Radlett House, Radlett Place, London, NW8 6BT

Drainage Assessment

This report forms part of a wider Basement Impact Assessment

0034/LH/09-2011/0030 Rev C

October 2011

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Client: T Group

Consultant: Potamos Consulting
Anchored
Edenbridge Road
Hartfield
East Sussex
TN7 4JN

Report Prepared By:

L. Hatch

…………………………………………
Laura Hatch BSc (Hons) MSc AIEMA

Registration of amendments:

Report Revision	Date	Amendment Details	Revision Prepared By
A	28/09/2011	Amended to more closely relate to the requirements of Camden Planning Guidance CPG4 and its requirements for a Basement Impact Assessment	LH
B	24/10/2011	Amended to restrict outflow from the flood attenuation tank to a sensible minimum that will minimise the risk of blockage rather than the true Greenfield runoff rate. Tank sizing altered accordingly to ensure its efficient operation	LH
C	27/10/2011	Peer review included	LH

Contents

1. Introduction

1.1. Introduction

Potamos Consulting have been instructed by the T Group to carry out a Drainage Assessment for development at Radlett House, Radlett Place, London, NW8 6BT.

The site currently comprises a detached two storey dwelling with a large front garden and smaller rear garden. It is understood that the site owner wishes to extend the property by constructing a basement and part sub-basement.

The London Borough of Camden has recently developed its Local Development Framework (LDF). The LDF now includes several new policies which are relevant to the proposed development (namely DP23: Water and DP27: Basements and Ligtwells). To meet the requirements of DP23 of the LDF a Drainage Assessment is required to support the planning application and ensure that consideration is given to the amount and rate of runoff that may be generated by the development along with appropriate sustainable means of managing this so as to not increase the pressure on the combined sewer network and the risk of flooding.

In addition to DP23 and DP27, this assessment has also been carried out in accordance with additional planning guidance for the development of basements and lightwells (CPG 4) recently prepared by the London Borough of Camden to support the LDF. This report, in conjunction with the accompanying Hydrogeological Risk Assessment and Ground Investigation reports, forms part of a wider Basement Impact Assessment as required by CPG 4 and includes reference to all four stages of assessment namely Screening, Scoping, Site Investigation and study and Impact Assessment

In line with the requirements of CPG 4 this report has been peer reviewed by a chartered engineer with the Institution of Civil Engineers and found to be suitable. A letter confirming this review is included as Appendix A.

This report is confidential to T Group, and Potamos Consulting accepts no responsibility whatsoever to other parties to whom this report, or any part thereof, is made known. Any such other parties rely on the report at their own risk.

1.2. Scope of Works

The Drainage Assessment comprises an initial screening exercise in line with the requirements of CPG4 and the “Surface flow and flooding screening flowchart” which forms Figure 3 of that document.

This is followed by a scoping assessment which includes calculation of the current runoff rates and volumes of surface water runoff from the site, calculation of likely future rates and volumes of surface water runoff from the site, comparison of the pre- and post-development values and consideration of the likely impacts.

A site investigation was not considered to be required on this occasion on the basis that the primary concern relating to the development was surface water runoff as opposed to water resources beneath the ground e.g. groundwater. This is discussed further in the accompanying Hydrogeological Risk Assessment which also forms part of the Basement Impact Assessment.

Finally the direct and indirect implications of the development on surface water flow and flooding are considered through an impact assessment with appropriate mitigation and management measures (sustainable drainage options) discussed.

The report has been prepared using published information and information provided by the Client which was made available at the time of writing only.

2. Screening

Screening is the first stage of the Basement Impact Assessment (BIA) required by Camden Planning Guidance for development of basements and lightwells (CPG 4). Screening enables identification of any matters of concern to the development which should be further investigated and is a process of determining whether or not a full BIA is required.

The screening assessment has been undertaken in accordance with the "surface flow and flooding screening flowchart" which forms Figure 3 of CPG 4. The screening flowchart requires consideration of the following questions and an answer of "yes", "no" or "unknown" to each. Consideration should be given to both the temporary and permanent works, along with the proposed surrounding landscaping and drainage associated with the proposed basement development.

Question 1: Is the site within the catchment of the pond chains on Hampstead Heath?

Approximately 3.5km north of the site at its closest lies Hampstead Heath. Within Hampstead Heath there are more than 25 ponds forming chains of interlinked water features. The ponds are no longer used for water supply but are used for recreational activities and wildlife habitat and are therefore protected under the Reservoirs Act. The site is located outside of the Hampstead Heath surface water catchment and therefore the answer to this question is "no".

Question 2: As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak-runoff) be materially changed from the existing route?

The answer to this question is "no". Surface water runoff rates and volumes will change as part of the development however, it is proposed to manage these so that the runoff from the site post-development is no greater than existing and is discharged in the same way as present.

Question 3: Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?

"Yes" as a result of the development there will be a change in the proportion of hard surfaced / paved external areas on site.

Question 4: Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses?

"No" all surface water runoff will be managed on site and discharges off site will be to a sewer rather than overland or to a watercourse.

Question 5: Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?

"No" all surface water runoff will be managed on site and discharges off site will be no different to existing. If anything there may be a slight improvement in the quality of off-site surface water discharges but this will not affect adjacent properties or downstream watercourses as the surface water runoff will be discharged to a sewer as existing.

Question 6: Is the site in an area known to be at risk from surface water flooding, such as South Hampstead, West Hampstead, Gospel Oak and King's Cross, or is it at risk from flooding, for example because the basement is below the static water level of a nearby surface water feature?

The site does not fall within the South Hampstead, West Hampstead, Gospel Oak or King's Cross areas of Camden and is not located on one of the streets listed in CPG 4 as being at risk of surface water flooding. The Environment Agency's indicative online flood map shows the site to fall within Flood Zone 1. Sites within Flood Zone 1 are considered to have less than a 1 in 1000 (0.1%) annual probability of flooding from rivers or the sea.

As the answer to Question 3 is "yes" a full Basement Impact Assessment will be required, however it is proposed that this will focus on assessment of the likely change in impermeable surface area on site as a result of the development and hence the likely impact of the development on surface water runoff and how this will be managed to ensure the development has no detrimental impact on neighbouring properties or the downstream catchment.

3. Scoping

The screening process discussed in Chapter 2 identified that the likely change in the proportion of hard surfaces on the site and the potential resultant change in surface water runoff rates and volumes resulting from the proposed development would need further investigation. The investigation undertaken to determine the potential impacts of the development is set out in this scoping section of the report.

