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February 2008

Flood Risk Assessment
Report
For a site at Pennine Way, Hemel Hempstead

Slick Developments Limited

Land at Pennine Way,
Hemel Hempstead
Flood Risk and Runoff Assessment

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Pennine Way, Hemel Hempstead

Joynes Pike and Associates (JPA) were commissioned to carry out a flood risk and runoff assessment for the proposed development site, located at Pennine Way, Hemel Hempstead.

In strict accordance with the sequential flood risk test as identified in Planning Policy Statement 25, Annex D, the site sits outside of any recognised flood zone, this places the site in an area of low probability of flooding.

It is considered that the site is not at risk of flooding from existing fluvial and development conditions under normal conditions as the site lies outside the “at risk” area.

Direct consideration has been given to the dispersal of storm runoff by environmentally considerate methods. Most specifically the use of swales and infiltration methods is recommended as the primary means of dispersal with the added option of rainwater harvesting from new roof water sources being utilised for toilet flushing and non-potable cold water supplies.

It is considered that 143m^3 of stormwater storage will give a level of confidence for storms of 1 in 30 return periods. However it is recommended that further investigation is carried out to determine the permeability of upper chalk layers.

Greywater storage and containment of up to 21m^3 capacity may reduce the required storage and the due reliance on potable water supplies for toilet, laundering and / or showering facilities.

1.0 INTRODUCTION

1.1 This report describes a Flood Risk and Runoff Assessment undertaken on behalf of Slick Developments Limited on a proposed development at Pennine Way, Hemel Hempstead.

1.2 The Government has placed increasing priority on the need to take full account of the risks associated with flooding at all stages of the planning and development process to reduce future damage to property and loss of life. Planning Policy Statement 25 (PPS25) Development and Flood Risk identifies how the issue of flooding is dealt within the drafting of planning policy and the consideration of planning applications.

1.3 The purpose of this report is to assist our client and the local Planning Authority to make an informed decision on the flood risks associated with the site redevelopment.

1.4 Local Planning Authorities have the powers to control development in accordance with the guidelines contained in PPS25, and are expected to apply a risk-based approach to development with the sequential test in Annex D table D.1 This sets out a sequential characterisation of flood risk in terms of annual probability of river, tidal and coastal flooding.

1.5 In exceptional circumstances, where it is considered necessary to meet the wider aims of sustainable development, an additional test may be applied. This is called the "Exception Test". If, when applied, the Exception Test cannot be satisfied, the development should not be permitted.

1.6 In accordance with the Sequential Test in PPS25 sites are to be classed as follows:

Table 1- Flood Zone Descriptions and Identification

Flood Zone	***Appropriate Planning Response***
Flood Zone 1 – *Areas with little or no risk of flooding.* *Annual probability of flooding less than 0.1%.*	***Low probability***. *All uses of land listed in table 2 are appropriate, however all development proposals should be considered in relation to the following:-* *(a) Their vulnerability to flooding from other sources as well as from river and sea flooding.* *(b) Their potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water runoff.* *For development proposals on sites comprising one hectare or above, these considerations should be incorporated in a FRA. This need only be brief unless the factors in (a) and (b) above, or other local considerations require particular attention.* *In this zone developers and local authorities should seek opportunities to:-* *i) Reduce the overall level of flood risk in the area through the layout and form of the development.* *ii) Mitigate the potential to increase flood risk*

	elsewhere through the appropriate application of sustainable drainage techniques.
Flood Zone 2 – *Areas with low to medium risk of flooding.* *Annual probability of flooding between 0.1% - 1.0% for rivers, and 0.1% - 0.5% for tidal, coastal.*	***Medium Probability*** *Water compatible, less-vulnerable and moderately vulnerable land uses are appropriate in zone 2 sites. Highly vulnerable uses are only applicable if the Exception test has been applied and successfully passed.* *All development proposals in this zone should be accompanied by a FRA, which should include:-* *a) Their vulnerability from other sources as well as from river and sea flooding.* *b) Their vulnerability to flooding over the lifetime of the development.* *c) Their potential to increase flood risk elsewhere through the addition of hard surfaces, the effect of the development on depth and speed of flooding to adjacent and surrounding property.* *d) A demonstration that residual risks of flooding after existing and proposed flood management and mitigation measures are taken into account, including flood defences, flood resistant and resilient design, escape evacuation, effective flood warning and emergency planning are acceptable.* *In this zone, developers and local authorities should seek opportunities to:* *I) Reduce the overall level of flood risk in the area through the layout and form of the development.* *II) Mitigate the potential to increase flood risk elsewhere through the appropriate application of sustainable drainage techniques.*
Flood Zone 3 – Areas with high risk of flooding. *Annual probability of flooding greater than 1.0% for rivers, and greater than 0.5% for tidal, coastal.*	***3a – High Probability*** *Water compatible and less vulnerable uses of land are appropriate in this zone.* *Moderately vulnerable and essential infrastructure uses should only be permitted if the Exception test has been successfully passed.* *Highly vulnerable uses should not be permitted.* *All development proposals should be accompanied by a FRA which should include points (a) to (d) from Zone 2 above.* *In this zone, developers and local authorities should seek opportunities to:* *i) Reduce the overall level of flood risk in the area through the layout and form of the development.* *ii) Mitigate the potential to increase flood risk elsewhere through the appropriate application of sustainable drainage techniques.* *iii) Relocate existing development to land in lower flood zones.*

