MJA CONSULTING
CIVIL AND STRUCTURAL ENGINEERS

PROPOSED RESIDENTIAL DEVELOPMENT
AT

MANOR FARM
& COPSEYS NURSERIES
DENVILLES
HAVANT
HAMPSHIRE

FLOOD RISK ASSESSMENT

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REFERENCES:

Technical Guidance to the National Planning Policy Framework (2012)
Department for Communities and Local Government ISBN: 978-1-4098-3410-6

Environment Agency Information © and database right *www.environment-agency.gov.uk*

CIRIA Report 624: Development and Flood Risk - Guidance for the Construction Industry (2004)

CIRIA Report 697: The SUDS Manual *www.ciria.org*

1 Executive Summary

- The complete surface water drainage strategy proposed for this development is a robust system which not only affords complete protection to the surrounding area from the proposed scheme, but will also provide a positive and significant improvement in flood protection to both upstream properties to the west and properties downstream of the site, by reducing and controlling the amount of surface water runoff from the site into the Nore Farm Stream.
  This will help mitigate the historical watercourse related flood incidences that have been recorded.

- The completed surface water drainage system will be designed with a significant factor of safety, with SUDS features capable of containing runoff from the exceptionally rare 1 in 100 storm event (1% chance of occurrence each year) plus an allowance of 30% for predicted future climate change effects.
  The design of the attenuation ponds account for the 'worst case scenario' of the total failure of all infiltration systems including a significant area of offsite runoff which could be picked up by the land drainage network.
  In addition, whilst the system is robustly designed to protect against high groundwater inundation, the overall storage capacity of the ponds has been increased by a further 25% to provide an additional safety buffer providing significant improvement and safety to properties along the Nore Farm Stream.

- The Environment Agency's indicative Flood Map shows the proposed development site to be located within Flood Zone 1 (lowest Risk), therefore is not within an area subject to either flooding or extreme flooding events.

- This FRA has assessed flood risk to and from this site including the highly sensitive Nore Farm Stream and the associated flooding issues experienced by property owners within the downstream catchment of this watercourse and seeks to improve the present situation.

- Although the site has no official recorded history of flooding, anecdotal evidence from local residents has indicated an historic flood event caused by rapid melting of snow from the site onto Fifth Avenue as well as flooding to rear gardens from rainfall runoff, possibly due to a combination of blocked road gullies and lack of maintenance of the existing drainage systems.
  Therefore the effects of developing this site upon the existing properties to the west and properties downstream of the Nore Farm stream has taken a significant importance in the design of the surface water drainage strategy for the site and the improvement it can provide.

- The principle surface water drainage strategy for the proposed development is to utilise SUDS (sustainable urban drainage systems) via infiltration to ground.
  SuDS features such as permeable block paving will drian runoff from the road network and driveways, whilst cellular crate soakaway cells will dispose of runoff from roofs. The philosophy of the SuDS is to replicate as closely as possible the natural drainage regime of the site before development and to improve the quality of the runoff, reducing and improving the impact on receiving watercourses.

- All SUDS features will be designed to cater for the 1 in 100 year + 30% climate change storm event in accordance with Environment Agency requirements.
  Upon completion of the development a management company will be given ownership of all SuDS structures on this site and entrusted with a robust inspection, cleaning and maintenance programme to ensure the optimum operation of the surface water drainage system.

- In the rare occurrence of an exceedance event or during periods of exceptionally high rainfall, a 'back-up' overflow system will be incorporated into the drainage system to safely direct excess runoff into a series of lined attenuation basins situated at the eastern boundary of the site.
  These shallow basins will temporarily contain runoff prior to discharging into the existing Nore Farm Stream watercourse at a maximum combined controlled rate of **28l/s**, equivalent to the existing Greenfield runoff rate for the whole site.
  The northern attenuation pond, situated within the former Copseys Nursery site will have a restricted maximum discharge of **16l/s** into the Nore Farm Stream.
  The southern attenuation ponds, situated within the former Manor Farm site will have a restricted maximum discharge of **12l/s** into the Nore Farm Stream.

- A low flow channel within the southern basin will take runoff from the access near Fifth Avenue, however as the full extent of these basins will only come into effect in rare circumstances, for the vast majority of time these basins will be completely dry and can be safely utilised as grassed areas of public open space.

- Although the construction of the proposed development will not impact on flood risk to the existing adjoining properties, a new positive land drainage system will be installed at the western boundary of the site to intercept and safely dispose of any overland flood flows encountered by existing home owners, improving the flooding risk situation currently experienced by the properties off Fifth Avenue.

- The existing Copseys Nursery area of the site is predominantly hardstanding with runoff currently discharging directly into the Nore Farm stream at an uncontrolled peak rate of **486l/s.**
  To achieve a level of betterment, the post development flows into the Nore Farm stream from the whole development will be reduced to a maximum discharge limit of **28 l/s.**
  This will ensure that the development does not only mitigate flood risk to existing and proposed properties at the development site, but also improves the flood risk condition to the properties that lie within the downstream catchment of the Nore Farm Stream.

2 Introduction

2.1 Scope

2.1.1 MJA Consulting was commissioned by BDW Southampton & Generator Group to undertake a Flood Risk Assessment to determine the potential flood risks associated with the proposed development at land situated at Manor Farm and Copseys Nurseries, Denvilles, Havant.

2.1.2 BDW are proposing to develop approximately 7.85ha of land involving the construction of 191No. residential dwellings, with associated access roads, hardstanding parking and soft landscaping.

2.2 Report Structure

2.2.1 The National Planning Policy Framework - *Department for Communities and Local Government (2012)* is the current guidance on development and flood risk in England and Wales.
This guidance replaces but retains key elements of Planning Policy Statement 25: Development and Flood Risk.
The Flood Risk technical guidance for the National Planning Policy Framework requires a Flood Risk Assessment to be carried out to consider all potential forms of flooding including that from river, sea, estuarial, land drainage, groundwater, overland flow, surface water run-off, sewer systems, and artificial water bodies (lakes, reservoirs, canals etc).
A Flood Risk Assessment is required to consider the impact of all these potential forms of flooding on both the development site and off site parties and land.

2.2.2 This report will take the structure of a 'Flood Risk Assessment' in accordance with the Environment Agency's Flood Risk Assessment Guidance, the National Planning Policy Framework and CIRIA Report 624 'Development and Flood Risk – Guidance for the Construction Industry.

2.2.3 The purposes of this report are:

- To confirm that the proposed development will not be subject to flood risk.
- To confirm that a satisfactory strategy for the disposal of surface and foul water from the proposed development is achievable.
- To confirm that this development will not increase the risk of flooding to any offsite parties and land.