3.1. Site Location

The site is located off Radlett Place to the south of Hampstead within Camden, northwest London and centred within OS grid reference E527143 N183807, as shown in Figures 1 and 2 below. The proposed development site covers an approximate area of 0.2ha.

Figure 1: Existing Site Layout

Figure 2: Aerial View of Site

The site is set within a predominantly residential area with dwellings forming each boundary and an area of recreational open space located to the north.

3.2. Site Description

The site comprises a three storey detached house of traditional brick and tiled roof construction set within a large landscaped front garden and smaller rear garden bounded by masonary walls and fencing. The property comprises of ground and first floors and a second floor within the pitched roof.

As shown on Figure 1, the site is accessed from Radlett Place via a driveway along the boundary of the front garden to the front door. The front garden comprises well managed soft landscaping, with a terrace (patio) surrounding the property. The topography of the site is generally flat / level.

3.3. On-site hydrology

The GroundSure Report (included within the accompanying Hydro-geological Assessment report) lists an onsite surface water feature labelled as St Ange’s Well. The feature comprises a historic extended culvert that is shown on Figure 3 below to flow from the south to the north.

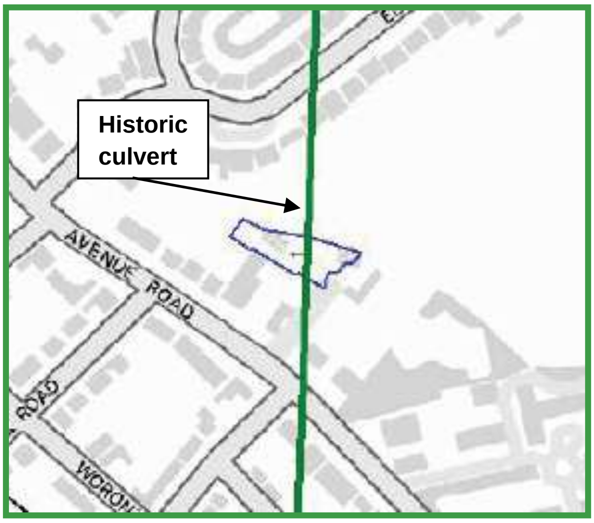


Figure 3: Location of historic culvert

There was no visual evidence of the historic culvert (e.g. sunken ground or a change in vegetation) observed during the site walkover. An additional internet search has therefore been undertaken and The Environment Agency, Thames Water, Camden Council and the Royal Parks have been contacted in order to obtain additional information. To date, responses have been received from the Environment Agency and Thames Water with the findings summarised below:

- The Environment Agency does not hold any information but indicated that the culvert runs from Hampstead Ponds to the Serpentine in Hyde Park, crossing the site en-route. The culvert may be managed by The Royal Parks;

- Thames Water confirmed that the culvert is not shown on any historic or current utility maps; and

- An internet search found that the well itself (St Ange's Well) is located within Kensington Gardens (TQ 2671 8068) and listed as a former medicinal water supply in a 1910 book *Springs, Streams and Spas of London; History and Associations*. The well is currently marked with a flush metal cover. It is therefore likely that the culvert runs from the Serpentine in Hyde Park onto Kensington Gardens to St Ange's Well.

Taking into account the limited information but also the age of the culvert and the subsequent volume of redevelopment that has occurred along its line, it is likely that it is no longer in use and if still present, potentially silted up and/or dry. Any additional significant information obtained from Camden Council and The Royal Parks will be forwarded on under a separate cover.

3.4. Off-site hydrology

The nearest off-site surface water feature comprises the Grand Union Canal (also known as Regents Canal) which flows approximately 550m southeast of the site. The Canal has not been classified under the Environment Agency's General Quality Assessment (GQA) scheme.

Further information has been obtained in order to assess the likely pond water level in Regents Park in relation to the proposed development. The site is shown to be situated at a height of approximately 22m above Regents Park indicating that the depth of the proposed basement is unlikely to be close to or below the level of pond waters in Regents Park.

As discussed in the screening assessment, approximately 3.5km north of the site at its closest lies Hampstead Heath. Within Hampstead Heath there are more than 25 ponds forming chains of interlinked water features. The ponds are no longer used for water supply but are used for recreational activities and wildlife habitat and are therefore protected under the Reservoirs Act. The site is located outside of the Hampstead Heath surface water catchment.

There are no surface water abstractions recorded in the Groundsure Report (provided as part of the accompanying Hydrogeological Risk Assessment) within 1km of the site. However, Camden's Geological, Hydrogeological and Hydrological study indicates that two abstractions are operational from Regents Canal (approximately 550m from the site). Further abstractions are also known to be carried out further afield from reservoirs owned by TWUL, the River Thames and the River Lee.

3.5. Existing runoff

The site has a total area of 2,042m^2 and comprises the existing house which measures 387m^2, a covered walkway to the side of the property measuring 90m^2, an area of patio/hardstanding measuring 96m^2 and 1,469m^2 of landscaped gardens.

There is also existing planning permission for a pool house measuring 160m^2 and an associated hard landscaping area of 48m^2. As such once this is constructed the permeable garden area will be reduced to 1,261m^2. However, as this has not yet been built it has not been taken into account when determining the existing runoff from the site.

Current peak surface water runoff rates from the site in a variety of storm events have been estimated using the Modified Rational Method (Hydraulics Research Limited, 1981). A copy of the calculations is provided in Appendix A and the estimated runoff rates are summarised in Table 1 below. It can be seen that in the peak 1 in 100 year plus climate change five minute storm the peak runoff rate from the site is likely to be 40.67 l/s. The calculations take into account the impermeable clay soils/geology at the site as discussed in more detail in the accompanying Hydrogeological Risk Assessment report (Ref. 0034/LH/09-2011/0029 RevA).

Table 1: Existing peak surface water runoff rates (l/s)

Return Period (Years)	Storm Duration (Minutes)	Rainfall Intensity (mm/hr)	Peak Runoff Rate (l/s)
1	5	71.92	13.40
	15	43.32	8.07
	30	22.17	4.13
	60	17.47	3.26
5	5	121.52	22.65
	15	71.97	13.41
	30	44.43	8.28
	60	28.12	5.24
30	5	172.22	32.10
	15	106.24	19.80
	30	65.99	12.30
	60	42.32	7.89
100	5	218.24	40.67
	15	137.70	25.66
	30	86.27	16.08
	60	55.42	10.33

3.6. Proposed development

The proposed development comprises the construction of a basement and sub-basement beneath the existing dwelling and extending towards the eastern site boundary beneath the existing garden area covering a total area of 905m^2. The basement will extend up to a depth of between to 3.8m and 7.8m below ground level (for the basement and sub-basement respectively). The basement is to be predominantly for recreational use including a cinema, a wine cellar, and a gym. As the proposed basement will be entirely below ground the only increase in impermeable area as a result of its development will be 43m^2 for the three proposed lightwells (two to the west of the existing property and one to the east).

