Construction of Park and Ride Facility, Land to the North-West of the A41, Bicester, Oxfordshire

Flood Risk Assessment

October 2013

ATKINS

Plan Design Enable

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This document has 113 pages including the cover and appendices.

Document history

Job number: 5124607			**Document ref: Bicester Park and Ride, Bicester - L2FRA**			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 0	Final	JD	AMR	KAF	LT	25/10/13

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Glossary

AEP	Annual Exceedance Probability
CFMP	Catchment Flood Management Plan
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
FRA	Flood Risk Assessment
NPPF	National Planning Policy Framework
RFRA	Regional Flood Risk Assessment
OCC	Oxfordshire County Council
SFRA	Strategic Flood Risk Assessment
TW	Thames Water
SuDS	Sustainable Drainage Systems

Executive summary

Site Name and Address	Bicester Park and Ride Bicester Oxfordshire OX25 2PA
Grid Reference:	SP 571 211
Size (hectares):	2.023 Ha

Current Use:		**Proposed Use:**	
	Greenfield: X		Residential:
	Brownfield (disused):		Commercial/Retail:
	Industrial:		Industrial:
	Commercial:		Hospital:
	Landfill:		Educational:
	Rail:		Rail:
	Residential:		Landfill:
	Other:		Other: X

Comment:	Currently agricultural.	**Comment:**	Park and ride facility.
Flood Zone:	Zone 1	**Vulnerability:**	Less vulnerable
Sequential Test:	Compliant	**Exception Test:**	Not required

Description:

Atkins was commissioned by Oxford County Council to prepare a Flood Risk Assessment to support an outline planning application for a proposed development on land at south of Vendee Drive, Bicester, Oxfordshire .
This Flood Risk Assessment has been prepared in accordance with the National Planning Policy Framework (NPPF)[1] and associated Technical Guidance[2]. The scope of this Assessment has been established through consultations with the Environment Agency, Oxfordshire County Council and Thames Water.

The proposed development site is located on the southern side of Bicester, Oxfordshire and is located immediately adjacent to the A41 and Alchester Road.

The site is located within the Environment Agency's Flood Zone 1 and is therefore not at risk from fluvial flooding. Since the site is greater than 1 hectare, further investigation into other types of flooding was carried out in line with the NPPF. Potential flooding from coastal waters, fluvial risks, canals and artificial sources including reservoirs, flood defences and culvert blockages were scoped out. Overland flow from adjacent sites has been identified as the most significant flood risks to the site with climate change providing a further residual risk. Drainage of the development will maintain existing greenfield run-off rates (calculated as 7.2l/s). SuDS measures will need to be incorporated into the design in order to provide a total storage volume of 1,601m³ (to be confirmed as part of the detailed design stage). The feasibility of infiltration measures will need to be investigated using site specific insitu testing to confirm the viability of the technique.

[1] National Planning Policy Framework, March 2012, Department for Communities & Local Government.

[2] Technical Guidance to the National Planning Policy Framework, March 2012, Department for Communities & Local Government.

Due consideration has been given to various forms of flooding and by the use of infiltration (If shown to be applicable) or the use of attenuation features incorporating appropriate flow control devices, the proposed development will not increase flood risk to the site, or the local area. The residual flood risk from overland flow and groundwater flooding can be effectively managed in accordance with the National Planning Policy Framework, Environment Agency requirements and a formal drainage strategy that accounts for exceedance flows.

1. Introduction

1.1. Atkins' Services

Atkins was commissioned by Oxfordshire County Council to undertake a FRA for the proposed development of the land south Vendee Drive, located to the South of Bicester.

This FRA aims to review and identify any key flood risk issues that will need further investigation, in compliance with the NPPF.

1.2. Scope of this Report

CIRIA C624 provides guidance on the implementation and good practice in assessing flood risks through the development process. The aim of C624 is to promote developments that are sustainable with regard to flood risk. The document recommends that a FRA should be undertaken in phases so that the type of development corresponds with the detail required. There are three levels of assessment that mirror those outlined in NPPF and are as follows:

Level 1 FRA (Screening Study): To identify if there are any flooding issues related to a development site which may warrant further consideration. The screening study will ascertain whether a Level 2 or Level 3 FRA is required.

Level 2 FRA (Scoping Study): Undertaken if a Level 1 study indicates that the site may lie within an area which is prone to flooding or that the site may increase flood risk due to increased runoff; and to confirm the possible sources of flooding which may affect the site. The Scoping Study will identify any residual risks that cannot easily be controlled and, if necessary will recommend that a Level 3 FRA is undertaken.

Level 3 FRA (Detailed Study): Undertaken if the Level 2 study concludes that quantitative analysis is required to assess flood risk issues related to the development site. This may include detailed hydraulic modelling of rivers or drainage systems.

Initial site checks using web-based mapping sources have identified that the site lies within fluvial Flood Zone 1. For flood risks to be adequately assessed it will be necessary to undertake an assessment for a ***Level 2 FRA (Scoping Study).*** The assessment will review flood risk and undertake the following:

- Review available existing information for the site;
- Undertake liaison with the EA, Local Planning Authority and Water Authority (as necessary);
- Assessment of fluvial flood risk to the site and determination of whether the development of the site is viable;
- Assessment of other forms of flood risk as detailed in NPPF (i.e. coastal/tidal/estuarine flooding, groundwater flooding, overland flows, drainage and artificial infrastructure flooding);
- Assessment of the impact of flooding on the site and the surrounding area;
- Assessment of access and egress for routine and emergency use;
- Assessment of how the layout and form of the development can be used to minimise or reduce flood risk;
- Assessment of any remaining (residual) risks to or from the site after the construction of any necessary mitigation measures and the means of managing those;
- Consideration of the proposal relative to any existing Strategic Flood Risk Assessment carried out by the Local Authority.

2. Policy Context

2.1. Flood Risk and Flood Probability

Flooding is a natural process that can present a range of different risks depending on its form. Flood practitioners and professionals define the risks presented by flooding according to an Annual Exceedance Probability (AEP), or as having a 'return period.'

Flood risk includes the statistical probability of an event occurring and the scale of the potential consequences. Flood risk is estimated from historical data and expressed in terms of the expected frequency of a flood of a given magnitude. The 10-Year, 50-Year and the 100-Year floods have a 10%, 2% and 1% chance of occurring in any given year, respectively. However, over a longer period the probability of flooding is considerably greater.

For example, for the 100-Year return period flood:

1. There is a 1% chance of the 100-Year flood occurring or being exceeded at least once in any single year;
2. A 26% chance of it occurring or being exceeded at least once in a 30-Year period; and
3. A 51 % chance of it occurring or being exceeded at least once in a 70-Year period.

Table 1 below provides a summary of the relevant AEP and corresponding return period events of a particular sensitivity:

Table 1. Definition of AEP and 'Return Period' Flood Events

100%	1 in 1 Year
10%	1 in 10 Years
2%	1 in 50 Years
1%	1 in 100 Years
0.5%	1 in 200 Years
0.1%	1 in 1000 Years

2.2. National Planning Policy Framework

Previously, Planning Policy Statements (PPS) set out the Government's national policies on different aspects of spatial planning in England. PPS 25: Development and Flood Risk[3], and its accompanying practice guide[4], set out the Government's spatial planning policy on development and flood risk. It aimed to ensure that flood risk was taken into account by all relevant statutory bodies from regional to local authority planning departments to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest risk. Where new development is, exceptionally, necessary in such areas, Government

[3] Department for Communities and Local Government (March 2010) Planning Policy Statement 25: Development and Flood Risk. HMSO, London.

[4] Department for Communities and Local Government (December 2009) Planning Policy Statement 25: Development and Flood Risk: Practice

policy aims to make it safe, without increasing flood risk elsewhere and, where possible, reducing flood risk overall.

The government has reviewed planning policy and released the new NPPF[5] and an accompanying Technical Guide[6], which supersede PPS25 but retains many of the previous policies and approach.

Local Authorities should only consider development in flood risk areas as appropriate where it is informed by a site specific FRA, based upon the EA's Standing Advice on flood risk. The FRA should identify and assess the risks of all forms of flooding to and from the development and demonstrate how flood risks will be managed so that the development remains safe throughout its lifetime, taking climate change into account.

Within the NPPF Technical Guide, there is a hierarchy that should be applied for flood risk management, with avoidance or prevention being the preferred first measure to reduce flood risk. Table 2 below presents the flood risk management hierarchy.

Table 2. Flood Risk Hierarchy

1	Assess	Undertake studies to collect data at the appropriate scale and level of detail to understand what the flood risk is.
2	Avoidance / Prevention	Allocate development to areas of least risk and apportion development types vulnerable to the impact of flooding to areas of least flood risk.
3	Substitution	Substitute less vulnerable development types for those incompatible with the degree of flood risk.
4	Control	Implement flood risk management measures to reduce the impact of new development on flood frequency and use appropriate design.
5	Mitigation	Implement measures to mitigate residual risks.

The NPPF and the Technical Guide assigns the level of risk depending on the annual probability of fluvial flooding occurring as follows:

i. Flood Zone 1: Low Probability (<0.1% AEP fluvial / sea flooding)
ii. Flood Zone 2: Medium Probability (0.1-1.0% AEP fluvial / 0.5-0.1% AEP sea flooding)
iii. Flood Zone 3a: High Probability (>1% AEP fluvial / >0.5% AEP sea flooding)
iv. Flood Zone 3b: Functional Floodplain (>5% AEP or designed to flood in 0.1% event)

Development should be directed as far as is practicable towards Flood Zone 1 areas to avoid fluvial flood risks wherever this is possible. For development proposed in any Flood Zone, should the development area be greater than 1 hectare a FRA will still be required to address design issues related to the control of surface water runoff and climate change, as well as considering any other potential sources of flood risk for the development site.

The broad aim of NPPF is to reduce the number of people and properties within the natural and built environment at risk of flooding. To achieve this aim, planning authorities are required to ensure that flood risk is adequately addressed during the initial planning stages of any development.