3 Existing Site

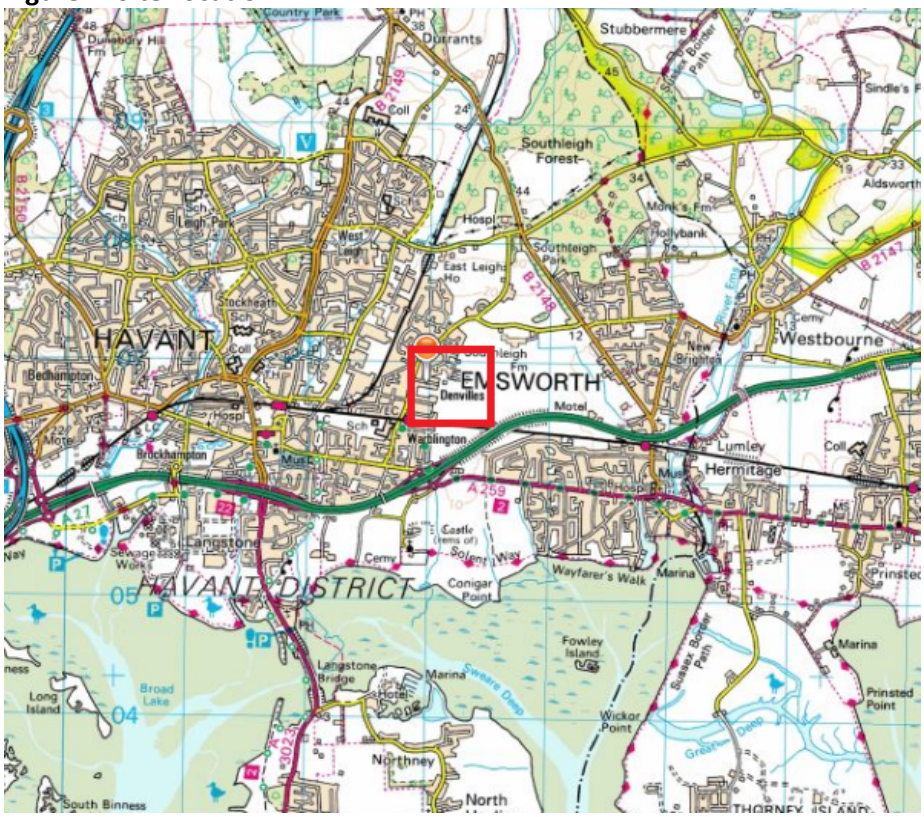
3.1 Site Location and Description

3.1.1 The site is located to the east of Havant in Hampshire.
The approximate National Grid Reference of the site is SU 73022 06767.
The overall site of approximately 7.85ha forms part of the current Copseys Plant Nursery (4.48ha) and land associated with Manor Farm (3.37ha).

3.1.2 The northern area of the site (Copseys Plant Nursery) predominately comprises of greenhouses with an area of hardstanding and one property within grass covered grounds.
The southern section of the site (Manor Farm) predominately comprises of open arable farm land with storage barns, associate farm structures, and No.17 & 19 Hallett Road.

3.1.3 The site is bound to the north, South & West by residential properties and to the East by open arable farm land.

Figure 1: Site Location



© 2011 Microsoft – Bing Map

Figure 2a: Development Site Boundary

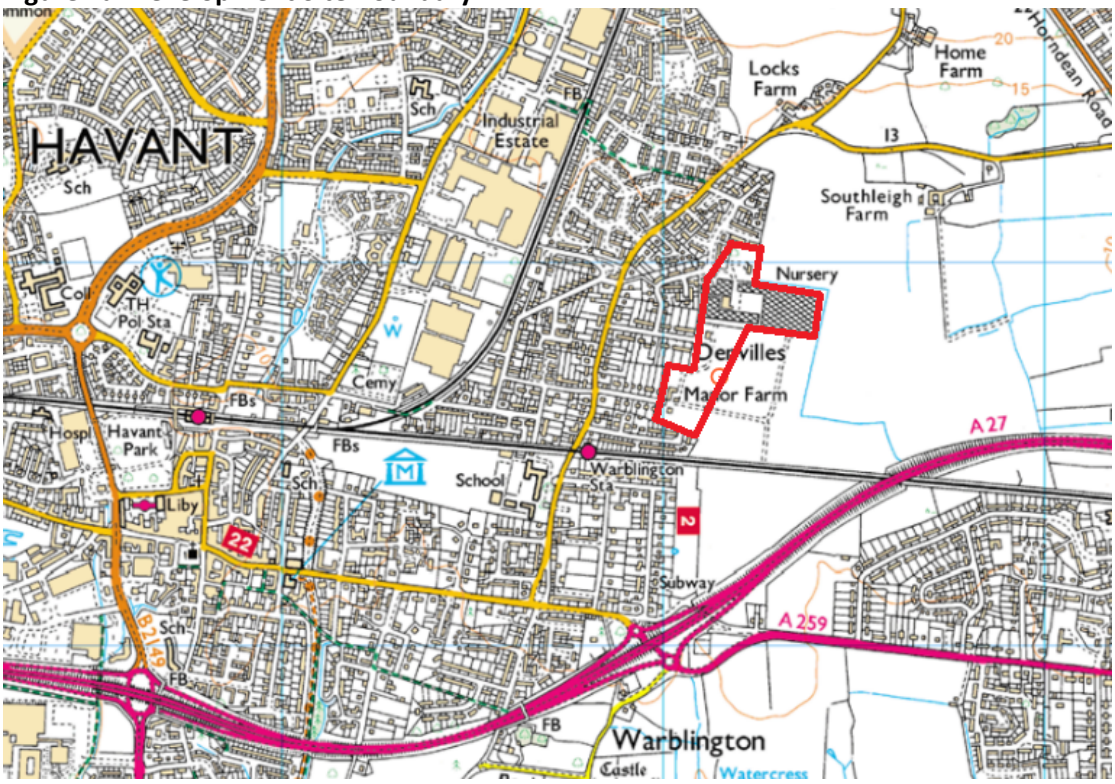


Figure 2b: Development Site Boundary

© 2011 Google – Map Data

4 Topographical and Geological Information

4.1 Topography

4.1.1 The topography of the existing Manor Farm site is generally flat, falling from 14.50mAOD to 13.000mAOD northwest to southeast.
Refer to Appendix B for the existing Topographical Survey.
No detailed topographical data exists for Copseys Plant Nursery, however the site is generally flat at approximately 15.00mAOD.

4.2 Geology & Hydrogeology

4.2.1 The British Geological Survey (BGS) 1:50 000 scale geological map describes the site geology as:
Bedrock: London Clay Formation - Clay, Silt and Sand.
Superficial Deposits: River Terrace Deposits (Undifferentiated) - Sand, Silt and Clay.

4.2.2 With reference to the site ground investigation report (J11002/DB/c02: Pre-purchase desk study & ground investigation letter report for the proposed residential redevelopment Nov 2012) by Wilson Bailey Geotechnical & Environmental, the ground conditions encountered across the site are described as follows.

4.2.3 Underlying the topsoil, where present, and beneath the concrete and tarmac hardstanding within the areas of the farm yard, the soils of the River Terrace Deposits were generally found to comprise a low strength sandy clay to depths of between 1.25 m and 2.80 m below ground level, beneath which lose and locally very loose variable sand and gravel soils were encountered to the maximum depth of investigation at 4.00 m in the majority of the exploratory positions.
Borehole No 5, which was drilled to the maximum depth of investigation at 5.45 m below ground level encountered firm gravel clay soils of the London Clay at a depth of 5.25 m below ground level.
No visual or olfactory indications of ground contamination were noted as part of the fieldwork phase of the ground investigation
Please refer to Appendix E for borehole location plan.

4.2.4 The Environment Agency's mapping website (www.maps.environmentagency.gov.uk) has classified the site as not located within a groundwater source protection zone for groundwater abstractions.
Groundwater vulnerability for this area is classed as a minor aquifer intermediate to high.

4.2.5 The underlying superficial soils are classified by the Environment Agency as being 'Secondary A' Aquifer. These are defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

4.2.6 The underlying bedrock is classified by the Environment Agency as being 'Unproductive Strata', these are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

4.3 Groundwater

4.3.1 A programme of groundwater monitoring has been carried out by Wilson Bailey Geotechnical & Environmental over a two year period from January 2011 to March 2013.
Groundwater levels were measured within standpipes installed at 7No. boreholes located across the site.
Refer to Appendix E for borehole location plan and table summary of results.

4.3.2 It should be noted that these groundwater levels have been observed during an exceptionally wet and sustained period of rainfall, with the Met Office confirming that 2012 was one of the wettest years on record in England, with the trend carried into early 2013.

4.3.3 The results indicate that the ground water table is highly seasonable with rapid fluctuations, found between 0.21m and 1.97m bgl.
It is apparent that there is a general rising trend of groundwater during 2012, which is consistent with the unusually consistent heavy rainfall experienced throughout the year.