	3b – Functional flood plains. *This zone comprises land where water has to be stored in times of flood.* *Only water compatible uses and essential infrastructure land uses should be permitted.* *Essential infrastructure in this zone should be subjected to and must pass the Exception test and be designed and constructed to:* *- Remain open in times of flood.* *- Result in no net loss of floodplain.* *- Not impede water flows.* *- Not increase flood risk elsewhere* *Less vulnerable, moderately vulnerable and highly vulnerable uses should not be permitted in this zone.* *All development proposals in this zone should be accompanied by a FRA, which should include:-* *(a) Their vulnerability from other sources as well as from river and sea flooding.* *(b) Their vulnerability to flooding over the lifetime of the development.* *(c) Their potential to increase flood risk elsewhere through the addition of hard surfaces, the effect of the development on depth and speed of flooding to adjacent and surrounding property.* *(d) A demonstration that residual risks of flooding after existing and proposed flood management and mitigation measures are taken into account, including flood defences, flood resistant and resilient design, escape evacuation, effective flood warning and emergency planning are acceptable.* *In this zone developers and local authorities should seek opportunities to:* *i) Reduce the overall level of flood risk in the area through the layout and form of the development.* *ii) Mitigate the potential to increase flood risk elsewhere through the appropriate application of sustainable drainage techniques.* *iii) Relocate existing development to land in lower flood zones.*

The following table concerns land uses and their respective levels of vulnerability.

Table 2 – Flood Risk Vulnerability Classification

Essential infrastructure	• *Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure.*
Highly Vulnerable	• *Police, Ambulance and Fire stations, Command centre and telecommunications installations required to be operational during flooding.* • *Emergency dispersal points.* • *Basement dwellings.* • *Gypsy and traveller sites using caravans or mobile homes.* • *Mobile or park homes for permanent residential use.*

	• *Installations requiring hazardous substances consent (DETR Circular 04/00 para. 18 "Planning controls for hazardous substances").*
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 institutions such as health services, nurseries and educational establishments.* • *Landfill and sites used for waste management facilities for hazardous waste.* • *Sites used for holiday or short-let caravans and camping,* ***subject to a specific warning and evacuation plan.***
Less Vulnerable	• *Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non-residential institutions; and assembly and leisure.* • *Land and buildings used for agriculture and forestry.* • *Waste treatment (except landfill and hazardous waste).* • *Minerals working and processing (except for sand and gravel working).* • *Water treatment plants.* • *Sewage treatment plants (if adequate pollution control measures are in place).*
Water Compatible Development	• *Flood control infrastructure.* • *Water transmission infrastructure and pumping stations.* • *Sewage transmission infrastructure and pumping stations.* • *Sand and gravel workings.* • *Docks, marinas and wharves.* • *Navigation facilities.* • *MOD defence installations.* • *Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.* • *Water-based recreation and tourism (excluding sleeping accommodation).* • *Lifeguard and coastal stations.* • *Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms.* • *Essential ancillary sleeping or residential accommodation for staff required by uses in this category (****subject to a specific warning and evacuation plan****).*

1.7 The following sources of information have been consulted as part of this assessment;

a) JPA archives
b) Environmental Agency Flood Map data and correspondence
c) Internet based mapping systems
d) Local Drainage Authority Plans
e) Site Survey Plans

1.8 With respect to the disposal of surface water runoff from the proposed development, consideration has been given to the restrictions placed upon new developments resulting from PPS25 and the planning process. Where possible, Sustainable Urban Drainage System (SUDS) options have been considered.

1.9 This report has been prepared by Joynes Pike & Associates Limited with all reasonable skill, care and diligence within the terms of the Contract with the client, Slick Developments Limited, and taking account of the information made available by the client, as well as the manpower and resources devoted to it by agreement with the client. Joynes Pike & Associates Limited disclaims any responsibility to the client and others in respect of any matters outside the scope of the above Contract.

