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Angels Nursery, Yapton Road Barnham, West Sussex Flood Risk Assessment

Prepared for the West Sussex County Council

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DOCUMENT CONTROL SHEET

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EXECUTIVE SUMMARY

LOCATION: The proposed development is located at Angels Nursery, Yapton Road (B2233), Barnham, West Sussex, PO22 0AY.

DEVELOPMENT DESCRIPTION: The development proposal is for the demolition of existing nursery buildings and construction of 100 no. of new dwellings comprising a mixture of two and two and a half storey detached, semi-detached and terraced housing and flats. The proposal seeks to change the land use from current open space/allotments to residential use.

SITE AREA AND CHARACTERISTICS:

Total area of the site is 3.5 ha. The site currently consists of existing nursery buildings and remaining pervious area. It was estimated that existing buildings comprise 5971 square metres approximately. Post-development site consists of 3.3ha of impervious surfaces. There are residential buildings/settlements close to the site. There is also a caravan site adjoining the proposed site on its eastern boundary.

SOURCES OF FLOODING: The sources of flood risk are fluvial, groundwater, surface water, surcharging of sewers and infrastructure failure.

VULNERABILITY: The proposed development is for “more vulnerable” land use (Ref.PPS25, Table D.2).

FLOOD ZONE: The site lies in Low Risk Flood Zone 1.

SEQUENTIAL TEST: A Sequential Test should be carried out by the LPA supported by an SFRA in which developments in high risk zones are steered first into Zone 1, and then to Zone 2, following a sequential approach. The proposed development is in Flood Zone 1.

The site is located in a moderately built up area with existing residential houses. An allocated site was found at 46 Barnham Road, Barnham close to the proposed site with planning permission for 32 dwellings. Therefore, the proposed development is consistent in location, type and scale with allocated sites and existing land use.

It is, however, not known whether the proposed site is consistent with a sequentially tested ‘allocated site’. It is also not known whether there are ‘reasonably available alternative sites’ in low risk areas in Zone 1. Therefore, LPA should be consulted to obtain a determination on the Sequential Test.

EXCEPTION TEST: An Exception Test is not required for ‘more vulnerable’ developments in Flood Zone 1. Nevertheless, this flood risk assessment supports the Section (c) of the Exception Test – i.e., the development is safe; dry access and egress can be provided, the development does not increase flood risk elsewhere as mitigation measures will be implemented to attenuate runoff volume, residual flood risks will be adequately managed. Information to support Sections (a) & (b) of the Exception Test is also provided in Section 1D.1. The development will reduce overall flood risk as runoff attenuation will be carried out. Buildings will be designed to be sustainable in terms of energy efficiency, flood risk, transport, use of space etc. Therefore, positive sustainability benefits outweigh negative impact of flood risk.

PROBABILITY OF FLOODING: The site is outside 1 in 1000 year fluvial flood plain. Therefore, the risk of fluvial flooding is low.

There is a risk of flooding due to surface water as the area is moderately built up. The flow paths appear to be in the direction of the river and not converging at the site. Therefore, surface water flood risk is moderate. However, this problem is common to many sites as sewers have been generally designed to lower 1 in 30 year standard in the past according to 'Sewers for Adoption'. Rainfall exceeding existing design standard could overwhelm the sewer system causing surface water flooding. Extreme rainfall events can happen anywhere within a short duration resulting in flash floods.

The site overlies a superficial secondary aquifer over a confining clay layer. Therefore, there is potential for rapid groundwater fluctuations following rainfall events especially during the winter. The only relevant Environment Agency monitoring borehole is located approximately 951 metres to the north-east of the site. However, the borehole has been defunct since 1997. Data between 1993 and 1997 indicate that the water table is relatively shallow, being between 1 and 2 metres below the ground. Therefore, the risk of groundwater flooding at the site is moderate to high.

RUNOFF ATTENUATION AND SITE DRAINAGE: It was calculated that the runoff volume will increase by 963.5m^3 due to the proposed development relative to present levels. This increased volume should be attenuated on site as a minimum using SUDS. Runoff calculation was based on FEH rainfall data and the guidance - Designing for Exceedance in Urban Drainage-Good Practice, C635, CIRIA 2006 and SUDS Manual, C697, CIRIA (2007).

It is recommended to consider using a number of suitable sustainable drainage methods to attenuate runoff volume following SUDS hierarchy (Table 8, Section 6B) and also considering site conditions. These SUDS methods include green roofs, detention basins (normally dry except after storm events), ponds (contain water but have additional capacity to store water), filter strips and swales, infiltration devices like soakaways, permeable pavements, rain water harvesting etc.

The site has sufficient space to provide infiltration basins and ponds. The proposed play area, picnic area, children's play area can be designed to act as infiltration basins during wet weather to which a part of the runoff from hard areas can be connected.

A part of the increased volume can be stored in the granular sub-base of the permeable pavements. It is recommended to use permeable pavements in car parking and patio areas.

Soakaways should be designed based on soil testing and groundwater monitoring. It was calculated that for an assumed infiltration rate of 0.5m/hr an area of $35\text{m} \times 35\text{m}$ (0.12ha or 3.4% of the total site area) is required to accommodate soakaways to attenuate 963.5m^3 . As the site is sufficiently large, this amount of storage is possible within the site. It is important that the base of the Soakaways is located at least 1m above the highest known groundwater level to avoid groundwater pollution.

LOSS OF FLOOD STORAGE: The development lies in an area outside the 1 in 1000 year extreme flood outline. Therefore, flood storage will not be displaced.

RESIDUAL RISKS & THRESHOLD FLOOR LEVEL: There could be residual risks due to exceedance of the design event. Residual risks could be reduced by appropriate planning and design. New pipes and sustainable drainage systems such as permeable pavements, soakaways, basins, ponds etc., should be designed to 1 in 100 year plus 30% flow increase for climate

change. As climate change is gradual this increase in capacity could absorb the exceedance flows in the short and medium terms.

The Environment Agency require that the finished ground floor level be set 300mm above the 1 in 100 year climate change flood level. As the site is located above 1 in 1000 year flood plain, this requirement is satisfied.

Finished ground floor level should also be raised above the surrounding ground to reduce the risk of flooding from surface water during intense rainfall events.

DRY ACCESS AND EGRESS: The site and the access roads are outside the 1 in 1000 year flood plain. Therefore, dry access to and egress from the site can be provided.

FLOOD PROOFING & RESILIENCE: Foundations, walls, floors will be water proofed, using suitable materials as discussed in Section 6D. It is recommended to use solid concrete floors. Detailed engineering design should take into account undermining of the foundations due to scour, hydrostatic and hydrodynamic loads and impact loads of floating debris on the structure and pressures exerted by groundwater on the foundation. It is recommended to refer to Defra publication entitled "Improving the Flood Performance of New Buildings-Flood Resilient Construction, Defra, May, 2007".