[5] Communities and Local Government (March 2012) National Planning Policy Framework.

[6] Communities and Local Government (March 2012) Technical Guidance to the National Planning Policy Framework.

Responsibility for the assessment lies with the developers and they must demonstrate the following:

- Whether the proposed development is likely to be affected by flooding
- Whether the proposed development will increase flood risk to adjacent properties
- That the measures proposed to deal with any residual flood risks are sustainable

The developer must prove to the LPA and the EA that any existing flood risk or flood risk associated with the proposed development can be satisfactorily managed.

2.3. Local Development Policies

2.3.1. Cherwell and West Oxfordshire District Council Strategic Flood Risk Assessment

A Level 1 SFRA[7] was produced by Scott Wilson on the behalf of Cherwell and West Oxfordshire District Council in 2009 to inform the development policies of the Local Development Framework and the Core Strategy. The proposed development falls within Cherwell District Council's catchment. The SFRA conforms to the National and Regional planning policy and was produced in accordance with PPS 25. It was produced to provide sustainable policies for the long-term management of flood risk.

The SFRA identified this site as a potential development site and that historical records show no evidence of flooding in the area. The SFRA gives guidance on future flood risk management and SuDS provision that have been considered as part of the FRA; in particular sections 12 Sustainable Flood Risk Management and 13 Site Specific Flood Risk Assessment Guidance have direct relevance for this development site.

2.3.1.1. Sustainable Drainage Systems

Within the SFRA it states wherever possible all new developments are to incorporate the use of Sustainable Urban Drainage Systems (SuDS).

SuDS should be implemented in line with current best practice and by applying the principles of The SuDS Manual (CIRIA C6978)[9]. This is in order to adapt to expected climate change, adopt sustainable design and to minimise surface water run-off and therefore minimise the risk of flooding.

The location of the site is identified as having a Standard Percentage Runoff (SPR) of 47% (an SPR of less than 20% is considered to be representative of a permeable site/catchment[10]). This means that soil characteristics around the site area allow approximately 53% of rainfall to infiltrate with the remainder contributing to overland flows (development of the site will increase the overall impermeability).

2.3.2. Regional Preliminary Flood Risk Assessment

In 2011, Oxfordshire County Council commissioned a Preliminary Flood Risk Assessment[11] (PFRA) in order to inform the preparation of the Strategic Flood Risk Management Strategy (due January 2014). The PFRA was produced in accordance with PPS25 as this was the appropriate guidance at the time of writing.

[7] Cherwell and West Oxfordshire District Council Strategic Flood Risk Assessment (April 2009). Report produced by Scott Wilson.

[9] Woods-Ballard, B., Kellagher, R., Martin, P., Jeffries, C., Bray, R & Shaffer, P. (2007) The SUDS Manual. CIRIA C697.

[10] Robson, A. J. and Faulkner, D.S. 1999. Adjusting for permeable catchments. In: Flood Estimation Handbook Volume 3, Statistical Procedures for Flood Frequency Estimation.

[11] Oxfordshire County Council Preliminary Flood Risk Assessment, Preliminary Assessment Report (June 2011). Report produced by JBA Consulting.

The PFRA shows there have not been any serious flooding events with adverse consequences within the Bicester area. The Bicester area is also indentified as an area that is not susceptible to future flooding although there is little locally specific information available on future flood risk especially in rural areas and recommends referring to the local SFRA for further details.

2.3.3. Cherwell District Council's Proposed Submission Local Plan

In Cherwell District Council Proposed Submission Local Plan (PSLP). The risk of flooding from rivers and watercourses across the district of Cherwell is high, the district falls within three major river catchments, these are; River Cherwell (which in extreme flood events co-joins with the Oxford Canal), The Great Ouse and the Warwickshire Avon catchment. Groundwater and sewer flooding has also occurred at various locations across the district.

Due to the location and distance away from site the risks of flooding from the River Cherwell, The Great Ouse, The Warwickshire catchment and the Oxford Canal are minimal.

The PSLP details various recommendations for developers in order to manage and minimise flood risk, an excerpt of the summary is given below.

It is recommended that developers should:

- Encourage close liaison with planners and developers to ensure future urban growth is appropriate and helps manage flood risk.
- Investigate the opportunities for and the feasibility of broad scale SuDS and encourage them to be implemented, where practical.

2.3.4. River Thames Catchment Flood Management Plan

In the River Thames Catchment Flood Management Plan (CFMP)[12] Bicester is identified within Policy Option 6. Policy Option 6 is defined as an area of low to moderate flood risk where the Environment Agency with others will take action to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.

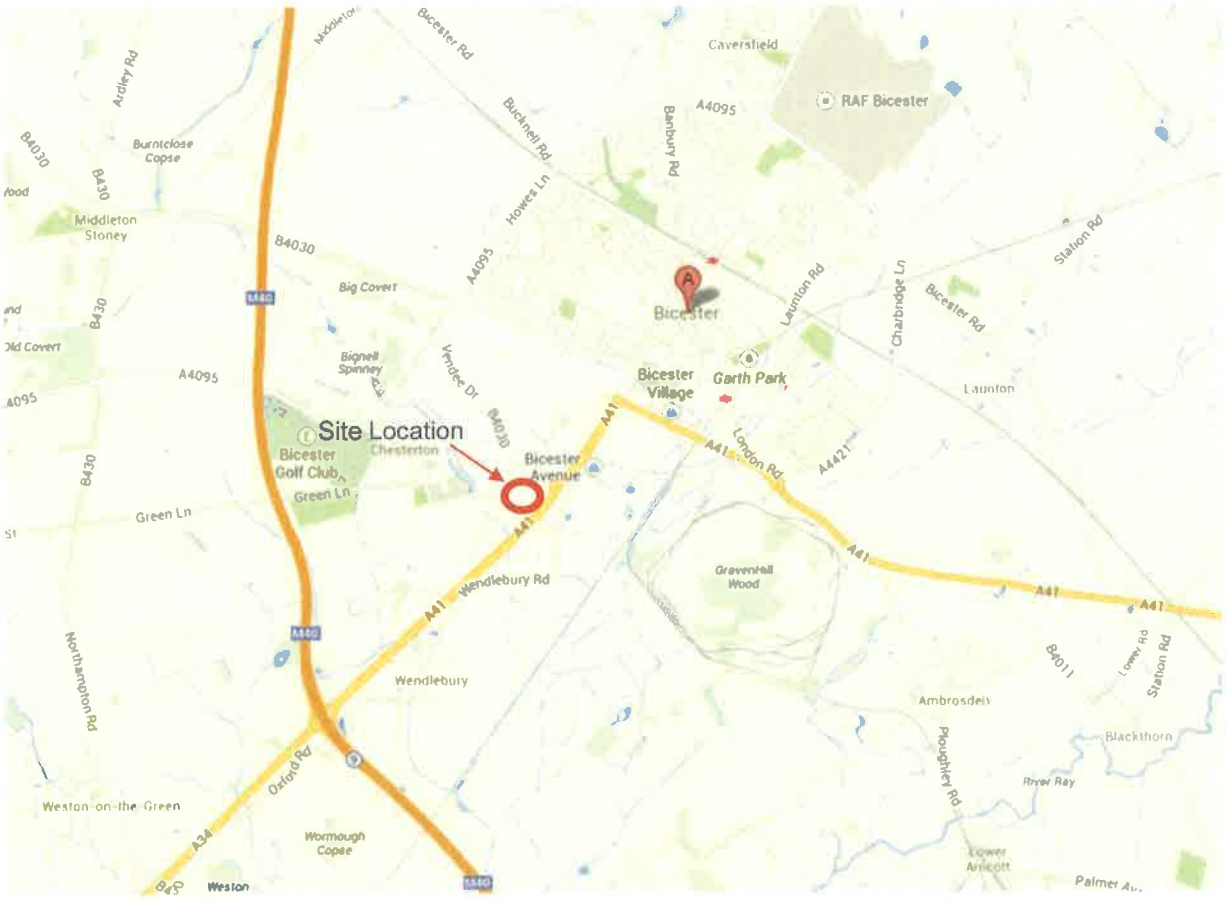
In keeping with the PSLP the development site will also satisfy the requirements of the CFMP.

[12] http://www.walthamforest.gov.uk/documents/ke81-thames-catchment-flood-management-plan-summary-report.pdf. Last accessed October 2013

3. Development Site Information

3.1. Site Location

The proposed development site is located on the southern side of Bicester, Oxfordshire. The northern boundary of the site is formed by Vendee Drive and to the east the A41. The southern boundary is formed by Alchester Road. The North West corner of the western boundary is situated adjacent to the new junction off Vendee Road and a new housing estate; the western boundary then runs parallel to the A41 until it reaches Alchester Road



Site Location Plan

The site plans and illustrative masterplan for the proposed development are provided in Appendix A.1.

3.2. Previous Use

The historical use of the site and surrounding area has been determined by reference to the maps viewed on Old Maps Online[13]. These maps indicate that the land has been used for agricultural purposes for more than 100 years.

[13] Old Maps Online, http://www.oldmapsonline.org . Last accessed September 2013

3.3. Existing Site Features

3.3.1. Topography

The proposed development site has a total area of 2.023ha. Ground levels within the site generally fall from north-west to south-east towards a ditch that runs along the eastern boundary, this ditch falls from north to south. The highest elevation within the site is located in the north-western corner of the site and has a ground level of approximately 67.06m AOD. The lowest point on the site is found on the eastern boundary adjacent to the ditch with a level of approximately 65.4m AOD. The approximate fall across the site is 1:110. Refer to Appendix A.2 for further details.

3.3.2. Geology

At the site location, the British Geological Survey[14] maps identify the bedrock geology as Kellaways Clay comprising of mudstone. According to BGS maps, there are no superficial deposits recorded. The recent preliminary ground investigation undertaken on site has indicated that the reported absence of superficial deposits is correct. The site is covered by a variable thickness of Grass over stiff slightly sandy slightly gravely clay which directly overlies very dense clayey sandy fine to course mudstone gravel.