1.10 This report has been produced on behalf of the client and no responsibility is accepted to any Third Party for all or any part. This report should not be relied upon or transferred to any other parties without the express written authorisation of Joynes Pike & Associates Limited. If any unauthorised Third Party comes into possession of this report, they rely on it at their own risk and the authors owe them no duty of care or skill.

1.11 The findings and opinions conveyed within this report are based on information obtained from a variety of sources, as detailed, which Joynes Pike & Associates Limited believes are reliable. Nevertheless, Joynes Pike & Associates Limited cannot and does not guarantee the authenticity or reliability of the information it has relied upon from these sources.

1.12 The site plans enclosed in this report should not be used for scaling purposes.

2.0 THE SITE

2.1 Site Location

2.1.1 The proposed development is located off Pennine Way, Hemel Hempstead. The site has an approximate ordnance survey grid reference of 506831, 208877. The site is roughly square in shape and covers an area of approximately 2.32 Ha.

2.1.2 Access to the site may be gained off Pennine Way. The site entrance is situated off an existing turning head at the end of Pennine Way.

2.1.3 Pennine Way is accessed off the B487, Redbourne Road runs from the Hemel Hempstead Industrial Estate in the south up to Link Road to the north.

2.1.4 The site boundaries are formed by Pennine Way and an existing commercial development to the east, dense vegetation and an existing residential development to the south, playing fields and residential developments to the west and dense vegetation followed by a school to the north.

2.1.5 The land situated to the east of the site initially has a 2.2m high metal security fence with several trees sitting along its perimeter, beyond which is situated an existing warehouse unit along with its associated car park and delivery bays. The warehouse is also accessed off Pennine Way. The land to the south of the site is made up of a dense tree line which runs along the site boundary. Situated beyond this tree line there is a fairly large residential development which is initially accessed off Jupiter Drive/Saturn Way. Within the tree line lies a footpath or former railway line situated at the bottom of a 2-3 metre embankment. The area of land initially located to the west of the site is made up of playing fields and existing rugby pitches situated at the bottom of a 1.5 metre embankment. These fields are separated from the site along its perimeter by a 3.0m high security fence. Further west of the playing fields is made up of a residential development which is accessed off Cumbrian Way/Malvern Way. The land to the north again is initially made up of a dense tree line. To the north of the tree line appears to be an existing school along with its associated playing fields and hardstanding areas.

2.1.6 The River Gade lies approximately 1.2 miles to the west of the site. The river flows from south to north and the information on the Environment Agency flood maps indicates that the river does not pose a flood risk to the site.

2.2 Existing Site Description

2.2.1 The site is currently in use by the Hemel Stags Rugby Club. The site is accessed off Pennine Way within the north-east corner of the site. This dual entrance/exit arrangement leads into a car park which has an approximate area of 0.26 Ha and has spaces for around 82 cars. Within the south-west corner of the car park sits the existing rugby club building which it is assumed is currently used as a bar/social area for the use of the players and members. This building is best described as an “L” shaped brick built and rendered building and has an area of approximately 0.055 Ha. To the west of the car park there is a small wooden building which has an area of around 0.01 Ha it is assumed this building is currently in use as changing rooms and showers for players. The remaining 2.0 Ha of the site are made up of the main area of the rugby pitch which sits within the western area of the site and grassed areas which surrounds the rugby pitch as well as running along the southern boundary of the

site to the south of the existing car park. The northern and southern boundaries of the site are made up of dense tree lines which separate the site from the residential development to the south and the school site to the north.

2.2.2 Using the information received as part of the topographical survey for the site it appears that the site generally falls in a south-westerly direction before reaching steep embankments at the western and southern boundaries. The levels within the site entrances at Pennine Way sit at a level of between 146.53mAOD and 146.13mAOD respectively. The high side of the car park is situated to the west with a level of between 146.70mAOD in the north and 146.38mAOD in the south corner. The car park falls from west to east at a gradient of around 1 in 50 giving a low spot on the car park within the south-eastern corner. At this point the car park has a level of around 145.70mAOD. The existing L shaped clubhouse building is raised above the car park at a slightly higher level, with the entrance in to the building being is set at a level of 146.62mAOD. The timber building to the west of the car park also has a level of around 146.65mAOD. Along the southern side of the L shaped building the ground slopes steeply from the edge of the building at a gradient of around 1 in 6 down to a level of 145.65m AOD at the bottom of the slope. The grassed area to the south of the building and car park is relatively flat. From the bottom of the slope down in to the southern boundary of the site there appears to be a gradient of around 1 in 100 giving an average ground level within the south-eastern corner of the site of 145.5mAOD at the edge of the undergrowth. The main area of the rugby pitch which sits to within the western side of the site again is generally flat falling in a south-westerly direction at a gradient of 1 in 140. The low point within the western side of the site sits at the top of the bank within the far south-west. At this point there is a level of 144.79mAOD with the average ground level across the rugby pitch being at a level of 145.50mAOD.