An above ground two storey pool house measuring 160m^2, with an associated patio/hardstanding area of 48m^2, is also to be constructed in the eastern corner of the site; however this part of the development has already received planning approval and has therefore not been taken into account when determining the runoff from the site post development.

The development proposals are shown on Drawings EVJ_010 revision B, EVJ_011 revision C, and EVJ_012 revision B in Appendix B.

The implications of the proposed 43m^2 increase in impermeable area resulting from the proposed basement, in terms of surface water runoff, is discussed in Chapter 4.

4. Impact Assessment

As discussed in Chapter 4, the proposed basement development will result in a 43m^2 increase in impermeable site area. As such surface water runoff rates and volumes from the site post-development are expected to increase very slightly. The purpose of this impact assessment is to determine the magnitude of the likely increase in runoff and the significance of this.

The revised runoff estimates for the site post development are shown in Table 2 below and the calculations are included in Appendix A. When compared to the pre-development estimates provided in Table 1 it can be seen that in the peak 1 in 100 year five minute storm peak runoff from the site would increase by 3.06 l/s. This increase is considered minor and likely to have only a minor, if any, effect on the off-site risk of surface water flooding.

Table 2: Post-development peak surface water runoff rates (l/s)

Return Period (Years)	Storm Duration (Minutes)	Rainfall Intensity (mm/hr)	Peak Runoff Rate (l/s)
1	5	71.92	14.41
	15	43.32	8.68
	30	22.17	4.44
	60	17.47	3.50
5	5	121.52	24.35
	15	71.97	14.42
	30	44.43	8.90
	60	28.12	5.63
30	5	172.22	34.51
	15	106.24	21.29
	30	65.99	13.22
	60	42.32	8.48
100	5	218.24	43.73
	15	137.70	27.59
	30	86.27	17.29
	60	55.42	11.10

Although the proposed development will only result in a minor increase in runoff compared to the existing situation, Policy DP23 of the London Borough of Camden LDF (below) requires that developments reduce their water consumption and pressure on the combined sewer network and the risk of flooding through the capture and re-use of surface water and grey water on-site. Whilst Policy DP22 (below) requires developments to include appropriate climate change adaptation measures including the management of surface water runoff through the installation of sustainable drainage systems.

Policy DP22 - Promoting sustainable design and construction

The Council will require development to incorporate sustainable design and construction measures. Schemes must:

a) demonstrate how sustainable development principles, including the relevant measures set out in paragraph 22.5 below, have been incorporated into the design and proposed implementation; and
b) incorporate green or brown roofs and green walls wherever suitable.

The Council will promote and measure sustainable design and construction by:

c) expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 and Code Level 4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016.
d) expecting developments (except new build) of 500 sq m of residential floorspace or above or 5 or more dwellings to achieve "very good" in EcoHomes assessments prior to 2013 and encouraging "excellent" from 2013;
e) expecting non-domestic developments of 500sqm of floorspace or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019.

The Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as:

f) summer shading and planting;
g) limiting run-off;
h) reducing water consumption;
i) reducing air pollution; and
j) not locating vulnerable uses in basements in flood-prone areas.

Policy DP23 - Water

The Council will require developments to reduce their water consumption, the pressure on the combined sewer network and the risk of flooding by:

a) incorporating water efficient features and equipment and capturing, retaining and re-using surface water and grey water on-site;
b) limiting the amount and rate of run-off and waste water entering the combined storm water and sewer network through the methods outlined in part a) and other sustainable urban drainage methods to reduce the risk of flooding;
c) reducing the pressure placed on the combined storm water and sewer network from foul water and surface water run-off and ensuring developments in the areas identified by the North London Strategic Flood Risk Assessment and shown on Map 2 as being at risk of surface water flooding are designed to cope with the potential flooding;
d) ensuring that developments are assessed for upstream and downstream groundwater flood risks in areas where historic underground streams are known to have been present; and
e) encouraging the provision of attractive and efficient water features.

To meet the requirements of Policies DP22 and DP23 and mitigate the potential impacts of the development runoff will need to be reduced compared to the existing situation. Therefore it is proposed to reduce runoff from the site post-development to the Greenfield equivalent rate.

The Greenfield Runoff Rate for the site can be determined using the methodology set out in the Institute of Hydrology Report Number 124 (IoH 124) and guidance stipulated in the Interim Code of Practice for Sustainable Drainage Systems (National SuDS Working Group, 2004). These state that the Greenfield runoff rate for sites below 50ha can be derived from the calculated mean annual flood flow, QBAR. A copy of the calculations is provided in Appendix C and the estimated runoff rates are summarised in Table 3 below.

Table 3: Greenfield Runoff Rate

Event	Flow Rate (m^3/s)	Flow (l/s)	Flow Rate (l/s/ha)
QBAR	0.0009	0.9	4.411
1 year (Q1)	0.0008	0.8	3.749
5 year(Q5)	0.0012	1.2	5.646
25 year (Q25)	0.0019	1.9	9.439
30 year (Q30)	0.0020	2.0	9.881
100 year (Q100)	0.0029	2.9	14.070

The SuDS options available for reducing the runoff from the site to the Greenfield rate are limited by the characteristics of the site. It is not considered an option to use infiltration-based SuDS techniques such as soakaways due to the clay soils/geology at the site having poor permeability. This is discussed further in the accompanying Hydrogeological Risk Assessment. Consequently the preferred surface water management option for the site is to attenuate rainwater in storage crates (aquacells) beneath the garden area for controlled discharge to Thames Water's sewers, via the existing connection. As discussed above, it would be our intention to reduce the runoff discharged to the Thames Water's sewer to the Greenfield equivalent rate; however the CIRIA SuDS Manual (CIRIA, 2007) states that it is essential to adjust the limiting discharge rate to take into account the need to have a minimum practical orifice size of 75mm diameter to ensure the risk of blockage is acceptable, although sewage undertakers usually insist on a minimum of orifice of 150mm diameter. The only exception to this rule is for outfalls downstream of filtration devices such as permeable pavements which through the nature of their operation will significantly reduce the risk of blockage. As such it is generally accepted that with a minimum orifice size of 75mm and a recommended gradient of 1:30 for a pipe of that size limitation of flow to less than 5l/s is impractical.