4.3.4 With reference to Fig.1 – Appendix E, the summer rainfall has prevented the summer trough in water levels from occurring during 2012, although the peak levels during the winter of 2012 to March 2013 are not shown to be significantly higher than those measured on the site during previous winters.
These results would therefore support the view that even during sustained periods of heavy rainfall the site does not become flooded.

4.3.5 It should be noted that BH4 & BH5 which yield the highest recorded ground water levels, are located in lower parts of the site in an area of a former brick works.
This area in particular has been backfilled with fill material which is possibly causing a locally higher perched water table.

4.4 Soil Permeability

4.4.1 Soakage tests were undertaken at the site by Wilson Bailey Geotechnical & Environmental on 18.01.13 in accordance with BRE365.
The results indicate infiltration of between *1.2x10-5m/s – 1.8x10-6m/s* within the superficial deposits across the site.
Refer to Appendix C for infiltration test results and trial pit location plan.

4.5 Catchment Information

4.5.1 Watercourses

The nearest ordinary watercourse to the development is the 'Nore Farm Stream' which borders the eastern boundary of Copseys nursery. This runs south past Manor farm and under the A27 where it joins the main tributary discharging to Chichester Harbour 1.5km south of the site.

4.5.2 During the assessment of flood risk to and from this site, the highly sensitive nature of the Nore Farm Stream and the associated flood issues experienced by property owners within the downstream catchment has been greatly considered.
We believe that the surface water drainage systems proposed for this development will have a positive influence, reducing the risk of flooding from the Nore Farm Stream

4.5.3 Water bodies

Chichester harbour is located 1.5km south of the development.

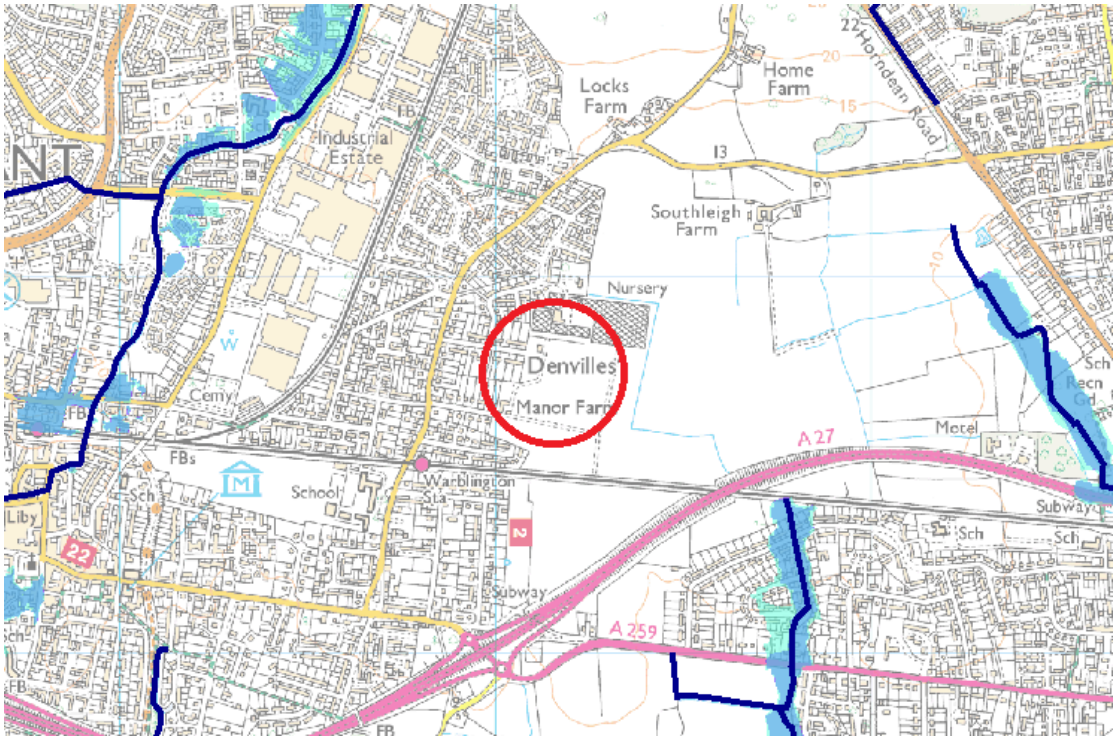
4.5.4 History of Flooding

The site has no official recorded history of flooding from groundwater, rivers / tidal (fluvial), artificial sources and flooding or from overloaded sewer networks.
Anecdotal evidence from local residents has indicated an historic pluvial flood event caused by the rapid melting of snow from the site onto Fifth Avenue.
It is also understood that the houses within Fifth Avenue have experience pluvial overland flooding to rear gardens from rainfall runoff.
This could be due to combination of blocked road gullies and possible lack of maintenance of the existing drainage systems.

5 Flood Risk Assessment

5.1 Flood Zone Map

Figure 3: Extract from Environment Agency Flood Zone Map



© Environment Agency 2011

Main Rivers

Dark blue shows the area that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be flooded:

- From the sea by a flood that has a 0.5 per cent (1 in 200) or greater chance of happening each year.
- From a river by a flood that has a 1 per cent (1 in 100) or greater chance of happening each year.

Light blue shows the additional extent of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1 per cent (1 in 1000) chance of occurring each year.

5.2 The Environment Agency's indicative Flood Map shows the site to be located within Flood Zone 1.
This is land assessed as having a less than 1 in 1000 (<0.1%) (lowest risk) annual probability of flooding from a river or stream in any year by the Environment Agency and is not within an area subject to either flooding or extreme flooding events.

5.3 The flood risk technical Guidance to the National Planning Policy Framework Table 2: Flood Risk Vulnerability classification, classifies residential developments as 'More Vulnerable'.

NPPF Table 2 of technical Guidance: Flood Risk Vulnerability classification

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[6].
- Sites used for holiday or short-let caravans and camping, *subject to a specific warning and evacuation plan.*[7]

5.4 Table 2 & 3 would indicate that 'more vulnerable' developments located within Flood Zone 1 are considered appropriate under the National Planning Policy Framework.

NPPF Table 3: Flood Risk Vulnerability and Flood Zone 'compatibility'

Flood risk vulnerability classification (see table 2)		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood zone (see table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	×	×	×

Key: ✓ Development is appropriate.
× Development should not be permitted.

5.5 Sequential Test

5.5.1 The National Planning Policy Framework Guidance states that Planning Authorities should complete a risk based 'Sequential Test' at all stages of the planning process, to steer new development to areas with the lowest probability of flooding.

5.5.2 Under the requirements of the 'sequential test' and as the proposed development is already located within flood zone 1 (lowest risk), there are no more suitable, developable and deliverable alternative sites, better located from a flood risk perspective, which would accommodate the proposed development.

6 Impact of Development on Flood Risk

6.1 This section identifies sources of potential flood risk to the site.
The sources of flooding that could potentially affect the site include flooding from groundwater, rivers / tidal (fluvial), overland runoff (pluvial), artificial sources and flooding from overloaded existing and proposed sewer networks.

6.2 Existing Watercourses

The Nore Farm Stream that bounds the eastern part of the site does not present a flood risk and is assessed as having a less than 1 in 1000 (<0.1%) (lowest risk) annual probability of flooding this site by the Environment Agency.

6.3 Fluvial

The topographical survey indicates that the lowest ground elevation on the site is approximately 13.00mAOD, while ground elevation at head of the tributary is 10.00m and the Chichester harbour at approximately < 5.00mAOD. It is therefore highly unlikely that the tributary or Chichester harbour will have an influence on fluvial/ tidal flooding at the site.

6.4 Pluvial (Overland Flow)

6.4.1 All proposed attenuation features within the development are designed to manage the 1 in 100 year return storm (1% chance of occurrence each year) plus an extra allowance of 30% for the potential increase in peak rainfall predicted up to 2115.

