Flood Risk Assessment

July 2019

EAS

Marina at Boddington Road
Claydon
Cherwell District

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1 Introduction

1.1 This Flood Risk Assessment has been prepared in support of a planning application for a 192 berth marina and clubhouse on the Oxford Canal at land to the east of Boddington Road, Claydon, Banbury, OX17 1TD. In addition there will be a car park and further parking spaces around the site, and a new lake. 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 February 2019, and the Planning Practice Guidance (PPG), published March 2014.

1.4 An earlier version of this FRA was sent to the Environment Agency (EA) and Oxfordshire County Council (OCC) for a review. The EA and OCC comments are included as **Appendix C** of this report and the main points commented on are as follows:

- The proposed development in incompatible with the flood zone.
- The FRA fails to demonstrate 1) The loss of floodplain storage within the 1% (1 in 100) flood extent with an appropriate allowance for climate change caused by the proposed development can be mitigated for. 2) Absence of detailed modelling.
- Use of non-mains foul drainage system in a publicly sewered area. No justification has been provided for this method of foul sewage.
- Swale is located in Flood Zone 3 and a concern was raised whether this could be inundated by floodwater and that groundwater or fluvial flows could enter it.
- The outfall of the SuDS system appears to be located in Flood Zone 3, and a concern was raised whether the outfall would operate in flood conditions as well as normal conditions.
- Parts of the site include proposed hardstanding gravel areas with no provision for drainage. It is unlikely that surface water will permeate into the gravel car park areas. No construction details were provided.
- The FRA states that the proposed clubhouse, parking areas and access will have levels well in excess of existing levels. However, there appears little description of the existing flood levels at the site and potentially whether exceedance flooding may be diverted or directed onto neighbouring property.

1.5 These issues have been commented on and addressed in this report.

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

1.7 This FRA is set out as follows:

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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 report.

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2 Policy Context

Introduction

2.1 This section sets out the policy context. The contents of this FRA are based on the advice set out in the National Planning Policy Framework (NPPF) published in February 2019 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.

National Planning Policy Framework

2.3 Paragraph 164 footnote 50 of the NPPF states:

"A site-specific flood risk assessment should be provided for all developments in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use."

2.4 The flood zones are defined as:

- 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 a 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.

2.5 Paragraph 155 discusses the suitability of development location, particularly with regards to future risks induced by climate change:

"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere".

2.6 Paragraph 156 of the National Planning Policy Framework (NPPF) sets out how:

"Strategic policies should be informed by a strategic flood risk assessment, and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other

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relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards".

2.7 A copy of the Environment Agency's Flood Map for Planning is included in **Appendix D**. The mapping shows that the site is located wholly 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. Flood Zones 2 and 3 lie to the north of the site.

2.8 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

2.9 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, which was re-adopted.

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

Policy ESD 6: Sustainable Flood Risk Management

2.11 Policy ESD 6 states: "*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.*

2.12 *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.*

2.13 *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.*

2.14 *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.*

2.15 *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*

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- *Development sites located within 9m of any watercourses.*

2.16 *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."*

2.17 Policy ESD 6 also states that 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)

2.18 Policy ESD 7 states: *"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.*

2.19 *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

2.20 Policy ESD 16 states: *"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.*

2.21 *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.*

2.22 *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.*

2.23 *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.*

2.24 *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.*

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2.25 *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, updated May 2017)

2.26 The Level 1 Strategic Flood Risk Assessment (SFRA) was published in 2009 and updated in May 2017.

2.27 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."*

2.28 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.

2.29 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.

2.30 The SFRA notes that a failure on the nearby Clattercote Reservoir (which is approximately 2.60km to the south) could inundate the floodplains of the Oxford Canal and cause flooding in Cropredy. Reference to the EA online mapping suggests the resulting flood extent is very similar to the fluvial flood extent at the site.

2.31 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)

2.32 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.

2.33 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.

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3 Site Description

3.1 The planning application for a 192 berth marina and clubhouse on the Oxford canal at land to the east of Boddington Road, Claydon, Banbury, OX17 1TD. In addition there are 142 parking spaces proposed around the site. A lake has also been included in the scheme to the east of the proposed marina. 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 4.00ha and with average depth of 1.50m, this results an approximate basin volume of 60,000m^3.