The MicroDrainage software (Version 12.6) has been used to determine that storage crates measuring for example 5m x 4m x 1m deep would provide sufficient storage to manage the runoff in all storms up to and including the 1 in 100 year plus 30% event so that off-site runoff to the local sewer is limited to the practical minimum rate of 5 l/s. The full output from MicroDrainage is provided in Appendix C. The expected infiltration rate across the site was set to 0.0001 as recommended by Table 4.7 of the SuDS Manual (CIRIA, 2007) for clay soils. Detailed design in terms of the location and depth of the crates will be required pre-construction.

5. Conclusions

A screening exercise undertaken in line with the requirements of Camden Planning Guidance (CPG 4) identified that as the proposed development will result in a change in the impermeable surface areas on site and therefore has the potential to impact upon surface water runoff rates and volumes a full Basement Impact Assessment would be required. This report forms part of that Basement Impact Assessment along with the accompanying Hydrogeological Risk Assessment and Ground Investigation reports.

More information about the proposed development and the existing surface water and flood risk situation at the site was collected as part of the scoping stage of the assessment. At the conclusion of this stage of the assessment a site investigation was not considered to be required to provide additional information.

The impact assessment identified that the proposed development will result in a minor 43m^2 increase in impermeable area and hence a minor increase in surface water runoff rates and volumes from the site.

However, London Borough of Camden LDF policies DP22 and DP23 require that developments reduce the pressure on the local sewer network and manage the effects of climate change by reducing surface water runoff. As such it is proposed to meet the requirements of these policies and mitigate the impacts of the proposed development by incorporating a SuDS scheme, comprising underground aquacell surface water storage crates, into the development proposals so as to reduce the surface water runoff rates and volumes being released from the site to the local sewer in all events up to and including the 1 in 100 year plus 30% event, as close as possible to Greenfield equivalent rates. Runoff is proposed to be limited to 5 l/s which is the recommended minimum discharge to prevent pipe blockage. To achieve this aquacells, measuring for example 5m x 4m x 1m deep, will be provided below the garden with outflow controlled by an orifice. Detailed design will be required prior to construction.

Prior to construction works taking place it is also recommended that the course and condition of the extended historic culvert, believed to be linked to St Ange's Well be investigated further and if necessary plans be made for its diversion around the proposed development.

Appendix A

Tully De'Ath Consultants

Laura Hatch
Potamos Consulting
Anchored, Edenbridge Road
Hartfield
East Sussex
TN7 4JN

AJP/cmw/10470
26th October 2011

Dear Laura

Re: Radlett House, Radlett Place, London NW8 6BT

As a chartered engineer with the Institution of Civil Engineers I confirm that I have reviewed your Drainage Assessment report 0034/LH/09-2011/0030 Revision B dated October 2011 and have no further comments to make.

Yours sincerely
for Tully De'Ath

Andrew Picton B.Eng (Hons) C.Eng, M.I.C.E.

Appendix B

POTAMOS CONSULTING	**Project No:** **0034**	**Sheet:** **1 of 4**
	Project Title: **Radlett House, London**	
	Engineer: LH	**Date:** 14/09/2011

Modified Rational (Wallingford) Method

1) Determine the 5 year 60 minute rainfall depth (m5-60) for the site location from Figure A.1 of the Rational Method

m5-60 = 21mm

Determine the ratio (r) of the 5 year 60 minute rainfall depth (m5-60) to the 5 year 2 day rainfall depth for the site location from Figure A.2 of the Rational Method

r = 0.4

2) Determine the rainfall depths in the 5 year return period event for all required storm durations (m5-D) from m5-D = Z1 (m5-60). Z1 is obtained from Figures A3.a and A3.b of the Rational Method

m5-5	Z1 = 0.36	m5-5 = 21 x 0.36 = 7.56mm
m5-15	Z1 = 0.64	m5-15 = 21 x 0.64 = 13.44mm
m5-30	Z1 = 0.79	m5-30 = 21 x 0.79 = 16.59mm
m5-60	Z1 = 1.00	m5-60 = 21 x 1.00 = 21.00mm

The calculation of peak runoff for storm durations up to 6 hours (m5-360) is desirable, however insufficient Z2 data (see below) is provided within the Rational Method to permit this and the use of FEH data is ill-advised for site specific assessments

3) Convert the 5 year rainfall depths to rainfall depths for all required return period events (mT-D) from MT-D = Z2 (m5-D). Z2 is obtained from Tables A1 and A2 of the Rational Method

m1-5	Z2 = 0.61	m1-5 = 7.56 x 0.61 = 4.61mm
m1-15	Z2 = 0.62	m1-15 = 13.44 x 0.62 = 8.33mm
m1-30	Z2 = 0.63	m1-30 = 16.59 x 0.63 = 10.45mm
m1-60	Z2 = 0.64	m1-60 = 21.00 x 0.64 = 13.44mm
m5-5	Z2 = 1.03	m5-5 = 7.56 x 1.03 = 7.79mm
m5-15	Z2 = 1.03	m5-15 = 13.44 x 1.03 = 13.84mm
m5-30	Z2 = 1.03	m5-30 = 16.59 x 1.03 = 17.09mm
m5-60	Z2 = 1.03	m5-60 = 21.00 x 1.03 = 21.63mm
m30-5	Z2 = 1.46	m30-5 = 7.56 x 1.46 = 11.04mm
m30-15	Z2 = 1.52	m30-15 = 13.44 x 1.52 = 20.43mm
m30-30	Z2 = 1.53	m30-30 = 16.59 x 1.53 = 25.38mm
m30-60	Z2 = 1.55	m30-60 = 21.00 x 1.55 = 32.55mm

POTAMOS CONSULTING	**Project No:** 0034	**Sheet:** 2 of 4	
	Project Title: Radlett House, London		
	Engineer: LH	**Date:** 14/09/2011	

m100-5	Z2 = 1.85	m100-5 = 7.56 x 1.85 = 13.99mm
m100-15	Z2 = 1.97	m100-15 = 13.44 x 1.97 = 26.48mm
m100-30	Z2 = 2.00	m100-30 = 16.59 x 2.00 = 33.18mm
m100-60	Z2 = 2.03	m100-60 = 21.00 x 2.03 = 42.63mm