3.3.3. Hydrological Features

3.3.3.1. Groundwater

The EA maps[15] identify this area of Bicester is located in an area that is not vulnerable to groundwater flooding and also not in a groundwater protection zone.

The site location is within a surface water nitrate vulnerable zone but not a groundwater nitrate vulnerable zone.

3.3.3.2. Other features

The EA detailed river network map[16], included in Appendix A.3, indicates all of the watercourses in the vicinity of the site. The nearest watercourse to the site is a surface level drain to the north of the site which flows into a culvert under the A41 approximately 65m away from the development site. No modelling of this watercourse has been undertaken.

The Gagle Brook is the nearest major watercourse to the site and is approximately 300m to the west at the nearest point. It is an ordinary watercourse and flows east to west to the south of the site. From the EA detailed river network map there is no evidence of any culverted sections of the Gagle Brook within close vicinity of the development site.

The nearest Main River to the proposed development site is Langford Brook which is approximately 490m to the east.

There is no evidence from records provided by Thames Water that there are any existing public sewers within the development boundary. The nearest public sewer to site is approximately 120m to the south of the site in Alchester Road. From on site investigations and the topographical survey show that there is highway drainage adjacent to the site serving the A41.

[14] British Geological Survey, http://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html. Date accessed February 2012.

[15] Environment Agency Flood Risk Mapping, http://www.environment-agency.gov.uk/homeandleisure/floods/default.aspx . Last accessed September 2013

[16] Envirocheck Flood Sceening Report (August 2013). Report produced for Atkins by Landmark information Group

There is no evidence of on-site drainage systems.

The site currently drains to a highway ditch (adjacent to the A41) that runs along the eastern boundary of the proposed site. It is assumed that this ditch then flows through a culvert under Alchester Road and then discharges into Gagle Brook.

Refer to Appendix A.2 for existing site conditions plans.

Beyond the Gagle Brook is the Oxford Canal approximately 8km from the western boundary of the site.

3.3.4. The Proposed Development

The proposed development (refer to Appendix A.1 for details) comprises an outline scheme for a park and ride facility, which will serve the town of Bicester and the local area. The facility will provide 580 car spaces (566 standard spaces plus 14 disabled spaces) together with 60 cycle spaces, a bus turning area and associated shelters. There will be no buildings provided as part of the development. The detailed design (including proposed finished levels) has yet to be determined; any residual flood risks identified by this assessment will therefore need to confirmed and addressed during the next stage of work.

To the north of the site there is a new residential estate under construction. The land to the west of the propose park and ride facility is designated for future development.

4. Review of Potential Flood Risks

4.1. History of Flooding

The Oxfordshire County Council (OCC) Preliminary FRA report shows no evidence of historic flood in and near the proposed development site.

The Cherwell and West Oxfordshire Level 1 SFRA[7] indicates no evidence of flooding within the area.

The EA historic flood map provided as part of the Envirocheck Report[13] does not indicate any instances of flooding.

A consultation request was issued to the EA for any evidence of historic flooding; no indication of historic flooding was highlighted within their response. It was noted additionally that although there are no records of flooding to the site, it does not necessarily mean that the site has never historically flooded.

4.2. Coastal, Tidal and Estuarine Flood Risk

Oxfordshire is an inland county and within this area there are no rivers that are hydraulically linked or under the influence of coastal or tidal waters in the form of estuarine systems.

It can therefore be stated that the site is not at risk of flooding from tidal, coastal or estuarine flood risks. Therefore, flood risk from this source can be scoped out.

4.3. Fluvial (River) Flood Risk

The nearest watercourse to the site is the Gagle Brook which flows east to west approximately 300m to the south of the proposed development site. The watercourse flows under the A41 and eventually joins the River Ray.

The EA flood risk map indicates that the site is located wholly within Flood Zone 1. The floodplain (Flood Zones 2 and 3) associated with the Gagle Brook is located approximately 250m from the site. The floodplain (Flood Zones 2 and 3) associated with the Langford Brook is located approximately 200m from the site.

From correspondence received from the EA no concerns have been raised in relation to fluvial flooding refer to Appendix for details8.2.1.D.1.

Hence in line with NPPF, there is a low probability (<0.1% AEP) of fluvial flooding on the site. This flood risk can therefore be scoped out.

4.4. Groundwater Flood Risk

Groundwater flooding occurs when water stored within the ground reaches capacity and rises above the ground surface level. This is most likely to occur in low lying areas located above aquifers or where impermeable bedrock is overlain with permeable superficial deposits. Groundwater flooding requires significantly longer to drain than flooding from surface sources and is particularly susceptible to long periods of consistent rainfall.

The EA groundwater vulnerability map[16] indicates that the site is not located over either, a principle or secondary aquifer or is it within a groundwater protection zone.

The JBA PFRA for Oxfordshire indentifies areas which are likely to be susceptible to groundwater flooding. The development site is outside of these areas and is therefore deemed not at risk of groundwater emergence.

Within the Envirocheck report there is no evidence from the BGS data shown that there is a risk for groundwater flooding within the development site. The nearest risk is approximately 30m to the west of the site with the potential for groundwater to reach the surface. The location of the flooding is to the west of

Alchester Road, any emerging groundwater is therefore unlikely to affect the proposed development as it is likely to be intercepted by the existing highway and drained away from the site.

Although previous studies have confirmed there have been no recorded instances of groundwater flooding, until the depth of groundwater is determined there remains a residual risk. The recent preliminary ground investigation indicates groundwater level is generally in excess of 1m with the average depth between 1.2m and 1.8m. Therefore, the risk of local groundwater flooding cannot be wholly scoped out as this would need monitoring to capture seasonal variation.

4.5. Overland Flow Risk

4.5.1. Flooding Risk from Adjacent Sites

The site lies south of the town of Bicester and is predominantly surround by Greenfield agricultural land with the exception of a new residential being constructed to the North of Vendee Drive and an existing caravan park situated on the opposite side of the A41 to the south east. The topography of the site is a gentle slope from east to west.

There are two newly constructed ponds to the north of the site situated either side of the new constructed access into the residential development. These ponds are assumed to serve this development. From observations on site there are no evident outfall structures and may suggest they operate as infiltration ponds, these ponds are hydraulically connected. As these are new constructed ponds it is assumed that they have been designed to the current standards and have capacity to deal with the 100 Year + climate change event. Vendee Drive is at a higher level than the top of bank for both ponds so in extreme conditions if the ponds were to overtop then they would flood the immediate Greenfield land to the south and away from the development.

Overland flow from the areas to the west and east of the site has the potential to directly influence the site. The land to the west will remain as agricultural land so an allowance will need to be made to intercept this flow and make provision for it within the detailed design of drainage systems.

Immediately adjacent to the east of the site is the A41, the carriageway level has a higher elevation than the proposed development site. Existing highway drainage systems should ensure that runoff is fully contained within the highway corridor; there is a residual risk that during extreme events that exceed the design capacity of those systems that the eastern boundary of the site may be subject to flooding. Consideration will need to be given during the detailed design stage to exceedance flows from this existing drainage system.

4.5.2. Flooding to Adjacent Sites

Due to the topographical arrangement of the site and the surrounding area, run-off generated from the development would not affect the surrounding areas. Overland flow generated within the site would flow in an easterly direction to a proposed attenuation pond but is subject to the detailed design of finished levels for the development.

4.5.3. Flooding to the Proposed Development Site

The Envirocheck screening report provided pluvial flood risk maps for 75, 100 and 1000 Year return period storm events (refer to Appendix B.3 for further details). The 75 Year return period storms did not indicate any pluvial or minor river flooding within the site boundary or local vicinity. The 100 Year event shows an isolated area of pluvial and minor river flood within the development site. The Wallingford UK SuDS Tool[17] estimates the Standard Percentage Runoff (SPR) as 47% and HOST class as 25; meaning that only 53% of water falling on the site surface would infiltrate if the site were wholly greenfield. The impermeability of the site will be significantly altered by the proposed development and mitigation measures to manage the corresponding increase in surface water runoff will therefore be required.

At this stage the risk of flooding from overland flows cannot be completely scoped out. The surface water drainage strategy will include management measures to enable the risk to be minimised. Additional measures will be required to manage exceedance flow conditions.

[17] H R Wallingford UK Suds Tool, http://geoservergisweb2.hrwallingford.co.uk/uksd/index.htm, last accessed September 2013.

4.6. Artificial Drainage Flood Risk

The Level 1 SFRA has indicated that there have been no issues with flooding of artificial drainage systems within the postcode region boundary.

As part of this assessment, the sewer records have been obtained from Thames Water. The sewer records indicate that there is no public surface or foul water system within or near the development site. The nearest public foul water sewer is located in Alcester Road to the south which is approximately 120m away from site. On the A41 there is existing highway drainage that could pose a potential risk to the development site. The carriageway of the A41 is at a higher elevation than the site so in extreme events there is a potential for surface water to flood onto site. The existing highway ditch is however likely to intercept any exceedance flows.

As no sewer flooding has been recorded within the site boundary or within the post code region, this source of flood risk can therefore be scoped out. However, due to the close vicinity of the highway drainage within the A41 this may provide a residual risk to the development that should be considered further as part of the detailed design stage.

4.7. Infrastructure Flood Risk

4.7.1. Canals

The nearest canal to the site is the Oxford Canal located approximately 8km to the west of the site boundary. This is located beyond the Gagle Brook and hence does not present a flood risk to the development site.

Therefore, the risk of flooding from canals can be scoped out of this assessment.

4.7.2. Reservoirs

There are no raised reservoirs in Bicester that would present a flood risk to the development site. The EA flood maps indicate that there is no reservoir flooding likely to occur in the local area of the site.

The risk of flooding from reservoirs can therefore be scoped out.