3.5 An 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 E**) 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.

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Existing 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

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4 Potential Sources of Flooding

Fluvial

4.1 A copy of the Environment Agency's Flood Map for the area is included in **Appendix D.** The mapping shows 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.

4.2 To the immediate north is the floodplain of the watercourse and Flood Zones 2 and 3. The proposed development site is outside of Flood Zones 2 and 3.

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

4.4 The Risk of Surface Water mapping shows 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.

Proposed Uses and Compatibility with Flood Zone

4.5 The EA commented that the proposed development is incompatible with the flood zone. Following this, the whole development has been located outside of Flood Zones 2 and 3 and is wholly within Flood Zone 1, where all development types are acceptable.

4.6 The Floodmap for Planning has been overlaid with the proposed site layout in **Appendix F**. This demonstrates that no part of the proposed development is within Flood Zones 2 or 3. Therefore, the proposed uses are considered to be suitably located.

Floodplain Compensation

4.7 The EA commented that the previous FRA failed to demonstrate the loss of floodplain storage for the 1 in 100 year (+35%CC) event could be mitigated for. As the proposed development has now been entirely located in Flood Zone 1, there is no requirement for floodplain compensation. It is noted that there is a proposed gravelled track/footpath around the new lake which passes through Flood Zone 3. The Applicant has confirmed that this will be at existing ground level and no land-raising is proposed for the track, therefore no floodplain compensation is required for this.

4.8 To conclude, the proposed development is entirely in Flood Zone 1 which is compatible with the proposed uses and no floodplain compensation is necessary. The risk of fluvial flooding to the site is considered to be low.

Surface Water

4.9 Surface water flooding refers to flooding caused when the intensity of rainfall, particularly in urban areas, can create runoff which temporarily overwhelms the capacity of the local drainage systems or does not infiltrate into the ground. The water ponds on the ground and flows towards low-lying land. This source of flood risk is also known as 'pluvial'.

4.10 The Risk from Surface Water mapping provided by the EA is included as **Appendix G,** and an overlay of this with the proposed development layout is in **Appendix H**. The extent is greater than the fluvial flood extent as this risk is from overland flow towards the watercourse rather than flooding from the watercourse.

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4.11 The overlay map shows part of the access road and parking to be within the low and medium risk areas. A very small part of the access road and car parking also enters the high risk area.

4.12 Due to the water compatible nature of the development, the hazard caused by this flood risk is not considered to be substantial. A new drainage system will serve the proposed development which will manage the surface water up to and including a 1 in 100 year (+40%CC) storm event, thereby reducing the level of surface water risk shown on the maps.

4.13 **Appendix H** also shows the proposed clubhouse is within the 'low risk' flood extent. 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. Any overland flow within this area will be directed to the marina basin due to the falls in the ground level and will be unlikely to pose a significant risk to the clubhouse.

Sewer

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

Artificial Sources

4.15 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.

4.16 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.

4.17 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 I**).

4.18 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.

4.19 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.

4.20 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

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be a good proxy to the likely area at risk of a flood event occurring as a result of a breach of the canal, being located only 1.2km to the west of the development.

4.21 The online EA 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

4.22 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.

4.23 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.

4.24 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 on 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.

4.25 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 settlements in the local area.

4.26 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.

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5 Mitigation Measures

5.1 A review of the Environment Agency's Flood Map for the area (**Appendix D**) indicates the site is in Flood Zone 1, at 'Low' risk of flooding from fluvial or tidal sources. There is safe access and egress to the site even during an extreme flooding event and no floodplain compensation is required as a result of the development.

5.2 The Risk from Surface Water mapping 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. The proposed development will include a new drainage system which will collect the surface water falling onto the access roads and attenuate it before discharging to the nearby watercourse. This will prevent the level of surface water flood risk shown on the EA maps occurring and ensure there is safe access and egress from the site.

5.3 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.

5.4 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.

5.5 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.

5.6 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.

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6 Proposed Drainage Strategy

Relevant SUDS Policy

6.1 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.

6.2 The SUDS management train incorporates a hierarchy of techniques and considers all three SUDS criteria of flood reduction, pollution reduction, and landscape and wildlife benefits. 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.

6.3 The philosophy of SuDS is to replicate as closely as possible the natural drainage from a site predevelopment 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; and
- Providing habitats for wildlife in developed areas, and opportunity for biodiversity enhancement.