HEALTH AND SAFETY: Electrocution is a potential Health and Safety Risk during floods. Therefore, all electrics – power outlets, service metres, plants, sub-stations, transformers and boilers should be kept as high as possible (preferably 1m) above finished ground floor level as recommended by the Association of British Insurers.

It is recommended to provide upper floors for escape in an emergency flooding and to provide sleeping accommodation on upper floors.

CONCLUSION: The proposed development, will not increase flood risk elsewhere as mitigation measures will be implemented to attenuate increased runoff volume and flood storage will not be displaced. As the site and access routes are outside the 1 in 1000 year extreme flood outline, the development is safe and safe dry access and egress to and from the site can be provided. The development proposal seeks to change present open space/allotments to residential use which needs to be assessed in terms of amenity and sustainability. The development is broadly consistent with the local development documents and contributes to the sustainability appraisal of the Core Strategy. Therefore, the development is consistent with the requirements in PPS25.

NOTE: This assessment is based on Planning Policy Statement 25 on Development and Flood Risk (referred to as PPS25). This report is compiled in compliance with the requirements of the Department for Communities and Local Government, Development and Flood Risk Practice Guide, June 2008.

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INTRODUCTION

In October 2009 Brighton Consulting were commissioned by the West Sussex County Council to carry out a Flood Risk Assessment for the proposed development at Angels Nursery, Yapton Road (B2233), Barnham, West Sussex. The development proposal seeks to change the land use from current open space/allotments to residential use consisting of 100 dwellings.

This assessment is based on Planning Policy Statement 25 on Development and Flood Risk (referred to as PPS25). This report is compiled in compliance with the requirements of the Department for Communities and Local Government, Development and Flood Risk Practice Guide, June 2008.

In carrying out the Flood Risk Assessment, information was obtained from the Environment Agency and Arun District Council. Development plans, topography survey were provided by Mr Paul Collins of PPC Planning & Property Consultants Ltd.

For the avoidance of doubt and for the sake of clarity, some information is repeated in more than one section.

FLOOD RISK ASSESSMENT

1 Development Description and Location

1A.1 Site location

The site comprises the land at Angels Nursery, Yapton Road (B2233) Barnham, West Sussex.

A Location Plan is shown in Appendix A as Figure A2.

1A.2 Development description

The development involves the demolition of existing nursery buildings and construction of 100 new dwellings comprising a mixture of two and two and a half storey detached, semi-detached and terraced housing and flats.

A Site Layout is shown in Appendix A as Figure A3.

1A.2 Site area and characteristics

Total area of the site is 3.5 ha. The site currently consists of existing nursery buildings and remaining pervious area. It was estimated that existing buildings comprise 5971 square metres approximately. Post-development site consists of 3.3ha of impervious surfaces. There are residential buildings close to the site. There is also a caravan site adjoining the proposed development on its eastern boundary.

1A.3 Local geology, hydrogeology

The geology at the site is complex. The site is situated on 2 varieties of superficial deposit: Raised Beach Deposits composed of sand and gravel and River Terrace Deposits composed of sand, silt and clay. Both are classified as secondary aquifers.

The superficial deposits overlie London Clay that is classified as unproductive strata. However, the clay overlies the Lambeth Group that is classified as a secondary aquifer and Undifferentiated Chalk that is classified as a principal aquifer. The Lambeth Group outcrops approximately 100 metres to the south of the site whilst the chalk outcrops approximately 200 metres to the south. The developers should be aware of this as any intrusive construction techniques (such as piling) may provide pathways for pollution through the clay to the sensitive aquifers beneath.

The only relevant Environment Agency monitoring borehole is located approximately 951 metres to the north-east of the site. However, the borehole has been defunct since 1997. Data between 1993 and 1997 indicate that the water table is relatively shallow, being between 1 and 2 metres below the ground.

As the site overlies a superficial secondary aquifer over a confining clay layer, there is potential for rapid groundwater fluctuations following rainfall events that could present a risk of groundwater flooding, however, the EA have no records of any groundwater flooding events at this site.

Barnham Rife is situated approximately 120 metres to the west. It is possible that groundwater flow in the superficial deposits is towards this surface water feature.

1B Vulnerability classification

The development falls into the “less vulnerable” category under the PPS25 vulnerability classification.

1C Local development documents

The Arun District Local Plan 2003 was adopted on the 17th April, 2003 and covers the period up to 2011. It forms a statement of Arun District Council's planning policies, which will be used as a basis for decision making in planning applications. It consists of a written statement, and Proposals Map.

The key aim of the plan is to apply the principles of sustainable development in assessing development proposals, striking the balance between the need for development and the protection of scarce resources.

The Local Development Framework (LDF) will replace adopted Local Plan. The Development Planning Documents (DPD), forming the LDF (i.e., Core Strategy and Site Allocations) are currently under review.

According to the Local Plan, the deficit in housing supply in 1996-2011 is 1530. Policy GEN5 covers the provision of new residential developments. The existing site is shown as an open space and allotments in the Local Plan.

POLICY AREA6 Allotments states “The District Council will resist the development of allotment sites where it is considered that a loss of amenity will occur. An exception to this may be allowed where improved facilities for allotment holders can be provided or a suitable alternative site provided”.

Therefore, the planners will need to weigh the pros and cons of the development in terms of provision of housing and sustainability.

1D Sequential and exception tests

1D.1 Sequential test

PPS25 requires that a Sequential Test be carried out by the LPA to steer the developments first into low risk Flood Zone 1 and then to medium risk Flood Zone 2 following a sequential approach. PPS25 states “ Only where there are no ‘reasonably available’ sites in Flood Zone 1 and 2 should decision makers consider suitability of sites in high risk Flood Zone 3, applying Exception Test if required”. This flood risk assessment provides supporting information to carry out the Sequential Test.

The Environment Agency Flood Map, Figure A1, Appendix A, shows that the site is in Flood Zone 1.

The site is located in a moderately built up area with existing residential houses. An allocated site was found at 46 Barnham Road, Barnham close to the proposed site with planning permission for 32 dwellings. Therefore, the proposed development is consistent in location, type and scale with allocated sites and existing land use.

It is however not known whether the allocated sites in the close proximity have been sequentially tested at strategic level or whether there are “reasonably available alternative sites” in lower risk areas. Therefore, the LPA should be consulted to obtain a determination on the Sequential Test.