4) Convert the rainfall depths into point intensities using the equation:

$$i = \frac{mT\text{-}D}{D}$$

where:

i = point intensity
T = return period
D = storm duration

m1-5 = 4.61/(5/60) = 55.32mm/hr
m1-15 = 8.33/(15/60) = 33.32mm/hr
m1-30 = 10.45/(30/60) = 20.90mm/hr
m1-60 = 13.44/(60/60) = 13.44mm/hr

m5-5 = 7.79/(5/60) = 93.48mm/hr
m5-15 = 13.84/(15/60) = 55.36mm/hr
m5-30 = 17.09/(30/60) = 34.18mm/hr
m5-60 = 21.63/(60/60) = 21.63mm/hr

m30-5 = 11.04/(5/60) = 132.48mm/hr
m30-15 = 20.43/(15/60) = 81.72mm/hr
m30-30 = 25.38/(30/60) = 50.76mm/hr
m30-60 = 32.55/(60/60) = 32.55mm/hr

m100-5 = 13.99/(5/60) = 167.88mm/hr
m100-15 = 26.48/(15/60) = 105.92mm/hr
m100-30 = 33.18/(30/60) = 66.36mm/hr
m100-60 = 42.63/(60/60) = 42.63mm/hr

5) Apply an aerial reduction factor (if required) to the rainfall using Figure A.4 of the Rational Method based on the site area of 2,042m^2 (0.002km2 0.2042ha). Aerial reduction factors are only required for sites over 1km^2 in area and hence will not be applied to the rainfall intensities calculated above.

6) Adjust the peak rainfall intensities for the anticipated effects of climate change. This is done in line with the recommendations given in Appendix B of Planning Policy Statement 25 (PPS25) (Communities and Local Government 2006, updated 2010) which suggests an increase in peak rainfall intensity of 30% between 2085 and 2115, appropriate to the 100 year design lifetime of the development

POTAMOS CONSULTING	**Project No:** 0034	**Sheet:** 3 of 4	
	Project Title: Radlett House, London		
	Engineer: LH	**Date:** 14/09/2011	

m1-5 = 55.32 x 1.3 = 71.92mm/hr
m1-15 = 33.32 x 1.3 = 43.32mm/hr
m1-30 = 20.90 x 1.3 = 22.17mm/hr
m1-60 = 13.44 x 1.3 = 17.47mm/hr

m5-5 = 93.48 x 1.3 = 121.52mm/hr
m5-15 = 55.36 x 1.3 = 71.97mm/hr
m5-30 = 34.18 x 1.3 = 44.43mm/hr
m5-60 = 21.63 x 1.3 = 28.12mm/hr

m30-5 = 132.48 x 1.3 = 172.22mm/hr
m30-15 = 81.72 x 1.3 = 106.24mm/hr
m30-30 = 50.76 x 1.3 = 65.99mm/hr
m30-60 = 32.55 x 1.3 = 42.32mm/hr

m100-5 = 167.88 x 1.3 = 218.24mm/hr
m100-15 = 105.92 x 1.3 = 137.70mm/hr
m100-30 = 66.36 x 1.3 = 86.27mm/hr
m100-60 = 42.63 x 1.3 = 55.42mm/hr

7) Calculate the existing peak runoff rates using the equation:

Q = 2.78 CiA

where:
Q = peak discharge (l/s)
C = dimensionless coefficient where C = C_v x C_R
i = rainfall intensity (mm/hr)
A = contributing catchment area (ha)

C_v = 0.9 (clay soils)

C_R = 1.30 (recommended value)

The contributing catchment area comprises approximately 573m^2 (0.0573ha) of existing impermeable roof and hardstanding areas.

m1-5 = 2.78 x 0.9 x 1.3 x 71.92 x 0.0573 = 13.40 l/s
m1-15 = 2.78 x 0.9 x 1.3 x 43.32 x 0.0573 = 8.07 l/s
m1-30 = 2.78 x 0.9 x 1.3 x 22.17 x 0.0573 = 4.13 l/s
m1-60 = 2.78 x 0.9 x 1.3 x 17.47 x 0.0573 = 3.26 l/s

m5-5 = 2.78 x 0.9 x 1.3 x 121.52 x 0.0573 = 22.65 l/s
m5-15 = 2.78 x 0.9 x 1.3 x 71.97 x 0.0573 = 13.41 l/s
m5-30 = 2.78 x 0.9 x 1.3 x 44.43 x 0.0573 = 8.28 l/s
m5-60 = 2.78 x 0.9 x 1.3 x 28.12 x 0.0573 = 5.24 l/s

m30-5 = 2.78 x 0.9 x 1.3 x 172.22 x 0.0573 = 32.10 l/s
m30-15 = 2.78 x 0.9 x 1.3 x 106.24 x 0.0573 = 19.80 l/s
m30-30 = 2.78 x 0.9 x 1.3 x 65.99 x 0.0573 = 12.30 l/s
m30-60 = 2.78 x 0.9 x 1.3 x 42.32 x 0.0573 = 7.89 l/s

m100-5 = 2.78 x 0.9 x 1.3 x 218.24 x 0.0573 = 40.67 l/s
m100-15 = 2.78 x 0.9 x 1.3 x 137.70 x 0.0573 = 25.66 l/s
m100-30 = 2.78 x 0.9 x 1.3 x 86.27 x 0.0573 = 16.08 l/s
m100-60 = 2.78 x 0.9 x 1.3 x 55.42 x 0.0573 = 10.33 l/s

8) Calculate the post-development peak runoff rates using the equation:

Q = 2.78 CiA

where:
Q = peak discharge (l/s)
C = dimensionless coefficient where C = C_v x C_R
i = rainfall intensity (mm/hr)
A = contributing catchment area (ha)

C_v = 0.9 (clay soils)

C_R = 1.30 (recommended value)

The contributing catchment area comprises approximately 573m^2 (0.0573ha) of existing impermeable areas and 43m^2 (0.0043ha) of proposed new impermeable area. This gives a total post-development contributing area of 616m^2 (0.0616ha).

m1-5 = 2.78 x 0.9 x 1.3 x 71.92 x 0.0616 = 14.41 l/s
m1-15 = 2.78 x 0.9 x 1.3 x 43.32 x 0.0616 = 8.68 l/s
m1-30 = 2.78 x 0.9 x 1.3 x 22.17 x 0.0616 = 4.44 l/s
m1-60 = 2.78 x 0.9 x 1.3 x 17.47 x 0.0616 = 3.50 l/s

m5-5 = 2.78 x 0.9 x 1.3 x 121.52 x 0.0616 = 24.35 l/s
m5-15 = 2.78 x 0.9 x 1.3 x 71.97 x 0.0616 = 14.42 l/s
m5-30 = 2.78 x 0.9 x 1.3 x 44.43 x 0.0616 = 8.90 l/s
m5-60 = 2.78 x 0.9 x 1.3 x 28.12 x 0.0616 = 5.63 l/s