4.7.3. Flood Defence Structures

The EA have indicated that there are no formal flood defence structures in the immediate area that are maintained by the Agency and service the site.

The risk of flooding from the failure of flood defence structures can therefore be scoped out.

4.7.4. Culvert Blockages

There is an unnamed ordinary watercourse that is approximately 62m from the northern and eastern boundaries at its nearest point. The watercourse is culverted under the A41 Oxford road.

No modelling for the blockage of this culvert was undertaken in the OCC Level 1 SFRA. However, given the topography of the area and the culvert being located downstream of the newly constructed pond it is assumed that the pond has adequate capacity to store the additional volume if this culvert was to block. It is anticipated that flooding associated with a culvert blockage would not increase flood risk on the site.

The flood risk associated with blockage of the culvert can therefore be scoped out of the assessment.

4.8. Climate Change

The future implications of climate change are outlined in NPPF and in research carried out by DEFRA. A range of recommendations have been made for precautionary approaches to development design for rainfall, river flows, wind speeds and wave heights. This has been summarised as an extract from the NPPF Technical Guidance and the estimations for rainfall and river flow implications (excluding coastal factors) are presented in Table 3 below.

Table 3. Recommended national and precautionary sensitivity ranges for peak rainfall intensities

Peak Rainfall Intensity	+5%	+10%	+20%	+30%
Peak River Flow	+10%	+20%	+20%	+20%

For any development, climate change (for rainfall-runoff calculations and surface water management considerations) will need to be accounted for in accordance with its planned designed lifetime. Short duration rainfall may increase by 30% and flows by 20%, with suggestions that winters could become generally wetter and could lead to an increase in identified flood zones.

5. Drainage Strategy

Any FRA should inform the development of a drainage strategy so that the principles of surface water management for the site are actively applied. This should address foul and surface water discharges.

The drainage systems on the site will be owned and maintained by Oxfordshire County Council and should be designed in accordance with the relevant aspects of the Highways Agency Design Manual for Roads and Bridges (Volume 4 Geotechnics & Drainage). The design should also seek to mitigate against identified flood risks in accordance with this assessment.

The car park will have a surface area greater than 800m² and in accordance with PPG3[18] the detailed design should consider the incorporation of appropriate SuDS measures or oil separators in order to reduce the potential for polluted runoff to be discharged from the site.

5.1. Surface Water Management Proposals

The proposed development will increase the volume of surface water runoff generated. In order to mitigate against the potential to increase local flood risk the detailed design of drainage systems needs to ensure that surface water discharges into receiving drainage system should not exceed the existing greenfield run-off rate for the site.

SuDS should be used on site where possible and an attenuation pond could be implemented. It would be most appropriate to locate this adjacent to the eastern boundary due to the topography of the site and the presence of some proposed open space in this area. Section 5.2 discusses the use of SuDS and specifically those measures that can be incorporated into the design.

The recent preliminary ground investigation indicates that the ground conditions underlying the site may not be suitable to allow adequate infiltration due to the SPR value. This is subject to infiltration testing being undertaken during the detailed design stage. Surface water flows will therefore need to be attenuated using appropriate SuDS techniques and discharged into the local drainage systems with appropriate controls to attenuate flows.

OCC (as the Highway Authority) have indicated that a connection to the existing highway drainage system adjacent to the site would be appropriate if infiltration is proven to not to be viable. It has been agreed that a discharge rate of 7.2l/s from the site can be accommodated within the existing highway drainage system as this represents the existing Greenfield runoff rate. The proposed discharge will make use of existing outfalls and routes to ensure that the development has no impact on existing conditions. For this flow rate to be achieved an attenuation pond is required. Based on a discharge rate of 7.2l/s and the worst case storm event for the 100 Year plus climate change event the total storage volume required to be provided on the site is 920m³ (calculated using the UK SuDS Website Design Tool[19] the outputs of which are given in Appendix E). By way of comparison the MicroDrainage WinDES Source Control module has been used to calculate equivalent storage requirements for the site. The results using this method are provided in Appendix E and indicate a requirement for an attenuation pond with a storage volume of 748m³ and permeable paving providing additional storage of 853m³ to allow an appropriate SuDS treatment train to be provided. The WinDES method have provided the more onerous results and have been adopted for the purposes of the outline design, i.e. total storage volume of 1,601m³; these values will need to be confirmed as part of the detailed design stage.

5.2. Foul Water Management Proposals

The current proposed general arrangement has no proposed structures or any facilities that would require a foul water connection.

Therefore a foul water management proposal is not required.

[18] Pollution Prevention Guideline 3: Use and Design of Oil Separators in Surface Water Drainage Systems: Environment Agency: April 2006
[19] HR Wallingford: UK Sustainable Drainage: Greenfield Runoff and Stormwater Storage Estimation Tool

5.3. Use of Sustainable Drainage Systems

Surface water should be managed in accordance with appropriate design standards; for which most developments are required to accommodate at least the 1 in 30 Year storm event without flooding. For rainfall in excess of this, surface water control can be further developed by applying a range of SuDS techniques. Selection of the SuDS type is dependent on development type, the known ground conditions and site topography. Implementing SuDS techniques can reduce volumes of water released, increase water quality and improve landscape, biodiversity and public amenity.

The HR Wallingford UK SuDS Tool indicated that the site has a HOST soil class of 25 with an SPR of 47%. This soil has limited infiltration characteristics and hence a greater volume of surface water attenuation will be required for the new development. In order to reduce the surface water discharge for the site to 7.2/l/s, storage devices will be required to manage the majority of runoff.

SuDS should be implemented in line with current best practice and by applying the main principles of The SuDS Manual (CIRIA C697). A review of suitable SuDS options has been undertaken for this site and the results are shown in the table below. The table lists most of the SuDS designs that could be applicable to developments in general and each of these systems has been considered as to whether it is or is not appropriate for inclusion within the proposed development.

Table 4. Potential SuDS Techniques and Suitability for Bicester Park and Ride

Source Control	Site layout & management	Good housekeeping and good design.	Yes	Include provision for SuDS at design stage. Include suitable kerbing, site layout and drainage facilities to control on-site and prevent off-site flooding.
	Water butts	Collection of rainwater for reuse within gardens.	No	Not appropriate as there are no buildings proposed on the site.
	Rainwater harvesting and re-use	Larger-scale collection of rainwater for attenuation or for reuse in appropriate ways (e.g. toilet flushing or irrigation).		
	Permeable pavement	Allow inflow of rainwater into underlying soil or construction.	Yes	Include for paved areas but may need to be a sealed construction rather than soakaway. System will need to be designed to allow surface water to be discharged carried to attenuation pond
	Green roofs	Vegetated roofs that reduce runoff volume and rate	No	Not appropriate as there are no buildings proposed on the site.
Retention	Rainwater attenuation	Collection of rainwater within storage pond to reduce runoff rates (until pond capacity reached).	Yes	Ideal for storage of runoff and can be throttled to control outflow to desired rates.
Detention	Detention basin	Dry depressions designed to store water for a specified retention time and quantity	Yes	Large space requirement may make ponds more suitable.

Filtration	Filter drain	Linear drains or trenches filled with permeable material, often with piped drainage in the base.	Consider	May be considered for use on the perimeter of the car park.
	Filter strip	Vegetated strips of gently sloping ground designed to drain water evenly from impermeable surfaces and filter out particles.		
	Bio-retention areas	Vegetated areas for collecting and treating water before discharging or infiltrating	Consider	Provide a treatment train system. Use is likely to be limited to the perimeter areas on the northern and eastern boundary.
	Sand filters	Treatment devices using sand beds as filter media	No	More appropriate for treatment of industrial areas
	Silt removal devices	Manhole or other devices to remove silt	No	Not be necessary as silt loading would be expected to be low.
Infiltration	Soakaways	Sub-surface storage and infiltration systems	Consider	Infiltration potential will be dependent on the permeability of the underlying soils; site investigation will be required to confirm this.
	Infiltration trenches	Similar to filter drains but allow infiltration through trench bases and sides		
	Infiltration basins	Depressions that store and dispose of water via infiltration		
Open Channel	Swales / cut-off ditch	Shallow, vegetated channels to conduct or retain water and provide filtration (permitting infiltration when unlined).	No	Not suitable with proposed development layout and topography.
Wetland	Ponds	Depressions used for storing and treating water with permanent pool and marginal aquatic vegetation.	Yes	Provide treatment and amenity/biodiversity benefits. Area identified in the south-east corner of the site.
	Shallow pond or pocket wetland	Shallower ponds where runoff flows through aquatic / wetland vegetation for attenuation and filtration but which may dry out	No	Require continuous through-flow of water and/or high groundwater levels which may not be present on the site.
Other	Pipes and subsurface storage	Conduits and accessories as conveyance measures and/or storage. Can be combined with sedimentation and filter media systems	Yes	Oversized pipes, box culvert units or crate storage systems could be utilised to provide below-ground attenuation storage.

Overall the preferred method for disposal of surface water on the site should be by infiltration; the site geology however suggests that this is unlikely to be feasible. Notwithstanding this further investigations during the detailed design stage should be undertaken to confirm this to be the case (investigations will need

to include site specific permeability testing in accordance with BRE Digest 365 Soakaway Design). If infiltration is found to be viable, even if at a limited number of locations then the following could specifically be included by the design:

- Infiltration basin located in the south-east corner of the site;
- Use of permeable paving.

The following measures could specifically be included by the design where infiltration is demonstrated not to be feasible.

- Attenuation pond located in the south-east corner of the site with a discharge into the existing highway drainage system serving the A41 (which is the outfall from the existing site). Flows from the site would be controlled with by a hydrobrake flow control or orifice plate.
- Permeable paving incorporating an impermeable membrane below the drainage layer. The outfall from the system would be into the same existing highway drainage system referred to above.

The overall combination of measures to be incorporated will need to be confirmed during the detailed design stage.

