Marina at Boddington Road

Claydon

Cherwell District

Flood Risk Assessment

May 2018

EAS

Document History

JOB NUMBER: **1319**

DOCUMENT REF: **Marina at Boddington Road, Claydon, FRA**

REVISIONS: **Final 2**

Revision	Comments	By	Checked	Authorised	Date
Draft 1	For client comment	EE	SA	SA	16/11/2017
Draft 2	Including SB Rice comments	SA		SA	27/11/2017
Draft 3	Minor revisions	SA		SA	20/12/2017
Final	Revised masterplan and including comments	SA	LW	SA	26/04/2018
Final 2	Minor revisions	SA	LW	SA	09/05/2018

Unit 23
The Maltings
Stanstead Abbotts
Hertfordshire SG12 8HG
Tel 01920 871 777

EAS

www.eastp.co.uk

Contents

1 Introduction

1.1 This Flood Risk Assessment has been prepared in support of a planning application for a 250 berth marina on the Oxford canal at land to the east of Boddington Road, Claydon, Banbury, OX17 1TD to include a clubhouse. A location plan is included as **Appendix** A and the site layout is included as **Appendix B.**

1.2 The grid reference for the site is **446095, 251164**

1.3 The contents of this FRA are based on the advice set out in The National Planning Policy Framework (NPPF) and the Technical Guidance to the NPPF, published March 2012, and the Planning Practice Guidance (PPG), published March 2014.

1.4 This report is based on the following data: Environment Agency Flood Maps, BGS geological information, OS mapping, topographic survey, and outline drainage calculations.

1.5 This FRA is set out as follows:

- Section 2 – outlines current policy guidance.
- Section 3 – site description, including site levels, proximity to watercourses etc.
- Section 4 – outlines potential sources of flooding.
- Section 5 – proposes flood risk mitigation measures.
- Section 6 – describes the existing site hydrology and outlines a surface water drainage strategy.
- Section 7 – concludes the study.

2 Policy Guidance

National Policy

2.1 The contents of this FRA are based on the advice set out in The National Planning Policy Framework (NPPF) published March 2012 and the Planning Practice Guidance (PPG), published March 2014.

2.2 According to the Canal and Rivers Trust, The NPPF, defines canals as 'open space' and should also be regarded as green infrastructure. Docks, Marinas and wharfs are defined as 'Water compatible development' in Table 2 of Planning Practice Guidance: Flood Risk and Coastal Change and therefore is compatible with all flood zones.

2.3 The Planning Practice Guidance NPPF Table 1 (Paragraph 065) defines each Flood Zone along with appropriate land use and FRA requirements. The flood zones are defined as follows:

- *Flood Zone 1 – This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river flooding (<0.1%).*
- *Flood Zone 2 – This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding.*
- *Flood Zone 3a – This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), and for tidal flooding at least a 0.5% annual probability of flooding from tidal sources.*
- *Flood Zone 3b – This zone comprises land where water has to flow or be stored in times of flood.*

2.4 A copy of the Environment Agency's Flood Map for Planning is included in **Appendix C**. The mapping shows that the majority of the site is located within Flood Zone 1, at 'Low' risk of fluvial or tidal flooding. Flood Zone 1 indicates the annual probability of flooding to be less than 1 in 1000. Approximately 15% of the site falls within Flood Zone 3 (High Risk) due to a watercourse to the north of the site.

2.5 The above national policy guidance has been considered within this site-specific FRA, including a proposed SUDS drainage strategy to ensure that the development would not increase the risk of flooding to the site or elsewhere.

Local Policy

Cherwell District Council Adopted Local Plan 2011- 2031

2.6 The Local Plan sets out broadly how the District will grow and change in the period up to 2031. The Local Plan sets out the long term spatial vision for the District and contain policies to help deliver that vision. The plan was originally adopted in July 2015, but was reissued in December 2016 as Policy Bicester 13: Gavray Drive was re-adopted.

