South West Milton Keynes

Flood Risk Assessment

Environmental Statement Appendix 8.1

Pell Frischmann

OCTOBER 2014

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APPENDICES

EXECUTIVE SUMMARY

Pell Frischmann has been commissioned to produce a Flood Risk Assessment (FRA) for a proposed mixed-use development situated to the south west of Milton Keynes.

The site is currently greenfield and covers an area of approximately 144 ha. The Tattenhoe Brook flows along the northern western corner of the site prior to being culverted under Standing Way (A421) and Bottle Dump roundabout. There is a small brook, a tributary of the River Ouzel, located 100 m to the south of the site. There are numerous field drains on the site which are culverted under the railway and discharge into the tributary of the River Ouzel.

The EA Flood Map indicates that the north west of the site lies within Flood Zone 3; an area at high risk of flooding (>1% annual probability of flooding in any given year) and Flood Zone 2; an area at medium risk of flooding (1% - 0.1% annual probability of flooding in any given year). However, the majority of the site is within Flood Zone 1; an area at low risk of flooding (<0.1% annual probability of flooding in any given year) and the EA have no records of flooding at the site. There are no records of groundwater flooding in the area and due to the nature of the underlying impermeable clay, the risk of flooding from groundwater is low. There are strategic ponds located 250 m to the north of the site however there is considered to be a low risk of flooding from artificial sources due to the distance from the site.

It is considered that the site passes the Sequential Test as all built development will be located outside of Flood Zone 2 and 3.

Consultations have been undertaken with the Environment Agency, Internal Drainage Board, Aylesbury Vale District Council and Milton Keynes Council and all parties are keen to see a wide range of Sustainable Drainage Systems implemented across the site.

The site has been split into sub-catchments based on existing topography and the proposed land use parcels. Existing greenfield runoff rates have been calculated for each sub-catchment to mimic the existing greenfield runoff characteristics for the proposed surface water drainage strategy.

A review of the site investigation data indicates that infiltration testing failed, as the effective depth was not reached, therefore soakaways are not a viable option at the site.

It is recommended that a series of sustainable drainage systems are utilised on the site in line with CIRIA SuDS Manual C697. This should include green roofs, rainwater harvesting systems and permeable paving for driveways and areas of car parking. The use of permeable paving will reduce the amount of attenuation required and provide a level of source control in line with the SuDS Treatment Train.

It is proposed to attenuate the surface water runoff in a series of attenuation basins to control up to the 1 in 100 year event plus 30% allowance for climate change. The strategy proposes a cascading attenuation system at the northern boundary of the site which will discharge to the Tattenhoe Brook at restricted rates. The attenuation basins located on the southern boundary will discharge to the fields drains at restricted rates. The field drains then discharge into brook situated approximately 100 m to the south of the site.

Further information on the gas and oil pipelines is required as the proposed surface water drainage system crosses both pipelines.

1. INTRODUCTION

Pell Frischmann was appointed by the South West Milton Keynes Consortium to undertake a Flood Risk Assessment (FRA) in support of a proposed mixed use development situated to the south west of Milton Keynes.

This report has been provided to meet National Planning Policy Framework (NPPF) (2012) and the associated Planning Practice Guidance (2014). It is anticipated that the National Standards for Sustainable Drainage will be finalised and released later in 2014. Following the release of this guidance, the surface water drainage strategy for the proposed development may need to be revised to take into account the changes set out in this document.

2. THE SITE

2.1 SITE LOCATION

The site is situated approximately 9.5 km to the south west of central Milton Keynes and approximately 25 km to the north of Aylesbury. It is located on the urban fringes of Milton Keynes to the south of the A421. The centre of the site is located at National Grid Reference SP837323 as illustrated in Figure 1 below.