6.4.2 Overland flow results from rainfall that is unable to infiltrate into the ground due to soil saturation and/or a high water table, runs off hard impermeable surfaces or surcharges from manholes/SuDS structures during intense storm events which exceed sewer design capacity or due to structural/operational failure.

6.4.3 To mitigate the risk of overland flooding the design levels of hard paved and landscaped areas as part of the proposed design of the development will aim to contain and safely direct any flood flows to areas of the site as to cause minimum flood risk and disruption to properties and residents.
The finished floor slab levels of the buildings shall be set a minimum of 150mm above finished ground level.
Dry exit routes will be provided for each property and safe egress from the site is provided with the provision of raised ground floor slab levels and raised pavement levels.

6.4.4 Any overland runoff that occurs due to infiltration exceedance/failure of the permeable paving within the development road network will be contained within the road limits by raised kerb edges and raised pavement levels.
Excess runoff will be temporarily stored until capacity returns within the permeable paving sub-base, with residual runoff safely contained within the road limits and routed to low points of the site.

6.4.5 The majority of the proposed road network will fall towards the eastern boundary of the site, where the topography of the existing land continues to fall towards the east.

6.4.6 Therefore the greatest risk of potential overland runoff from the proposed development is to the existing ordinary watercourse (Nore Farm Stream) that borders the eastern boundary of Copseys nursery.
To mitigate the potential increase in overland flow leaving the proposed development site and into the existing watercourse, an overflow system consisting of collector cells located within the permeable paving sub-base will collect excess runoff a series of attenuation ponds (northern and southern), before discharging into the existing watercourse at controlled rate equivalent to the Greenfield runoff rate for the pre-developed site (Qbar).

6.4.7 Local residents have indicated a previous flood event near Fifth Avenue was caused by the rapid melting of snow from the development site.
The provision of a new land drainage system at the boundary of the proposed site will intercept and safely dispose of any overland flows.
This will ensure that offsite parties will not experience an increase in pluvial flood risk, and that the development drainage proposals will provide betterment over the existing site conditions.
A full allowance for the potential runoff from this area will be included in the pond detailed design storage calculations.
This will ensure that the existing properties are drained effectively and that flood risk is not increased to both the existing and proposed properties at the development site and properties within the downstream catchment of the site.

6.4.8 Provided design & landscaping consider overland flow routes and the proposed road drainage is adequately designed and constructed, the risk of flooding of buildings on site from overland flows will not increase beyond the current level of risk.
This will ensure that this development does not impact on or pose any increased flood risk to the site or offsite parties and land.

6.5 Groundwater

6.5.1 No evidence or instances of groundwater flooding have been recorded.
The proposed plans for the site do not include basements and the height of proposed finished floor levels will preclude groundwater flooding from being an issue.
It is recommended the site is raised in the region of 450mm to increase the dissolution layer (the distance between the underside of any permeable structure and the water table) to a minimum of 1m.
The material used to raised the site should be a free-draining open graded aggregate, i.e. Type 3 granular sub-base or similar.
Any residual overland runoff caused by the raising of site levels will be intercepted by a proposed network of land drains and ditches around the western boundary of the site and conveyed into the proposed development drainage system.

6.5.2 Whilst there should be a suitable level of interaction between the free-draining stone material used to raise the site and the existing strata, it should be acknowledged that the lower infiltration rates of the existing strata could cause residual lateral flows within the free-draining stone material.

6.5.3 The possibility of high groundwater and for lateral flows will be considered within the geotechnical design of the house foundations and potential issues mitigated through the use of vibro stone columns.

6.5.4 The topography of the site would suggest that any lateral groundwater flow at the site will be in an easterly direction away from the existing development and towards the Nore Farm Stream.
Any lateral flow that has not infiltrated into the existing strata will be collected at the eastern boundary of the site by a series of collector cells and distributed into the attenuation ponds.
This will ensure that the peak flow rate into the Nore Farm stream is not increased post development as a result of the raising of the site and that there will be no increase in flood risk to the properties downstream of the site.

6.5.5 All attenuation ponds are to be lined with an impermeable membrane to prevent the interaction of the groundwater table and the function of the SuDS structure.

6.6 Existing Sewers

6.6.1 Surface

The existing surface water sewers that serve the various roofed and paved areas within the Copsey's Nursery site will be abandoned and removed, therefore posing no risk of flooding to the proposed development.

6.6.2 Foul

The existing foul water system that serves the Copseys Nursery site will be abandoned and removed, therefore posing no risk of flooding to the proposed development.

6.7 Proposed Site Drainage

6.7.1 A Flood Risk Assessment requires that an evaluation of all proposed artificial drainage systems and infrastructure within, or in close proximity to the site is carried out.
In the context of this development, the following systems are to be installed which need to be assessed in terms of potential flooding through the capacity of the systems being exceeded or the structural, hydraulic, mechanical or operational failure of the system occurring:

- Piped gravity foul and surface water drains.
- SuDS systems for the collection and conveyance of surface water runoff within the site boundary.
- Foul water pumping station and associated rising main.

6.7.2 All piped sewers will be designed to the Sewers for Adoption (7th edition) requirement of 'no surcharge of pipes up to the 1 in 1 year storm' and 'no flooding up to the 1 in 30 year storm event'.
Southern Water will be consulted with to ensure that there is adequate capacity in the local foul network to receive the foul flows from the proposed development.

6.7.3 The foul water pumping station and rising main will be designed and installed in accordance with Sewers for Adoption (7th edition) specifications.
As the entire site is located within Flood Zone 1 (lowest risk) the pumping station will not be located in an area susceptible to flooding.
For the rising main a non-degradable marker tape should be laid 300 mm above the top of the pipe.
The pumping station should be fully automatic with provision for remote monitoring by telemetry.
To ensure that sewage flooding does not occur at or upstream of the pumping station during plant or power failure, additional storage will be provided.
This storage will be above the high level alarm and below the lowest connected lateral drain or private sewer invert.

6.7.4 The surface water runoff generated on the site as a result of the development will be managed using appropriate SuDS techniques up to the 1 in 100 +30% storm event. This will ensure that the peak rate of surface water leaving the developed site is no greater than the existing Greenfield runoff rate, including the temporary condition during the construction of new buildings.

6.8 Structures Affecting Local Hydraulics

There is no evidence of structures affecting the hydraulics of watercourses in the vicinity of the site that would impact on flood risk at the site.

6.9 Other Water Bodies

There are no reservoirs or canals or other artificial sources of flooding within the area.

7 Existing and Proposed Site Runoff

7.1 This section aims to calculate the estimated peak runoff rates and volumes of surface water leaving the site, for the pre and post development conditions. These discharge rates can then be used for the preliminary design of the surface water drainage strategy for the proposed development.

7.2 Catchment Area

7.2.1 The existing and proposed permeable and impermeable areas are listed below:

	Permeable	Impermeable	Total
Existing Site Area	51,500 m²	27,000 m²	78,500 m²
Proposed Site Area	47,100 m²	**Southern Site** 16,900 m² Site 4250 m² offsite + 25% Groundwater = 26,400 m² **Northern Site** 14,500 m² Site 0m² offsite + 25% Groundwater = 18,100m²	91,600 m²

7.2.2 This represents a total of 44,500 m² (4.45ha) in potential contributing impermeable area post development, which is an overall increase of 17,500m² (1.75 ha) over existing site conditions.

7.2.3 The total impermeable catchment area for the proposed site includes an allowance for any offsite areas that could potential drain into the proposed development drainage system.
This area has been calculated at 4250m², please refer to Appendix G for a plan of the potential offsite areas.
Due to the potential risk of groundwater infiltrating into any SuDS systems on site, an additional contingency of 25% of the total contributing impermeable area will be included with SuDS design calculations.