Pre-development Runoff Rate

6.4 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
- Q1 year 3.6 l/s/ha
- Q30 years 8.6 l/s/ha
- Q100 years 11.3 l/s/ha

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6.5 The greenfield runoff rates and calculations are included at **Appendix J**.

Site-Specific SuDS

6.6 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 C753. 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.	Not used on clubhouse due to proposed pitch of roof.	No
Infiltration devices & Soakaways (source control)	Store runoff and allow water to percolate into the ground via natural infiltration.	Some infiltration may be possible but unlikely to be high due to mudstone geology.	No
Pervious surfaces (source control)	Storm water is allowed to 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 in the clubhouse.	Possibly
Swales (permeable conveyance)	Broad shallow channels that convey / store runoff, and allow infiltration (ground conditions permitting).	Unlikely to be used as other methods are being used.	No
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.	Filter drains are proposed along concrete access road but assumed that no infiltration will occur for a worst case scenario.	Yes
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.	Detention basins are proposed for attenuation prior to discharge.	Yes
Attenuation Underground (end of pipe treatment	Oversized pipes or geo-cellular tanks designed to store water below ground level.	Unlikely to be used.	No

Table 1: Site-Specific Sustainable Drainage Methods

Proposed SuDS Drainage Strategy

6.7 Given the presence of mudstone beneath the site, infiltration rates are considered to be variable. While an informal infiltration system will be used for some areas (e.g. gravel car parks), it is not

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recommended to drain large areas to soakaways and the like. Instead it is recommended that runoff will be discharged to either the watercourse or the new marina.

Car Parks and Access Roads

6.8 It is standard practice for gravel roads and parking areas to be dealt with in an informal manner, however to address the concerns raised by Oxfordshire County Council in their letter dated 03rd April 2019, these areas will now be treated as impermeable hardstanding and as such attenuation will be provided for the surface water runoff from these areas.

6.9 The surface water runoff from the access roads and parking areas outside of the marina basin are to be directed to filter drains along the edges of the access roads. The filter drains will then outfall at a restricted rate to a detention basin located on the eastern side of the site via orifice plates. The detention basin will then outfall to the adjacent lake.

6.10 The filter drains are to be gravel filled with 30% voids and a 225mm diameter perforated pipe in its sub-base. There will be an access chamber every 90m along the filter drains to allow for access in order to maintain and desilt the filter drains.

6.11 WINDES Source Control was used in order to estimate the size of the filter drains and detention basin required to provide adequate attenuation for rainfall events up to and including a 1 in 100 year +40% climate change storm. Due to gradients and falls across the site, two separate filter drains have been proposed.

6.12 The first filter drain is located adjacent to the northern section of access road. This section of filter drain will provide attenuation for and convey surface water runoff from 4540m^2 (0.454 ha) of access roads and car parking areas. WINDES estimated that to provide adequate attenuation, this filter drain would have to be 612m long, 0.8m wide and 1.2m deep. This filter drain is proposed to cascade to the detention basin via a 120mm orifice plate at a rate of 31.3 l/s.

6.13 The second filter drain is located adjacent to the southern section of access road. This section of filter drain will provide attenuation and convey surface water runoff from 3100m^2 (0.31 ha) of nearby access roads and car parking areas. WINDES estimated that to provide adequate attenuation, the filter drain would have to be 282m long, 1.2m deep and 0.8m wide. This section of filter drain will outfall to a proposed detention basin located to the north east of the site at a restricted outfall rate of 33.1 l/s via a 122mm orifice plate.

6.14 The two filter drains have been modelled as a cascading system in WINDES MicroDrainage, discharging to a detention basin located to the north east of the marina basin. The detention basin will have a base area of 1200m^2 and surface area of 1500m^2 with 1:3 side slopes, to provide the required volume of 697m^3 to manage up to and including a 1 in 100yr (+40%CC) storm event. The outfall of the detention basin will be restricted via a 47mm orifice plate, to **3.3 l/s**. This is the 1 in 1 year greenfield runoff rate based on the total areas of the access roads, car parking areas and the surface area of the detention basin, which totals 9140m^2 (0.914 ha). The outfall will be to the proposed large lake to the east of the marina, and as it is restricted to a 1 in 1 year greenfield rate, there will be a negligible increase in the water level of the lake.