2.7 The following Local Plan policies have been considered in this report:

Policy ESD 6: Sustainable Flood Risk Management

2.8 *The Council will manage and reduce flood risk in the District through using a sequential approach to development; locating vulnerable developments in areas at lower risk of flooding. Development proposals will be assessed according to the sequential approach and where necessary the exceptions test as set out in the NPPF and NPPG.*

2.9 *Development will only be permitted in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding.*

2.10 *In addition to safeguarding floodplains from development, opportunities will be sought to restore natural river flows and floodplains, increasing their amenity and biodiversity value. Building over or culverting of watercourses should be avoided and the removal of existing culverts will be encouraged.*

2.11 *Existing flood defences will be protected from damaging development and where development is considered appropriate in areas protected by such defences it must allow for the maintenance and management of the defences and be designed to be resilient to flooding.*

2.12 *Site specific flood risk assessments will be required to accompany development proposals in the following situations:*

- *All development proposals located in flood zones 2 or 3*
- *Development proposals of 1 hectare or more located in flood zone 1*
- *Development sites located in an area known to have experienced flooding problems*
- *Development sites located within 9m of any watercourses.*

2.13 *Flood risk assessments should assess all sources of flood risk and demonstrate that:*

- *There will be no increase in surface water discharge rates or volumes during storm events up to and including the 1 in 100 year storm event with an allowance for climate change (the design storm event)*
- *Developments will not flood from surface water up to and including the design storm event or any surface water flooding beyond the 1 in 30 year storm event, up to and including the design storm event will be safely contained on site.*
- *Development should be safe and remain operational (where necessary) and proposals should demonstrate that surface water will be managed effectively on site and that the development will not increase flood risk elsewhere, including sewer flooding.*

2.14 *Where a site is in close proximity of the Oxford Canal, the Level 3 FRA should include breach analysis.*

Policy ESD 7: Sustainable Drainage Systems (SuDS)

2.15 *All development will be required to use sustainable drainage systems (SuDS) for the management of surface water run-off. Where site specific Flood Risk Assessments are required in association with development proposals, they should be used to determine how SuDS can be used on particular sites and to design appropriate systems.*

2.16 *In considering SuDS solutions, the need to protect groundwater quality must be taken into account, especially where infiltration techniques are proposed. Where possible, SuDS should seek to reduce flood risk, reduce pollution and provide landscape and wildlife benefits. SuDS will require the approval of Oxfordshire County Council as LLFA and SuDS Approval Body, and proposals must include an agreement on the future management, maintenance and replacement of the SuDS features*

Policy ESD 16: The Oxford Canal

2.17 *We will protect and enhance the Oxford Canal corridor which passes south to north through the District as a green transport route, significant industrial heritage, tourism attraction and major leisure facility through the control of development.*

2.18 *The length of the Oxford Canal through Cherwell District is a designated Conservation Area and proposals which would be detrimental to its character or appearance will not be permitted. The biodiversity value of the canal corridor will be protected.*

2.19 *We will support proposals to promote transport, recreation, leisure and tourism related uses of the Canal where appropriate, as well as supporting enhancement of the canal's active role in mixed used development in urban settings.*

2.20 *We will ensure that the towpath alongside the canal becomes an accessible long distance trail for all users, particularly for walkers, cyclists and horse riders where appropriate.*

2.21 *Other than appropriately located small scale car parks and picnic facilities, new facilities for canal users should be located within or immediately adjacent to settlements.*

2.22 *The Council encourages pre-application discussions to help identify significant issues associated with a site and to consider appropriate design solutions to these and we will seek to ensure that all new development meets the highest design standards*

Cherwell and West Oxfordshire Level 1 Strategic Flood Risk Assessment (2009)

2.1 The Level 1 Strategic Flood Risk Assessment (SFRA) was published in 2009

2.2 The SFRA states that *"The Oxford Canal runs parallel to the River Cherwell and merges with it at two points within the District, sharing the same channel for 1.5km within the middle reach. A series of locks control water levels along the Oxford Canal with a series of overflow weirs ensuring any excess flows in the canals are diverted to the River Cherwell. During flood conditions the River Cherwell and the Oxford Canal are largely co-joined and therefore comments regarding the surcharging of the canal and the scope for flood protection and compensation are as for main rivers."*

2.3 It is noted that the River Cherwell is not adjacent to the development site at this location, as the tributary of the High Furlong Brook and River Cherwell is at least 2km downstream of the site.