7.3 Existing Surface Water Runoff Rate

7.3.1 **Copseys Nurseries (Northern Section – 4.48ha)**

The 4.48ha Copseys Nursery area of the site is predominantly hardstanding and accounts for 2.7ha of impermeable area, with the majority of runoff discharging directly into the Nore Farm stream unattenuated.

7.3.2 A suitable method for the estimation of peak flow from impermeable areas is the '*Rational method' Q = 2.78 CIA*.
Refer to Appendix D for a summary of results.

Where:

Q = flow (l/s)
I = rainfall intensity (mm/hr), return period & equal to time of concentration
A = Impermeable area drained (ha)
C = runoff coefficient, assumed to be 1.0

Impermeable Catchment: 2.7ha

1 in 1 year	**152 l/sec**
1 in 30 year	**372 l/sec**
1 in 100 year	**486 l/sec**

7.3.3 The volume criterion is calculated for the 100 year 6 hour storm event including a 30% increase in rainfall intensity for climate change (EA/DEFRA W5-074/A – Preliminary rainfall runoff management for developments).

$$V=\frac{2.78CIA}{1000} \times 21600(6hr) = \mathbf{1686m^3}$$

7.3.4 Although the majority of the Copseys Nursery site is classed as 'Brownfield', the Environment Agency seeks opportunities to achieve betterment on redevelopments by limiting the runoff characteristics to that of the site in its Greenfield state.
Therefore to achieve a level of betterment and a reduction in peak flows discharging into the Nore Farm Stream watercourse, the whole existing site area of 4.48ha will be classed as 'Greenfield' and the existing runoff rate QBar will be calculated accordingly to determine the discharge constraint from the proposed development site.

7.3.5 The existing peak run-off rate for this northern section has been be calculated using the IH Report 124 'Flood estimation for small catchments'(Marshall and Bayliss, 1994) Greenfield run-off methodology, interpolated for sites under 50ha using Micro Drainage software.
Refer to Appendix D for a summary of results.

IH124 mean annual flood flow rate equation:
$QBAR_{<50ha} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$

Catchment: 4.48ha

1 in 1 year	13.7 l/sec
1 in 30 year	36.4 l/sec
1 in 100 year	51.2 l/sec
QBar	**16.1 l/sec**

7.3.6 The storm water runoff volume from a site should be limited to the existing runoff volume wherever possible.
The volume criterion is calculated for the 100 year 6 hour storm event:
Volume = % Runoff x Total Rainfall x Area = **1075m³**

7.3.7 Manor Farm (Southern Section – 3.37ha)

The 3.37ha Manor Farm portion of the site will be classed as 'Greenfield' and existing runoff rates and volumes will be calculated using the Institute of Hydrology Report 124 methodology, interpolated for sites under 50ha using Micro Drainage software.
Refer to Appendix D for a summary of results.

Catchment: 3.37ha

1 in 1 year	10.3 l/sec
1 in 30 year	27.4 l/sec
1 in 100 year	38.5 l/sec
QBar	**12.1 l/sec**

7.3.8 The storm water runoff volume from a site should be limited to the existing runoff volume wherever possible.
The volume criterion is calculated for the 100 year 6 hour storm event:
Volume = % Runoff x Total Rainfall x Area = **809m³**

7.3.9 Therefore, the total combined existing Greenfield (Qbar) runoff rate from the whole 7.85ha site is **28l/s,** and the 100year 6hr combined runoff volume is 1884 m³.

7.4 Proposed Development Surface Water Runoff Rate

7.4.1 The estimated peak runoff rate from the proposed site is based on 100% runoff from impermeable areas and 0% runoff from permeable areas, in accordance with CIRIA C697 - The SuDS Manual & Preliminary rainfall runoff management for Developments (EA/DEFRA W5-074/A).

7.4.2 A full allowance for the potential runoff from the offsite area will be included in both this estimate and any attenuation design storage calculations.
This will ensure that the existing properties are drained effectively and that flood risk is not increased to either the existing or proposed properties at this site and downstream.

7.4.3 The National Planning Policy Framework requires that consideration is given to the effect of climate change on the flows generated by any new development. For piped surface water drainage, an increase in 30% is considered as a likely increase in rainfall intensity due to long term climate change, up to 2115.

NPPF Table 5: Recommended national precautionary sensitivity ranges for peak rainfall intensities:

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	*+5%*	*+10%*	*+20%*	*+30%*
Peak river flow	*+10%*	*+20%*		
Offshore wind speed	*+5%*		*+10%*	
Extreme wave height	*+5%*		*+10%*	

7.4.4 A suitable method for the estimation of peak flow is the *Rational method, Q = 2.78 CIA*.

Where:

Q = flow (l/s)
I = rainfall intensity (mm/hr), return period & equal to time of concentration
A = Impermeable area drained (ha)
C = runoff coefficient, assumed to be 1.0

Refer to Appendix D for a summary of results.

7.4.5 **<u>Copseys Nurseries (Northern Section)</u>**
Impermeable Area – 1.45ha
+25% Groundwater contingency = 1.81ha

<u>Catchment: 1.81ha</u>

1 in 1 year	**131 l/sec**
1 in 30 year	**323 l/sec**
1 in 100 year	**423 l/sec**

7.4.6 The volume criterion is calculated for the 100 year 6 hour storm event including a 30% increase in rainfall intensity for climate change (EA/DEFRA W5-074/A – Preliminary rainfall runoff management for developments).

$$V=\frac{2.78CIA}{1000} \times 21600(6hr) = \mathbf{1467m^3}$$

7.4.7 **Manor Farm (Southern Section)**
Impermeable Area – 1.69ha
Offsite Impermeable catchment – 0.425ha
+25% Groundwater contingency = 2.64ha

Catchment: 2.64ha

1 in 1 year	**191 l/sec**
1 in 30 year	**472 l/sec**
1 in 100 year	**617 l/sec**

7.4.8 The volume criterion is calculated for the 100 year 6 hour storm event including a 30% increase in rainfall intensity for climate change (EA/DEFRA W5-074/A – Preliminary rainfall runoff management for developments).

$$V=\frac{2.78CIA}{1000} \times 21600(6hr) = \mathbf{2140m^3}$$

7.4.9 Therefore, the total combined peak runoff rate (1:100y + 30%) from the proposed site (4.45ha of impermeable area) is **1040l/s,** and the 100year 6hr combined runoff volume is 3607m³.

7.4.10 It can be seen that as a result of this development and the increase in impermeable areas, the peak rate and volume at which surface water could potentially runoff the site will be much greater than in its Greenfield state. Additional runoff due to development should be disposed of by way of infiltration, or if this is not feasible due to soil type, discharged from the site at flow rates below 2l/s/ha.
Where compliance to 100 year volumetric criterion cannot be met or fully demonstrated, the limiting discharge for the up to 100 year return period into a receiving watercourse or sewer will be constrained to QBar (mean annual peak rate of runoff for the Greenfield site).

7.4.11 In summary, the post development flows into the Nore Farm Stream from both the northern and southern portion of the development combined, will be limited to a maximum of **28 l/s** up to the 1:100year + 30% storm event.

7.4.12 The northern portion of the site, formerly Copseys Nursery will have a restricted maximum discharge of **16l/s.**
The southern portion of the site, formerly Manor Farm will have a restricted maximum discharge of **12l/s.**

8 Surface water drainage strategy

8.1 The National Planning Policy Framework requires that new developments do not exacerbate flood risks elsewhere, which means there is a need to control drainage and runoff to ensure there are no increases in overland flow as a result of the development.

8.2 The Building Regulations Document H (2002) details a hierarchy of potential methods of disposing of surface water from a site:

- An adequate soakaway or some other adequate infiltration system, or where that is not practicable,
- A watercourse, or where that is not practicable,
- A sewer

8.3 Surface water runoff will be managed in accordance with current requirements to incorporate Sustainable Urban Drainage into development. The suitability of various techniques has been assessed using the SuDS management train as stated in the CIRIA Manual C697. The various techniques will be reviewed as to their suitability in consideration of the characteristics of the development to manage runoff at source. The use of SUDS systems will provide an improvement to the biodiversity and water quality and a reduction in runoff peak runoff flows.