Table D.3²²: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability classification (see Table D2)		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (see Table D.1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	x	Exception Test required	✓
	Zone 3b 'Functional Floodplain'	Exception Test required	✓	x	x	x

Key:

✓ Development is appropriate

x Development should not be permitted

Figure 1. Flood risk vulnerability and flood zone compatibility (PPS25)

1D.2 Exception test

PPS25 section D9 states that for the Exception Test to be passed:

- "It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the Development Planning Document (DPD) has reached the 'submission' stage, the benefits of the development should contribute to the Core Strategy's Sustainability Appraisal;*
- the development should be on developable, previously developed land or if it is not on previously developed land, that there are no reasonable alternative sites on previously developed land; and*
- a FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and where possible, will reduce flood risk overall."*

For 'more vulnerable' developments in Flood Zone 1, an Exception Test, as shown in Figure 1, is not required. Nevertheless, the following information is provided to support the requirements of the Exception Test:

- The buildings will be designed to be sustainable in terms of energy use, flood risk, transport, efficient use of space etc. Increased runoff will be attenuated using sustainable drainage systems. It is proposed to attenuate runoff to Greenfield levels. Therefore, positive sustainability benefits will outweigh the negative benefits due to flood risk.
- The proposed buildings are located in a developable previously developed site.
- The development will not increase flood risk elsewhere as mitigation measures will be carried out to reduce increased runoff volume and flood

storage volume will not be displaced as the site is outside the 1 in 100 year flood plain. Safe dry access and egress can be provided in a 1 in 1000 year event. Residual flood risk will be adequately managed. Hence, the development is safe.

The developers should try to achieve more of the following sustainability objectives to satisfy the Section (a) of the Exception Test.

Table 1. Exception Test, Part (a) Sustainability Checklist

Sustainability Objectives
To reduce vulnerability to the effects of climate change
To reduce contributions to climate change
To use materials efficiently and minimise waste, then re-use or recover it through recycling, composting or energy recovery
To provide for and maintain sustainable sources of water supply
To maintain and enhance bio diversity and geo-diversity
To maintain and enhance the quality of landscapes and townscapes
To conserve and enhance the historic environment
To protect and enhance the quality of land and soil
To protect and improve air quality
To protect and improve water quality
To provide everybody with the opportunity to live in a decent home
To reduce poverty and social exclusion
To reduce anti-social activity, crime and manage the fear of crime
Improve opportunities and access to jobs
To protect and improve human health
To improve the quality of where people live
To minimise vibration, noise and light pollution
Help everyone access basic services easily, safely and affordably
Give everyone access to learning, training, skills and knowledge
Increase access to and encourage participation in cultural activities
To encourage a diverse, robust and thriving economy
Promote vitality and viability of town and local centres
To reduce the effect of congestion

2 Definition of the Flood Hazard

2A Sources of flooding

The sources of flooding are fluvial, groundwater, surface water, sewer surcharging and infrastructure failure.

2B Description of the potential sources of flooding

2B.1 Flooding sources, mechanisms, pathways

Flooding from rivers would occur due to over bank flow due to breach of the embankment. However, the site is outside the area of extreme flood outline.

Intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems can run quickly off land and result in local flooding.

In urban areas, rainwater is frequently drained into surface water sewers or sewers or sewers containing both surface and waste water known as combined sewers. Flooding can result when the sewer is overwhelmed by heavy rainfall, becomes blocked or is of inadequate capacity.

The area is moderately paved. Therefore, the generation of surface run off could be moderate. Also, general slope is towards the watercourse. Hence, floor would be in the direction of the river.

Groundwater flooding occurs when water levels in the ground rise above surface elevation. It is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). These may be extensive, regional aquifers, such as chalk or sandstone, or may be localised sands or river gravels in valley bottoms underlain by less permeable rocks. Water levels below the ground rise during wet winter months, and fall again in the summer as water flows out into rivers. In very wet winters, rising water levels may lead to the flooding of normally dry land. The groundwater levels at the site could vary between 1m to 2m below ground level. Therefore, there is a probability for the groundwater to emerge to the surface.

2B.2 Duration of flooding

The duration of fluvial flood peak could be around 6 -12 hours based on specialist judgement.

Floods due to surface water and surcharging of sewers could last days and even weeks as high river levels could cause backing up of water in the sewers.

Joint occurrence of several factors, such as tidal surges, blockages of sewers, culverts, flash flooding and fluvial floods could cause severe flooding and may take even weeks to subside.

2C Existing and proposed surface water drainage at the site

The PPS25 requires that the developed rate of runoff and volume to a water course or receiving water body should not be greater than the existing runoff rate and volume.

2C.1 Existing surface water drainage

Surface water flows from the site, are piped to the existing public sewers at present. While exact design standard of the sewers are not known, it is generally thought that these sewers could have been designed to 1 in 30 year or lower standard according to 'Sewers for Adoption'.

Existing runoff from the hard surfaces, was calculated using FEH rainfall data for 30 mins duration and using modified rational method. The guidance in the publications entitled "Designing for exceedance in urban drainage- Good Practice, C635, CIRIA 2006 and SUDS Manual, CIRIA C697" recommend the use of a routing coefficients of CR=1.3 and a volumetric runoff coefficient CV of between 0.6 and 0.9. Here, CR=1.3 and CV=0.6 were used.

Table 2. Existing runoff from 5971sqm nursery buildings

Return Period (yrs)	Rain Fall (mm)	Rainfall intensity (mm/hr)	Time (mins)	Discharge (l/s)	Volume (m ³)
1	4.1	8.2	30	10.6	19.1
30	23.3	46.6	30	60.3	108.6
100	34.6	69.2	30	89.6	161.3

Institute of Hydrology Report No.124 (Marshall & Bayliss, 1994) method was used to compute the runoff from pervious area as shown in the following

table. SAAR=779mm and a moderate value for the Standard Percentage Runoff or soil index, SOIL=0.3 were used in this calculation. Report no. 124 used 71 small rural catchments less than 25km² where SOIL ranged from 0.1 (very low runoff) to 0.53 (very high runoff). Reference was made to Section A7.8 of *Designing for exceedance in urban drainage-Good Practice*, C635, CIRIA 2006.

Table 3. Existing runoff from 29,029sqm green/permeable area

Return Period (yrs)	Time (mins)	Discharge (l/s/ha)	Discharge (l/s)	Volume (m ³)
1	30	1.2	3.43	6.18
30	30	5.4	15.79	28.42
100	30	7.1	20.73	37.31

Table 4. Existing runoff from the total 3.5ha site

Return Period (yrs)	Time (mins)	Discharge (l/s)	Volume (m ³)
1	30	14.0	25.3
30	30	76.1	137.0
100	30	110.3	198.6

2C.2 Proposed surface water drainage

The proposal is to discharge surface water runoff from the site to the existing public sewers after attenuation to Greenfield level.

The detailed design of the proposed surface water drainage system has yet to be undertaken and will be submitted during detailed design stage to seek drainage consent from the Environment Agency.

The Environment Agency requirement is that any new development will have a 1 in 100 year urban drainage system standard design. To meet this requirement all new pipes will be designed to 1 in 100 year standard with a 30% climate change allowance included.

Post-development runoff from the hard surfaces, was calculated using FEH rainfall data for 30 mins duration and using modified rational method. Coefficients CV=0.6 and CR=1.3 were used according to the guidance in the publication entitled "Designing for exceedance in urban drainage-Good Practice, C635, CIRIA 2006".