5.4. Management of Exceedance Flows

For rainfall events that exceed the drainage design (1 in 30 year storm event) or modelled events up to and including the 1 in 100-Year event (plus climate change allowance), any water flooding from the surface water drainage system should be fully contained and managed within the site and not flood adjacent areas. Any overland flows should be controlled in a manner that will avoid flooding of property or vulnerable areas, plus ensure that depths and velocities involved are safe.

A number of design principles and careful planning techniques can utilise ground slope and landscape features, including bunds, roads and kerb features to safely route overland flows away from development, provide additional above-ground storage and ensure water does not pond or affect safety on the principal access routes of the site.

The detailed design stage for the site should refer to Table 13.1 of the Flood Risk Assessment Guidance for New Development: Phase 220. Low hazard overland flows are generally considered to be those with a depth of less than 250mm and a velocity less than 0.5m/s.

[20] Environment Agency & DEFRA (2006): Flood Risk Assessment Guidance for New Development- Phase 2 Framework and Guidance for Assessing and Managing Flood Risk for New Development.

6. Mitigation and Residual Flood Risks

6.1. Flood Risks Scoped Out

- **Coastal, Tidal and Estuarine Flood Risk:**
  The site lies entirely inland and is not hydraulically linked or under the influence of coastal or tidal factors. The site is therefore not at risk of flooding from tidal, coastal or estuarine flood risks.

- **Infrastructure Flood Risk - Canals:**
  The nearest canal to the site is the Oxford Canal located approximately 8km to the west. Local topography is such that this does not affect flood risk on the site.

- **Infrastructure Flood Risk – Reservoirs:**
  There are no raised reservoirs in Bicester that would affect the proposed development site in the event of their failure.

- **Infrastructure Flood Risk – Flood Defences:**
  The EA have indicated that there are no formal flood defence structures in the immediate area that are maintained by the Agency.

- **Infrastructure Failure Risk – Culvert Blockages:**
  The closest culvert is 65m to the east where an ordinary watercourse crosses the A41 Oxford Road. Given the topography of the area and the extents of Flood Zones 2 and 3a, it is anticipated that a culvert blockage would not cause flooding on the site.

- **Fluvial (River) Flood Risk:**
  The EA flood risk map indicates that the site is located wholly within Flood Zone 1. The floodplain (Flood Zones 2 and 3) associated with the Gagle Brook is located approximately 250m from the site. The floodplain (Flood Zones 2 and 3) associated with the Langford Brook is located approximately 200m from the site. From correspondence received from the EA no concerns have been raised in relation to fluvial flooding. Hence in line with NPPF, there is a low probability (<0.1% AEP) of fluvial flooding on the site. This flood risk can therefore be scoped out.

6.2. Identified Flood Risks and Mitigation

- **Climate Change**
  The drainage design and potential pluvial flood risks associated with the site will need to include allowances for climate change in terms of increased peak rainfall intensities and increased peak river levels according to Table 3 of the NPPF.

- **Overland Flow Risk**
  In order to manage the risk associated with the increased volume of overland flow from the development, a suitable surface water drainage strategy must be prepared. Adequate provision for the control of surface water run-off will be needed in order to compensate for the loss of permeable surfaces as a result of development and also prevent any flood risk to adjacent sites.

  As part of the detailed surface water management strategy a review of adjacent highway drainage should be carried out to ensure that in extreme and exceedance events there is no increase in overland flood risk to the site. In the first instance infiltration should be considered as the principal means of disposing surface water from the site. Should this be discounted then SuDS measures should be incorporated into the design of drainage systems to attenuate surface water runoff so as

not to exceed the existing Greenfield runoff rate from the site. By maintaining existing discharge rates and location this will ensure that there will be no increase in flood risk to adjacent sites.

6.3. Residual Flood Risk

The risks remaining after applying the sequential approach and taking mitigating actions are known as the residual risks.

Overland flow will pose a residual flood risk for the site. Sufficient measures will need to be taken to ensure that any exceedance flows from the site and adjacent developments can be managed in an extreme rainfall event. Exceedance flow is the excess flow that appears on the surface when the subsurface drainage systems reach capacity. Exceedance flows will be conveyed on the ground by surface flood pathways, these can be roads, paths or depressions in the landscape.

OCC have confirmed that there is sufficient capacity in the existing highway drainage system to receive the surface water runoff from the proposed development, based on an existing Greenfield discharge rate of 7.2l/s. There may be a residual flood risk from this existing drainage network in extreme events or if there is an infrastructure failure.

In order to manage the exceedance flow best practise should be followed as stated in section 5.4.

The assessment has demonstrated that the site is not at risk of groundwater flooding. Notwithstanding this the recent preliminary ground investigation indicates groundwater levels are generally in excess of 1m with the average depth being between 1.2m and 1.8m. Therefore, the risk of local groundwater flooding cannot be wholly scoped out as this would need monitoring to capture seasonal variation.

7. Application of Flood Risk Policy

7.1. National Planning Policy Framework (NPPF)

The broad aim of NPPF is to reduce the number of people and properties within the natural and built environment at risk of flooding. To achieve this aim, planning authorities are required to ensure that flood risk is adequately addressed during the initial planning stages of any development.

Responsibility for the assessment lies with the developers and they must demonstrate the following:

- Whether the proposed development is likely to be affected by flooding;
- Whether the proposed development will increase flood risk to adjacent properties; and
- That the measures proposed to deal with any residual flood risks are sustainable.

The developer must prove to the LPA and the EA that any existing flood risk or flood risk associated with the proposed development can be satisfactorily managed.

7.2. Vulnerability Classification

The vulnerability of the development land use must be taken into account as the consequences of flooding may not be acceptable for particular types of development. The NPPF defines the 'Flood Risk Vulnerability' classification (Table 2 in the NPPF Technical Guide) based on the intended use of a proposed development site. The vulnerability of the development has been classified as 'more vulnerable' as it is predominantly residential. The retail units would be classified as 'less vulnerable'.

7.3. Sequential Test

The NPPF states that the risk-based Sequential Test should be applied at all stages of planning. Its aim is to steer new development to areas at the lowest probability of flooding. Development should be directed to areas within Flood Zone 1 wherever possible and, if this is not possible, then sequentially direct development to areas least at risk within Flood Zones 2 and the Flood Zone 3.

Table 5. Flood Risk Vulnerability and Flood Zone Development Compatibility

Flood Zone	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone 1	✔	✔	✔	✓	✔
Flood Zone 2	✔	✔	Exception test required	✓	✔
Flood Zone 3a	Exception test required	✔	✗	Exception test required	✔
Flood Zone 3b	Exception test required	✔	✗	✗	✗

Key: ✗ Development is not appropriate; ✔ Development is appropriate

The proposed development site has been identified within the 'less vulnerable' category as shown in Table 5. This confirms development in Flood Zone 1 is suitable.

The flood risk assessments made in Section 4 have identified that the site lies entirely within Flood Zone 1. Therefore the site passes the Sequential Text and the Exception Test is not necessary for this development. However, the residual flood risks should also be considered in site design.

7.4. Application of the Exception Test

As the site lies wholly within Flood Zone 1 and the Sequential Test was passed, the Exception Test is not required.

8. Conclusions & Recommendations

8.1. Conclusions

The proposed development site has been reviewed for various forms of flood risk, as recognised by the NPPF. Flood risks that have been scoped out at this stage include: coastal, tidal and estuarine flood risks, canals, reservoirs, flood defences, fluvial (river) flood risks and culvert blockages. Those which after mitigation propose a residual risk include: overland flow risk, groundwater flooding and artificial infrastructure failure. Appropriate oversizing of attenuation SuDS in accordance with Table 3 should appropriately mitigate the expected effects of climate change.

Oxfordshire County Council have agreed that a connection into the existing highway drainage is acceptable as long as the rate of discharge is limited to the existing Greenfield run-off rate of 7.2l/s.

A number of SuDS techniques have been considered to attenuate the additional surface water run-off that will be generated from the proposed development. The most suitable approach would be the provision of storage ponds or detention basins along the eastern boundary of the site, refer to Appendix A.1 for further details. The existing geology suggests that the potential to use infiltration on the site is likely to be low.

In line with the NPPF guidance, the flood risk assessments made in section 4 have identified that the site lies entirely in Flood Zone 1. Therefore the site passes the Sequential Test and the Exception Test is not considered necessary for this development.

8.2. Recommendations

As a result of this assessment, it is recommended that:

- A ground investigation scheme should be commissioned to confirm ground conditions on the site; the scheme should include insitu permeability tests to confirm the viability of infiltration techniques.
- A drainage strategy and surface water management plan should be developed to manage run-off from the development. The plan shall demonstrate the use of SuDS and ensure that run-off from the site is not discharged into the existing highway drainage system at a rate greater than 7.2l/s.
- Future changes due to climate change should be considered in all storage features.
- Exceedance flows should be fully contained and managed within the site up to the 1 in 100 plus climate change storm event so as not to cause flooding elsewhere with reference to Table 13.1 of the Flood Risk Assessment Guidance for New Development: Phase 2.
- The EA's Pollution Prevention Guidelines should be followed during the detailed design and construction process to ensure that the risks of pollution to groundwater and/or surface water features is minimised or avoided entirely.
- An undeveloped buffer zone is established along the western boundary to contain SuDS features.
- The completion of EA's pro-forma for development over 1ha (included within Appendix D.2).

8.2.1. Residual Flood Risk Management

The residual flood risk will need to be considered in the drainage strategy for the site. It is recommended that a management train of SuDS features is provided on the site.