8.4 Results from the soil permeability testing (*1.2x10-5m/s – 1.8x10-6m/s)* indicate that the use of infiltration would be a feasible method of managing the surface water runoff generated by the proposed development.

8.5 Sustainable Drainage Systems (SuDS) will be incorporated into the surface water drainage strategy to mitigate the additional runoff and reduce flood risk to downstream areas.

8.6 SuDS features such as permeable paving, cellular crate soakaways, swales and shallow retention basins will be utilised and will be designed to cater for the 1 in 100 year + 30% climate change storm event in accordance with Environment Agency requirements.

8.7 The philosophy of the SuDS utilised will be to replicate as closely as possible the natural drainage regime of the site before the development and improve the quality of the runoff, reducing the impact on receiving watercourses.

8.8 A ground water monitoring programme has indicated that the water table is highly seasonable with rapid fluctuations, found generally between 0.21m and 1.97m bgl. It is proposed that only shallow soakaway structures are used and that the site is raised in the region of 450mm to increase the dissolution layer (the distance between the underside of any permeable structure and the groundwater table) to a minimum of 1m.

8.9 The material used to raised the site should be a free-draining open graded aggregate, i.e. Type 3 granular sub-base or similar.
Any residual overland runoff caused by the raising of site levels will be intercepted by a proposed network of land drains and ditches around the western boundary of the site and conveyed into the proposed development drainage system.

8.10 The principle surface water drainage strategy for all runoff from the development is to utilise infiltration for all storm events up to the 1 in 100 year + 30% climate.
In exceedance events or during periods of high groundwater, an overflow system will be incorporated into the network to contain and direct excess runoff into the attenuation basins prior to discharging into the existing Nore Farm Stream watercourse at a controlled rate equivalent to the Greenfield runoff rate.
The existing site produced a combined QBar (Mean annual Greenfield peak flow) of **28 l/s** leaving the site into the Nore Farm Stream Watercourse.
The northern portion of the site, formerly Copseys Nursery produced a Qbar of **16l/s.**
The southern portion of the site, formerly Manor Farm produced a Qbar of **12l/s.**

8.11 Therefore, the post development flows into the Nore Farm stream will be limited to a maximum of **28 l/s** up to the 1 in 100 year +30% storm event.
The northern portion of the site, formerly Copseys Nursery will have a restricted maximum discharge of **16l/s.**
The southern portion of the site, formerly Manor Farm will have a restricted maximum discharge of **12l/s.**

8.12 The attenuation ponds are to be lined with an impermeable membrane to prevent the interaction of the groundwater table with the function of the SuDS structure.

8.13 The surface water drainage strategy for the site will follow the principals as outlined below:

8.14 Residential Areas:
Roof drainage will drain via traditional rainwater down pipes discharging to shallow cellular crate soakaways or sub base drainage systems.
Each house will also have a 200L rainwater butt connected to a down pipe with a draw off tap.
Where feasible, high level overflows will connect these soakaways to the permeable block paving sub-base.

8.15 Driveways and Parking Courts
Parking courts will be constructed using a mixture of permeable block paving in the parking bays and tarmac surfacing on the running areas. Runoff from both areas will drain through the block paving to the permeable sub base below.
As runoff percolates through the structure, pollutants and contaminates are filtered out by the bedding layer providing an improvement in water quality.

8.16 Residential Access Road:

The adoptable roads will drain via a permeable surface of either permeable block paving or permeable macadam. The sub base for both will be designed to attenuate the 1:100 year + 30% climate change event.

An overflow system consisting of collector cells located within the permeable paving sub-base will collect excess runoff into the attenuation ponds, before discharging into the existing watercourse at controlled rate equivalent to the Greenfield runoff rate for the site 28 l/s (Qbar).

8.17 Attenuation Ponds

The attenuation ponds are designed to collect excess runoff from the permeable paved road systems.

These ponds are to be lined with an impermeable membrane to prevent the interaction with the groundwater table and have a maximum water depth of 0.53m . The outflow from the ponds will discharge into the existing Nore Farm stream at a maximum combined controlled rate of 28l /s (Greenfield Runoff rate QBar) via flow control structures situated within the outlet control chambers of the ponds

.

8.18 The northern attenuation pond, situated within the former Copseys Nursery site will have a restricted maximum discharge of **16l/s** into the Nore Farm Stream.

The southern attenuation ponds, situated within the former Manor Farm site will have a restricted maximum discharge of **12l/s** into the Nore Farm Stream.

8.19 The control structures will be a brick built or precast concrete manhole ring control chamber containing a hydraulic vortex flow control device, i.e Hydrobrake or similar.

8.20 SuDS Management and Maintenance

A management company will be given ownership of all SuDS structures on this site including the soakaways, permeable block paved road system and the attenuation pond / flow control chamber and will be entrusted with a robust inspection, de-silting and maintenance programme to ensure the optimum operation of the surface water drainage network is continually maintained.

It is also recommended that the management agreement of SuDS will be incorporated into a section 106 agreement.

8.21 Pollution Mitigation

A level of treatment will be provided to runoff from the permeable block paving system through filtration of hydrocarbons and other pollutants through the pavers , filter membrane and stone media sub-base.

The attenuation ponds will also provide a level of sediment capture prior to discharge into the Nore Farm stream.

9 Foul water drainage strategy

9.1 The foul water discharge from each property will drain via gravity through the development to a new pumping station located at the south of the site.
This flow will then be pumped via a rising main discharging to an existing Southern Water foul sewer located in Hallett Road.
The foul system will be offered for adoption to Southern Water.

9.2 The predicted peak foul discharge rate for the proposed development based on the Sewers for Adoption 7th figure (4000 l/dwelling/day) for the proposed 191 units will be 8.8l/s Peak Foul Flow.

9.3 Southern Water has confirmed that capacity exists in the network to receive a peak flow of 4.8l/s from the development pumping station.

10 Summary & Conclusion

10.1 The Environment Agency's indicative Flood Map shows the proposed development site to be located within Flood Zone 1.
This is land assessed as having a less than 1 in 1000 (<0.1%) (lowest risk) annual probability of flooding from a river or stream in any year by the Environment Agency and is not within an area subject to either flooding or extreme flooding events.

10.2 The site has no official recorded history of flooding from groundwater, rivers / tidal (fluvial), artificial sources and flooding or from overloaded sewer networks.
Anecdotal evidence from local residents has indicated an historic pluvial flood event caused by the rapid melting of snow from the site onto Fifth Avenue.
It is also understood that the houses within Fifth Avenue have experience pluvial overland flooding to rear gardens from rainfall runoff.
This could be due to combination of blocked road gullies and possible lack of maintenance of the existing drainage systems.

10.3 The design philosophy for management of surface water runoff from this site is to utilise infiltration via SuDS features throughout the development.
These will include permeable block paving, cellular crate soakaways, and shallow attenuation ponds to provide a sustainable drainage system.

10.4 The philosophy of SuDS is to replicate as closely as possible the natural drainage from a site before development and improve water quality, reducing the impact on receiving watercourses.

10.5 The complete surface water drainage system has been designed with a significant factor of safety in mind.
All the SUDS features within the drainage system are capable of containing runoff from the exceptionally rare 1 in 100 storm event (1% chance of occurrence each year) plus an allowance of 30% for predicted future climate change effects.
The design of the storage basins account for the 'worst case scenario' and are sized for full attenuation of all impermeable areas on the proposed site, including a significant area of offsite runoff which could be picked up by the land drainage system.
In addition, whilst the system is robustly designed to protect against high groundwater inundation, the overall storage capacity of the ponds has been increased by a further 25% to provide an additional safety buffer for groundwater infiltration via the system overflow network.