Calculated surface water runoff rates from hard areas for 1, 30,100 year storm events for a 30 minutes duration are given below in Tables 5.

Table 5. Post-development runoff from 3.3ha hard paved area with 30% climate change allowance added (Ref. PPS25, Table B.2)

Return Period (yrs)	Rain Fall (mm)	Rainfall intensity (mm/hr)	Rainfall intensity (mm/hr) +30%	Time (mins)	Discharge (l/s) Climate Change	Volume (m ³) Climate Change
1	4.1	8.2	10.7	30	76.3	137.3
30	23.3	46.6	60.6	30	433.5	780.3
100	34.6	69.2	90.0	30	643.7	1158.7

Institute of Hydrology Report No.124 (Marshall & Bayliss, 1994) method was used to compute the runoff from pervious area as shown in the following

table. SAAR=779mm and a moderate value for the Standard Percentage Runoff or soil index, SOIL=0.3 were used in this calculation. Report no. 124 used 71 small rural catchments less than 25km² where SOIL ranged from 0.1 (very low runoff) to 0.53 (very high runoff). Reference was made to Section A7.8 of *Designing for exceedance in urban drainage-Good Practice*, C635, CIRIA 2006.

Table 6. Post-development runoff from 0.2ha green/permeable area with 30% climate change allowance added (Ref. PPS25, Table B.2)

Return Period (yrs)	Time (mins)	Discharge (l/s/ha) Climate Change	Discharge (l/s) Climate Change	Volume (m ³) Climate Change
1	30	2.6	0.51	0.92
30	30	7.1	1.41	2.55
100	30	9.3	1.86	3.34

Table 7. Post-development runoff from the total 3.5ha site

Return Period (yrs)	Time (mins)	Discharge (l/s) Climate Change	Volume (m ³) Climate Change
1	30	76.8	138.2
30	30	434.9	782.8
100	30	645.6	1162.1

1 in 100 year runoff volume has increased from 198.6m³ to 1162.1m³ due to the development. Therefore, the increased volume of 963.5m³ should be attenuated using SUDS.

3 Probability

3A Flood zone

The proposed site lies outside the 1 in 1000 year return flood plain. Therefore, the site is in Low Probability Flood Zone 1.

3B Strategic flood risk assessment

In preparing this site specific flood risk assessment reference was made to Arun District Council's SFRA (2008) prepared by Capita Symonds consultants.

3C Probability of the site flooding

Fluvial flooding

The site is outside the 1 in 1000 year flood plain as shown in the Environment Agency Flood Map.

Therefore, the risk of fluvial flooding at the site is low.

Surface water

The area is built up with a moderate proportion of paved areas. Therefore, there is a moderate risk due to surface water and sewer surcharge flooding during extreme events. The general slope of the area is towards their river. Therefore, the flow could also be in the direction of the river. This is a

common problem to most sites as local drainage is designed to 1 in 30 year standard according to 'Sewers for Adoption'.

Surface water flooding is typically generated by short duration, intense rainfall events exceeding the design event where precipitation is unable to infiltrate the ground or enter the drainage system. The resultant effect is water being transferred overland causing localised flooding.

Groundwater

There is a risk of ground water flooding especially during wet winters.

The only relevant Environment Agency monitoring borehole is located approximately 951 metres to the north-east of the site. However, the borehole has been defunct since 1997. Data between 1993 and 1997 indicate that the water table is relatively shallow, being between 1 and 2 metres below the ground.

As the site overlies a superficial secondary aquifer over a confining clay layer, there is potential for rapid groundwater fluctuations following rainfall events that could present a risk of groundwater flooding, however, the EA have no records of any groundwater flooding events at this site.

As the recorded groundwater levels are shallow, the groundwater flood risk at the site is moderate to high.

3D Existing rates & volumes of runoff generated from the site

Existing runoff rates and volume are shown in Table 4, Section 2C.1.

4 Climate Change

Table B.2 of the PPS25 recommends a 20% increase in peak river flows and 30% increase in rainfall intensity over the next 100 years.

The risk of flash flooding could increase as storminess and frequency of storms increases in the future. Sewers are generally designed to 1 in 30 year standard according to 'Sewers for Adoption'. However, climate change could bring intense rainfall events exceeding current design standard overwhelming the existing sewers.

The site is classified as a secondary aquifer. Therefore, the risk of groundwater flooding is moderate at present. However, the risk of groundwater flooding could increase if climate change brings in more rainfall and higher river levels. This will be especially severe during winter as winter rainfall is predicted to increase as a result of climate change.

Therefore, the standard of flood defence would fall from current levels while the risk of fluvial, tidal, groundwater and surface water flooding could increase as a direct consequence of climate change.

The adverse impact of the climate change could be mitigated by appropriate planning and design. Following steps will be taken to mitigate climate change impact.

- New pipes will be designed with a 30% allowance provided for rainfall intensity to account for climate change.
- Threshold floor level will be raised 300mm above the climate change flood level.

- Permeable pavements and other Sustainable Drainage Systems will be designed to store increased runoff volume due to climate change.

5 Detailed Development Proposals

The development involves the demolition of existing nursery buildings and construction of 100 new dwellings comprising a mixture of two and two and a half storey detached, semi-detached and terraced housing and flats.

A Site Layout is shown in Appendix A as Figure A3.

6 Flood Risk Management Measures

6A Flood defences

There are no purpose built flood defences at the site.

6B Sustainable drainage systems (SUDS)

Table 8 shows a hierarchy of recommended sustainable drainage systems in order of sustainability. It is recommended to consider using one or more of the listed methods to attenuate surface runoff on site depending on the site conditions.

These SUDS methods include living roofs, detention basins (which are normally dry except after storm events), ponds (ponds contain water in dry weather, and are designed to hold more when it rains), filter strips and swales, infiltration devices (e.g. soakaways-need soil testing), permeable pavements, rain water harvesting etc.

Infiltration devices such as soakaways are not recommended if the water table is close to the surface pollutants could be easily dispersed into the aquifer. The recorded groundwater levels at the site vary between 1m and 2m. Therefore, infiltration devices should be designed based on soil tests and groundwater level information. Generally, the base of the infiltration unit should be located 1m above the maximum possible groundwater level.

Section 7B gives a more information on flow attenuation using sustainable drainage methods.

SUDS and the sewer network will be maintained by the owners during life time of the development.

Table 8. SUDS hierarchy

	SUDS Technique	Flood Reduction	Water Quality Improvement	Landscape & Wildlife benefit
Most sustainable 	Living roofs	✓	✓	✓
	Basins and ponds - constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips & swales	✓	✓	✓
	Infiltration devices - soakaways - infiltration trenches & basins	✓	✓	✓
	Permeable surfaces & filter drains - gravelled areas - solid paving blocks - porous paving	✓	✓	
	Tanked systems - over sized pipes / tanks - storms cells	✓		
Least sustainable				

6C Dry access and egress

The site and access roads are outside 1 in 1000 year extreme flood outline. Therefore safe dry access to and egress from the site can be provided.