2.4 The SFRA also states that canals are considered to be controlled water bodies so flood risk is deemed to be minimal unless overtopped in storm conditions. There is, however, a residual risk of structural failure.

2.5 For potential development sites located adjacent to canals, the residual risk of flooding should be identified during a site specific FRA. Should a major development area be located next to canals, then consideration should be given to undertaking a Level 2 SFRA study for that area. This study would determine the residual risks of flooding from canals.

Oxfordshire County Council Preliminary Flood Risk Assessment (2011)

2.6 PFRAs are a broadscale assessment of flood risk from local sources (surface runoff, groundwater and ordinary watercourses) across the county. They utilise existing available data gathered from a variety of sources.

2.7 Some overtopping and breaching of the Oxford Canal occurred during the July 2007 event. Map 4 of the PFRA shows Canal flooding in July 2007. Five breaches are mapped to the east of Claydon although none to the north. It was noted that no predictive information was available specifically on future flood risk from canals and that canal flooding is unlikely to occur or have adverse effects independently from a main river flooding event on the River Cherwell.

3 Site Description

3.1 The planning application for a 250 berth marina on the Oxford canal at land to the east of Boddington Road, Claydon, Banbury, OX17 1TD to include a clubhouse. A location plan is included as **Appendix A** and a site layout plan is included as **Appendix B.**

3.2 The grid reference for the site is **446095, 251164**

3.3 The site is bounded by Boddington Road to the west and the Oxford Canal to the south. To the north lies a copse and a tributary of the High Furlong Brook with further agricultural fields to the north. To the east (within the site boundary) lies Glebe Farm and further agricultural land. Access to the site will be from Boddington Road.

3.4 The site area is 17.79ha. The marina basin covers an area of 4ha and with average depth of 1.5m, this results an approximate basin volume of 60,000m^3.

3.5 A proposed irrigation lake is proposed as part of the development proposals to the east of the marina, which covers an area of 2.16ha and has an average depth of 2.5m, this results in an approximate lake volume of 54,000m^3.

Local Watercourses

3.6 The nearest watercourse is a tributary of the High Furlong Brook running parallel to the site boundary flowing in an easterly direction from the Wormleighton Reservoir. The watercourse turns south at the north east extent of the site to form the boundary of the land parcel where it becomes a Main River. The watercourse flows southwards under Main Street close to Claydon Locks on the Oxford Canal before joining the High Furlong Brook approximately 2.5km downstream of the site.

3.7 Further north of the site, the Canal Feeder from Boddington Reservoir flows in a south westerly direction, flowing under Boddington Road approximately 150m north of the site in the opposite direction to the ordinary watercourse referred to above.

Site Levels

3.8 The topographical survey (**Appendix D**) shows the site generally falls in a northerly direction away from the Oxford Canal. The water level in the canal is recorded as 114.99m AOD with site levels at the northern boundary of the site ranging between 112m in the west of the and 108m in the east.

3.9 The invert to the ditch at the north of the site is in the region of 107.9m AOD to 106.5m AOD and levels indicate that the watercourse is some 2m deep along the northern boundary.

Geology

3.10 With reference to the British Geological Survey online mapping, the site is located within an area of Charmouth Mudstone with no superficial deposits. To the north, within the floodplain of the ordinary watercourse, alluvial deposits of clay, silt, sand and gravel are recorded.

Existing Site Drainage

3.11 The site is currently undeveloped and therefore it is unlikely that any formal drainage system is in place. It is assumed that rainfall falling onto the site drains northwards towards the watercourse

4 Potential Sources of Flooding

Fluvial

4.1 A copy of the Environment Agency's Flood Map for the area is included in **Appendix C**. The mapping shows the majority of the site to be in Flood Zone 1, at 'Low' risk of flooding from fluvial or tidal sources. Areas in Flood Zone 1 have a less than 1 in 1000 probability of flooding each year. **Appendix E** is an overlay of the proposed site layout with the EA flood zones.