2.3 Existing Site Drainage

2.3.1 The site is served by storm and foul sewers to an extent, details of these are included as Appendix C, and can be generally described as follows:-

2.3.2 There is an existing storm sewer which runs along Pennine Way. The head of the run sits within the site entrance at the end of the road. This manhole has a reference of 8902 having a cover level of 145.44mAOD and an invert level of 144.1mAOD. This sewer extends along Pennine Way initially as a 375mm diameter pipe to manhole reference 9901. This manhole sits adjacent to the existing warehouse and has a cover level of 144.53mAOD and an invert level of 142.45mAOD then the sewer continues as a 375mm diameter pipe down to manhole reference 1901. This manhole is located around half way along Pennine Way and has a cover level of 143.81mAOD and a invert level of 141.55mAOD. As the sewer continues downstream from this manhole the pipe size increases to a 450mm diameter pipe. The sewer continues along Pennine Way until it reaches manhole reference 1003 which is located within the junction of Redbourne Road and Pennine Way. This manhole has a cover level of 141.51mAOD with an invert level of 138.61mAOD. At this point the sewer changes direction flowing away from the site in a northerly direction continuing as a 450mm diameter pipe through manhole references 1004, 1001 and 1103.

2.3.3 There is an existing foul sewer which runs along Pennine Way with the head of the run within the site entrance at the end of the road. This manhole has a reference of 8901 with a cover level of 145.22mAOD and an invert level of 144.11mAOD. The sewer falls in a easterly direction along Pennine Way having a pipe diameter of 225mm. The sewer continues to manhole reference 9902 which is situated adjacent to the existing factory unit. This manhole has a cover level of 144.56mAOD with an invert level of 142.77mAOD. The sewer continues along Pennine Way to manhole reference 0002. This manhole has a cover level of 143.32mAOD with an invert level of 139.75mAOD. From this point the 225mm diameter sewer continues until a point where it meets manhole reference 1002. This manhole sits within the junction of Redbourne Road and Pennine Way and has a cover level of 141.53mAOD with an invert level of 137.74mAOD. At this point the foul sewer changes direction flowing away from the site in a northerly direction continuing as a 225mm diameter pipe through manhole references 1005 and 1107.

2.3.4 On site drainage appears to be split into two systems. The foul water discharges to the sewers in Pennine Way from a manhole midway along the western side of the car park and immediately outside the timber buildings. The storm drainage appears to be collected into a system which flows to a point midway along the north-west boundary. At this point there are a collection of chambers with sump depths of approximately 2.5 metres. It is assumed that these are existing soakaways.

2.4 Sources of Existing Flooding

2.4.1 The Environment Agency on-line flood map indicates that the site falls outside of any recorded or recognised flood zone and will not be at risk from flooding.

2.4.2 Correspondence from the Environment Agency suggests the site is outside of any known main river flood plain, and there are no records of flooding within the vicinity of the site. Hence this puts the site at very low risk of less than 0.1% risk of flooding.

2.4.3 The River Gade lies some considerable distance to the west of the site. It is an open channel as it flows in a northerly direction. Indications are that the river is of a sufficient distance away from the site and does not currently pose a flood risk to the site.

2.4.4 The river appears to have dense vegetation and trees along both banks. The river flows in a southerly direction along the western side of the Highfield area of Hemel Hempstead.

2.4.5 The storm drainage within Pennine Way is at a depth of between 1.33 metres and 3.79 metres deep. The sewers within the vicinity of the site are not thought to constitute a significant flood risk.

2.4.6 The foul drainage within Pennine Way is at a depth of between 1.11 metres and 3.79 metres deep. The sewers within the vicinity of the site are not thought to constitute a significant flood risk.

2.5 Sources of Potential Flooding

2.5.1 From the junction between Pennine Way and Redbourne Road the road appears to fall away from the site at a gradient of approximately 1 in 50. There is a level within the entrance of the site of around 146.06mAOD and from this point Pennine way appears to fall as a steady gradient down to a point within the junction of Redbourne Road. At this point the level of the road is around 141.50mAOD. Redbourne Road also appears to fall away from Pennine Way down towards Link Road where a level is recorded as 137.97mAOD within the traffic island. This gives a gradient along Redbourne Road of 1 in 36. With the natural gradient of road network falling away from the site it is unlikely that any excessive rainfall events will affect the site. Any flooding contained within the highways from a severe storm event will naturally follow the path of the road network and fall away from the site along Pennine Way before falling down Redbourne Road down towards Link Road.