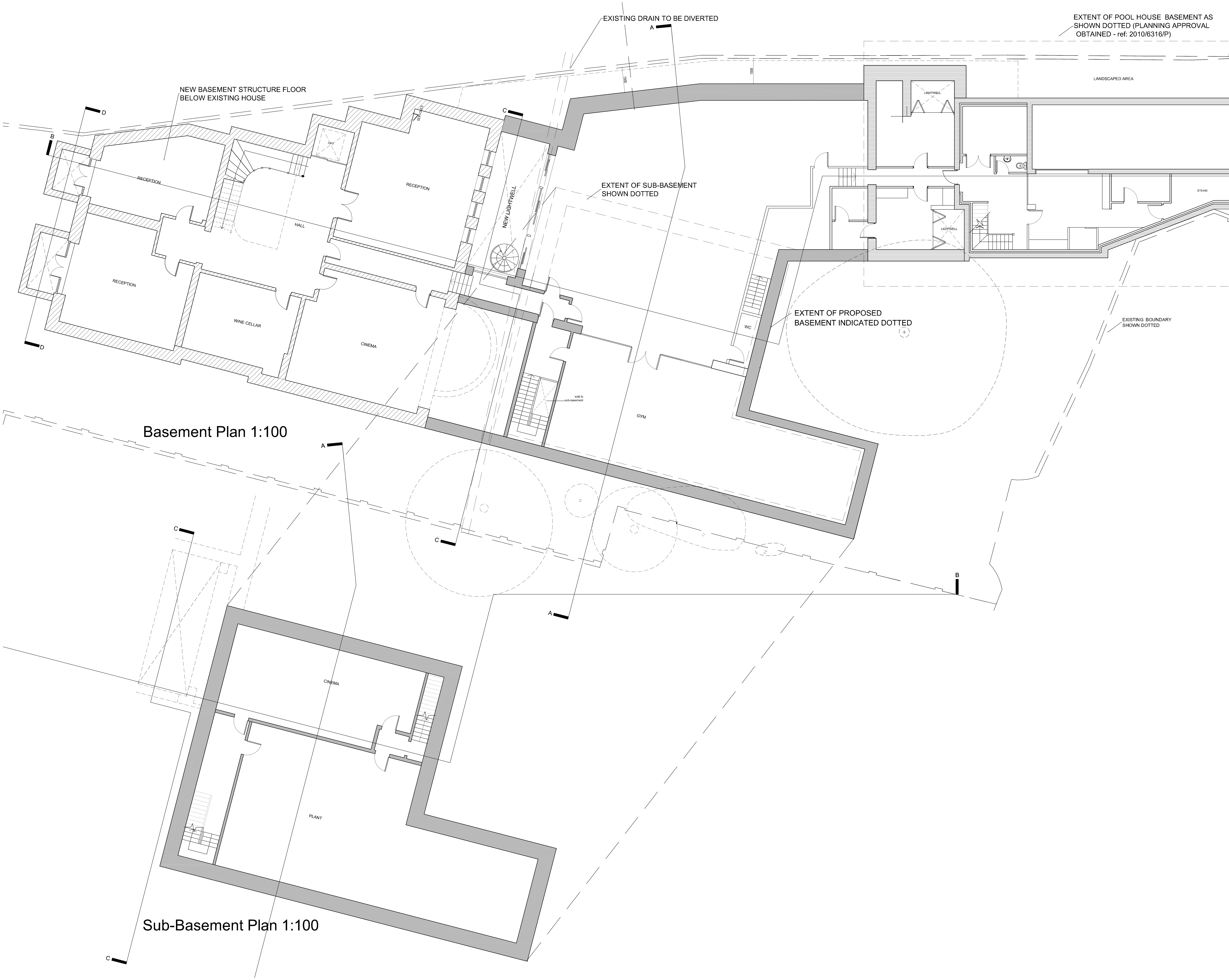
m30-5 = 2.78 x 0.9 x 1.3 x 172.22 x 0.0616 = 34.51 l/s
m30-15 = 2.78 x 0.9 x 1.3 x 106.24 x 0.0616 = 21.29 l/s
m30-30 = 2.78 x 0.9 x 1.3 x 65.99 x 0.0616 = 13.22 l/s
m30-60 = 2.78 x 0.9 x 1.3 x 42.32 x 0.0616 = 8.48 l/s

m100-5 = 2.78 x 0.9 x 1.3 x 218.24 x 0.0616 = 43.73 l/s
m100-15 = 2.78 x 0.9 x 1.3 x 137.70 x 0.0616 = 27.59 l/s
m100-30 = 2.78 x 0.9 x 1.3 x 86.27 x 0.0616 = 17.29 l/s
m100-60 = 2.78 x 0.9 x 1.3 x 55.42 x 0.0616 = 11.10 l/s

Appendix C

Note

This drawing is not to be scaled. Use figured dimensions only. All dimensions are to be checked on site and any discrepancies, errors or omissions are to be reported to the architect prior to commencement of works.



ALL DIMENSIONS APPROXIMATE

SCHEME DESIGN SUBJECT TO STRUCTURAL ENGINEER /SERVICES ENGINEER, & PLANNERS COMMENT

PLANNING

rev	date	description	by
B	30/08/11	Basement wall to north boundary modified Planning application rev	st
A	24/08/11	conservatory link reference omitted	st

BB PARTNERSHIP LTD
CHARTERED ARCHITECTS
THE TRAFALGAR . 17 REMINGTON STREET . LONDON N1 8DH
TEL . 020 7336 8555 FAX . 020 7336 8777
e-mail . architect@bbpartnership.co.uk

client	David Tucker
project	Radlett House NEW BASEMENT
drawing	Proposed Basement and Sub-Basement Plans
date	May 2011
scale	1:100 @ A1
drawn by	ST
drg.no.	EVJ_010
rev.	A B

do not scale . check all dimensions on site ©

Note

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Ground Floor Plan 1:100

ALL DIMENSIONS APPROXIMATE

SCHEME DESIGN SUBJECT TO STRUCTURAL ENGINEER /SERVICES ENGINEER, & PLANNERS COMMENT

PLANNING

C	30/08/11	Basement wall to north boundary modified Planning application rev	st
B	24/08/11		st
A	05/08/11	Exsiting porch and covered walkway added	ST