6D Flood resistant/resilient buildings

PPS25 recommends the use of flood resistant and resilient building techniques. Damage to the property during floods could be mitigated by incorporating flood proofing methods and materials into the building design.

Following measures are recommended to increase flood resilience of the building.

- Raising ground floor level as high as possible.
- Keeping electrical sockets, switch boards, substations, service meters, transformers, plants, boilers and wiring 1m above finished ground floor level as recommended by the Association of British Insurers.
- Installing no return valves in toilets and drains
- **Dry Proofing:** choosing flood proof materials and construction methods to prevent seepage/ingress of water through floors, walls, foundation, doors, windows. The risk of groundwater and surface water seepage could be reduced by using concrete floors, damp proof course and wall skirting.
- **Wet Proofing:** using materials to increase flood resilience of the building - A variety of water-resistant paints and coatings are

available to help prevent floodwater soaking into the external face of the wall, thus allowing the wall to dry out more quickly. For new properties the choice of materials including bricks, mortars and renders should be carefully considered to limit water penetration. Generally denser materials will provide greater flood resistance.

- Undermining of foundations due to scour, hydrostatic and hydrodynamic loads on the structure, load impacts of floating debris, pressure on foundations due to groundwater should be considered during engineering design.

Following Table extracted from the publication - Improving flood resilience of buildings through improved materials, methods and details, June 2005 published by CIRIA - lists suitable materials for flood proofing.

Table 9. Summary of material suitability for building components (source: Scottish Executive, 2004b)

Component	Most suitable	Suitable	Unsuitable
Flooring	Concrete, pre-cast or in situ	Timber floor, fully sealed, use of marine plywood	Untreated timber Chipboard
Floor covering	Clay tiles Rubber sheet floors Vinyl sheet floors	Vinyl tiles Ceramic tiles	
External walls – to Max flood level	Engineering brick Reinforced concrete	Low water absorption brick	Large window openings
Doors	Solid panels with waterproof adhesives Aluminium, plastic or steel	Epoxy sealed doors	Hollow core plywood doors
Internal partitions	Brick with waterproof mortar Lime based plasters	Common bricks	Chipboard Fibreboard panels Plasterboard Gypsum plaster
Insulation	Foam or closed cell types	Reflective insulation	Open cell fibres
Windows	Plastic, metal	Epoxy sealed timber with waterproof glues and steel or brass fittings	Timber with PVA glues and mild steel fittings

Guidance on flood resilient building design can be obtained from the following web sites.

The publication “Improving the Flood Performance of New Buildings-Flood Resilient Construction, Defra, May, 2007”.

http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf

Repair and restoration of buildings following floods, CIRIA.

<http://www.ciria.org.uk/flooding>

7 Offsite Impacts and Proposed Mitigation Measures

7A Loss of flood storage and level-to-level compensation

Flood storage will not be displaced as the site is in the Flood Risk Zone 1.

7B Increased runoff and attenuation

1 in 100 year runoff volume will increase from 198.6m³ to 1162.1m³ due to the development. Therefore, the increased volume of 963.5m³ should be attenuated using SUDS on site.

SUDS Hierarchy as shown in Table 8 should be followed in choosing attenuation methods.

Basins ponds

Basins and ponds store water at the ground surface, either as temporary flooding of dry basins and flood plains, or permanent ponds. These structures can be designed to manage water quantity and quality. Detention basins are normally dry except after storm events and ponds contain water in dry weather, and are designed to hold more when it rains.

The site has ample space to provide infiltration basins and ponds. The proposed play area, picnic area, children's play area can be designed to act as basins during wet weather with part of the runoff water connected to those areas.

Filter strips & swales

Filter strips and swales are vegetated surface features that drain water evenly off impermeable areas. Swales are long shallow channels whilst filter strips are gently sloping areas of ground. Both devices mimic natural drainage patterns by allowing rainwater to run in sheets through vegetation, slowing and filtering the flow. Swales can also be designed for a combination of conveyance, infiltration, detention and treatment of runoff.

Infiltration devices (soakaways, infiltration trenches/basins)

Infiltration devices drain water directly into the ground. They may be used at source or the runoff can be conveyed in a pipe or swale to the infiltration area. They include soakaways, infiltration trenches and infiltration basins as well as swales, filter drains and ponds. Infiltration devices can be integrated into and form part of the landscaped areas.

Soakaways and infiltration trenches are completely below ground, and water should not appear on the surface.

Infiltration devices such as soakaways are not recommended if the water table is close to the surface pollutants could be easily dispersed into the aquifer. The recorded groundwater levels at the site vary between 1m and 2m. Therefore, infiltration devices should be designed based on soil tests and groundwater level information. Generally, base of the infiltration unit should be located 1m above the maximum possible groundwater level.

Assuming an infiltration ratio of 0.5m/hr, 254 nos. of 2.5m diameter 1.1m deep open soakaway cylinders would be sufficient to accommodate runoff from the 3.3ha developed area (SUDS Manual, CIRIA C697). This is equivalent to an area of 35m X 35m (0.12ha or 3.4% of the total site area).

Permeable pavements

Part of the required attenuation volume can be stored in the granular sub-base of permeable pavements. Permeable pavements are recommended for car parking areas and other patio areas where hard pavements are necessary.

7C Effect on coastal & river morphology

There is no effect on river and coastal morphology as the development will not cause scour or deposition of sediment in the main river channel or coastal zone.

8 Management of Residual Risks

8A Residual risks & design threshold floor level

Residual risks may occur due to extreme events exceeding the design event. Implementation of the following mitigation measures will reduce residual risks.

- New pipes will be designed to absorb runoff from 1 in 100 year rainfall events with 30% flow increase for climate change included. It is anticipated that the increased capacity of the sewers would be able to accommodate exceedance flows during the short and medium terms assuming climate change would occur gradually over the next 100 years.
- Environment Agency require that the finished ground floor level be raised 300mm above the 1 in 100 yr climate change flood level. As the site is located above the 1 in 1000 year flood level, this requirement is already satisfied.
- Raise the finished ground floor level as high as practically possible relative to surrounding ground level to reduce the risk of surface water flooding and flooding.
- Install a regular maintenance regime to ensure efficient functioning of the sewers and sustainable drainage network.
- Subscribe to flood warning service of the Environment Agency and develop evacuation plans.
- Design buildings to be flood resilient and resistant as discussed in section 6D.
- Have additional SUDS storage volume such as ponds, basins, permeable pavements to reduce runoff volume from the site.
- Provide upper floors for temporary escape until flood water recedes or evacuation takes place.
- Have sleeping accommodation on the upper floors.