2.5.2 Pennine Way which is the access road in to the site appears to sit slightly below the level of the car park within the site. The high point of the car park sits within the site entrance at a level of 146.53mAOD. From this point the entrance slopes down to the turning head at the end of Pennine Way which has a level of 146.06mAOD giving a gradient falling away from the site of 1 in 20. In the event of severe storm events the natural flow path of any rainwater within the car park will be down in to the southern most channel of the car park where it is then positively drained. Any excess flow will flow out of the site and along Pennine Way.

2.5.3 The River Gade is generally an open channel as it passes the site, flowing in a southerly direction. Information taken from the Environment Agency flood maps indicates that the river is prone to flooding at point to the west of the site however taking in to account the level difference between the site and the river this places the site outside of any potential flood zones.

2.5.4 There is a mixture of residential and industrial use developments in the vicinity of the site area. To the south and west of the site there are residential developments. To the east of the site there is a metal fabricating factory unit with the area of land to the north of the site being made up of an existing school with its associated playing fields. None of the surrounding areas are considered to be a potential source of flooding.

2.6 Existing River Courses

2.6.1 The River Gade is around 1.5 miles to the west of the site. It flows in a southerly direction past the site passing through Water End, Noake Mill and Piccotts End. At this point the river runs parallel with the A4146 before being culverted below the A4147 Link Road and flowing past the site. The river continues flowing in a southerly direction both as an open channel and a culverted watercourse. The river passes through the areas of Gadebridge, Hammerfield and Two Waters before changing direction and flowing away in a westerly direction.

2.6.2 As the river is not close to the site and the level difference between the site and the river it is not thought that the river posses any potential flooding issues to the site. All of the information received from the Environment Agency and from their flood maps places the site well outside of any flood zones that affect the Hemel Hempstead Area.

3.0 PROPOSED DEVELOPMENT

3.1 Proposed Layout

3.1.1 The proposed layout plan shows the site as being redeveloped to include a new clubhouse which will house a bar, changing room, showers etc, which will replace the existing timber built changing facilities. Along with the new club house and stands the proposals indicate that there is to be a new all weather sports pitch which is to sit within the south-eastern corner of the site and possible upgrade works to the main pitch. It also appears that there will be works taking place to upgrade the existing clubhouse and car parking area. The new all weather sports pitch is to be located to the south of the existing building and has an area of 0.16 Ha. It is assumed that this area will be semi permeable having filter drains along its length to drain the majority of the water from the pitch. The new clubhouse is to sit in the centre of the site with a seating area which will look out on to the Rugby Pitch. The new building will be a fairly rectangular shaped building having a total area of 0.175 Ha. The car park at the front of the site is to be extended slightly to include additional disabled car parking spaces as well as an access road through to the all weather sports pitch and new club house, This area will also provide an access way out on to the open grassed land which sits along the southern boundary of the site.

3.1.2 The proposed site has been calculated as having a total impermeable area of 0.65Ha assuming that the all weather sports pitch will be semi permeable. It is anticipated that the total impermeable area of the site will be 0.73Ha, hence giving a figure of 31% of the total site area which is to be impermeable area.

3.1.3 According to table D2 of PPS25, table 2 of this report, the proposed development can be classified as “Less Vulnerable” in terms of flood risk.

3.2 Future Sources of Flooding

3.2.1 The increases in storm event frequency and severity, due to climate change, will ultimately result in increased runoff rates and volumes from all developed areas. This will ultimately have an effect on sewer systems and affected watercourses.

3.2.2 The proposed development has an impermeable area of around 31% of the total site area. This will increase the impermeable area from that of the existing site and the run off potential of the site will therefore rise from the present situation. Given that the site is currently greenfield in nature, this is likely to increase the likelihood and potential risks.

4.0 FLOOD RISK ASSESSMENT

4.1 The site is not thought to be at risk of flooding from outside sources. It is known that both Pennine Way and Redbourne Road fall away from the site with a gradient of 1 in 50 along Pennine Way and 1 in 36 along Redbourne Road. It is also known that both of the existing roads are positively drained along their full length.

4.2 Correspondence from the Environment Agency, included as Appendix E, indicates that there is no history of flooding within the vicinity of the site or within the local area. This information also points to the fact that the chances of flooding within the site are less than 0.1%.

4.3 Taking into account the above information, it is thought that the whole of the site area is not at risk from flooding.

4.4 As the site is relatively flat across its whole length and given that the site is not at risk from flooding it is suggested that the Finished Floor Level for the new building within the site could be set to existing ground level, hence giving a FFL for the proposed building of between 146.00mAOD and 146.30mAOD. It Is suggested that a target level of 146.25mAOD would be appropriate from the point of view of access.