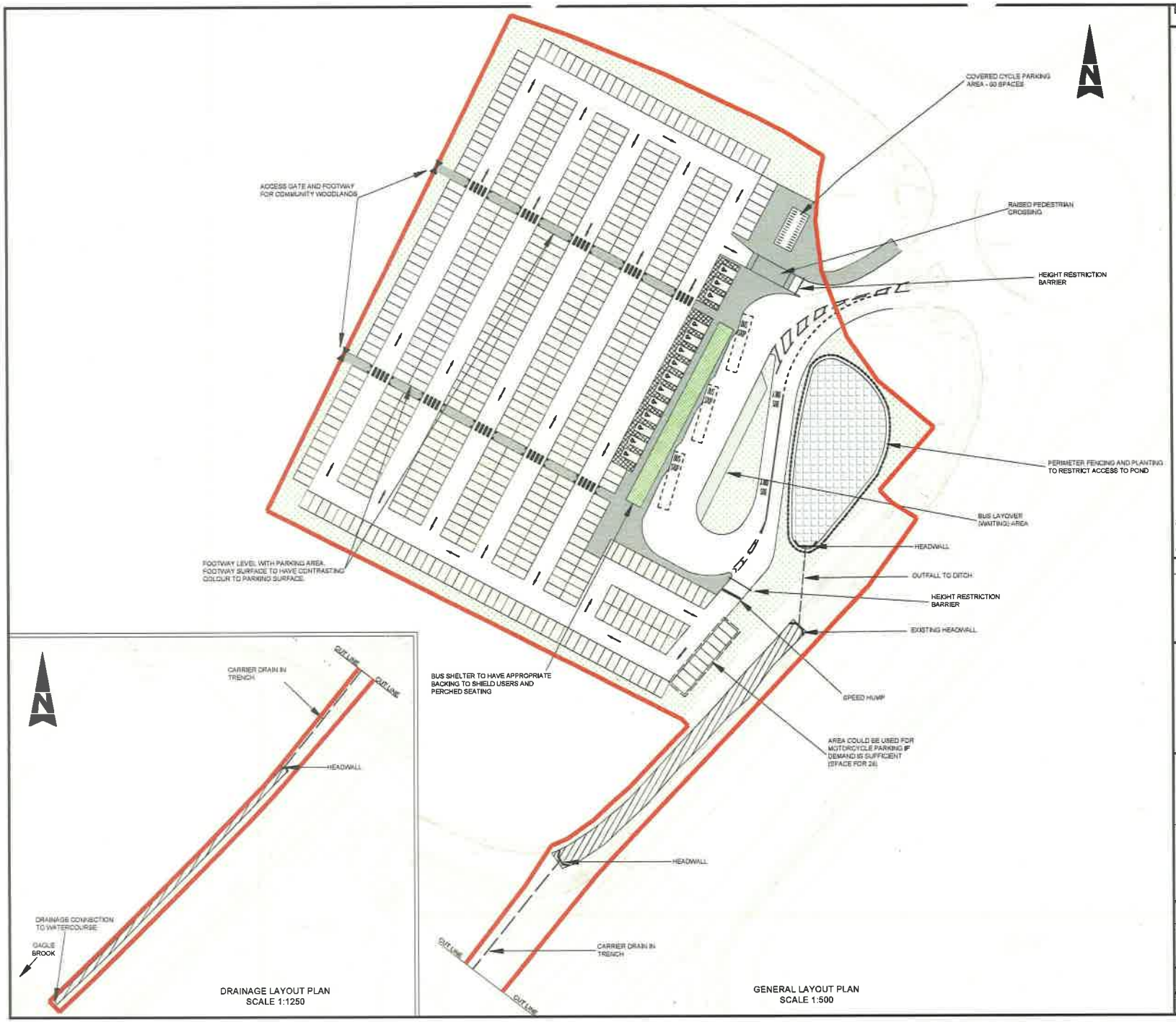
With appropriate design and mitigation measures, in conjunction with a drainage strategy for the site, the flood risk will be low and exceedance events manageable. Therefore, further analysis via a Level 3 FRA is not necessary.

Appendices

Appendix A. **Site Information**

A.1. Proposed Site Development and Location Plan

- Proposed General Arrangement: 5124607/BIC/FEA/010



Drawing No. 5124607/BIC/FEA/010 | Revision 1

KEY

- APPLICATION BOUNDARY
- PEDESTRIAN FOOTWAY
- SOFT LANDSCAPING
- ATTENUATION POND
- EXISTING DITCH TO BE CLEARED AND RE-GRADED
- POROUS PAVEMENT
- BOLLARD

Rev.	Date	Purpose of revision	Drawn	Checked	Approved
0	30/10/13	FOR INFORMATION	MJG	AL	SRH
1	31/10/13	FOR INFORMATION	MJG	AL	SRH

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Project title
BICESTER REMOTE
PARK AND RIDE

Drawing title
DEVELOPMENT PROPOSAL -
GENERAL ARRANGEMENT

Drawing Status: FEASIBILITY

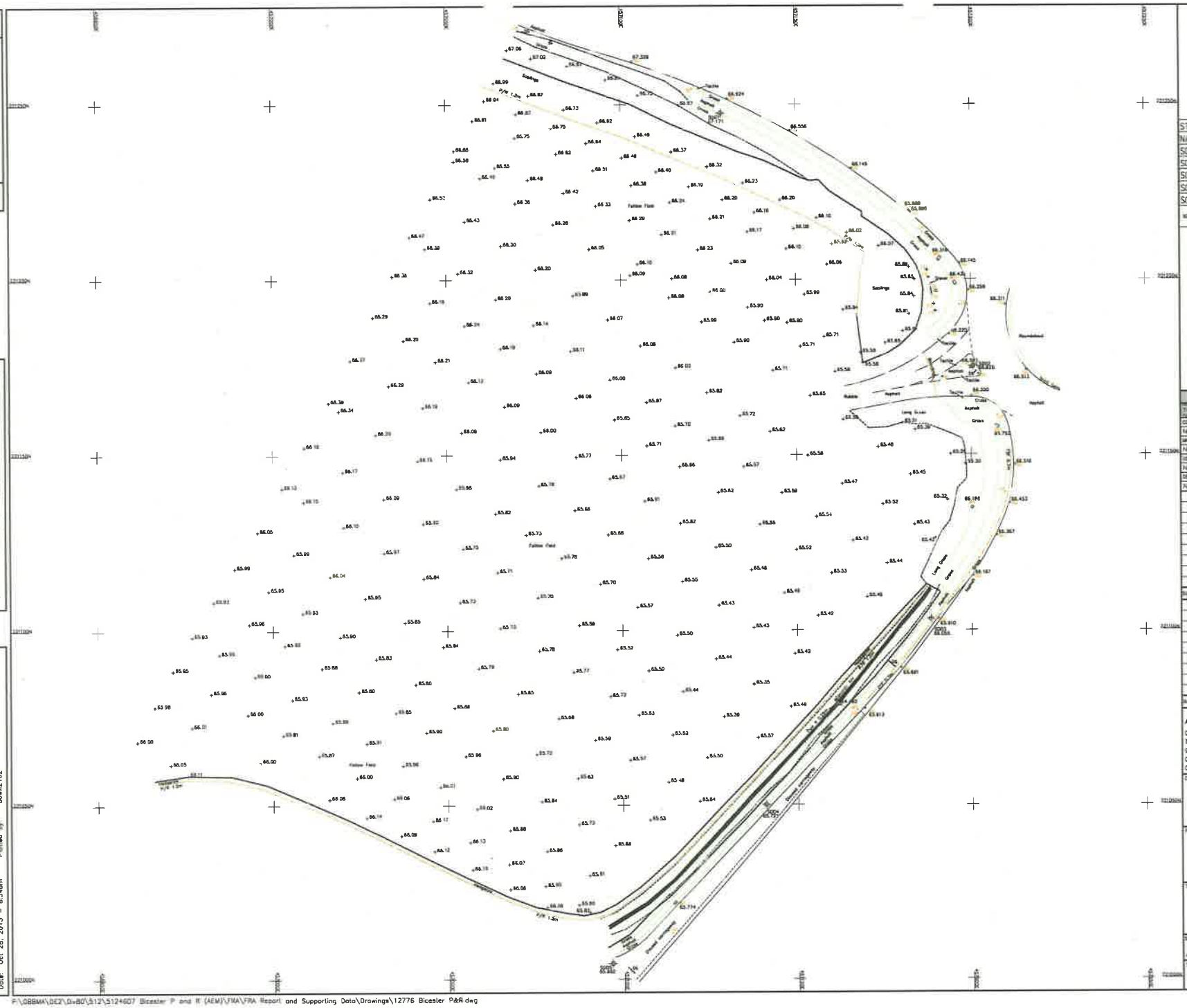
Scale @ A1	Drawn by	Checked by	Approved by
VARIOUS	MJG	AL	SRH
	Date drawn 23/10/13	Date checked 30/10/13	Date approved 30/10/13

Oxfordshire Project No. & File Ref: 5124607

Drawing No. 5124607/BIC/FEA/010 | Revision 1

A.2. Topographical Survey

- 2D Topographical Survey with Annotated Levels – Drawing Number 5124607/520/TP/TG/PL01
- Existing Site Features – Drawing Number 5124607/FRA/001



Rev -

Status AB

Drawing Number 5124607/520/TP/TG/PL01

DO NOT SCALE

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File: 12776 Bicester P&R.dwg

Date: Oct 28, 2013 - 8:54am

Plotted by: down2162

ATKINS

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S003	457188.266	221103.109	66.055
S004	457140.790	221049.976	65.721
S005	457096.626	221004.588	65.662

NOTE: CO-ORDINATES & LEVELS ARE RELATED TO THE OS NATIONAL GRID & DATUM

SURVEY LEGEND

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING SIGNIFICANT RESIDUAL RISKS:

CONSTRUCTION
NONE

MAINTENANCE/CLEANING
NONE

USE
NONE

DECOMMISSIONING/DEMOLITION
NONE

Rev	Purpose of Issue	Date	Auth

Rev	Description	By	Date	Chk'd	Auth

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Client: OXFORD CITY COUNCIL

Project: BICESTER PARK & RIDE

Title: 2D TOPOGRAPHICAL SURVEY WITH ANNOTATED LEVELS

Sheet Size	Original Scale	Designed/Drawn	Checked	Authorised
A1	1 500	JJA Date 23/08/13	BJM Date 23/08/13	HHS Date 23/08/13