8B.1 Health and safety

- Exit routes should be provided within the building and within the site to be used in a flooding situation.
- There is a risk of people falling into pits, manholes during floods and hence the manhole covers should be designed to resist uplifting.
- There is a risk of electrocution and failure of services during floods. Therefore, all electrics - power outlets, plants, substations, transformers, service meters and boilers - should be located (preferably 1m) above ground floor level with cables dropping from distribution located above flood level as recommended by the Association of British Insurers (ABI).
- Chemicals and fuel storage tanks should be stored securely well above flood level.
- Floods may cause buoyancy of stored container units, boxes, and materials. This can cause health and safety hazards.
- Health & Safety issues arising due to floods before, during and after the construction should be addressed.
- Prepare an emergency Flood Plan (see Appendix D)
- The Flood Plan should be incorporated into the Health and Safety Plan/file and given to the first occupants of the house.

8B.2 Flood insurance

It is recommended that the owners obtain adequate flood insurance cover to minimise the economic losses.

8B.3 Management of risks during life time of the development

The designers should take measures to reduce flood risk by incorporating mitigation measures into the design taking into account the design life of the building (i.e., 100 years). The owners/ facilities management agents will be vested with the responsibility of maintaining the mitigation measures including sewers, sustainable drainage systems and manage the risks during the life time of the development.

8B.4 Emergency flood plan

It is important that every house and business develop an Emergency Flood Plan to minimise the damage from floods. An emergency flood plan would include a list of useful contact numbers of the Environment Agency FloodLine, Emergency Services, an awareness of escape routes and instructions how to respond to a flooding situation (also see Section 8B.1 under Health & Safety).

- Register with Environment Agency Floodline. Contact number 0845 988 1188 to receive flood warnings, by telephone, mobile, fax.
- Know emergency services contact 999 and 112.
- Know Your Escape Routes to the outside of the flood plain. Identify Exit Routes within the building and within the site.

- Prepare an emergency Flood Plan (see Appendix D).
- The Flood Plan should be incorporated into the Health and Safety Plan/File and given to the first occupants of the dwellings.
- More information on the preparation of an emergency flood plan is available on the following web site. <http://www.environment-agency.gov.uk/homeandleisure/floods/38329.aspx>
- A form to design a flood response plan is attached as Appendix D.

8B.5 Flood warning service

The Environment Agency operates a flood warning service in all areas at risk of flooding which is available on their web site www.environment-agency.gov.uk.

The proposed site is located in an Environment Agency's Flood Warning Area.

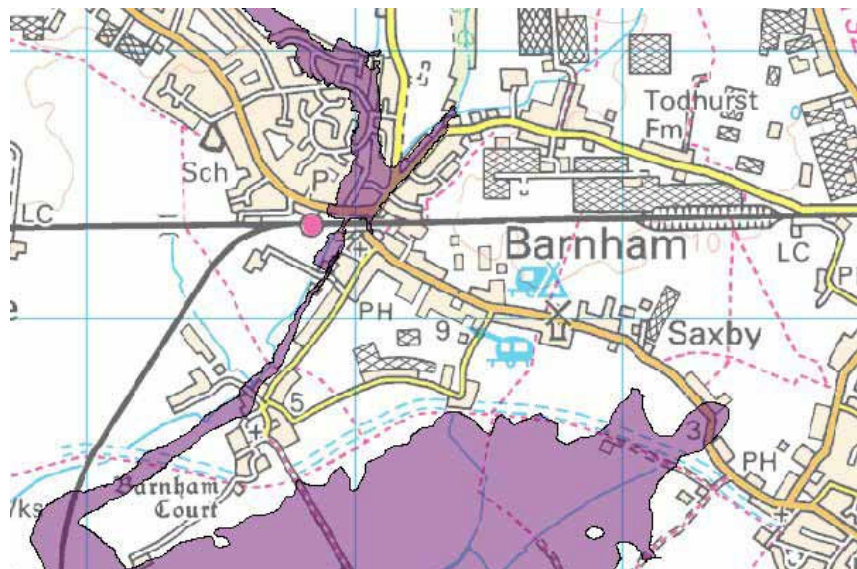


Figure 2. Environment Agency Flood Warning Area (EA Copyright)

There are four flood warning codes that indicate the level of severity of flooding expected in the area.

Table 10. Flood warning codes

Flood Warning Code	Description
Flood Watch	Flooding of low-lying land and roads is expected. Make the necessary actions to prepare for a flood event.
Flood Warning	Flooding of homes and businesses is expected. Take immediate action.
Severe Flood Warning	Severe flooding is expected. Extreme danger to life and property is expected. Take immediate action.
All clear	Flood watches or warnings are no longer in force for this area

The flood warnings are disseminated through a variety of mediums that include TV, radio, Flood Warnings Direct which is a service direct to phone/fax/pager/internet. Loudhailers are also used in certain

circumstances. There is also an emergency Floodline number (0845 988 1188) and a quick dial number for individual rivers.

As stated on the website the Environment Agency aim to give a minimum of two hours warning prior to the onset of a flood event. However, the rapid onset of some flood events, particularly with a high intensity rainfall event within an urban catchment means that sometimes a sufficient warning cannot always be raised.

CONCLUSIONS & RECOMMENDATIONS

Table 11. Summary of Conclusions & Recommendations

Constraint	Impact	Mitigation
Building in Flood Zone 2,3	Flood risk is moderate to high	The site is in Flood Zone 1.
Runoff increased	Flood risk in adjacent areas will increase	Runoff will be attenuated to greenfield level by using SUDS – basins, ponds, permeable pavements, soakaways are recommended. Soakaway base should be 1m above the highest known groundwater level. Infiltration rates should be determined by soil tests.
Flood storage displaced	Flood risk is increased In adjacent areas	Flood storage will not be displaced.
Dry access and egress not available	Emergency services cannot have access, people cannot escape to safer areas	The site and access roads are outside the 1 in 1000 year extreme flood outline.
Residual risks Exceedance of design flood water level Surface water, flash floods Defence breach or overtopping	Flooding the ground floor	Finished floor level will be raised as high as possible relative to surrounding ground level. Sleeping accommodation will be located on upper floors.
Flood proofing	Increase flood resilience/resistance, reduce losses	Flood proof materials will be used in the construction, concrete floors, damp proof course, concrete skirting are recommended to cut off groundwater emergence, surface water ingress, water absorption, see Section 6D.
Health and Safety		Electrics, boilers, chemical & fuel storage, should be kept well (preferably 1m) above the finished ground floor level.

REFERENCES

Association of British Insurers (ABI), undated, Flood Resilient Homes – What homeowners can do to reduce flood damage.

CIRIA, Designing for Exceedance in Urban Drainage-Good Practice, C635, 2006

CIRIA, The SUDS Manual, C697, 2007

CIRIA Sustainable Urban Drainage Systems Initiative
<http://www.ciria.org/suds/index.html>

Department for Communities and Local Government, December, 2006, Planning Policy Statement 25: Development and Flood Risk.

Department for Communities and Local Government, February 2007, Development and Flood Risk: A Practice Guide Companion to PPS25, 'Living Draft', A Consultation Paper.