4.5 There does not appear to be a potential risk of flooding to the local infrastructure or surrounding developments resulting from the proposed development. However due to the increase in runoff from the site it will be necessary to manage the increase in runoff and the associated disposal of stormwater.

4.6 As previously noted the River Gade runs past the site to the west. The river does not have a history of any major flooding based on the Environment Agency flood maps. At the time of writing this report no information was available regarding any flood defences with the vicinity of the site.

5.0 RUNOFF ASSESSMENT

5.1 General

5.1.1 The Environment Agency requirements are that there should be no increase in the rate of surface water emanating from a newly developed site above that of any previous development. Furthermore it is the joint aim of the Agency and local planning authorities to actively encourage a reduction in the discharge of storm water as a condition of approval for new developments. In addition, all drainage systems should be sized to accommodate for the rainfall event of a 1 in 100 year rainfall event and should further include an allowance for a further 20% to account for the effects of climate change.

5.1.2 Part H of the building regulations recommends that storm water runoff shall discharge to one of the following listed in order of priority:-

a) An adequate soakaway system or similar infiltration device appropriate to local ground conditions and/or site space constraints. Or
b) A suitable watercourse. Or
c) A sewer

5.1.3 A recent site investigation shows the site to be based on a firm brown or orange clay with some flints overlying very weak white chalk at depths of between 1.7-3.0 metres. The chalk in question is considered to be Upper Chalk measures and is identified as a Major Aquifer with high potential permeability rates. The site investigation report does record some contamination in the vicinity of an existing electrical sub-station, located near the site entrance, and also near the site of a former spoil heap. The extent of contaminations is thought to be limited and is currently separated from the Aquifer by the impervious clay layer.

5.1.4 It is considered that infiltration methods will be appropriate for the disposal of stormwater from the development but that suitable care must be taken to protect the Aquifer from the risks of contamination from possible pollutants.

5.1.5 The following assessment relates runoff from the proposed development to that of a greenfield site and enables us to evaluate the storage requirements. Without dedicated infiltration test results it is not possible to fully assess the time taken for the stormwater to dissipate but an indication of required storage for the runoff can be calculating using an assumed infiltration time. Indications are that the weathered chalk of the upper chalk layer is highly porous and may offer flow rates of between 10^{-3} to 10^{-5} m/s, so by assuming a rate of say 5×10^{-5} m/s can anticipate a drain down time for the proposed runoff can be calculated.

5.1.6 The site runoff can be estimated using the Lloyd -Davies formula as follows:-

$Q = 2.78.A.i.C_vC_r$ Where A = Area (ha)
i = Design rainfall intensity (mm/hr)
C_vC_r = Run off and routing coefficients ≈ 1.0

Since design rainfall intensity and hence runoff will vary, not only with return period but also with storm duration, a selection of events have been evaluated for a simple system in the Hemel Hempstead area.

5.1.7 The design rainfall intensity will vary depending on the return period of the storm event. Using M5-60min rainfall data of 20.0mm and rainfall ratio r = 0.40 from HR Wallingford statistical maps[1], and given the equation above, table 3 below has been compiled to illustrate the variation in predicted site run-off from the existing and proposed developments.

5.1.8 Consideration has been given to the ground conditions in order to assess whether infiltration methods can be used to resolve issues surrounding the disposal of storm runoff, in this case soakaways are considered to provide a potential option for surface water drainage.

5.1.9 A further option which has been considered whilst writing this report is the use of grey water drainage systems this would include the harvesting and reusing of rainwater which falls on the proposed and exiting roofs. The rainwater would be stored in a suitably sized underground tank before being reused as tap water for sinks and showers and water for filling the toilet systems etc.

5.2 Greenfield Runoff Assessment

5.2.1 Based on the survey plan and visual site information it may be assumed that the site is currently 100% greenfield. From this, greenfield runoff for the site has been calculated using the IOH Rural runoff estimation method using the following formula:-

$$Q_{bar} = 1.08\ (AREA/100)^{0.89} \times (SAAR)^{1.17} \times (SPR)^{2.17}$$

Where: AREA = 50 Ha, SAAR = 750 mm (Wallingford Vol 3 - maps), SPR = 0.37 (rural).
For sites with areas of less than 50Ha, a 50Ha base area is used for the calculation, this is later modified to suit the actual site area. The figure for SPR (rural) is based on standard soil types as defined in FEH documentation or by observations, the Kimmeridge Clays found to be underlying the site may be defined as 0.496 (soil type 5)
The above information is contained in a number of documents, most notably "Greenfield estimation of peak flow rate of runoff" (Technical Report W5-074/A revision C), and the HR Wallingford guidance manual "Use of SUDS in high density developments" (SR666) - appendices.