6.15 The short section of access road at the site entrance will be of concrete construction and has a fall from the site towards the Boddington Road. A filter drain located adjacent to this section, along with a linear drain at the site entrance, will collect runoff and convey it to a second small pond at the north west of the site. The area draining to this pond will be 640m^2. This pond will be 0.5m deep with a base area of 40m^2 and surface area of 100m^2. This provides 33.4m^3 of

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volume to manage up to and including a 1 in 100 year (+40%CC) storm event. A 26mm orifice plate control will restrict the discharge rate to 1.00 l/s. The outfall will discharge runoff to the watercourse to the north, via the pipe network from the foul water outfall from the private treatment plant.

6.16 The use of filter drains, a pond and a detention basin will not only provide the required attenuation volume to manage the runoff, but will allow runoff to be filtered before it is discharged, thereby improving water quality. These SuDS features will also benefit

6.17 The details of the filter drains, small pond and detention basin along with details of the online controls are included within the WINDES output included at **Appendix K**. The proposed SuDS layout is shown on a drainage strategy drawing included at **Appendix L**. This drawing also shows the proposed impermeable areas.

Areas Draining to the Marina Basin

6.18 The access roads within the marina basin are utilising a gravel construction and will also be treated as impermeable hardstanding. It is proposed that the surface water runoff from these access roads along with the buildings, maintenance yard and other hardstandings within the marina basin is be directed and stored within the marina. This approach has been agreed with the Canal and River Trust.

6.19 With reference to the drainage drawing in **Appendix L**, the proposed clubhouse, service and maintenance yard and footpaths and access roads within the marina basin cover 5910m^2. These are located within the marina basin clay liner. As such, this area 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.

6.20 WINDES Source Control was again used in order to estimate the extent in which the water level of the marina would rise in order to accommodate surface water runoff form hardstandings within the basin following a 1 in 100 year storm +40% climate change storm.

6.21 By preventing any water leaving the basin within the calculation, WINDES estimated that for the 1 in 100 year +40% climate change storm, the hardstandings/access roads/roof areas within the marina basin would produce a total runoff volume of 795.8m^3. As the marina basin has a total area of 30,000m^2 (3 hectares), accommodating the runoff within the marina would result in a 27mm rise in water level within the marina (795.8/30,000 = 0.0265). However, as the marina is connected to the canal this rise in water level will not be reached and in reality the level change is unlikely to be perceptible.

6.22 Details of the marina and runoff from hardstandings within the marina basin are included within the WINDES output included at **Appendix K**.

HGV Access

6.23 The comments by Oxfordshire CC noted the requirement for some areas of the site to be accessed by HGVs. These areas would require a heavy-duty permeable system or hardstanding draining to a separate SuDS system.

6.24 The revised site layout now shows the access roads that are to be used by HGV's are proposed to utilise a concrete construction rather than a gravel construction in order to ensure that the road will be capable of handling the extra wear generated by the HGV's, as show on the proposed drainage strategy included at **Appendix L**. The surface water runoff from the majority

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of these areas will be directed to a filter drain which will then outfall to the detention basin at the eastern side of the site. The concreted areas within the marina basin will outfall to the marina itself as described above.

Foul Water Drainage

Discharge Calculations

6.25 The EA commented that they would object to the use of a non-mains foul drainage system in a publicly sewered area and they require justification of this method of foul sewage disposal. The proposed development is for a marina which will accommodate up to 192 narrowboats. The boats themselves are not part of the planning application, and it is understood that foul waste from narrowboats is usually pumped out to an underground holding tank where it will be periodically emptied via a licenced waste disposal firm.

6.26 The only property within the proposed development which will require management of foul flows is the clubhouse and accommodation within this building (which is a single two-bedroom apartment). Given the clubhouse has a members room, toilet facilities, kitchen and small laundry as well as a dwelling within it, the discharge rates have been considered.

6.27 It is proposed that a Klargester private treatment plant is used to treat the foul flows from the clubhouse and discharge it back into the watercourse. A private foul water pumping station and a rising main will be necessary to direct foul flows from the clubhouse to the proposed treatment plant, due to the level differences. The proposed location of the pumping station, treatment plant and outfall are shown on the drainage strategy drawing in **Appendix L.** There will be a flap valve on the outfall to prevent backing up of flows within the system.