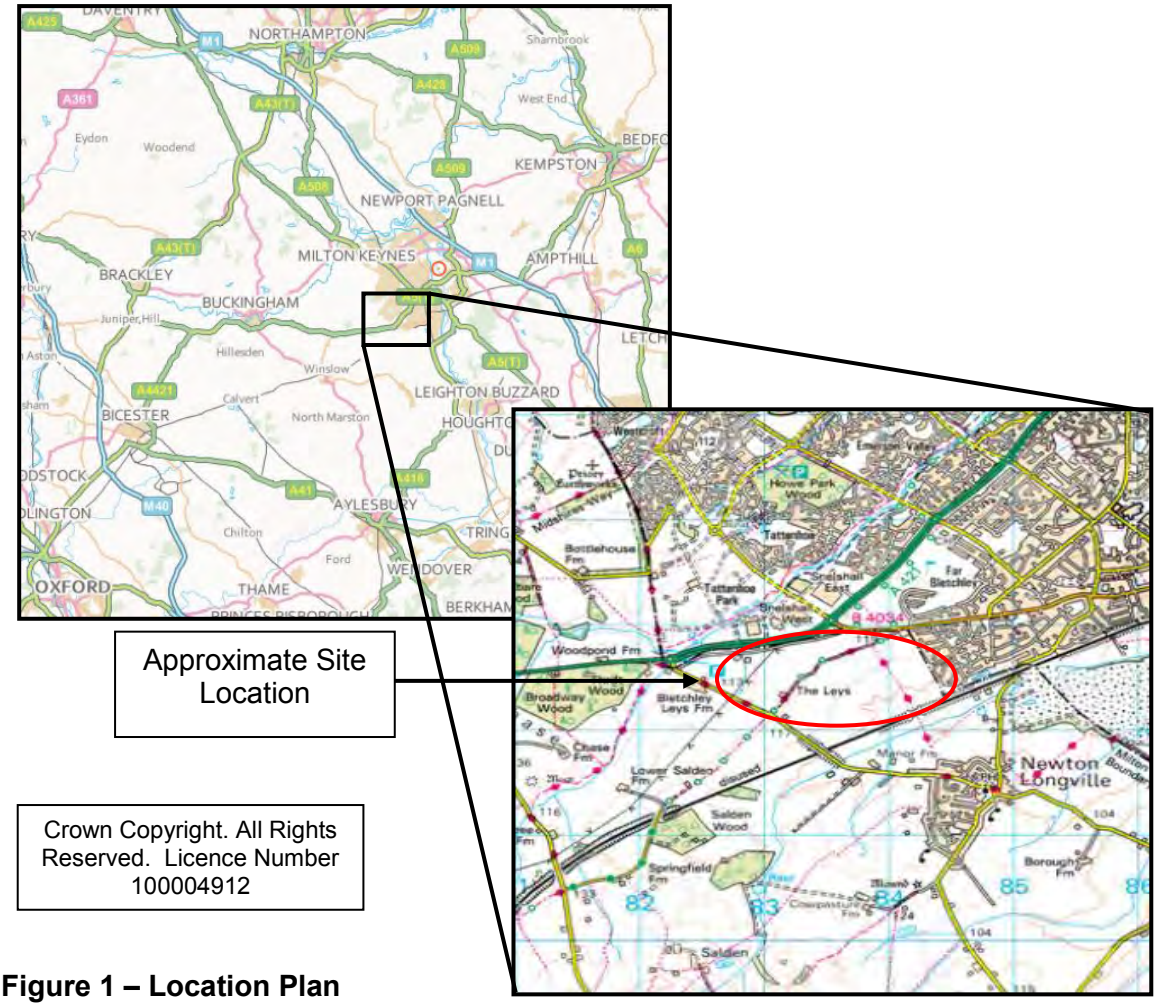

Figure 1 – Location Plan

2.2 SITE DESCRIPTION

The site is currently irregular in shape, comprises greenfield agricultural land and covers a total area of approximately 144 ha. The site boundary is illustrated in the aerial photograph shown in Figure 2 below.

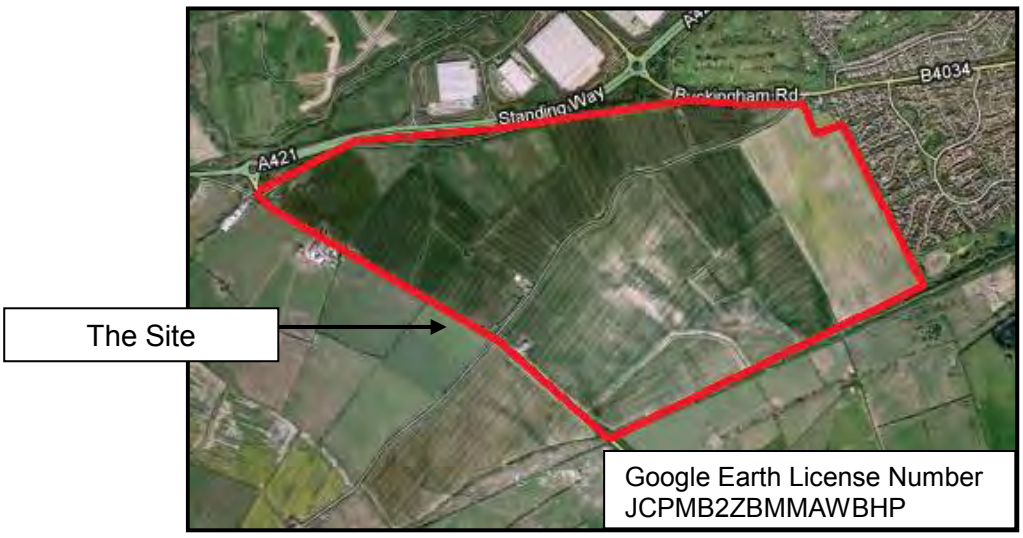

Figure 2 – Aerial Photograph of the Site

The site is bound to the north by Standing Way (A421) with Windmill Hill Golf Centre and Milton Keynes beyond. The site is bound to the east by housing, Newton Road and Blue Lagoon Park beyond. The site is bound to the south by a disused railway line which demarks the southern boundary of the site. Further agricultural fields and the village of Newton Longville are situated to the south of the railway. The site is bound to the west by Whaddon Road and further agricultural fields.

2.3 WATERCOURSE

2.3.1 Tattenhoe Brook

The source of the Tattenhoe Brook is situated approximately 2 km to the south west of the site near the aqueduct and flows to the north east past Crabtree Farm, Chase Farm and Salden Farm. The Tattenhoe Brook flows along the north western corner of the site in a north easterly direction. It is culverted under Bottle Dump roundabout and flows as Loughton Brook through Tattenhoe Park and Milton Keynes prior to discharge into the River Great Ouse at New Bradwell. An inspection of the culvert system at Bottle Dump roundabout deemed the culverts to be in 'good condition' as detailed in a report by Brookbanks Consulting in April 2010 (ref 1285/FRA/01).

The Tattenhoe Brook is designated as an Ordinary Watercourse and therefore the responsibility of land drainage falls with the Local Authority.

2.3.2 Tributary of The River Ouzel

There is a small brook, a tributary of the River Ouzel, 100 m to the south of the southern site boundary. It flows eastwards through Bletchley and discharges into the River Ouzel near Mill Farm approximately 2.5 km to the east of the site.