4.2 The Environment Agency has confirmed that there is no detailed modelling available for this watercourse, and as such a flood depth cannot be determined.

4.3 The Risk of Surface Water mapping shows a similar trend of water leaving the watercourse and this is discussed further below. Should flooding occur from this watercourse, it is likely that water would be contained within a natural floodplain to the north of the site rather than flood the site.

4.4 A small area along the northern boundary of the site is shown to be in Flood Zone 3, limited to the access bellmouth and a small part of the access roads only; this area covers 2596sqm and is illustrated in Appendix E. As the site access is proposed to be raised above existing levels to achieve a suitable road alignment into the site from the public highway, there will be a small volume of floodplain volume lost as a result of the development. By raising the access this will provide adequate mitigation to maintain safe access and egress from the site should an extreme rainfall event occur.

4.5 An estimate of the lost flood volume has been calculated based on the extent of Flood Zone 3 and an average depth of land raising of 2m to be approximately 5192m^3. As part of the application an irrigation lake is proposed to serve the surrounding farm land, which will be created from the excavated material required to build up the northern bank of the marina.

4.6 The total area of the irrigation lake is 2.16ha with an approximate volume of 54,000m^3. It is evident that the lost volume of 5192m^3, can therefore easily be replaced within the irrigation reservoir. The reservoir borders Flood Zone 3 which will ensure that the flood waters can easily enter the reservoir. Based on the area of the lake an additional 240mm of storage above the level of the irrigation storage will be required to accommodate the floodplain storage (5192m^3 / 21,600sqm).

4.7 In terms of the guidance set out in the NPPF a Marina is defined as a water compatible development so would be acceptable in FZ3.

4.8 Further details on mitigation measures are provided in Section 5.

Surface Water

4.9 The Risk from Surface Water mapping and an overlay with the proposed site layout is included as

Appendix F. As with the Flood Map for Planning, it shows the access road and parking to be at risk of surface water flooding in the 'low' and 'medium' risk scenarios, but the extent is greater as this risk is from overland flow towards the watercourse rather than flooding from the watercourse.

4.10 Due to the water compatible nature of the development, the hazard caused by this flood risk in not considered to be substantial. As described above the proposed access will be raised approximately 2m above the existing ground levels to meet the levels along the public highway and this will provide adequate mitigation to maintain safe access and egress from the site should an extreme rainfall event occur at a time where the watercourse is already at or over capacity.

4.11 **Appendix G** contains an overlay of the surface water flood map with the proposed site layout. It can be seen that the 'low risk' flood area extends to parts of the proposed clubhouse. The development proposals include land raising within this part of the site to achieve the water level within the adjacent marina basin and as a result the buildings will raised well in excess of a level likely to experience flooding as a result of overland flow.

Sewer

4.12 There are no surface water or foul sewers in the vicinity of the site. The risk of flooding from sewers is therefore **negligible.**

Groundwater

4.13 Due to the nature of the development it is unlikely that groundwater flooding will be problematic, should it occur.

Artificial Sources

4.14 Cherwell District Council Adopted Local Plan 2011- 2031, Policy ESD6, requires that 'where a site is in close proximity of the Oxford Canal, the Level 3 FRA should include breach analysis'. The required breach analysis would identify whether the canal would pose a risk to a new development site, to understand what mitigation measures may be required to protect the development.

4.15 In the case of the proposed marina the development will be hydraulically linked to the canal and is water compatible, as such the risks to the marina from a breach of the canal are low and the impact of a breach would be likely to be limited to the low lying parking off the access road on the northern side of the marina basin. As a result a full breach analysis of the canal is not required, however the risk have been considered further below.

4.16 Oxford Canal is the only canal in the county. It enters Oxfordshire in the very northern tip of the county near Claydon, and extends southwards through Banbury and into central Oxford. The Canal and Rivers Trust confirmed that they have no records of overtopping or flooding at this location (**Appendix H**).