6.28 The EA required the foul water discharge rates to be calculated from the club house and facilities building. These have been detailed in **Appendix M** based on the guidance set out in the British Water publication "Flows and Loads – 4: Sizing Criteria, Treatment Capacity for Sewage Treatment Systems". The assumptions have also been detailed, including the calculations being based on the peak season usage from March to October and having the facilities building open from 8am until 8pm. This results in a foul discharge rate of 2.36m^3 per day, which is the equivalent of 3 four-bedroom properties according to the guidance on the gov.uk website (https://www.gov.uk/government/publications/sewage-discharges-calculator-for-domestic-properties).

6.29 In the EA objection letter dated July 2018, it is stated "*We consider it reasonable to connect to the public sewer if the distance to the site is less than the number of properties x 30 metres….Our records suggest there are public sewers in Claydon (870 metres)…which we think a development of this size should connect to.*"

6.30 Given the above discharge calculations, the foul flows leaving the proposed development will be the equivalent of 3 four-bedroom properties. Using the above analysis, 3 x 30 metres = 90 metres. This is significantly lower than the closest public sewer in Claydon, 870 metres from the site. This sewer is also at an elevation approximately 10m higher than the site so the foul flows would need to be pumped, which is not sustainable. The rising main would need to pass either over or under the canal to reach the public sewer. Passing under is not a viable option due to the canal structure being above it. Passing over would have to be via the listed canal bridge on the Boddington Road, and it is highly likely that the Canals and Rivers Trust would object to this due to the potential to weaken the bridge.

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6.31 The cost of the pumping station and laying the rising main to connect one building to the public sewer in Claydon would be prohibitively expensive and impractical, therefore a private treatment plant has been proposed to serve the development.

Ecological Considerations

6.32 The EA raised concerns about the potential impact of treated foul water discharge entering the watercourse. A further ecological survey was carried out which confirmed the Wormleighton Brook forms part of the Claydon and Wormleighton Brook, Source to Highfurlong Brook WFD waterbody (GB106039037370). This waterbody is classified as in 'poor' condition (2016) due to elevated levels of phosphate, high ammonia and low dissolved oxygen levels.

6.33 To ensure the private treatment plant serving the development does not adversely impact this watercourse, the plant will conform to BS EN 12566-3. A permit will be sought from the EA for discharge to a waterbody and the discharge will be monitored to ensure the levels of phosphate, ammonia and BOD will comply with the requirements of the permit.

6.34 The treated flows will also pass through a small reed bed before entering the brook, which will further filter and treat the water.

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7 Maintenance of Development Drainage System

7.1 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 maintain the filter drains, detention basin, pond and connecting pipework as well as the foul water sewer network, and ensure there are no blockages in the drainage system which would result in flooding.

7.2 Maintenance tasks for a French drain or filter drain and pond or detention basin taken from CIRIA SuDS Manual C753 have been included in Tables 2 and 3.

Maintenance Schedule	Required Action	Frequency
Regular maintenance	Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices.	Monthly or as required.
	Inspect filter drain surface, inlet/outlet pipe and control systems for blockages, clogging, standing water and structural damage.	Monthly
	Inspect pre-treatment systems, inlets and perforated pipes for silt accumulation and establish appropriate silt removal frequencies.	Six monthly
	Remove sediment from pre-treatment devices.	Six monthly or as required
Occasional maintenance	Remove or control tree roots where they are encroaching the sides of the filter drain using recommended methods (e.g. NJUG 2007 or BS 3998: 2010)	As required
	At location with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium.	Five yearly or as required
	Clear perforated pipework of blockages.	As required

Table 2: Maintenance tasks for French Drain or Filter Drain (Source: CIRIA C753, The SUDS Manual)

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

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	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 vegetation where possible. Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions if required.	Annually 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. Re-level uneven surfaces and re-instate design levels. Scarify and spike topsoil level to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface. Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip. Remove or dispose of oils or petrol residues using safe standard practices.	As required. As required. As required. As required. As required.
Monitoring	Inspect inlets, outlets and overflows for blockages, and clear if required. Inspect infiltration surface for ponding, compaction, silt accumulation. Record areas where water is ponding for >48 hours. Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly Monthly, or when required. Half yearly.

Table 3: Maintenance tasks for ponds and detention basins (Source: CIRIA C753, The SUDS Manual)

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8 Conclusion

8.1 This FRA is to support a planning application for a 192 berth marina along with a clubhouse, service yard and parking areas, on the Oxford Canal at land to the east of Boddington Road, Claydon, Banbury, OX17 1TD. An irrigation lake is also proposed as part of the application.