2.3.3 Field Drains

There are several field drains on the site; in the northern section of the site, the most prevalent field drain rises adjacent to Whaddon Road on the western boundary. It flows in a northerly direction where it is culverted under A421 and joins the Tattenhoe Brook near Steinbeck Crescent.

In the southern section of the site, there are four field drains situated to the south of Weasel Lane which flow along hedge lines where they discharge into the brook which flows adjacent to the base of the disused railway line embankment. The ditch conveys water to a point situated approximately 300 m to the west of the eastern site boundary where the ditch discharges into an arched brick culvert beneath the railway. The field drains discharge into the brook, stated in section 2.3.2, which flows in an easterly direction prior to discharge into the River Ouzel. The network of field drains is illustrated in Figure 3 below.

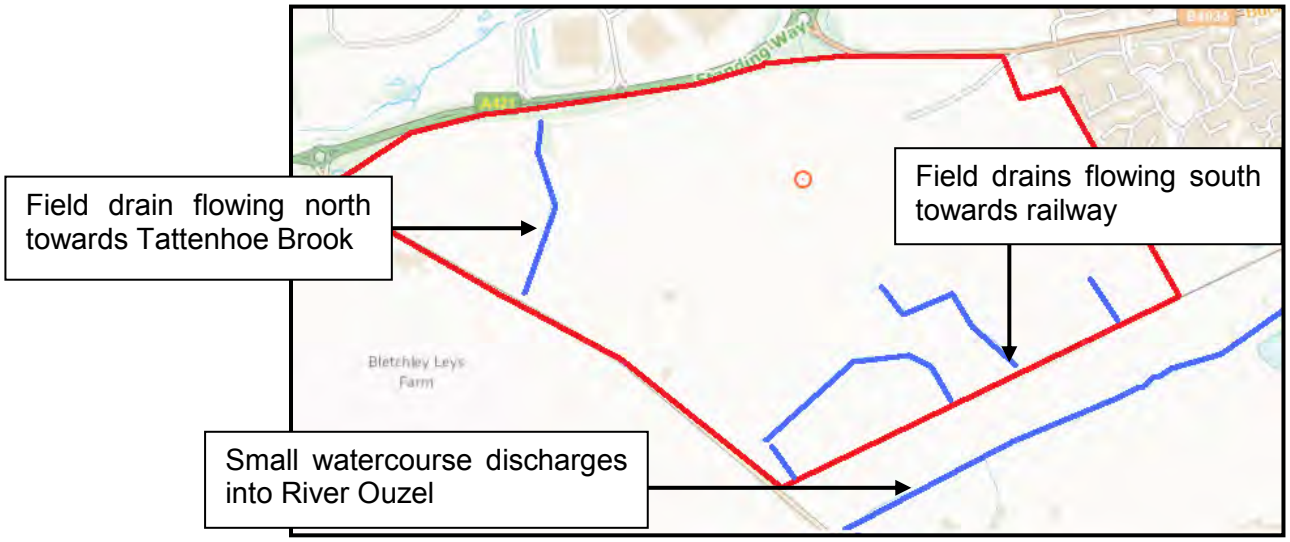

Figure 3 – Location of Field Drains at the Site

2.4 TOPOGRAPHY

The topographic survey of the site indicates that there is a ridge along Weasel Lane. The land to the north of Weasel Lane slopes towards Standing Way (A421) and the land at the north west of the site falls eastwards towards the forested area. The highest level on the northern section of the site is along Weasel Lane at 120.38 mAOD and the lowest level in this area is 102.79 mAOD towards the northern site boundary.

The land to the south of Weasel Lane slopes southwards to the railway line from a level of 119.92 mAOD at Weasel Lane to 91.66 mAOD. The topographic survey has been included in Appendix A.

2.5 GEOLOGY

British Geological Survey online mapping source indicates that the site is underlain by Mudstone from the Oxford Clay Formation with superficial deposits of Till. The mapping indicates superficial deposits of Alluvium – Clay, Silt, Sand and Gravel at the north west corner of the site which follows the course of the Tattenhoe Brook.

There are no Groundwater Source Protection Zones near to the proposed site.

2.5.1 Site Investigation

A site investigation was completed by the RAW Group in August 2008 confirmed the presence of Glacial Till in the form of grey gravely clay in trial pits up to 3.8 mbgl. The Oxford Clay was not encountered within the trial pits.

2.6 STRATEGIC BALANCING PONDS

A strategic flood mitigation area has been built as part of the Milton Keynes Partnership, at Tattenhoe Park which is situated approximately 250 m to the north of Standing Way (A421). In August 2006, Pell Frischmann produced an FRA in support of the development at Tattenhoe Park (Report Ref R05000.094.001/C). Above ground attenuation basins with a total volume of 14100 m^3 have been designed to attenuate surface water runoff from the site for the 1 in 100 year event, plus an allowance for climate change; flows from the ponds are restricted to greenfield runoff rates.

The Milton Keynes Council Strategic Flood Risk Assessment (2008)[1] (SFRA) indicates that Milton Keynes has a system of strategic balancing lakes, including the ponds in Tattenhoe Park, which have been designed to control fluvial flood risk for the 1 in 100 year event up to the 2011 development scenario. The drainage into these balancing lakes is through Anglian Waters surface water sewers. The SFRA adds that this should be continued for future development within the area. Section 8 details the surface water drainage strategy for the proposed development.