Based on the above, the figure for Q_{bar}(rural) is calculated as follows:-

Q_{bar}(rural) $= 1.08(50/100)^{0.89} \times (750)^{1.17} \times (0.37)^{2.17}$
$= 0.583 \times 2311.12 \times 0.1156$
$= 156$ l/s (for 50 Ha)
which adjusted for the proportional area gives:-
$156 \times (2.32)/50 = 7.23$ l/s

The rainfall event on which the above runoff is based, however, has a return period of approximately 2.3 years, so in order to quantify the runoff of a 1 in 1 year event we must multiply the calculated runoff by 0.85 as recommended by the regional growth curves (for hydrological region 6).

Hence modified greenfield runoff = 7.23 x 0.83 = 6.15 l/s.

[1] From Flood Studies Report - 1976

Since design rainfall intensity and hence runoff will vary with rainfall intensity a selection of events have been evaluated for a simple system in the Hemel Hempsted area. For the respective events the greenfield runoff may also be considered to vary and so adjustments have been included to show the variation in runoff.

Table 3 – Greenfield Runoff to show the variation of runoff with intensity

Return Period	2 year Greenfield Runoff	Conversion Factor	Greenfield Runoff
(yr)	(l/s)	(-)	(l/s)
1	7.23	0.85	6.15
30	7.23	2.20	15.91
100	7.23	3.16	22.85

Table 4 - Estimated Runoff from Existing Site

Return Period	Storm Duration	Average Rainfall Intensity	Proposed Runoff at 0.65 Ha	Greenfield runoff	Residual Runoff	Soakaway Storage Volume
(yr)	(mins)	(mm/hr)	(l/s)	(m^3)	(l/s)	(m^3)
1	15	30.99	56.00	6.15	49.85	44.865
	30	20.21	36.52	6.15	35.91	64.638
	60	12.80	23.13	6.15	16.98	61.128
	120	7.94	14.35	6.15	8.20	59.040
	180	5.98	10.81	6.15	4.66	50.328
	240	4.88	8.82	6.15	2.67	38.448
	360	3.65	6.60	6.15	0.45	9.720
	480	2.96	5.35	6.15	0.00	0.00
	600	2.51	4.54	6.15	0.00	0.00
	720	2.20	3.98	6.15	0.00	0.00
	960	1.78	3.22	6.15	0.00	0.00
	1440	1.33	2.40	6.15	0.00	0.00
30	15	76.03	137.39	15.91	121.48	109.332
	30	49.50	89.45	15.91	73.54	132.372
	60	30.81	55.67	15.91	39.76	143.136
	120	18.61	33.63	15.91	17.72	127.584
	180	13.72	24.79	15.91	8.88	95.904
	240	10.99	19.86	15.91	3.95	56.880
	360	8.03	14.51	15.91	0.00	0.00
	480	6.43	11.62	15.91	0.00	0.00
	600	5.40	9.76	15.91	0.00	0.00
	720	4.69	8.47	15.91	0.00	0.00
	960	3.74	6.76	15.91	0.00	0.00
	1440	2.72	4.92	15.91	0.00	0.00
100	15	98.68	178.31	22.85	155.46	139.914
	30	64.79	117.08	22.85	94.23	169.614
	60	40.51	73.20	22.85	50.35	181.260
	120	24.46	44.20	22.85	21.35	153.720
	180	17.96	32.45	22.85	9.60	103.680
	240	14.34	25.91	22.85	3.06	44.064
	360	10.42	18.83	22.85	0.00	0.00
	480	8.30	15.00	22.85	0.00	0.00
	600	6.96	12.58	22.85	0.00	0.00
	720	6.02	10.86	22.85	0.00	0.00
	960	4.78	8.64	22.85	0.00	0.00
	1440	3.46	6.25	22.85	0.00	0.00

5.2.2 On the above table, storm events producing less gross runoff than the calculated greenfield runoff rate of the site are deemed not to store anything. In practice there will be some storage however the above assessment provides a guide.

5.3 Sustainable Drainage Options

5.3.1 The following assessment is based on a sample soil infiltration rate of 5×10^{-5} m/s which is very much towards the lower end of the anticipated scale for chalk. Assuming the design storm event being a 1 in 30 year storm of 60 minute duration, from the above table it will be necessary to provide approximately 143m^3 of storage. If a swale 8 metres wide and 1 metre deep at its centre is to contain the full volume of runoff then its length will be as follows:-

Cross Section = 8 x 1 x 0.5 = 4m^2
Length = Volume / Cross Section Area
= 143/4 = 35.75m (Say 40m)

Thus the minimum required length will be 35.75m if the same swale has a filter trench 0.5m wide x 2.0m deep at its centre, it will present a filter area of 40 x (2+2) x 0.5 = 80m^2. From this, the time to drain the swale will be 143/ (80 x (5×10^{-5})) = 89375 seconds or 24.8 hours. If however the soil infiltration rate is 5×10^{-4} m/s the drain time is improved to 143/ (80 x (5×10^{-4})) = 3575 seconds or 59.60 minutes.