4.17 Most canal water levels are managed around a normal operating zone (NOZ) which is typically +/- 200mm, but water levels outside of the NOZ may be experienced at times as detailed on the Canal Trust website here: https://canalrivertrust.org.uk/business-and-trade/inland-marina-development-guide/feasibility/water-levels-and-flood-risk.

4.18 In its current form the site is shown to be at a lower elevation than the Oxford Canal and as such the site is currently at risk if a breach was to occur on the bank of the canal, however once the marina is constructed maintaining the same water level as the canal, then this risk will be reduced to the lower lying access tracks and car parking to the north of the basin.

4.19 Breach modelling of the canal in this location was not available, however a breach of the nearby Wormleighton Reservoir is included in the long term flood mapping at the gov.uk website, would be a good proxy to the likely area at risk of flood event occurring as a result of a breach of the canal, being located only 1.2km to the west of the development.

4.20 The Reservoir flood map shows a very similar extent to the Risk of Flooding from Surface Water mapping, which as discussed above is only likely to impact upon the lower lying area to the north of the basin (following the proposed earthworks to construct the marina). The risk to the marina development from a breach from the canal is therefore not considered to be significant particularly in light of the water compatible nature of the development and would not require any further mitigation outside the construction of the raised marina structure.

Breach of the Marina

4.21 As the marina volume is over 25,000m^3 the design and construction is required to be overseen by a qualified Panel Engineer as per the requirements of the Reservoirs Act 1975. The risk of a breach of the marina is therefore highly unlikely to occur.

4.22 In the extremely rare event a breach occurred, as in the case of a breach of the canal the EA flood mapping for the nearby Wormleighton Reservoir located 1.2km west of the site would provide a useful proxy of the maximum extent of the impact downstream of the site.

4.23 The EA Reservoir Flood Map illustrates that a breach event at the Wormleighton Reservoir would lead to flooding along the route of the High Furlong Brook, through an area of agricultural fields; and would therefore have a much reduced impact when compared to a more urban environment. The nearest settlement identified as being at risk in the Reservoir flood map is Clattercote (approximately 3km downstream); however from a review of the local topography the risk of reservoir flooding shown to Clattercote is appears to be from the Clattercote reservoir located in the high ground to the west of the hamlet and not the Wormleighton Reservoir.

4.24 It can therefore be seen from the EA Reservoir Flood Map that in the rare event of a breach event at the Wormleighton Reservoir or by proxy a breach event at the proposed Claydon Marina, that there would

not be a risk to any local settlements in the local area.

4.25 In the event of structural failure of the Oxford Canal or the marina, it is envisaged that the marina would be isolated at the narrowest point of the entrance by the use and incorporation of stop planks, limiting the volume of water that could be discharged downstream.

5 Mitigation Measures

5.1 A review of the Environment Agency's Flood Map for the area (Appendix C) indicated the majority of the site to be in Flood Zone 1, at 'Low' risk of flooding from fluvial or tidal sources. As described in Section 4 a small area of the site including the proposed access falls within Flood Zone 3 and it is proposed to be raise the bellmouth and part of the access road above the existing site levels. This will provide safe access and egress to the site at the time of an extreme rainfall event but will require floodplain compensation.

5.2 An estimate of the lost flood volume has been calculated based on the extent of Flood Zone 3 and an average depth of land raising of 2m to be approximately 5192m^3. As part of the application an irrigation lake is proposed to serve the surrounding farm land, which will be created from the excavated material required to build up the northern bank of the marina.

5.3 The total area of the irrigation lake is 2.16ha. It is evident that the lost volume of 5192m^3, can easily be replaced within the irrigation reservoir. The reservoir borders Flood Zone 3 which will ensure that the flood waters can easily enter the reservoir. Based on the area of the lake an additional 240mm of storage above the level of the irrigation storage will be required to accommodate the floodplain storage.