3. EXISTING FLOOD RISK

3.1 FLUVIAL FLOOD RISK

3.1.1 Environment Agency (EA)

The EA Flood Map indicates that part of the north west corner of the site lies within Flood Zone 3; an area at high risk of flooding. The NPPF Planning Practice

[1] Milton Keynes Council, Strategic Flood Risk Assessment For Local Development Framework, Level 1, Volume 1, July 2008

Guidance (2014) indicates that Flood Zone 3 comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (<0.1%).

3.2 SURFACE WATER FLOOD RISK

The Milton Keynes SFRA stated that the Anglian Water DG5 register indicates that the nearest recorded incident of sewer flooding from the surface water network is at Newton Road in Bletchley, situated approximately 500 m to the east of the proposed site. The flooding was reported to have been due to the hydraulic incapacity of the surrounding sewers.

The Aylesbury Vale District Council Strategic Flood Risk Assessment (2009)[2] includes a map indicating locations of historic flooding incidents within the council area. The site is shown to have no records of flooding and has been included in Appendix B.

The SFRA has no reports of surface water flooding at site, therefore there is considered to be a low risk of flooding from surface water.

3.3 GROUNDWATER FLOOD RISK

The Milton Keynes SFRA and the Milton Keynes Water Cycle Study stated that there are no records of groundwater flooding in the Milton Keynes area. The Aylesbury Vale District Council SFRA indicates that the EA hydrogeology team have indicated that that the risk of flooding from groundwater is low due to the geology of the area.

3.4 FLOOD RISK FROM ARTIFICAL SOURCES

There is a range of artificial water infrastructure in the immediate vicinity. This includes the ponds in Tattenhoe Park, 250 m to the north of the site, a pond at Newbury Crescent and Natural Gas Reception Centre. However it is unlikely that flooding from any of these sources would impact on the site, consequently there is considered to be a low risk of flooding from artificial sources.

4. POLICY AND GUIDANCE

4.1.1 Aylesbury Level 2 Strategic Flood Risk Assessment (2009)

The Aylesbury Level 2 SFRA informed the preparation of the Aylesbury Vale Core Strategy with regards to flood risk. It is intended to assist the District Council in applying the Sequential Test and Exception Test, providing a method of managing flood risk while still allowing necessary development to occur.

It states that development within Flood Zones 2 and 3 should be limited to public open space and if it passes the Exception Test, essential infrastructure.

[2] Aylesbury Town Level 2 Strategic Flood Risk Assessment, Final Report, 9 April 2009, 0T5436

4.1.2 Aylesbury Vale Planning Policy

Saved policies of the Aylesbury Vale District Local Plan (AVDLP) form part of the development plan and show their policies and proposals for the use of land and buildings. The AVDLP was adopted in January 2004.

Two of the three related drainage policies in the AVDLP have not been saved: policy GP.65 under the 'Protection of River and Surface Waters' and policy GP.67 under 'Flooding and Surface Water Management'. Consequently, developers are advised to refer to the NPPF and associated guidance. The one saved drainage policy from the AVDLP is outlined below.

Policy GP.66 under the '*Protection of River and Surface Waters'* states that: in riverside and canal side development proposals, the Council will require access corridors and buffers adjacent to the watercourse:

a) Conserve and enhance existing areas of landscape or wildlife value;
b) Promote public access and provide recreational opportunity; and,
c) Protect or enhance the environment and habitat of those watercourses.

A Vale of Aylesbury Local Plan (VALP) is in preparation. During this time developers are advised to refer to the NPPF and the associated Planning Practice Guidance (2014).

4.1.3 Aylesbury Vale District Council Useful Reference for Developers

This document accompanies the Level 2 SFRA and it states that on new developments Aylesbury Vale District Council will adopt open watercourses and above ground SuDS features such as swales and wet/dry detention basins where they are in public open space and do not only serve highway drainage. However it is noted that this policy may be reconsidered in light of proposed changes in drainage legislation; consultation regarding the implementation of the legislation is still ongoing.

4.1.4 Milton Keynes Council Strategic Flood Risk Assessment (2008)

The SFRA states a series of flood risk management objectives which are summarised below.

- To seek reduction in flood risk through spatial planning and site design
- To ensure surface water runoff from new developments remains at greenfield rates
- To enhance and restore the river corridor
- To protect and promote areas for future flood alleviation schemes
- To improve flood awareness and emergency planning

The SFRA has no records of flooding on the site.

The SFRA adds that the LPA should adopt a planning policy requiring the use of SUDS. Individual developments should be designed so that natural flood pathways are left free of buildings.

Future development should incorporate the same principles of sustainable drainage as already used within Milton Keynes and where possible use should be made of large scale strategic, rather than local SuDS as this allows easier monitoring and maintenance.

For new areas outside Milton Keynes including the expansion areas, discharge to watercourses is appropriate provided SuDS are incorporated on the development site to ensure that the discharge is restricted to the greenfield runoff rates. The most suitable SuDS techniques for new sites within Milton Keynes Borough, Aylesbury Vale and Mid Bedfordshire area are:

- Green roofs
- Rainwater harvesting and water butts
- Filter strips
- Filter trench / drain
- Swales
- Bio-retention areas
- Detention basins
- Ponds
- Geocellular / modular

The SFRA also gave information on the future maintenance of SuDS within the Milton Keynes area. The Internal Drainage Board and Parks Trust and Milton Keynes Council are prepared to take on maintenance of surface water drainage facilities providing funding is available. In addition, the Council and the Parks Trust will consider adopting areas of public open space surrounding new surface water drainage facilities.

4.2 MILTON KEYNES COUNCIL WATER CYCLE STUDY

The Milton Keynes Council Water Cycle Study Outline Strategy[3] has been reviewed in relation to the development. It states that future development has the potential to increase the frequency the consequence of such flooding through the increases in and runoff from impermeable areas. These increases can be mitigated through the use of integrated SuDS, careful development design, development control and masterplanning. Milton Keynes has a network of green infrastructure which will be maintained and enhanced through development design.