BB PARTNERSHIP LTD
CHARTERED ARCHITECTS
THE TRAFALGAR . 17 REMINGTON STREET . LONDON N1 8DH
TEL . 020 7336 8555 FAX . 020 7336 8777
e-mail . architect@bbpartnership.co.uk

client	David Tucker
project	Radlett House NEW BASEMENT
drawing	Proposed Ground Floor Plan

date	scale	drawn by
May 2011	1:100 @ A1	ST

drg.no.	rev.	A	B	C
EVJ_ 011				

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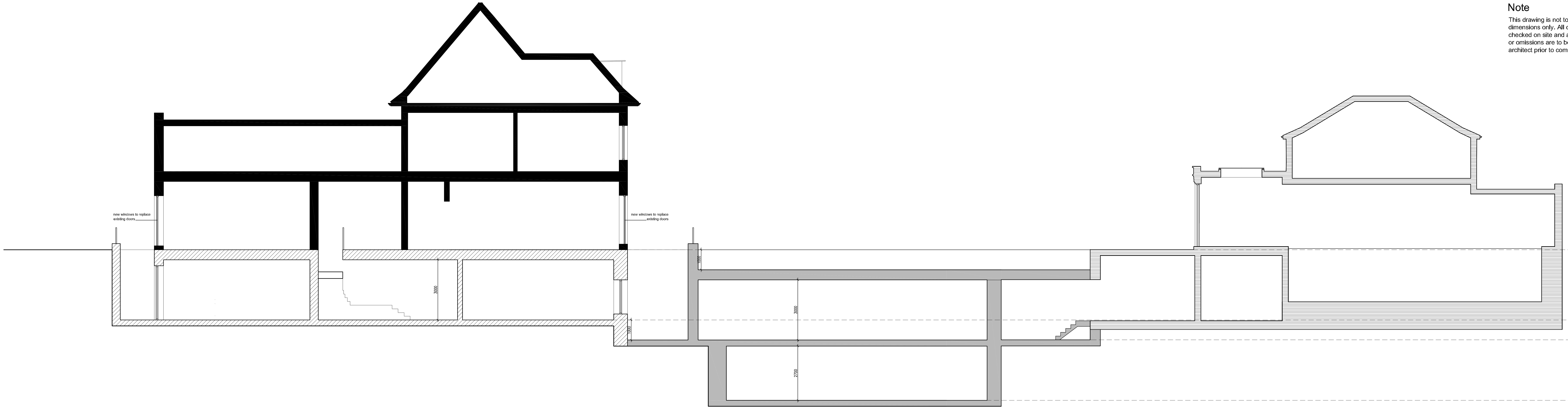
Note

This drawing is not to be scaled. Use figured dimensions only. All dimensions are to be checked on site and any discrepancies, errors or omissions are to be reported to the architect prior to commencement of works.



Section B-B

Section A-A

Section C-C

Section D-D

▬	Existing structure
▨	New basement construction to underside of existing house
▭	New basement/ sub-basement construction
▭	Pool house with planning approval

ALL DIMENSIONS APPROXIMATE

SCHEME DESIGN SUBJECT TO STRUCTURAL ENGINEER /SERVICES ENGINEER, & PLANNERS COMMENT

PLANNING

B	30/08/11	Planning application rev	st
A	24/08/11	Section A-A modified	st

BB PARTNERSHIP LTD
CHARTERED ARCHITECTS
THE TRAFALGAR . 17 REMINGTON STREET . LONDON N1 8DH
TEL . 020 7336 8555 FAX . 020 7336 8777
e-mail . architect@bbpartnership.co.uk

client	David Tucker
project	Radlett House NEW BASEMENT
drawing	Proposed sections
date	May 2011
scale	1:100 @ A1
drawn by	ST
drg.no.	EVJ_012
rev.	A B

do not scale . check all dimensions on site ©

Appendix D

IoH 124 Calculation of Greenfield Runoff

Project:	Radlett House, Radlett Place, London, NW8 6BT
Date:	14/09/2011

SAAR:	648mm	Taken from FEH CD-ROM Version 3 and checked against Wallingford Procedure Volume 3 Map: Average Annual Rainfall (1941-1970) mm
Site area:	50ha / 0.5km^2	Always assumed to be 50ha with runoff rates adjusted pro-rata later for actual site area
Soil Type SPR value:	0.47	Wallingford soil grading taken from Wallingford Procedure Volume 3 Map: Winter rain acceptance potential and converted to SPR value using the Flood Studies Report conversion table, also checked against FEH CD-ROM Version 3 SPRHOST value

Wallingford soil grading	SPR value from FSR
1	0.10
2	0.30
3	0.37
4	0.47
5	0.53

QBAR = 0.00108 x (AREA) $^{0.89}$ x (SAAR) $^{1.17}$ x (SOIL) $^{2.17}$

QBAR = 0.00108 x $0.5^{0.89}$ x $648^{1.17}$ x $0.47^{2.17}$

QBAR (50ha) = 0.221m^3/s

Runoff as calculated from the Regional Growth Curve Factor for FSR Hydrological Region 6/7:

Region 6/7	Growth Factor
1	0.85
2	0.88
5	1.28
10	1.62
25	2.14
30	2.24
50	2.62
100	3.19

Q1 50ha = 0.187 m^3/s = 187.465 l/s = 3.749 l/s/ha

Q5 50ha = 0.282 m^3/s = 282.301 l/s = 5.646 l/s/ha

Q25 50ha = 0.472 m^3/s = 471.972 l/s = 9.439 l/s/ha

Q30 50ha = 0.494 m^3/s = 494.026 l/s = 9.881 l/s/ha

Q100 50ha = 0.704 m^3/s = 703.547 l/s = 14.070 l/s/ha

Runoff as factored for site

Actual site area: 0.2042ha / 2,042m^2

QBAR Site = 0.0009 m3/s = 0.9 l/s = 4.411 l/s/ha
Q1 Site = 0.0008 m^3/s = 0.8 l/s = 3.749 l/s/ha
Q5 Site = 0.0012 m^3/s = 1.2 l/s =5.646 l/s/ha
Q25 Site = 0.0019 m^3/s = 1.9 l/s = 9.439 l/s/ha
Q30 Site = 0.0020 m^3/s = 2.0 l/s = 9.881 l/s/ha
Q100 Site = 0.0029 m^3/s = 2.9 l/s = 14.070 l/s/ha