Environment Agency, 2000, Fluvial Freeboard Guidance Note, R&D Technical Report W187.

Environment Agency Flood Map – <http://www.environment-agency.gov.uk/>

Institute of Hydrology, 1999, Flood Estimation Handbook, Institute of Hydrology, Wallingford, UK.

Marshall D C W & Bayliss, A C, 1994, Flood Estimation for Small Catchments, Report 124, Institute for Hydrology Wallingford, UK.

FEH Handbook, Centre for Ecology & Hydrology, Version 2.0

APPENDIX – A : PLANS & FIGURES

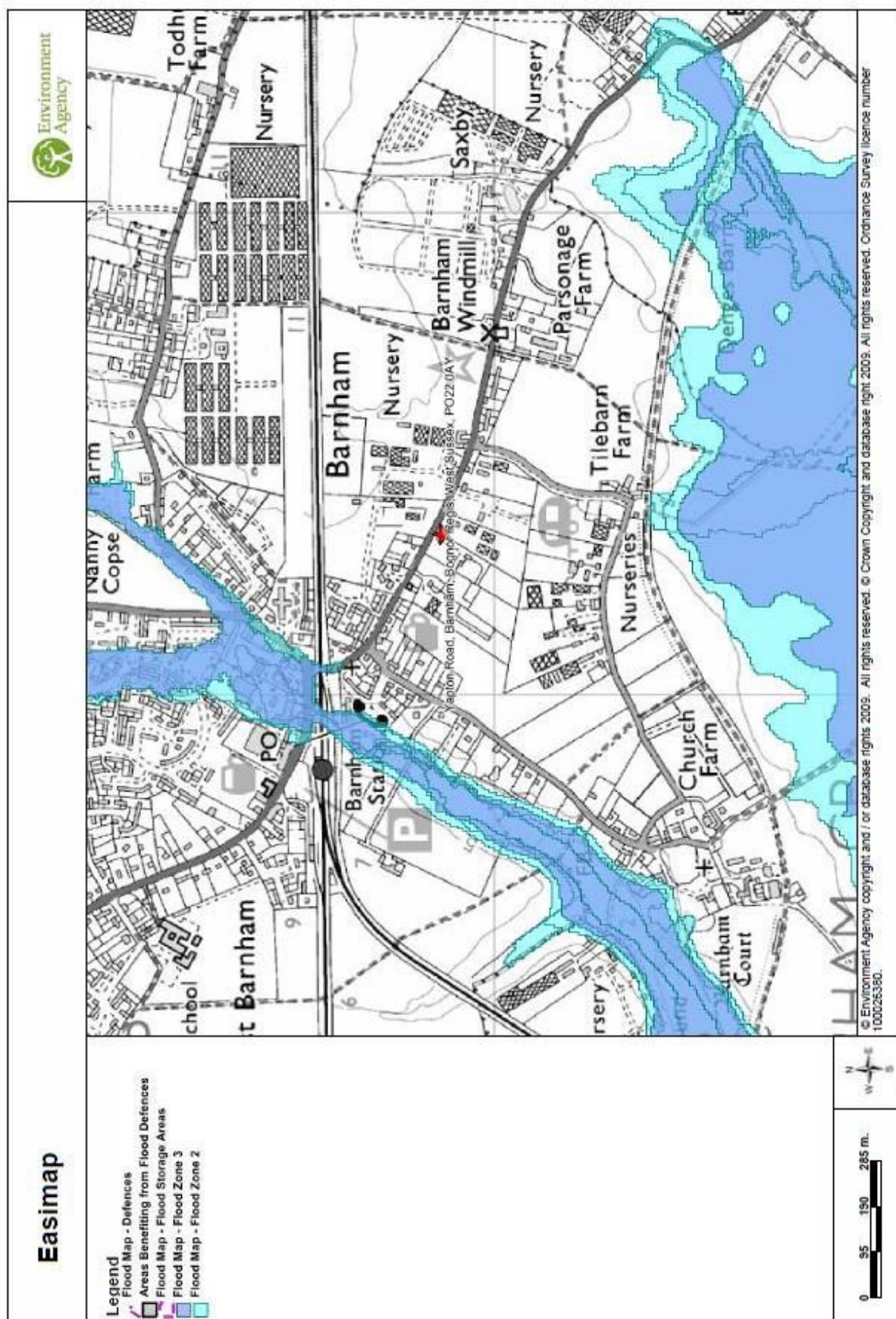


Figure A1. Environment Agency Flood Map (EA Copyright)