The document provides a generalised constraints matrix identifying constraints with flood risk, water resources, wastewater and environment. The proposed development site falls within the South Western Area. The risk of groundwater flooding in the South Western Area is thought to be low due to the relatively impermeable clay. There are several balancing ponds and lakes within the Bletchley and Newton Longville area which have an associated risk from artificial sources. Any major risk to development should be identified and addressed either as part of the SFRA or as part of a site specific FRA. The report concludes that there is no overriding flood risk constraint to the South Western Area that would require large-scale flood risk management or mitigation.

[3] Milton Keynes Water Cycle Study Outline Strategy, Final, December 2008

The report encourages natural infiltration by creation of open grassland landscaping for large developments to maximise runoff rate reduction and to encourage natural recharge of groundwater systems. However the South Western Area is likely to be significantly limited in terms of opportunities for infiltration SuDS due to the unsuitable underlying geology.

4.3 MILTON KEYNES CORE STRATEGY (ADOPTED 2013)

The Milton Keynes Core Strategy contains strategic policies and sets the framework for future detailed policies and Neighbourhood Plans. The Core Strategy replaces the strategic policies detailed in the 2005 Local Plan, including Policy S13 'Areas Liable to Flooding' that was deleted in 2008. The relevant policies outlined in the Core Strategy are presented below:

Policy CS6 states that when and if development comes forward for an area on the edge of Milton Keynes, which is wholly or partly within the administrative boundary of a neighbouring authority, this Council will put forward the following principles of development during the joint working on planning, design and implementation:

- The structure and layout should be based on the principles that have shaped the existing city, especially integrated flood management;
- A strategic, integrated and sustainable approach to water resource management (including SuDS and flood risk management) should be taken.

Policy CS12 states that new developments and major developments must be designed to support sustainable lifestyles for all. This will include:

- Appropriately locating developments to maintain and improve current flood risk and air quality standards; and
- Ensuring flood water management is planned at the largest appropriate scale of new development and, wherever possible, designed as public space.

Policy CS19 states that Green Infrastructure will be protected and enhanced. Open space will be provided in line with the Council's standards. The existing linear parks systems along the Broughton, Caldecotte and Loughton Brooks will be extended into urban extensions and along the Ouse and Ouzel Valleys to the north to provide multi-purpose green infrastructure that:

- Meets the need of existing and future residents; and,
- Is designed to manage flood risk.

5. PROPOSED DEVELOPMENT

The proposal is for a mixed use development, including residential use, employment, infrastructure, a local centre and primary school. This will lead to an increase in the amount of impermeable area, approximately 80.62 ha, at the site. Vehicular access will be from Standing Way (A421) and Whaddon Road. Please refer to drawing SWMK03\073 for a masterplan for the proposed development.

5.1 SEQUENTIAL TEST

It is considered that the site passes the Sequential Test as all built development is in Flood Zone 1 at low risk of flooding.

5.2 DEVELOPMENT DESIGN HORIZON

The site is intended to be developed for mixed use including residential and as such the design life (in terms of flood risk and drainage) is identified as 100 years in line with current best practice.

6. CLIMATE CHANGE IMPACTS

The potential impact of climate change is expected to cause an increase in the magnitude and frequency of extreme weather events as outlined in the NPPF 2012. The proposed development should seek to mimic the existing drainage situation through the use of Sustainable Drainage Systems (SuDS) where practicable and an allowance for climate change should be included.

6.1 INCREASED RAINFALL INTENSITY

The NPPF Planning Practice Guidance (2014) states that by 2115 peak rainfall intensities could increase by up to 30 %. For the purposes of this report, the design horizon of the proposed development is considered to be 100 years. Calculations of future run-off rates should be undertaken with a factor of 30 % added to the rainfall intensity parameter to represent the potential for increased rainfall intensities to 2115.

7. CONSULTATIONS

7.1 ENVIRONMENT AGENCY (EA)

The EA have been contacted in relation to the proposal and have stated that there is limited potential for infiltration at the site, discharge should be restricted to greenfield rates and attenuation features should be used to control the runoff.

7.2 INTERNAL DRAINAGE BOARD (IDB)

The IDB (The Bedford Group of Drainage Boards) was previously contacted in relation to the proposal and stated that on the basis that the site is upstream of the Board's district, the EA are commenting on it and that the overall proposal does not increase flows into the Tattenhoe Brook, the Board has no comment to make at this stage.

7.3 MILTON KEYNES COUNCIL

Milton Keynes Council (MKC) was contacted in March 2013 and February 2014 regarding the current proposals. MKC policy regarding flood risk management is summarised below:

- Expect consultation with the EA throughout the preparation of the FRA;
- Expect the flood risk management design to have been developed in accordance with local flood risk and planning policies, NPPF and related technical guidance and advice i.e. the EA and IDB.
- Expect existing surface water discharge rates to be maintained and if possible, reduced, based on greenfield conditions;
- Expect careful consideration of the destination of surface water runoff and may require consent;
- Consideration of multi-functional spaces; and,
- Expect water quality to be maintained to minimise risk of pollution to water bodies.