5.4 The Risk from Surface Water mapping also shows the access road and parking to be at risk of surface water flooding in the 'low' and 'medium' risk scenarios, but the extent is greater as this risk is from overland flow towards the watercourse rather than flooding from the watercourse. As described above the proposed access will be raised approximately 2m above the existing ground levels to meet the levels along the public highway and this will provide adequate mitigation to maintain safe access and egress from the site.

5.5 The surface water flood map also indicated that the 'low risk' surface water flood area extends to parts of the proposed clubhouse. The development proposals include land raising within this part of the site to achieve the water level within the adjacent marina basin and as a result the buildings will be raised well in excess of a level likely to experience flooding as a result of overland flow.

5.6 As the proposals involve excavation next to the Oxford Canal, care must be taken to avoid weakening the banks of the canal. It is noted that the Water Framework Directive (WFD) includes artificial waterbodies such as canals and therefore hard engineering of the banks should be kept to a minimum.

5.7 The marina will be higher than the land to the north and therefore is considered to be an impounding structure. As a volume of greater than 25,000m^3 is impounded the marina will fall under the Reservoirs Act and require registration with the Environment Agency and review by a qualified Panel Engineer. A breach of the marina is considered extremely unlikely and, as considered earlier in the section, would likely follow a similar pattern of flooding to the Wormleighton Reservoir.

5.8 A flood alert is available for the channel downstream of the Wormleighton Reservoir and therefore no additional flood alerts would be required. Users of the marina should also check for Strong Stream Warnings. A site specific flood warning and evacuation plan is recommended specifically if signs of any damage or cracking to any retaining structure at the marina is observed.

6 Outline Drainage Strategy

Relevant SUDS Policy

6.1 The NPPF states within Flood Zone 1, *"developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques (SUDS)".*

6.2 SUDS mimic the natural drainage system and provide a method of surface water drainage which can decrease the quantity of water discharged, and hence reduce the risk of flooding. In addition to reducing flood risk, these features can improve water quality and provide biodiversity and amenity benefits.

6.3 The SUDS management train incorporates a hierarchy of techniques and considers all three SUDS criteria of flood reduction, pollution reduction, and landscape and wildlife benefit. In decreasing order of preference, the preferred means of disposal of surface water runoff is:

- Discharge to ground.
- Discharge to a surface water body.
- Discharge to a surface water sewer.
- Discharge to a combined sewer.

6.4 The philosophy of SUDS is to replicate as closely as possible the natural drainage from a site pre-development and to treat runoff to remove pollutants, resulting in a reduced impact on the receiving watercourses. The benefits of this approach are as follows:

- Reducing runoff rates, thus reducing the flood risk downstream.
- Reducing pollutant concentrations, thus protecting the quality of the receiving water body.
- Groundwater recharge.
- Contributing to the enhanced amenity and aesthetic value of development areas.
- Providing habitats for wildlife in developed areas, and opportunity for biodiversity enhancement.

Pre-development Runoff Rate

6.5 The existing site comprises 100% Greenfield area, given that it is undeveloped. Greenfield runoff rate calculations have been carried out using the WinDes MicroDrainage software. The ICP SUDS Mean Annual Flood method was used. Greenfield runoff rates at the site for QBAR, 1 year, 30 year and 100 year events are summarised below per hectare.

- QBAR Rural 4.4 l/s/ha
- QBAR Urban 4.4 l/s/ha
- Q1 year 3.6 l/s/ha
- Q30 years 8.6 l/s/ha
- Q100 years 11.3 l/s/ha

6.6 The WinDes runoff rates and calculations are included at **Appendix I**.

Site-Specific SUDS

6.7 The various SUDS methods need to be considered in relation to site-specific constraints. Several SUDS options are available to reduce or temporarily hold back the discharge of surface water runoff. Table 1 outlines the constraints and opportunities to each of the SUDS devices in accordance with the hierarchical approach outlined in The SUDS Manual CIRIA C753i. It also indicates what could and could not be incorporated within the development, based upon site-specific criteria.