10.6 The provision of a new land drainage system at the boundary of the proposed site will intercept and safely dispose of any overland flows.
This will ensure that offsite parties will not experience an increase in pluvial flood risk, and that the development drainage proposals will in fact provide betterment over the existing site conditions.

10.7 Residential Areas:

Roof drainage will drain via traditional rainwater down pipes discharging to shallow cellular crate soakaways or sub base drainage systems.

10.8 Driveways and Parking Courts

Parking courts will be constructed using a mixture of permeable block paving in the parking bays and tarmac surfacing on the running areas. Runoff from both areas will drain through the block paving to the permeable sub base below.

As runoff percolates through the structure, pollutants and contaminates are filtered out by the bedding layer providing an improvement in water quality.

10.9 Residential Access Road:

The adoptable roads will drain via a permeable surface of either permeable block paving or permeable macadam. The sub base for both will be designed to attenuate the 1:100 year + 30% climate change event.

10.10 The initial ground investigations have shown that the ground water table is highly seasonable with rapid fluctuations, found generally between 0.21m and 1.97m bgl. It is proposed that only shallow soakaway structures are used and that the site is raised in the region of 450mm to increase the dissolution layer (the distance between the underside of any permeable structure and the groundwater table) to a minimum of 1m.

10.11 To mitigate the potential infiltration exceedance of the soakaway structures and any resultant overland flood flow, an overflow system consisting of collector cells located within the permeable paving sub-base will collect excess runoff.
This excess runoff will be temporally held in an attenuation ponds prior to discharging into the existing watercourse at a controlled rate equivalent to the Greenfield runoff rate of 28 l/s - QBar.
The northern attenuation pond, situated within the former Copseys Nursery site will have a restricted maximum discharge of **16l/s** into the Nore Farm Stream.
The southern attenuation ponds, situated within the former Manor Farm site will have a restricted maximum discharge of **12l/s** into the Nore Farm Stream.

10.12 The attenuation ponds are to be lined with an impermeable membrane to prevent the interaction of the groundwater table and the function of the SuDS structure.

10.13 A management company will be given ownership of all SuDS structures on this site and entrusted with a robust inspection, cleaning and maintenance programme to ensure the optimum operation of the surface water drainage system is continually maintained.

10.14 The foul and surface water piped drainage system will be designed in accordance with the requirements of Sewers for Adoption 7th Edition with the foul network offered to for adoption to Southern Water.

10.15 During the assessment of flood risk to and from this site, the highly sensitive nature of the Nore Farm Stream and the associated flood issues experienced by property owners within the downstream catchment has been greatly considered.

10.16 The existing Copseys Nursery site, which sits within the northern portion of the proposed development, currently discharges surface water runoff from all impermeable areas un-restricted into the Nore Farm Stream.
For the 100 year storm this can result in discharge rates as high as 486l/s into the watercourse.

10.17 Under the proposed surface water drainage scheme, the maximum discharge rate from the whole site for all storm events up to 1 in 100 year plus a 30% allowance for climate change, will **28l/s** into the Nore Farm Stream.
This will be split as per the equivalent Greenfield runoff for the northern and southern portions of the site.
The northern attenuation pond, situated within the former Copseys Nursery site will have a restricted maximum discharge of **16l/s** into the Nore Farm Stream.
The southern attenuation ponds, situated within the former Manor Farm site will have a restricted maximum discharge of **12l/s** into the Nore Farm Stream.

10.18 In the rare likelihood of an exceedance storm event or during periods of exceptionally high groundwater, a 'back-up' overflow system will be incorporated into the drainage system to safely direct excess runoff into a series of lined attenuation basins situated at the eastern boundary of the site.

10.19 These shallow basins will temporarily contain runoff prior to discharging into the existing Nore Farm Stream watercourse at a controlled rate equivalent to the existing Greenfield runoff rate.
As these basins will only come into effect in rare circumstances, for the vast majority of time these basins will be completely dry and being only 700mm deep can be safely utilised as grassed areas of public open space.

10.20 We believe that the complete surface water drainage strategy proposed for this development is a robust system which not only affords complete protection to the surrounding area from the proposed scheme, but will also provide a positive improvement in flood protection to both upstream properties to the west and properties downstream of the site, by reducing and controlling the amount of surface water runoff from the site into the Nore Farm Stream.
This will help mitigate the historical watercourse related flood incidences that have been recorded.

10.21 This report concludes to demonstrate the following:

- The proposed development will not be subject to flood risk, result in a loss of flood plain storage or impede flood flow routes.
- That a satisfactory strategy for the disposal of surface and foul water from the proposed development is achievable.
- This development will not increase the risk of flooding to any offsite parties and land or increase resident population within a flood plain
- The overall surface water drainage strategy for this development will provide a positive improvement in flood protection to both upstream and downstream properties.

APPENDIX A

DEVELOPMENT FOUL & SURFACE WATER STRATEGY

The principle surface water drainage strategy for all runoff from the development is to utilise infiltration for all storm events up to the 1 in 100 year + 30% climate.
In exceedance events or during periods of high groundwater, an overflow system will be incorporated into the network to contain and direct excess runoff into the attenuation basins prior to discharging into the existing Nore Farm Stream watercourse at a controlled rate equivalent to the Greenfield runoff rate of QBar – 28l/s.

Residential Roof Areas
Roof drainage will drain via traditional rainwater down pipes discharging to shallow cellular crate soakaways or sub base drainage systems.
Each house will also have a 200L rainwater butt connected to a down pipe with a draw off tap.
Where feasible, high level overflows will connect these soakaways to the permeable block paving sub–base.

Driveways and Parking Courts
Parking courts will be constructed using a mixture of permeable block paving in the parking boys and tarmac surfacing on the running areas. Runoff from both areas will drain through the block paving to the permeable sub base below.
As runoff percolates through the structure, pollutants and contaminates are filtered out by the bedding layer providing an improvement in water quality.

Residential Access Road
The adoptable roads will drain via a permeable surface of either permeable block paving or permeable macadam. The sub base for both will be designed to attenuate the 1:100 year + 30% climate change event.
An overflow system consisting of collector cells located within the permeable paving sub–base will collect excess runoff, discharging into an attenuation pond.

Attenuation Ponds
The attenuation ponds are designed to collect excess runoff from the permeable paved road systems.
These ponds are to be lined with an impermeable membrane and will have a maximum water level of 0.53m deep.
The outflow from the ponds will discharge into the existing Nore Farm stream at a maximum combined controlled rate of 28 l/s (Greenfield Runoff rate QBar) via a flow control structure:

Northern Pond – 16l/s
Southern Ponds – 12l/s

The control structures will be a brick built or precast concrete manhole ring control chamber containing a hydraulic vortex flow control device, i.e Hydrobrake or similar.