8. SURFACE WATER DRAINAGE STRATEGY

8.1 SOIL TYPE

A desktop assessment of the soil type has been undertaken in conjunction with the Wallingford Maps of Winter Rainfall Acceptance Potential (WRAP). The map indicates the permeability of soils across the UK on a scale of 1 to 5. The maps identify the site as within WRAP class 3. WRAP class 3 is described as:

i) Relatively impermeable soils in boulder and sedimentary clays, and in alluvium, especially in eastern England
ii) Permeable soils with shallow ground-water in low lying areas
iii) Mixed areas of permeable and impermeable soils, in approximately equal proportions

8.2 EXISTING SURFACE WATER RUNOFF RATES

The site is naturally formed by two catchments with the ridgeline along Weasel Lane as evident from the topographic survey included in Appendix A.

Due to the size of the site and the nature of the topography, the site has been split into 6 sub-catchments. The ridgeline along Weasel Lane dissects the site into two; the northern section of the site drains towards the northern boundary and the southern half of the site draining towards the southern boundary. Sub-catchments 1 – 3 drain the northern section of the site and sub-catchments 4-6 drain the southern half of the site. A plan identifying each of the sub-catchments on the site is included in Appendix C.

Initially the surface water runoff rate was calculated for the whole site and scaled down to 1 ha and then proportioned to each sub-catchment. In accordance with the Preliminary Rainfall Runoff Management for Developments, the Institute of

Hydrology 124 Report (IH 124) has been used to determine the existing greenfield surface water runoff rates for a range of return periods. The calculation was carried out in Micro Drainage and the results are indicated in Table 1 below and in Appendix D.

Table 1 - Existing Greenfield Runoff Rates

Return Period	1 in 1 Year (l/s)	1 in 30 Years (l/s)	1 in 100 Years (l/s)
Entire Site (143ha)	344	949	1406
1 ha	2.42	6.68	9.90
Sub-Catchment 1	63.11	174.09	257.90
Sub-Catchment 2	36.51	100.71	149.19
Sub-Catchment 3	36.10	99.58	147.51
Sub-Catchment 4	50.07	138.14	204.63
Sub-Catchment 5	105.31	290.51	430.35
Sub-Catchment 6	46.56	128.45	190.28

8.3 FUTURE SURFACE WATER RUNOFF

In accordance with Section 21 of the Planning Practice Guidance (2014), the proposed surface water drainage strategy will incorporate elements of SuDS. SuDS capture, store and release surface water and are designed to replicate predevelopment discharge rates and volumes as far as practical.

8.3.1 Surface Water Management Hierarchy

Soakaways

Discharge to soakaways is the preferred option of surface water disposal as outlined in the Building Regulations H3 (2000) and the CIRIA SuDS Manual C697. Soakaways have been considered at this site and site specific soakaway testing was undertaken in August 2008 as part of a wider site investigation undertaken by RAW Group. A review of this data indicates that the calculations did not use the full effective depth of the trial pit. BRE365 states that the volume outflowing between the 25% and 75% effective depth should be used when calculating the infiltration rate. Consequently, the tests indicate that the water did not drop to the depth required to enable calculation of the infiltration rate therefore the soil characteristics are not suitable for the use of soakaways at the site. Additional soakaway testing was carried out in March 2014 by Geosphere Environmental Ltd (ref number 796 GI BG BF SG/23-04-14/V20). Soakaway testing undertaken at three infiltration pits was unsuccessful as the infiltration observed in the cohesive soils was very poor. Therefore, soakaway devices were not considered further in the drainage design. Soakaway tests results are included in Appendix E.

Above Ground Storage

The surface water runoff will be conveyed via swales and piped systems to a series of attenuation basins along the northern and southern boundaries of the site. It is recommended that the swales and ponds are lined to prevent the ingress of groundwater. Surface water runoff at the site will be attenuated up to

the 1 in 100 year storm event plus 30% allowance for climate change in a cascading attenuation system at the northern boundary and a series of attenuation areas along the southern site boundary. The cascading attenuation system will attenuate runoff from sub-catchments 1 – 3. Sub-catchment 3 will be attenuated and discharge into the attenuation area in sub-catchment 2 at greenfield rates which will discharge at restricted greenfield rates into attenuation area in sub-catchment 1. The discharge from the attenuation area in sub-catchment 1 will discharge at greenfield runoff rates therefore providing betterment to the existing surface water drainage regime. A schematic of the cascading system is illustrated in Figure 4 below.

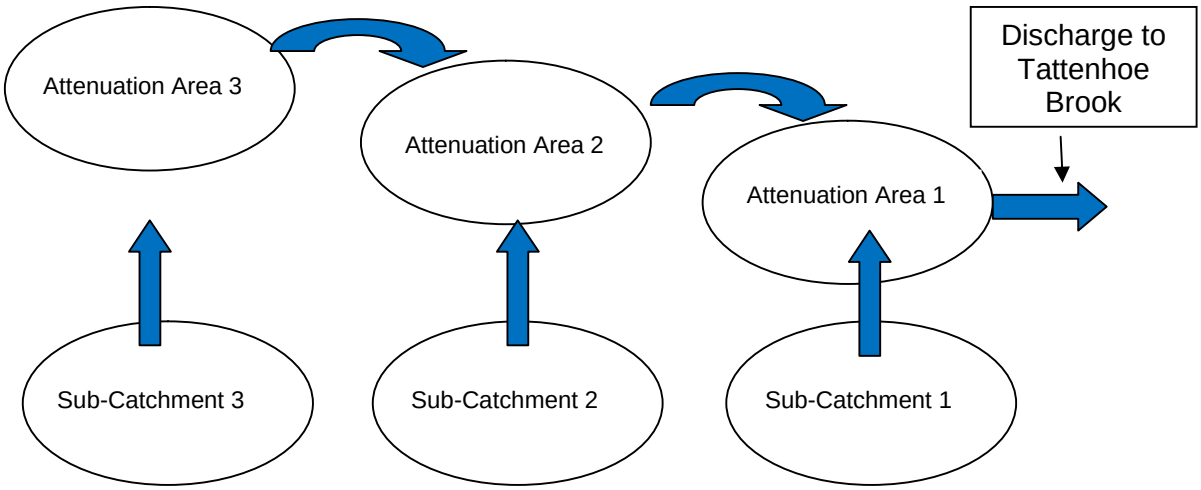

Figure 4 – Cascading Attenuation System Draining Sub-Catchments 1 – 3

The runoff from Sub-catchments 4 - 6 will be controlled in a series of attenuation areas within each sub-catchment which will discharge at restricted greenfield rates into the existing field drains.