8.2 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.

8.3 A review of the Environment Agency's Flood Map for the area indicated that the site is in Flood Zone 1, at 'Low' risk of flooding from fluvial sources.

8.4 The Risk from Surface Water mapping also shows part of 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. A new drainage system serving the roads and parking areas will ensure the surface water is managed and safe access will remain even during extreme storm events.

8.5 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.

8.6 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.

8.7 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.

8.8 A proposed drainage system has been discussed, whereby runoff from roads and car parking areas will be collected in filter drains and directed to a detention basin. This will provide two treatment stages before the runoff is discharged to the new lake at a 1 in 1 year greenfield rate.

8.9 The section of the access road at the site entrance will drain via a filter drain to a small pond, which will discharge to the watercourse to the north at 1.00 l/s. These have been modelled in WINDES MicroDrainage for a 1 in 100 year (+40%CC) rainfall event and sized accordingly.

8.10 Runoff from any roads, hardstandings or roof areas within the marina basin clay liner will discharge runoff directly to the marina basin. A WINDES Source Control calculation has determined the volume of runoff produced from these areas in a 1 in 100 year (+40%CC) event would raise the water level in the marina by 27mm which would be imperceptible.

8.11 The foul water from the clubhouse will be managed through a private treatment plant which will have an outfall to the watercourse to the north. It is proposed that there is a flap valve on the

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outfall to prevent backing up within the system during extreme fluvial events. A justification for using a private treatment plant, based on the practicalities and costs of connecting to the closest public foul sewer, has been carried out at the request of the EA.

8.12 It is proposed that the maintenance of the surface water and foul 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 filter drains, pond and detention bason and permeable surfaces on a regular basis and clear away blockages and debris when necessary. Some examples of maintenance tasks have been provided.

8.13 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.

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9 Appendices

Appendix: A – Location Plan
Appendix: B – Proposed Plans
Appendix: C – EA and Oxfordshire CC Comments
Appendix: D – EA Flood Data
Appendix: E – Topographical Survey
Appendix F – Flood Map Overlay with Proposed Development
Appendix G – Surface Water Map
Appendix H – Surface Water Map Overlay with Proposed Development
Appendix I – Canals and Rivers Trust Confirmation
Appendix J - Greenfield Runoff Rates
Appendix K – Proposed Drainage Layout
Appendix L – WINDES MicroDrainage Results
Appendix M – Foul Discharge Calculations