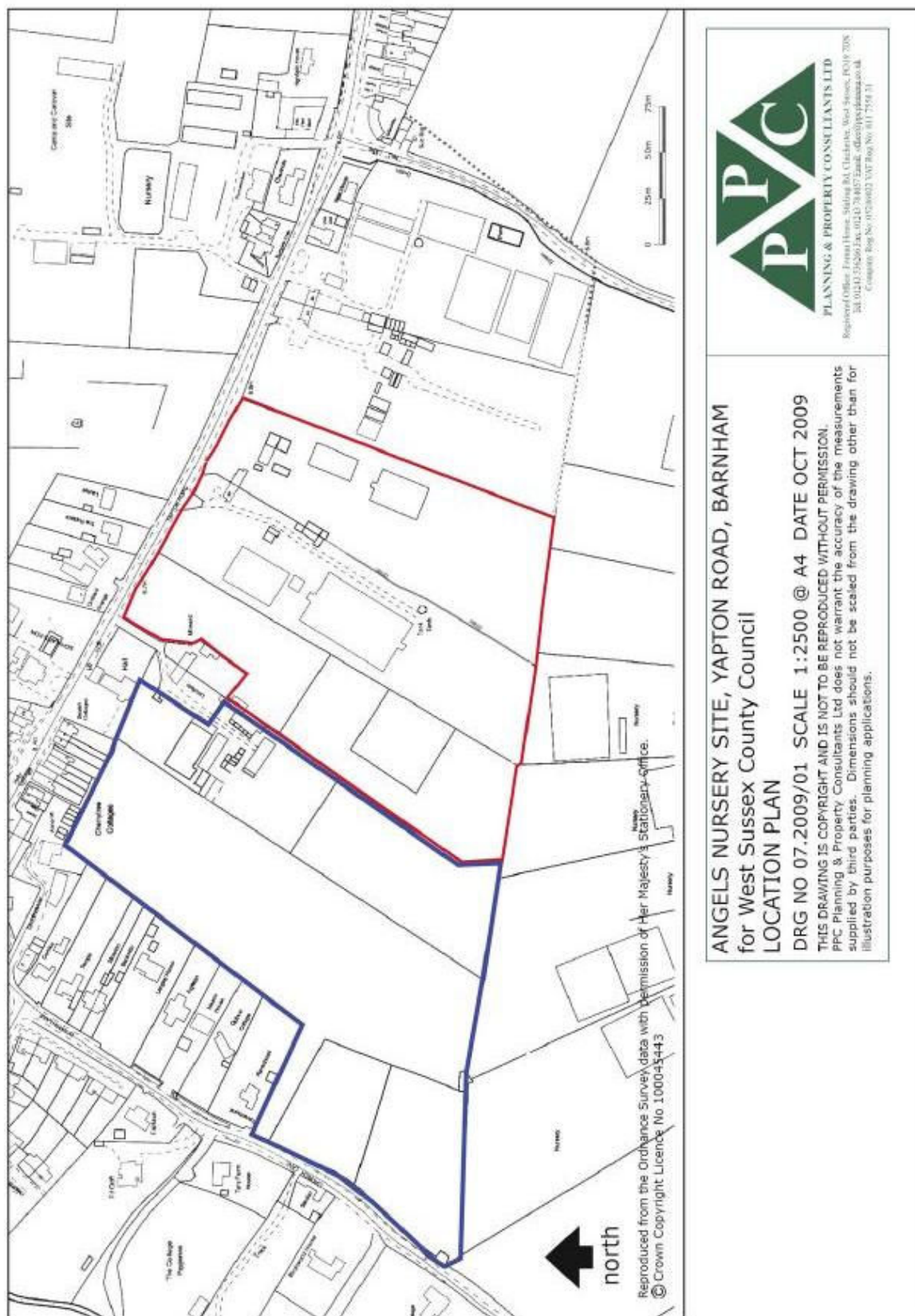


Figure A2. Location Plan



Figure A3.1 Site Layout (Existing)

APPENDIX – B: PHOTOS



Photo B1. Aerial photo of the site

APPENDIX – C: CORRESPONDENCE

From: Customer Contact SSD [sossd@environment-agency.gov.uk]
Sent: 18 November 2009 12:25
To: vidura
Subject: SSD/2009/001695 Data Request for Flood Risk Assessment
at Angels Nursery, Yapton Road (B2233), Barnham, West Sussex

Follow Up Flag: Follow up
Flag Status: Red

Attachments: Copy of POLLARDS NURSERIES.xls; Standard Notice
- Commercial.pdf; Yapton Road.pdf

Dear Vidura

Thank you for your enquiry regarding the above site.

The site identified does not lie within any flood risk area, as identified on the Environment Agency's most recent Flood Maps.

Please note that the above information refers only to flooding from rivers and/or the sea, and that properties may also be at risk from other elements of the drainage system such as surface water, highway drainage and the sewerage system. The Environment Agency is not in a position to comment on the risk from these other systems.

The geology at the site is complex. The site is situated on 2 varieties of superficial deposit: Raised Beach Deposits composed of sand and gravel and River Terrace Deposits composed of sand, silt and clay. Both are classified as secondary aquifers. The superficial deposits overlie London Clay that is classified as unproductive strata. However, the clay overlies the Lambeth Group that is classified as a secondary aquifer and Undifferentiated Chalk that is classified as a principal aquifer. The Lambeth Group outcrops approximately 100 metres to the south of the site whilst the chalk outcrops approximately 200 metres to the south. The applicant should be aware of this as any intrusive construction techniques (such as piling) may provide pathways for pollution through the clay to the sensitive aquifers beneath.

The only relevant Environment Agency monitoring borehole is located approximately 951 metres to the north-east of the site. The data for this borehole is attached, however, the borehole has been defunct since 1997. Data between 1993 and 1997 indicate that the water table is relatively shallow, being between 1 and 2 metres below the ground.

As the site overlies a superficial secondary aquifer over a confining clay layer, there is potential for rapid groundwater fluctuations following rainfall events that could present a risk of groundwater flooding, however, we have no records of any groundwater flooding events at this site.

Barnham Rife is situated approximately 120 metres to the west. It is possible that groundwater flow in the superficial deposits is towards this surface water feature.

I hope that we have correctly interpreted your request. Please see the attached Notice for details of permitted use.

Requests for information that is recorded are generally governed by the Freedom of Information Act 2000 (FOIA). The information you have requested is environmental and it is therefore exempted from the provisions of FOIA by FOIA s.39(1). We have therefore considered your request under the provisions of the Environmental Information Regulations 2004 (EIR).

If you are not satisfied with our response to your request for information you can contact us to ask for our decision to be reviewed. If you are still not satisfied following this, you can then make an appeal to the Information Commissioner, who is the statutory regulator for Freedom of Information.

Should you have any further queries, please do not hesitate to contact me.

Kind regards,

Kelly Broomfield
Communications Officer
Solent & South Downs Area

(External: 01962 764890
Internal: 723 4890

www.environment-agency.gov.uk

Environment Agency, Solent & South Downs Area Office, Colvedene Court, Wessex Business Park, Wessex Way, Colden Common, Winchester. SO21 1WP

P Did you know that over 90,000 properties are at risk of flooding across West Sussex, Hampshire, the Isle of Wight, Portsmouth and Southampton, should our defences fail? Find out if you are at risk by calling us or visiting our website.

APPENDIX – D: FLOOD PLAN

Personal flood plan



Name

Which flood warnings are you registered to receive? River:

Quickdial no: Reach:

General contact list	Company name	Contact name	Telephone
Floodline	Environment Agency		0845 988 1188
Electricity provider			
Gas provider			
Water company			
Telephone provider			
Insurance company and policy number			
Local council			
Local radio station			
Travel/weather info			

Key locations

Service cut-off	Description of location
Electricity	
Gas	
Water	

Who can help?

Relationship	Name	Contact details	How they can help?
Relative			
Friend or neighbour			

Be prepared for flooding. Act now

Personal flood plan

What can I do NOW?



Put important documents out of flood risk and protect in polythene	☐	Look at the best way of stopping floodwater entering your property	☐	Find out where you can get sandbags	☐	Identify what you would need to take with you if you had to leave your home	☐
Check your insurance covers you for flooding	☐	Make a flood plan and prepare a flood kit	☐	Identify who can help you	☐	Understand the flood warning codes	☐

What can you do when you receive a flood warning?

Actions	Location
Home	
● Move furniture and electrical items upstairs	
● Put flood boards, polythene and sandbags in place	
● Make a list now of what you can move upstairs or away from the risk	
● Turn off electricity, water and gas supplies	
● Roll up carpets and rugs	
● Unless you have time to remove them hang curtains over rods	
● Move sentimental items to safety	
● Put important documents in polythene bags and move to safety	
Garden and outside	
● Move your car out of the flood risk area	
● Move any large or loose items or weigh them down	
Business	
● Move important documents, computers and stock	
● Alert staff and request their help	
● Farmers move animals and livestock to safety	
Evacuation - Prepare a flood kit in advance	
● Inform your family or friends that you may need to leave your home	
● Get your flood kit together and include a torch, warm and waterproof clothing, water, food, medication, toys for children and pets, rubber gloves and wellingtons	

Be prepared for flooding. Act now