PRELIMINARY FOR PLANNING PURPOSES ONLY

REV. No.	DATE	DESCRIPTION	INITIALS
D	02.04.13	Pond discharge rates amended and volumes added	CP
C	25.03.13	Low flow channel added to attenuation areas	CP
B	19.03.13	Attenuation ponds amended to EA comments	CP
A	01.03.13	Attenuation pond lined with impermeable membrane	CP

Client: BARRATT

Project: Manor Farm, Copseys Nursery, Denvilles

Title: Development Overall Surface Water Strategy

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Scale	Date	Drawing No.	Rev
NTS	FEB 13	4527:70	D
Checked	Drawn KTG		

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PRELIMINARY FOR PLANNING PURPOSES ONLY

REV. No.	DATE	DESCRIPTION	INITIALS

Client: BARRATT

Project: Manor Farm, Copseys Nursery, Denvilles

Title: Development overall Foul drainage strategy

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Scale	Date	Drawing No.	Rev
1:500@A0	Nov 12	4527:P02	
Checked	Drawn KTG		

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APPENDIX B

TOPOGRAPHICAL SURVEY

TREES

A Ash
AB Alder
AP Apple
B Beech
C Cedar
CB Copper Beech
CH Cherry
CP Cypress
E Elm
EL Elder
EU Eucalyptus
F Fir
FM Field Maple
H Holly
HZ Hazel
HC Horse Chestnut
HH Hawthorn
HW Hawthorn
HY Holly
LB Indian Bean Tree
LB Laburnum
LM Lime
LP Larch Tree
LR Laurel
M Maple
MG Magnolia
OK Oak
P Pine
PA Poplar
PL Plane
PM Plum
PR Pear
PP Pissardi Plum
PR Pear
R Rowan
RO Red Oak
RD Rhododendron
S Sycamore
SB Silver Birch
SC Sweet Chestnut
SH Scots Pine
SJ Spruce
SY Sycamore
W Willow
WL Willow
WN Walnut
Y Yew

Species / Dia / Spread (max) / Ht
e.g. OK / 0.6 / 8 / 15

KEY

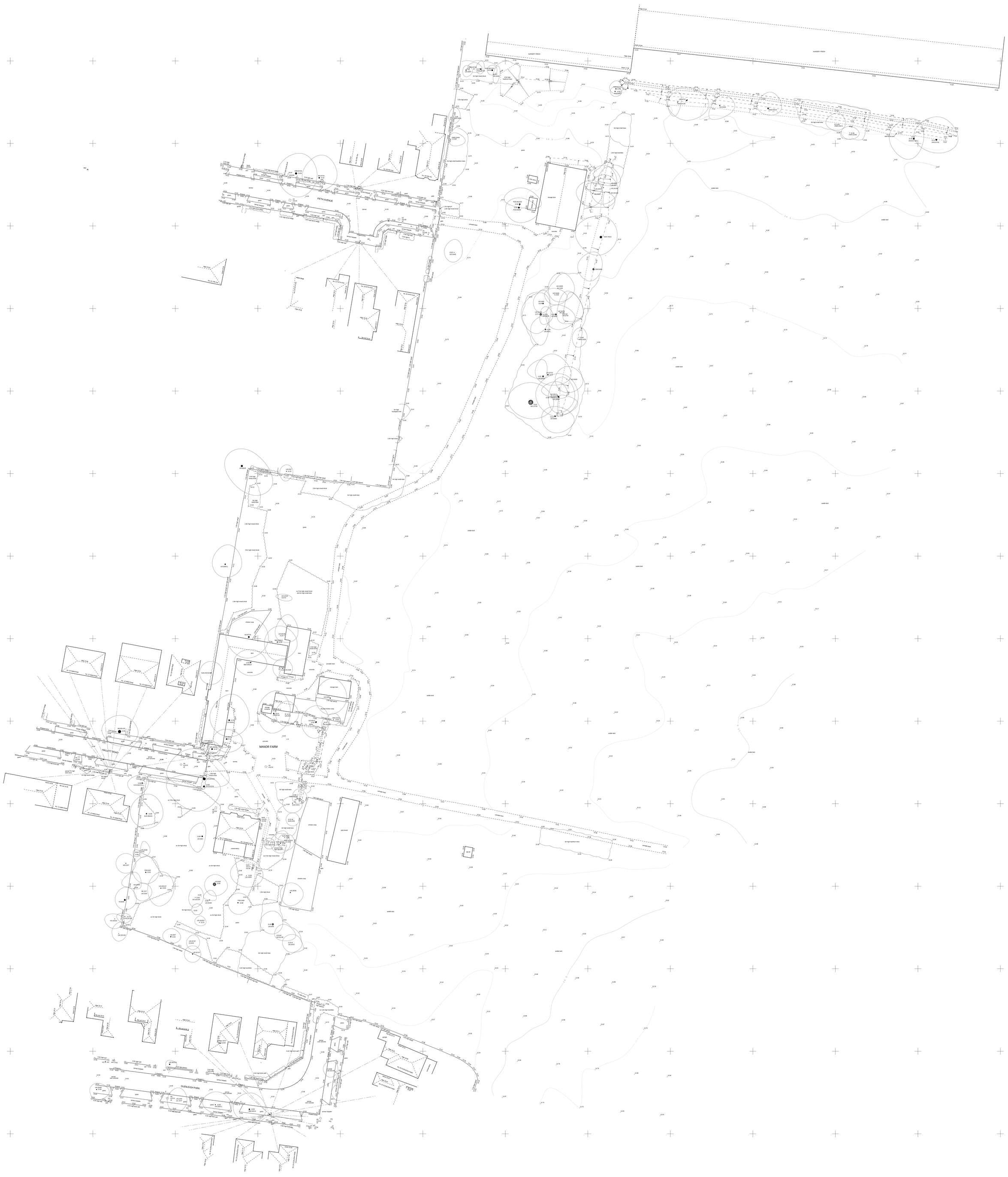
BT British Telecom
CB Control Box
CP Control Box
CL Cover Level
DV Drain Off Division
EL Electric
EP Electricity Pole
FH Fire Hydrant
GSV Gas Stop Valve
HT Height
IC Inspection Cover
IL Invert Level
LP Lamp Post
MH Manhole
MKR Marker
OHW Overhanging Wall
OH Overhead
G Road Gully
PC Protector
PC Pram Crossing
RNP Road Name Plate
S Soakaway
S/A Soakaway
ST Stay / Strut
TBM Temporary Bench (Undentified)
TB Telephone Box
TC Telecom
TL Traffic Light
TP Telegraph Pole
UP Utility Pole Lift
VP Vent pipe
WM Water Meter
WSV Water Stop Valve

FENCES

BWF Barbed Wire Fence
CBF Concrete Block Fence
CF Concrete Post
CPF Chestnut Paling Fence
ESF Estate Railing Fence
IRF Iron Railing Fence
PKF Picket Fence
PMF Post & Mesh Fence
PWF Post & Wire Fence
SCF Security Fence
WF Fence
WMF Wire Mesh Fence
WPF Wood Panel Fence

SURVEY STATION INFORMATION

STATION	EASTING	NORTHING	LEVEL	TYPE
H1	470930.390	106630.164	13.45	NAIL
H2	470878.300	106646.402	14.00	NAIL
H6	470879.240	106638.399	14.00	NAIL
H7	470937.680	106643.583	13.82	NAIL
H12	470904.610	106652.538	14.00	NAIL
H13	470904.610	106652.538	14.00	NAIL
H24	470906.770	106638.236	14.00	NAIL
H26	470925.575	106660.271	13.99	NAIL


FIFTH AVENUE
HALLETT ROAD
GLENLEIGH PARK
MANOR FARM
NURSERY FRESH
arable land
storage barn
chicken coop
poly tunnel
conservatory
concrete
green
orchard
orchard track
hedge
tarmac
tarmac footpath
tarmac over concrete
gate
fence
wire fence
post and wire fence
wire mesh fence
chestnut paling fence
iron railing fence
picket fence
concrete block wall
brick wall
2.5m high hedge
2.5m high conifer hedge
2.5m high privet hedge
2.5m high rose hedge
2.5m high bushes
2.5m high shrub
2.5m high mixed shrub
2.5m high mixed shrub and 5m high small trees
2.5m high small trees
2.5m high small hawthorn trees
2.5m high brambles
5m high small trees
5m high small hawthorn trees
5m high shrub
5m high mixed shrub
5m high mixed shrub and 5m high small trees
5m high small trees
5m high hawthorn trees
5m high brambles
5m high eucalyptus tree
5m high conifer tree
5m high conifer hedge
5m high rose hedge
5m high rose bushes
5m high rose bushes and 5m high small trees
5m high shrub
5m high mixed shrub
5m high mixed shrub and 5m high small trees
5m high small trees
5m high hawthorn trees
5m high brambles