Device	Description	Constraints / Comments	Appropriate
Living roofs (source control)	Provide soft landscaping at roof level which reduces surface water runoff.	Could be incorporated if appropriate	Possibly
Infiltration devices & Soakaways (source control)	Store runoff and allow water to percolate into the ground via natural infiltration.	Unlikely to be viable due to mudstone geology	No
Pervious surfaces (source control)	Storm water can infiltrate through the surface into a storage layer, from which it can either infiltrate and/or slowly release to sewers.	Could be used to provide a stage of treatment and as attenuation	Possibly
Rainwater harvesting (source control)	Reduces the annual average rate of runoff from the Site by reusing water for non-potable uses e.g. toilet flushing, recycling processes.	Could be used at this site	Possibly

Swales (permeable conveyance)	Broad shallow channels that convey / store runoff, and allow infiltration (ground conditions permitting).	May be appropriate for the development	Possibly
Filter drains & perforated pipes (permeable conveyance)	Trenches filled with granular materials (which are designed to take flows from adjacent impermeable areas) that convey runoff while allowing infiltration.	Unlikely to be viable due to poor infiltration rates	No
Infiltration basins (end of pipe treatment)	Depressions in the surface designed to store runoff and allow infiltration.	Unlikely to be viable due to poor infiltration rates	No
Wet ponds & constructed wetlands (end of pipe treatment)	Provide water quality treatment & temporary storage above the permanent water level.	May be appropriate for the development	Possibly
Attenuation Underground (end of pipe treatment)	Oversized pipes or geo-cellular tanks designed to store water below ground level.	Surface attenuation would be preferable for water quality treatment and ease of maintenance, however oversized pipes may be used	Possibly

Table 1: Site-Specific Sustainable Drainage Techniques

Proposed SuDS Drainage Strategy

6.8 Given the presence of mudstone beneath the site, infiltration drainage methods are highly unlikely to be sustainable so an attenuation strategy will be adopted which will discharge to the watercourse to the north.

6.9 The proposed site layout includes permeable gravel surfaces on the main car park and access tracks around the site which would not require a formal drainage system, but also includes a large concrete yard and access road leading from the public highway, a club house. Measuring off the proposed layout, the total impermeable area to be accommodated by the sustainable drainage system is 0.64ha.

6.10 However of this area 0.335ha is located within the marina basin clay liner is proposed to be directed by the designed surface gradients towards the marina basin at an uncontrolled rate. The reason for the uncontrolled runoff to the Marina from these areas is that it not possible to perforate the clay liner with pipework. The majority of the area to be drained to the marina basin is made up of the proposed maintenance / service area and clubhouse buildings.

6.11 It is proposed therefore that of the remaining 0.305ha impermeable areas that can be collected in via a sewer network will be drained to the watercourse to the north of the site, and that the level of surface water runoff will be no greater than the 100 year greenfield runoff rate for the impermeable area of 0.305ha of 3.7/s (11.3l/s/ha x 0.305ha).

6.12 A proposed SuDS layout is contained in **Appendix J** and the WINDES drainage model in **Appendix K**. It

is proposed that a series of surface water sewers collect surface water runoff from the yard and road areas; and this is directed to a swale located on the northern boundary of the site. The WINDES calculations indicate that to accommodate the 100 year plus 40% climate change storm event that a swale sized 32m long, with a 1.5m base and 1:2.2 sides will be required. It is proposed that the discharge rate to the watercourse will be limited to 3.7l/s by means of an orifice plate in a final control chamber.

6.13 It is also proposed due to the potential for standing vehicles on the yard that a petrol interceptor be provided to remove hydrocarbons prior to the outfall to the swale. The swale itself will also provide a further means of water quality treatment.

Maintenance of Development Drainage

6.14 It is proposed that the maintenance of the surface water drainage systems will be the responsibility of the site owner/manager and will not be offered for adoption. It will be the responsibility of the owner/manager to inspect the petrol interceptor on a regular basis and empty when necessary. It is also the responsibility of the manager/owner to maintain the sewer network and swale serving the site and ensure there are no blockages in the drainage system which would result in flooding.