Note: For Greenfield sites, the critical duration is generally not relevent and the prediction of the peak rate of runoff using IoH124 does not require consideration of storm duration

Note: PPS 25 does not provide guidance on applying climate change to Greenfield runoff, only to peak rainfall intensities and river flows

Appendix E

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 38 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	13.684	0.684	0.0	4.1	4.1	13.0	O K
30 min Summer	13.796	0.796	0.0	4.4	4.4	15.1	O K
60 min Summer	13.828	0.828	0.0	4.5	4.5	15.7	O K
120 min Summer	13.771	0.771	0.0	4.4	4.4	14.7	O K
180 min Summer	13.691	0.691	0.0	4.1	4.1	13.1	O K
240 min Summer	13.613	0.613	0.0	3.9	3.9	11.6	O K
360 min Summer	13.483	0.483	0.0	3.6	3.6	9.2	O K
480 min Summer	13.371	0.371	0.0	3.6	3.6	7.0	O K
600 min Summer	13.248	0.248	0.0	3.6	3.6	4.7	O K
720 min Summer	13.166	0.166	0.0	3.6	3.6	3.2	O K
960 min Summer	13.126	0.126	0.0	3.2	3.2	2.4	O K
1440 min Summer	13.098	0.098	0.0	2.3	2.3	1.9	O K
2160 min Summer	13.080	0.080	0.0	1.7	1.7	1.5	O K
2880 min Summer	13.070	0.070	0.0	1.3	1.3	1.3	O K
4320 min Summer	13.059	0.059	0.0	1.0	1.0	1.1	O K
5760 min Summer	13.052	0.052	0.0	0.8	0.8	1.0	O K
7200 min Summer	13.048	0.048	0.0	0.6	0.6	0.9	O K
8640 min Summer	13.045	0.045	0.0	0.6	0.6	0.8	O K
10080 min Summer	13.042	0.042	0.0	0.5	0.5	0.8	O K
15 min Winter	13.775	0.775	0.0	4.4	4.4	14.7	O K
30 min Winter	13.912	0.912	0.0	4.8	4.8	17.3	O K
60 min Winter	13.944	0.944	0.0	4.8	4.8	17.9	O K
120 min Winter	13.852	0.852	0.0	4.6	4.6	16.2	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	135.323	16
30 min Summer	88.744	28
60 min Summer	55.351	44
120 min Summer	33.286	80
180 min Summer	24.360	114
240 min Summer	19.417	146
360 min Summer	14.121	212
480 min Summer	11.248	276
600 min Summer	9.421	334
720 min Summer	8.148	376
960 min Summer	6.474	492
1440 min Summer	4.674	734
2160 min Summer	3.369	1100
2880 min Summer	2.668	1468
4320 min Summer	1.918	2188
5760 min Summer	1.516	2928
7200 min Summer	1.262	3568
8640 min Summer	1.087	4368
10080 min Summer	0.957	5096
15 min Winter	135.323	17
30 min Winter	88.744	30
60 min Winter	55.351	48
120 min Winter	33.286	86

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Σ Max Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	13.732	0.732	0.0	4.3	4.3	13.9	O K
240 min Winter	13.620	0.620	0.0	3.9	3.9	11.8	O K
360 min Winter	13.433	0.433	0.0	3.6	3.6	8.2	O K
480 min Winter	13.202	0.202	0.0	3.6	3.6	3.8	O K
600 min Winter	13.136	0.136	0.0	3.4	3.4	2.6	O K
720 min Winter	13.117	0.117	0.0	2.9	2.9	2.2	O K
960 min Winter	13.098	0.098	0.0	2.4	2.4	1.9	O K
1440 min Winter	13.080	0.080	0.0	1.7	1.7	1.5	O K
2160 min Winter	13.067	0.067	0.0	1.2	1.2	1.3	O K
2880 min Winter	13.059	0.059	0.0	1.0	1.0	1.1	O K
4320 min Winter	13.050	0.050	0.0	0.7	0.7	1.0	O K
5760 min Winter	13.045	0.045	0.0	0.6	0.6	0.8	O K
7200 min Winter	13.041	0.041	0.0	0.5	0.5	0.8	O K
8640 min Winter	13.038	0.038	0.0	0.4	0.4	0.7	O K
10080 min Winter	13.036	0.036	0.0	0.4	0.4	0.7	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
180 min Winter	24.360	122
240 min Winter	19.417	156
360 min Winter	14.121	226
480 min Winter	11.248	276
600 min Winter	9.421	314
720 min Winter	8.148	372
960 min Winter	6.474	490
1440 min Winter	4.674	736
2160 min Winter	3.369	1100
2880 min Winter	2.668	1464
4320 min Winter	1.918	2168
5760 min Winter	1.516	2872
7200 min Winter	1.262	3600
8640 min Winter	1.087	4360
10080 min Winter	0.957	5152

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	21.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.062

Time (mins)	**Area (ha)**
0-4	0.062

Model Details

Storage is Online Cover Level (m) 15.000

Cellular Storage Structure

Invert Level (m) 13.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00010 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00010

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	20.0	0.0	1.300	0.0	0.0
0.100	20.0	0.0	1.400	0.0	0.0
0.200	20.0	0.0	1.500	0.0	0.0
0.300	20.0	0.0	1.600	0.0	0.0
0.400	20.0	0.0	1.700	0.0	0.0
0.500	20.0	0.0	1.800	0.0	0.0
0.600	20.0	0.0	1.900	0.0	0.0
0.700	20.0	0.0	2.000	0.0	0.0
0.800	20.0	0.0	2.100	0.0	0.0
0.900	20.0	0.0	2.200	0.0	0.0
1.000	20.0	0.0	2.300	0.0	0.0
1.100	0.0	0.0	2.400	0.0	0.0
1.200	0.0	0.0	2.500	0.0	0.0

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md4 Invert Level (m) 13.000
Design Flow (l/s) 5.0 Diameter (mm) 80

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	1.200	5.5	3.000	8.6	7.000	13.2
0.200	3.5	1.400	5.9	3.500	9.3	7.500	13.7
0.300	3.0	1.600	6.3	4.000	10.0	8.000	14.1
0.400	3.2	1.800	6.7	4.500	10.6	8.500	14.5
0.500	3.5	2.000	7.1	5.000	11.2	9.000	15.0
0.600	3.9	2.200	7.4	5.500	11.7	9.500	15.4
0.800	4.5	2.400	7.7	6.000	12.2		
1.000	5.0	2.600	8.0	6.500	12.7		