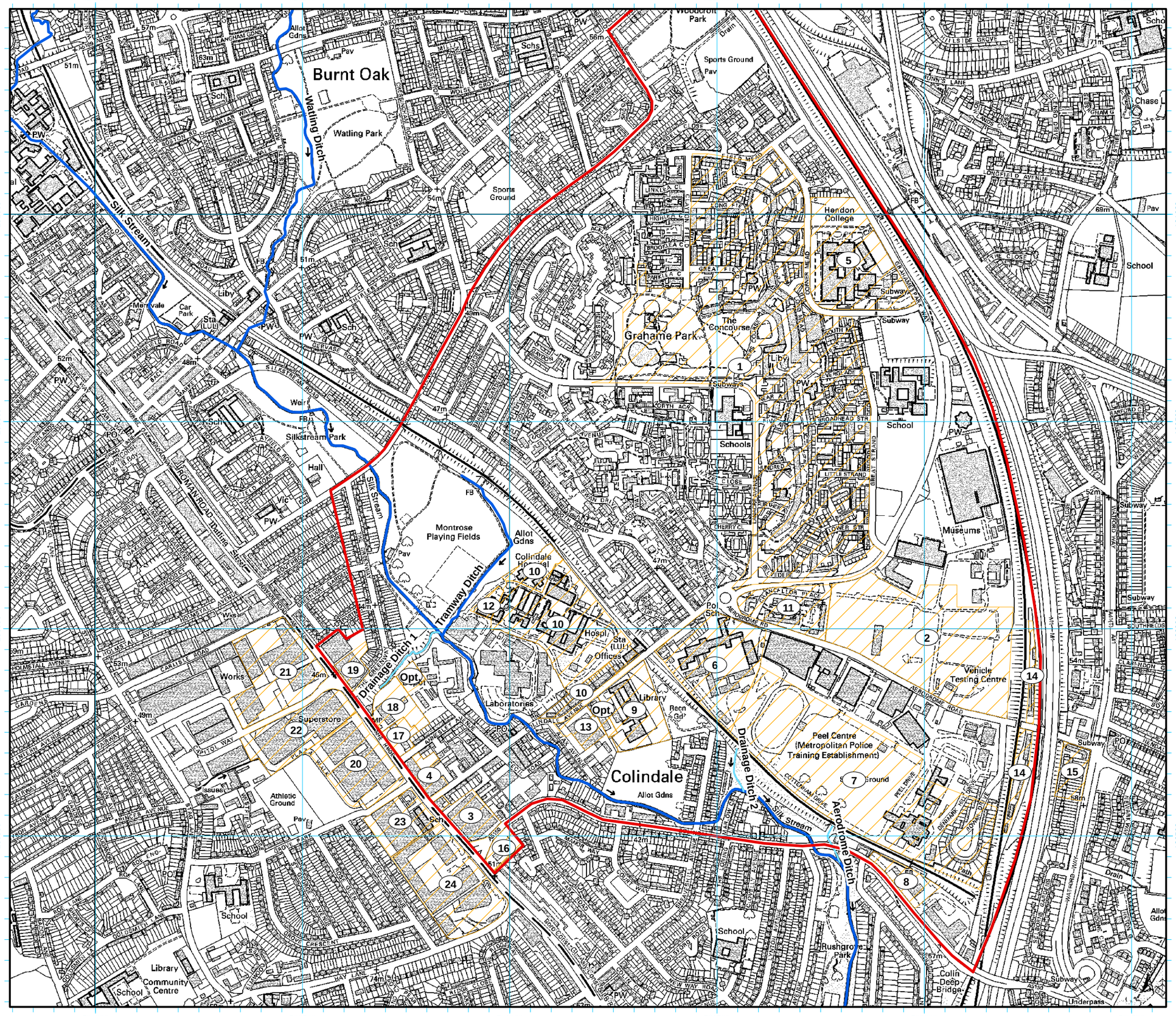
A map of main and ordinary watercourses is presented in Figure 6 below.

There are several small tributaries to the Silk Stream within the study area, as follows:

- Tramway Ditch (at Montrose Playing Fields), approximately 500 m long, 1 m wide open channel;
- Aerodrome Ditch (at Rushgrove Park), approximately 100 m long, 5 m wide, mostly culverted;
- Two other (un-named) surface water channels that drain to the Silk Stream: one near the former electricity board land site (approximately 215 m long open channel), one at the bottom of Marlow Court (approximately 110 m long open channel).

Table 5 - Watercourses maintenance responsibility

Watercourse name	Watercourse classification	Lead Organisation
Silk Stream	Main River	Environment Agency
Aerodrome Ditch	Main River	Environment Agency
Tramway Ditch	Ordinary Watercourse	LB Barnet
Unnamed ditch 1	Ordinary Watercourse	LB Barnet
Unnamed ditch 2	Ordinary Watercourse	LB Barnet



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Legend

- Colindale AAP - Study Area
- Development Sites
- Main Watercourses
- Ordinary Watercourses

NOTES

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: COLINDALE AAP

SURFACE WATER MANAGEMENT STRATEGY

Drawing Title: MAIN AND ORDINARY WATERCOURSES IN COLINDALE

Scale at A3: 1:9,000

Drawn	Approved
TB	MG

Stage 1 check	Stage 2 check	Originated	Date

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Drawing Number: **FIGURE 6**

Rev

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