8.3.2 Volume of Attenuation

The amount of attenuation storage required has been calculated on a sub-catchment basis. The calculations are based on the proposed layout indicated on the masterplan (drawing number SWMK03-073 Development Framework Plan). Outline surface water attenuation calculations have been undertaken in Micro Drainage. The calculations also include an allowance of 20% for greenfield runoff from the each catchment in addition to the proposed impermeable areas associated with the masterplan. The calculations are summarised for each sub-catchment in Table 2 below and in Appendix F.

Table 2 - Volumes of Attenuation Storage Per Sub-Catchment

Sub-Catchment	Proposed Impermeable Area (ha)	Attenuation Storage for 100 year event plus 30% Climate Change (m^3)
1	12.67	8390
2	6.89	4395
3	7.17	4096
4	7.57	3822

Sub-Catchment	Proposed Impermeable Area (ha)	Attenuation Storage for 100 year event plus 30% Climate Change (m^3)
5	17.00	9427
6	9.42	5275

The cascade provides attenuation for up to the 1 in 100 year event plus an allowance of 30% for climate change. The discharge from the basins will be restricted to greenfield rates and the proposed discharge rates will provide a betterment to the existing drainage scenario as indicated in Table 3 below.

Table 3 - Greenfield and Proposed Surface Water Runoff Rates

Sub Catchment	Greenfield Discharge Rate (l/s)	Proposed Discharge Rate (l/s)
1	258	255
2	149	149
3	147	147
4	205	204
5	430	428
6	190	187

The ponds have been designed to be offset from the development by 5 m and will have embankment slopes of 1 in 6 to meet health and safety requirements and landscaping objectives.

It is considered that the nature of these attenuation ponds will fit in with the strategic flood mitigation ponds located in the wider area such as Tattenhoe Park situated approximately 250 m to the north of the site. If permeable paving is used at the site to provide a level of source control then the volume of the ponds will decrease.

Once the scheme progresses and a more detailed masterplan is developed this surface water drainage strategy will need to be updated to reflect the updated contributing area for each development parcel.

8.3.3 Discharge Locations

Surface water runoff from the northern section of the site (sub catchments 1 – 3) will discharge, at rates lower than greenfield, into the Tattenhoe Brook which flows across the north western corner of the site. The brook is then culverted under Standing Way (A412) and the culvert is thought to be in 'good condition' as per (report ref 1285/FRA/01). There is an oil pipeline running north south between catchments 2 and 3. The outline surface water drainage strategy shows the proposed cascading system crosses the oil pipeline so further information on the pipeline will be required to determine suitable depths and freeboards.

Surface water runoff from the southern section of the site (sub catchments 4-6) will discharge, at restricted greenfield rates, into the field drains which flow southwards and are culverted under the railway line prior to discharging into a brook which flows eastwards. One outfall is located in catchment 5 and the other in catchment 6. The runoff from catchment 4 will be attenuated in an above

ground basin with the outflow restricted to greenfield rates. The runoff will be conveyed into catchment 5 where it will discharge into an existing field drain which then flows under a culvert at the railway embankment.

There is a high pressure gas pipeline running north south through the development which passes through catchments 4 and 5. It is recommended that the depth of the pipeline is ascertained as this will influence the drainage design. The drainage strategy may require updating once this information becomes available.

There is the option that the proposed road will be extended to the south of the site in catchment 5. If this option is brought forward in the future, it is proposed that the surface water runoff from catchment 4 is attenuated in the above ground storage basin and due to the proposed road levels it is routed via a pipe under the railway embankment and then discharges into the ditch to the south of the site boundary.

8.4 SUSTAINABLE DRAINAGE SYSTEMS

8.4.1 Source Control

It is recommended that water butts, green roofs, rainwater harvesting and permeable paving are used at the site wherever possible in order to provide a level of source control in line with the CIRIA SuDS Manual C697. Guidance in CIRIA 609 states that by implementing a 'SuDS Treatment Train', storm water from the site can be polished to an improved standard thus ensuring that the proposed development has no adverse impacts on the wider hydrology.

8.4.2 Site Control

It is recommended that swales are used along the internal roads to drain the sub-catchments to convey the runoff towards the attenuation basins. It is proposed that the cascading system on the northern boundary uses swales, where possible, to convey the runoff between the catchments. By utilising these methods of sustainable drainage the runoff will undergo a level of treatment in line with the SuDS Manual.

8.4.3 Regional Control

A series of attenuation basins are proposed at the northern and southern boundaries of the site. These ponds will be fitted with flow control devices to limit the runoff to existing greenfield rates.

8.5 EXCEEDANCE FLOWS

It is recommended that the final design layout takes consideration of CIRIA C635 Designing for Exceedance. The layout should ensure that any exceedance flows are routed away from properties and towards the areas of public open space. These should be used as flood flow pathways to route the flood water to the storage areas at the northern and southern site boundaries.