6.15 Some regular maintenance tasks for swales taken from The SUDS Manual (CIRIA, C753) have been included in Table 2 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).
	Inspect inlets, outlets and overflows for blockages and clear if required.	Monthly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies.	Half yearly
Occasional Maintenance	Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent	Annually

	vegetation where possible.	
	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 re-instate design levels.	As required.
	Scarify and spike topsoil level 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 or 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 surface 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.

Table 2: Maintenance tasks and frequencies for swales (The SUDS Manual C753, CIRIA)

7 Residual Flood Risks & Conclusions

7.1 This FRA is to support a planning application for a 250 berth marina on the Oxford Canal at land to the east of Boddington Road, Claydon, Banbury, OX17 1TD, to include a clubhouse. An irrigation lake is also proposed as part of the application.

7.2 The site is bounded by Boddington Road to the west and the Oxford Canal to the south. To the north lies a copse and a tributary of the High Furlong Brook with further agricultural fields to the north. To the east (within the site boundary) lies Glebe Farm and further agricultural land.

7.3 A review of the Environment Agency's Flood Map for the area (Appendix C) indicated that the majority of the site to be in Flood Zone 1, at 'Low' risk of flooding from fluvial or tidal sources. As described in Section 4 a small area of the site including the proposed access falls within Flood Zone 3 and it is proposed to be raise the bellmouth and part of the access road above the existing site levels. This will provide safe access and egress to the site at the time of an extreme rainfall event but will require floodplain compensation. It is proposed that the floodplain compensation be provided in the proposed irrigation lake located in the east of the site.

7.4 The Risk from Surface Water mapping also shows the access road and parking to be at risk of surface water flooding in the 'low' and 'medium' risk scenarios, but the extent is greater as this risk is from overland flow towards the watercourse rather than flooding from the watercourse. As described above the proposed access will be raised approximately 2m above the existing ground levels to meet the levels along the public highway and this will provide adequate mitigation to maintain safe access and egress from the site.

7.5 The surface water flood map also indicated that the 'low risk' surface water flood area extends to parts of the proposed clubhouse. The development proposals include land raising within this part of the site to achieve the water level within the adjacent marina basin and as a result the buildings will raised well in excess of a level likely to experience flooding as a result of overland flow.

7.6 The marina will be higher than the land to the north and therefore is considered to be an impounding structure. If a volume of greater than 25,000m^3 is impounded the marina will fall under the Reservoirs Act and require registration with the Environment Agency and review by a qualified Panel Engineer. A breach of the marina is considered extremely unlikely and would likely follow a similar pattern of flooding to the Wormleighton Reservoir.

7.7 A flood alert is available for the channel downstream of the Wormleighton Reservoir and therefore no additional flood alerts would be required. Users of the marina should also check for Strong Stream Warnings. A site specific flood warning and evacuation plan is recommended specifically if signs of any damage or cracking to any retaining structure at the marina is observed.

7.8 Given the presence of mudstone beneath the site infiltration drainage methods are highly unlikely to be sustainable at this site, so an attenuation strategy will be adopted, which will discharge to the watercourse to the north. It is proposed that the discharge rate from site will be no greater than the 100 year greenfield runoff rate.

7.9 A proposed SuDS design for the area of the site outside of the basin clay liner is proposed. The SuDS measures include a series of surface water sewers to collect surface water runoff from the yard and road areas, to be directed to a swale located on the northern boundary of the site. The WINDES calculations indicate that to accommodate the 100 year plus 40% climate change storm event that a swale sized 32m long, with a 1.5m base and 1:3 sides will be required. It is proposed that the discharge rate to the watercourse to the north of the development will be limited to 3.7l/s by means of an orifice plate in a final control chamber.

7.10 It is proposed that the maintenance of the surface water drainage systems will be the responsibility of the site owner/manager and will not be offered for adoption. It will be the responsibility of the owner/manager to inspect the petrol interceptor on a regular basis and empty when necessary. It is also the responsibility of the manager/owner to maintain the sewer network and swale serving the site and ensure there are no blockages in the drainage system which would result in flooding.

7.11 **We believe that the development proposals comply with the guidance provided by the NPPF and that no reason exists to object to the proposals in terms of flood risk or drainage.**