5.3.2 As can be seen, the defining issue will be the actual rate of infiltration of the upper chalk and the precise depths of the chalk below ground level. It is recommended that a number of specific infiltration tests are carried out to confirm suitability of the soil.

5.3.3 In terms of the provision of storage and soakaway media, it is recommended that an open swale 8.0 metres wide x 1.0 metres deep x 50 metres long is constructed to the north of the main pitch area beyond the new security fence. It will have a filter zone extending into the upper chalk and will be over sized sufficiently to accommodate more onerous storm events or storm recurrences.

5.3.4 As an alternative it is suggested that roof drainage from the new stand may be sourced into a separate soakaway or that a “Greywater” system may be utilised to assist in the flushing of toilets or for use in showers and reduce the requirement for portable water use in this area. As an estimate for the sizing of a suitable greywater system, the following formula should provide a guide.

Tank Size	= Collection Area	x Drainage Factor (Assume 75%)	x Filter Efficiency (Assume 90%)	x Annual Runoff (Assume 750mm)	= 0.05

Thus for the proposed stand

(17.1 x 48.6) x 0.75 x 0.9 x 750 x 0.05 = 21036 litres
=21m^3

Thus providing a suitable greywater system the swale or soakaway system may be reduced by up to 20m^3 with the added advantage that toilet flushing and cold water supply to the showers. This will naturally be a seasonal use, and will not be functional or available for all storm events. It will however reduce the cost of metered water supplies to the club and may be beneficial in the long-term.

5.3.5 Runoff from the car park may be passed through a bypass petrol / oil separator to remove oils, or may be held in a short duration retention system such that the retained hydro carbons will be broken down by micro biological actions. This may also include porous paving or a small holding facility which holds the relevant runoff for a period of 24 hours.

5.3.6 Attached as Appendix F is a copy of two suggested drainage options for the proposed development, the first option looks at taking the whole of the drainage area in to a swale at the north of the rugby pitch as described above. The second option suggested is to utilise a swale as well as a greywater storage tank for the harvesting of rainwater. These options have been produced as an indication of how the final drainage design may be achieved they are not intended to constitute a drainage design.

6.0 CONCLUSIONS

6.1 In accordance with the sequential test identified in PPS25, Annex D (table D1), the site can be identified as falling wholly within flood zone 1.

6.2 The proposed leisure development may be identified as “Less Vulnerable” in accordance with PPS25 Annex D (table D2). It is therefore considered that this development is appropriate and suitable for this location and will be adequately protected from flooding.

6.3 The disposal of storm runoff from the new site area can be accommodated in a suitable sized swale with an integral filter zone which penetrates the upper chalk layer will be sufficient for the disposal of storm runoff. It is considered that the swale should be sized at 143m^3.

6.4 It may also be appropriate to consider the collection and re use of roof runoff from the new stand building through a suitable greywater system. This should be sized at around 21m^3 and may be used to supply water to the toilet flushing system or as a cold water supply to the showers. The potential effectiveness of this will depend on the frequency of use of the building for matches and / or training purposes but may reduce the need for storm water storage and the corresponding costs associated with the supply of potable water. In this instance, it will be necessary to install separate cold water systems and identify “drinking” water notices to appropriate points.

6.5 If it is considered inappropriate to install above ground storage in the form of a swale then an appropriate below ground system may be installed. The completion of dedicated infiltration tests will confirm the exact permeability of the upper chalk zone and may permit a reduction in the size of stormwater storage facilities.

6.6 Since the upper chalk is considered to be a major aquifer it will be necessary to provide suitable interceptors in order to isolate light oils or hydrocarbons from the runoff. This may be done by means of a bypass petrol / oil interceptor or by using a 24 hour holding or low flow facility the use of porous paving or a dedicated wetland facility may be of use to assist bio treatment of runoff.

Appendix A
16070249/601 P1
Site Location Plan

Appendix B
16070249/602 P1
Flood Plan

Appendix C
Sewer Records

Appendix D
Topographical Survey

Appendix E
Proposed Site Layout

Appendix F
Proposed Drainage Scheme SK1
Proposed Drainage Scheme SK2

Appendix G
Correspondence