8.6 MAINTENANCE / ADOPTION

The maintenance of the surface water drainage system will be the responsibility of the developer until SuDS Approval Bodies are enforced. The Milton Keynes Strategic Flood Risk Assessment (2008) states that Milton Keynes Council and the Parks Trust will consider adopting areas of open space surrounding new surface water drainage facilities. This should be considered at the detailed design stage in conjunction with the SuDS legislation which is due to be released in 2014.

8.7 MAINTENANCE OF SWALES

The proposed surface water drainage strategy incorporates the use of swales within the proposed layout. The swales will need to be regularly maintained to ensure effectiveness and efficiency. The CIRIA SuDS Manual (C697) details a typical maintenance schedule for a swale as seen in Figure 5 below.

Maintenance schedule	Required action	Frequency
Regular maintenance	Litter and debris removal.	Monthly (or as required).
	Grass cutting – to retain grass height within specified design range.	Monthly (during growing season), or as required.
	Manage other vegetation and remove nuisance plants.	Monthly (at start, then as required).
Occasional maintenance	Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where possible.	Annually.
	Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, if required.	Annually, or if bare soil is exposed over 10 % or more of the swale treatment area.
Remedial actions	Repair erosion or other damage by re-turfing or reseeding.	As required.
	Re-level uneven surfaces and reinstate design levels.	As required.
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface.	As required.
	Remove build up of sediment on upstream gravel trench, flow spreader or at top of filter strip.	As required.
	Remove and dispose of oils or petrol residues using safe standard practices.	As required.
Monitoring	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly.
	Inspect infiltration surfaces for ponding, compaction, silt accumulation. Record areas where water is ponding for > 48 hours.	Monthly, or when required.
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Half yearly.

Figure 5 - Typical Maintenance Schedule for a Swale

8.8 MAINTENANCE OF ATTENUATION BASINS

The proposed surface water drainage strategy incorporates the use of attenuation basins within the proposed layout. The series of basins will need to be regularly maintained to ensure effectiveness and efficiency. The CIRIA SuDS Manual

(C697) details a typical maintenance schedule for an attenuation basin as seen in Figure 6 below.

Maintenance schedule	Required action	Frequency
Regular maintenance	Litter and debris removal.	Monthly.
	Grass cutting – for spillways and access routes.	Monthly (during growing season), or as required.
	Grass cutting – meadow grass in and around basin.	Half yearly (spring - before nesting season, and autumn).
	Manage other vegetation and remove nuisance plants.	Monthly (at start, then as required).
	Tidy all dead growth before start of growing season.	Annually.
	Remove sediment from inlets, outlet and forebay.	Annually (or as required).
	Manage wetland plants in outlet pool – where provided.	Annually.
Occasional maintenance	Re-seed areas of poor vegetation growth.	Annually, or as required.
	Prune and trim trees and remove cuttings.	2 years, or as required.
	Remove sediment from forebay, when 50% full and from micropools if volume reduced by > 25%.	3 – 10 years (or as required).
Remedial actions	Repair of erosion or other damage by re-seeding or re-turfing.	As required.
	Realignment of rip-rap.	As required.
	Repair/rehabilitation of inlets, outlets and overflows.	As required.
	Re-level uneven surfaces and reinstate design levels.	As required.
Monitoring	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly/after large storms.
	Inspect banksides, structures, pipework, etc for evidence of physical damage.	Monthly/after large storms.
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Half yearly.
	Check penstocks and other mechanical devices.	Half yearly.

Figure 6 – Typical Maintenance Schedule for an Attenuation Basin

9. SUMMARY AND RECOMMENDATIONS

- There are a number of field drains on the site and the Tattenhoe Brook is located to the north of the site and a tributary of the River Ouzel is located to the south of the site.

- The majority of the site is located within Flood Zone 1 of the EA Flood Map and therefore is at low risk of fluvial flooding. Flood Zone 3 encroaches onto the north western corner of the site and therefore this area is categorised as being at high risk of flooding. However the EA have no records of flooding at the site and no property will be located outside of Zone 1.

- The Environment Agency and Milton Keynes Council have been consulted on the proposal. They are keen for the development to encompass a range of sustainable drainage systems as part of the surface water drainage strategy.

- It is considered that the site passes the Sequential Test as all built development will be located within Flood Zone 1.

- The existing greenfield runoff rates have been calculated for each of the six sub-catchments within the site using the Institute of Hydrology 124 Report method.

- The surface water drainage system has been designed in outline to control runoff up to the 1 in 100 year event plus an allowance of 30 % for climate change. The attenuation calculation also includes a 20 % allowance for runoff from the areas of public open space reaching the drainage system. The proposed surface water system makes full use of a wide range of sustainable drainage devices in line with the SuDS Manual C697.

- Permeable paving should be used, where practical, on driveways within the residential area, in car parking areas and within the internal road work to provide a level of source control at the site.

- The runoff from sub-catchments 1-3 will be conveyed to a three tier cascading pond system which will provide attenuation prior to discharge into the Tattenhoe Brook at the north of the site. The runoff will discharge at rates lower than greenfield to the Tattenhoe Brook therefore the proposal provides betterment in terms of surface water drainage.

- The runoff from sub-catchments 4-6 will be conveyed to attenuation basins to the south of the site. The basins will attenuate the runoff which will discharge at restricted rates into the field drains at the south of the site.

- Further information on the oil and gas pipelines will be required for the detailed design stage.

- The proposed surface water drainage strategy will require regular maintenance as detailed in the CIRIA SuDS Manual (C697).