Status: AB

Drawing Number: 5124607/520/TP/TG/PL01

Rev -

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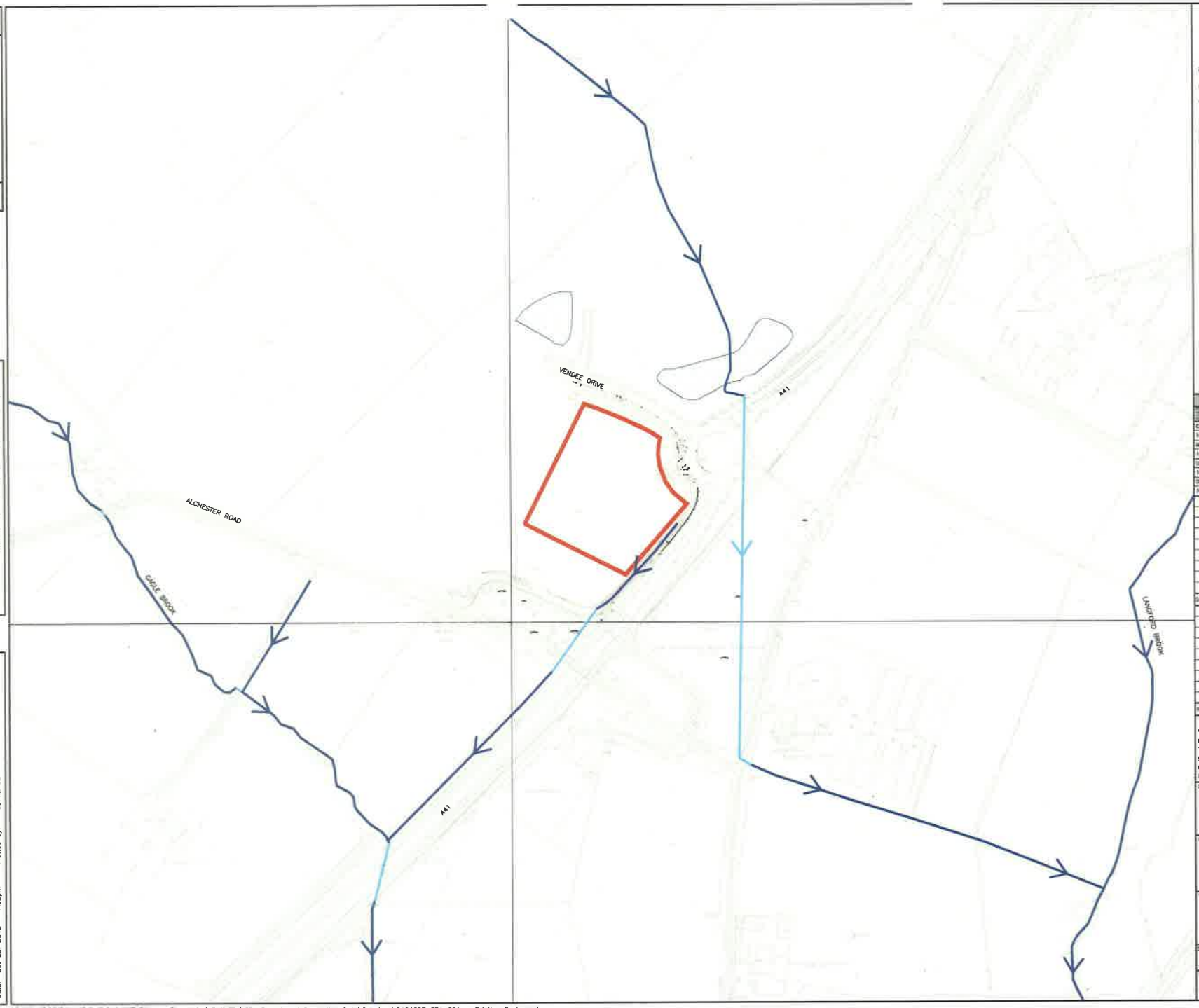

ATKINS

KEY

- PROPOSED PLANNING BOUNDARY
- EXISTING WATERCOURSE
- EXISTING CULVERTED WATERCOURSE
- EXISTING POND (TAKEN FROM THAMES WATER'S RECORDS)

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

CONSTRUCTION
NONE
USE
NONE
DECOMMISSIONING/DEMOLITION
NONE

Status	Rev	Purpose of issue	Date	Auth

Rev	Description	By	Date	Chk'd	Auth

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Client
OXFORD CITY COUNCIL

Project
BICESTER PARK & RIDE

Title
EXISTING SITE FEATURES

Sheet Size	Original Scale	Designed/Drawn	Checked	Authorised
A1	1:2000	JD Date 25/10/13	AR Date 25/10/13	Date

Status	Drawing number	Rev
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Status AB
Drawing Number 5124607/FRA/001
Rev -

DO NOT SCALE

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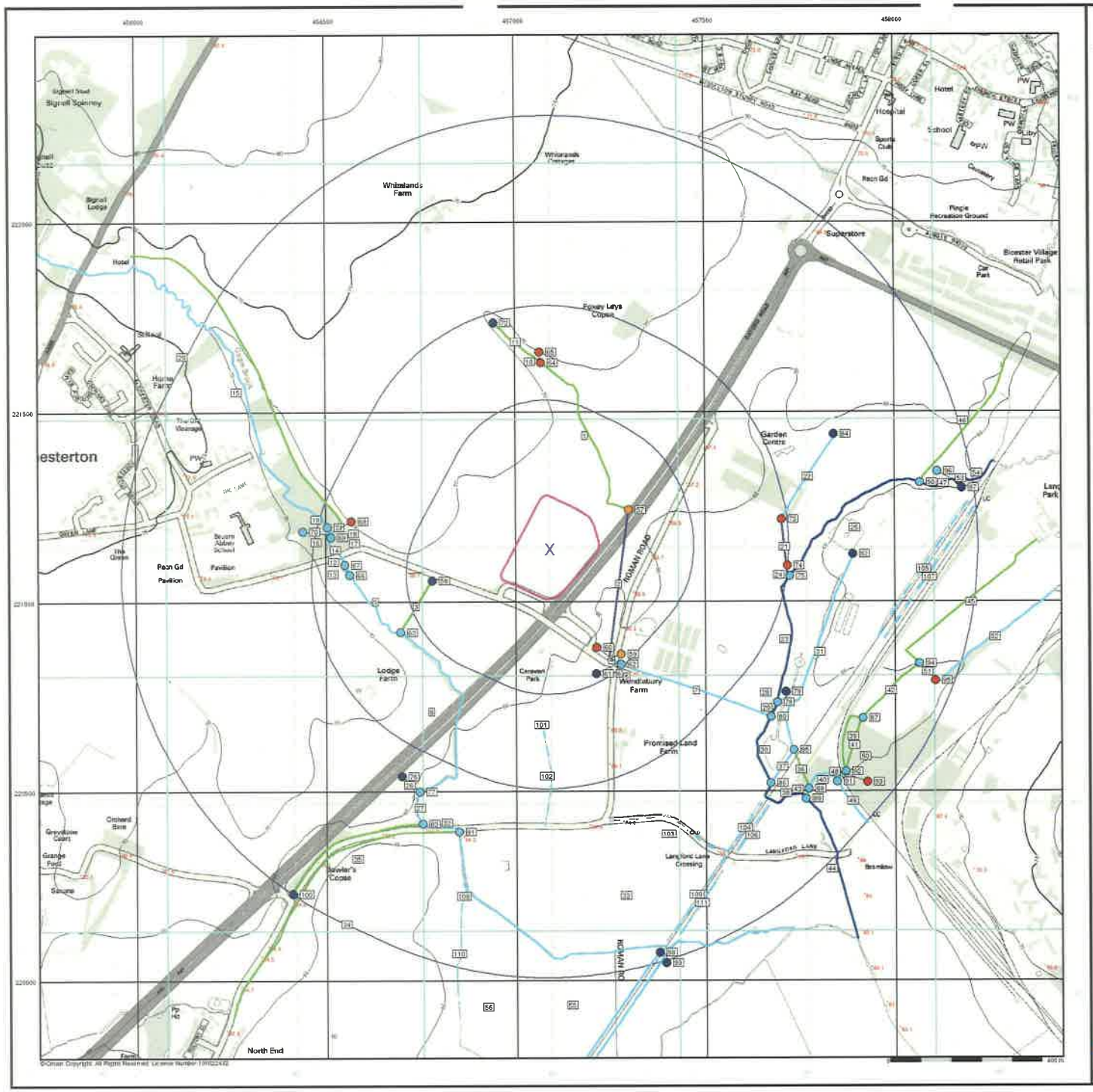
A.3. Hydrological Features

- EA Detailed River Network Map – Envirocheck Flood Screening Report (August 2013)



ATKINS

EA Detailed River Network Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID

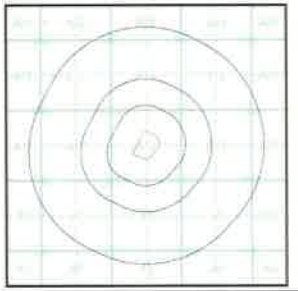
EA Detailed River Network Data

- Primary River
- Secondary River
- Tertiary River
- Canal
- Canal Tunnel
- Undefined River
- Lake/Reservoir
- Extended Culvert (greater than 50m)
- Underground River (inferred)
- Underground River (local knowledge)
- Downstream of High Water Mark
- Downstream of Seaward Extension
- Not assigned River feature
- Source
- Junction
- Sink
- Non-interactive Node
- Offline Drainage Feature
- Not assigned River feature
- Pseudo Node (general)
- Pseudo Node (High Water Mark)
- Pseudo Node (OS MasterMap polygon boundary)

Contours (height in metres)