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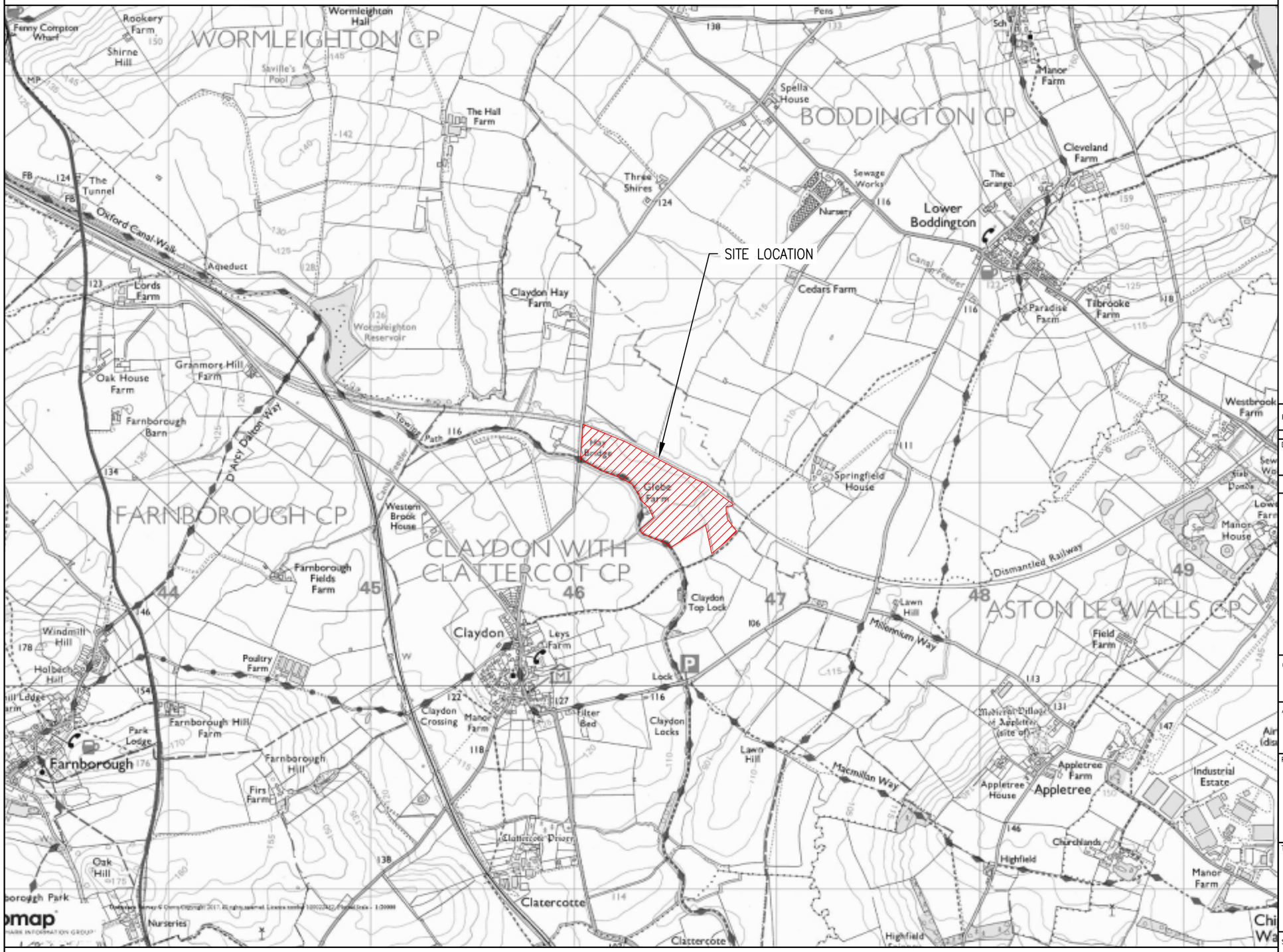
Appendix: A – Location Plan



REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS:

EAS

Unit 23, The Maltings, Stanstead Abbotts, Hertfordshire, SG12 8HG
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CLIENT:

ARCHITECT:

PROJECT:

CLAYDON MARINA
CHERWELL

TITLE:

LOCATION PLAN

SCALE @ A3:	DESIGN–DRAWN:	DATE:
1:20000	MC	27/11/2017

PROJECT No:	DRAWING No:
1319	FIG 01

Appendix: B – Proposed Plans

DO NOT SCALE FROM THIS DRAWING
Except for planning purposes

Revisions

Rev. No.	Date	Revision
A	07 11 18	Revised Planning Issue.
B	21 01 19	Scale amended to 1:1250. Footpaths revised.
C	28 01 19	Minor amendments to notes.
D	29 05 19	Revised site access road, Proposed works in flood zone relocated.
E	01 07 19	Revised landscaping & annotation.

Notes

Total number of berths: 192 (recreational)
Total number of parking spaces: 142
All roads & footpaths are to be constructed/surfaced with local permeable stone

LEGEND

- Concrete road surface
- Stone surfacing Local permeable stone
- Concrete footpath
- Trees at 2.0m centres
- Woodland trees at 3.0m centres
- Proposed scrub regeneration on LWS & land adjacent to it
- Individual trees
- Shrubs
- Grass / wild flowers / margins next to roads, paths & woodland etc - 2.0m wide
- Amenity grass
- Grassland
- Exg vegetation to remain
- Exg hedge retained, gapped up & allowed to grow taller
- Soft bank planted with coir rolls
- Marginal shallows
- Marina water area
- Bottom of earthworks / bank & extent of EA flood zone
- Extent of EA flood zone only
- A — Landscaping references
- Marker indicating end of access ramp to bridge (50m from centre of bridge)

0 10 20 30 40 50 [m]

PLANNING

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Job Title
PROPOSED MARINA AT BODDINGTON ROAD, CLAYDON, BANBURY

Drawing Scale / Sheet Size	Issue Date	Drawn By
1:1250 @ A1	01/07/2019	ALB

Drawing Title
PROPOSED SITE PLAN

Drawing Number
A05/020 E

CAD File Name
L:\Banbury Marina\A05-020E_Pro site plans