Standard Contour
Index Contour
167.3 Spot Height
45.8 Air Height

EA Detailed River Network Map - Slice A



Order Details

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Customer Ref:	5124607.500
National Grid Reference:	457090, 221140
Slice:	A
Site Area (Ha):	4.4
Search Buffer (m):	1000

Site Details

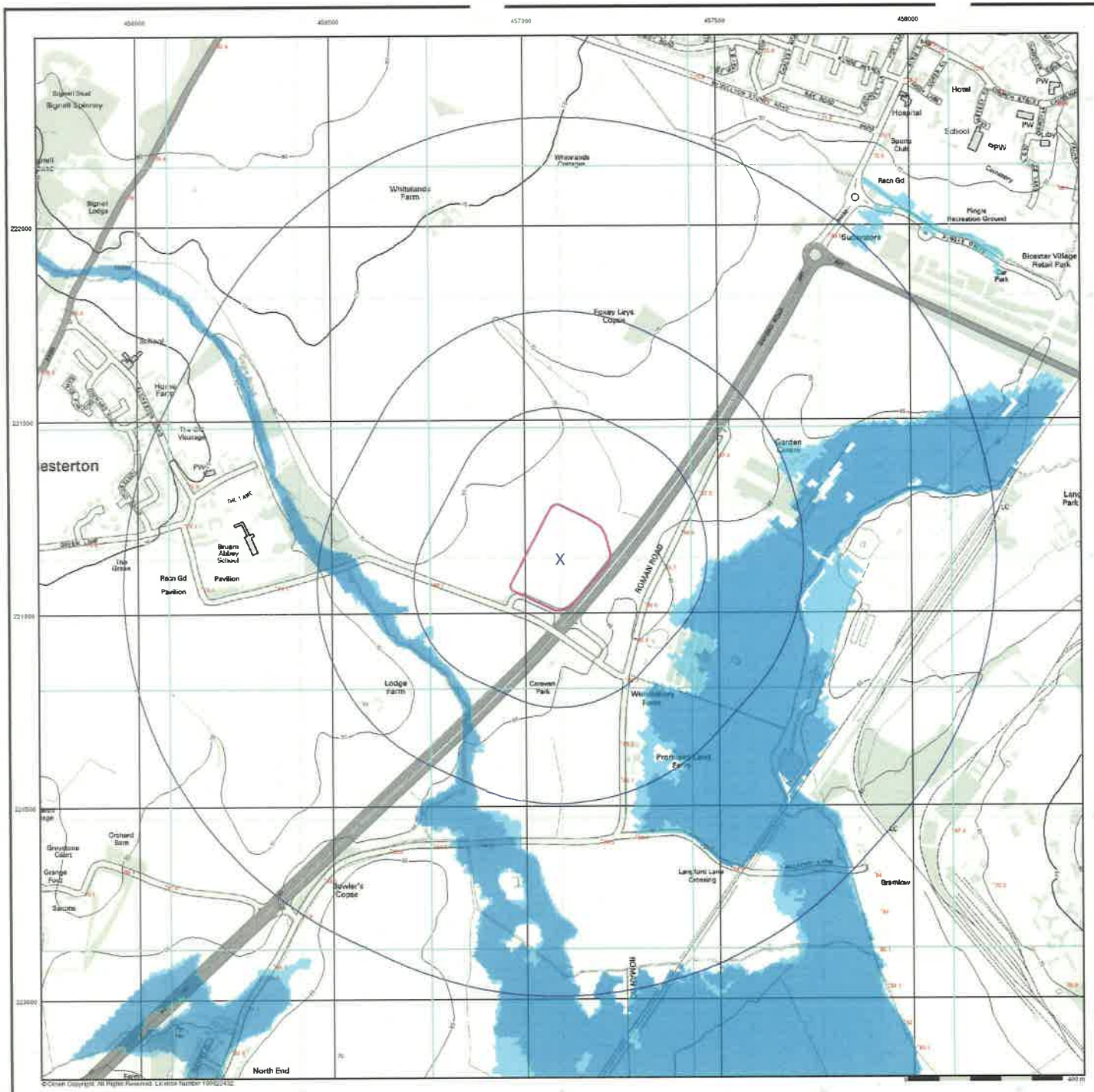
Site at 457100, 221130

Landmark
Tel 0844 844 9952
Fax 0844 844 9951
Web www.envirocheck.co.uk

Appendix B. **Flood Maps**

B.1. EA Flood Zone Maps

- EA Flood Data Map – Envirocheck Flood Screening Report (August 2013)
- EA National Flood Risk Assessment Map – Envirocheck Flood Screening Report (August 2013)
- EA Historic Flood Map – Envirocheck Flood Screening Report (August 2013)



ATKINS

EA Flood Data Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

Environment Agency Flood Data

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Contours (height in metres)

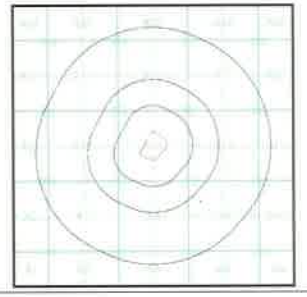
Standard Contour

Index Contour

Spot Height

Air Height

EA Flood Data Map - Slice A



Order Details

Order Number:	48704280_1_1
Customer Ref:	5124607.500
National Grid Reference:	457090, 221140
Slice:	A
Site Area (Ha):	4.4
Search Buffer (m):	1000

Site Details

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Tel 0844 844 9952
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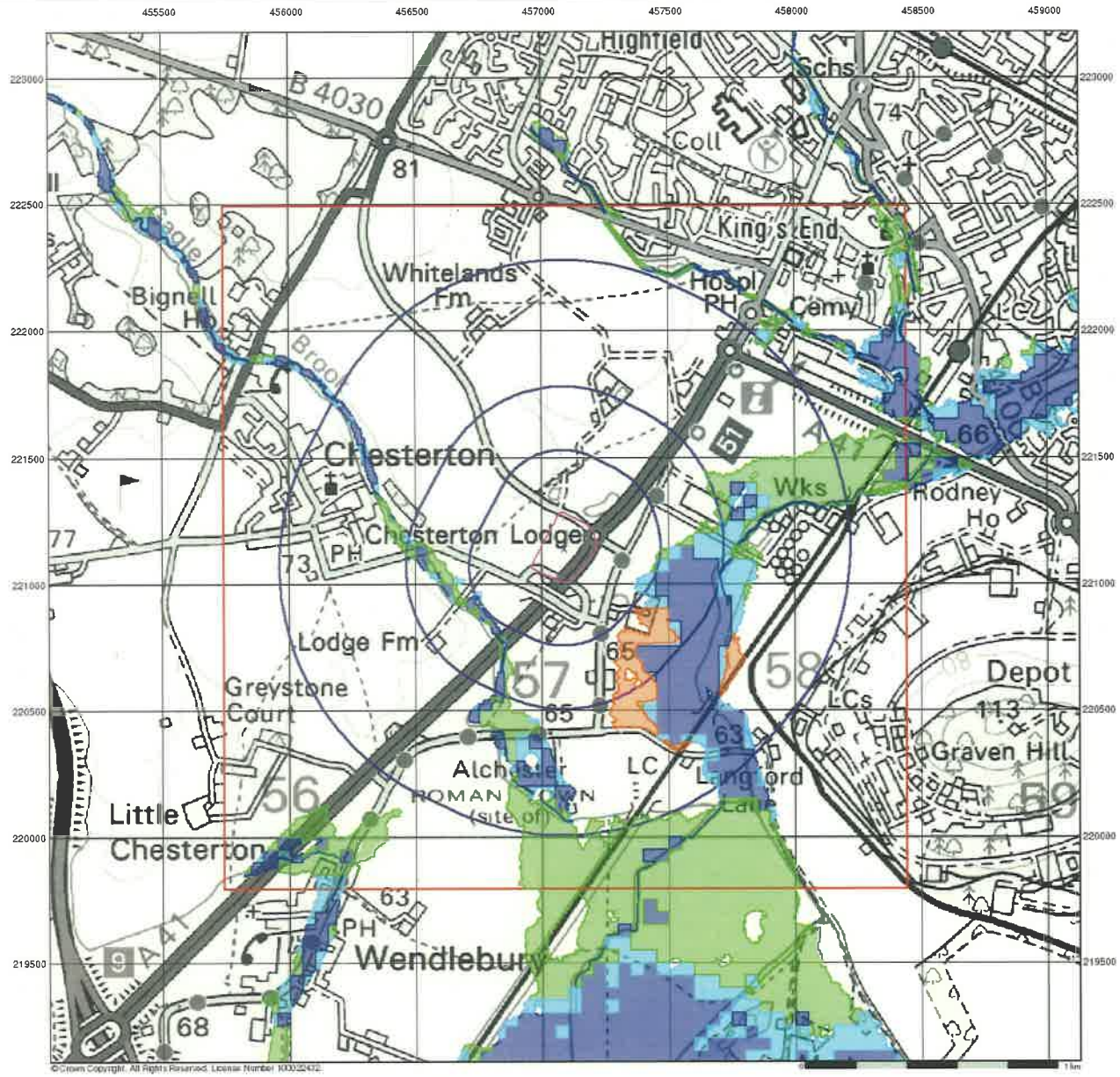
Web www.envirocheck.co.uk



ATKINS

EA NaFRA Data (1:50,000)

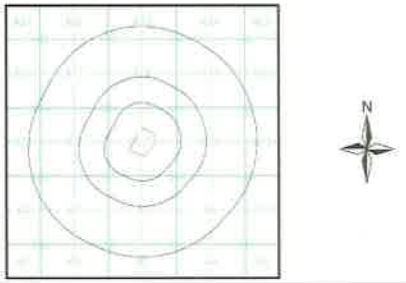
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

National Flood Risk Assessment (NaFRA)

- Significant Risk
- Moderate Risk
- Low Risk
- No Result

EA NaFRA Data Map - Slice A



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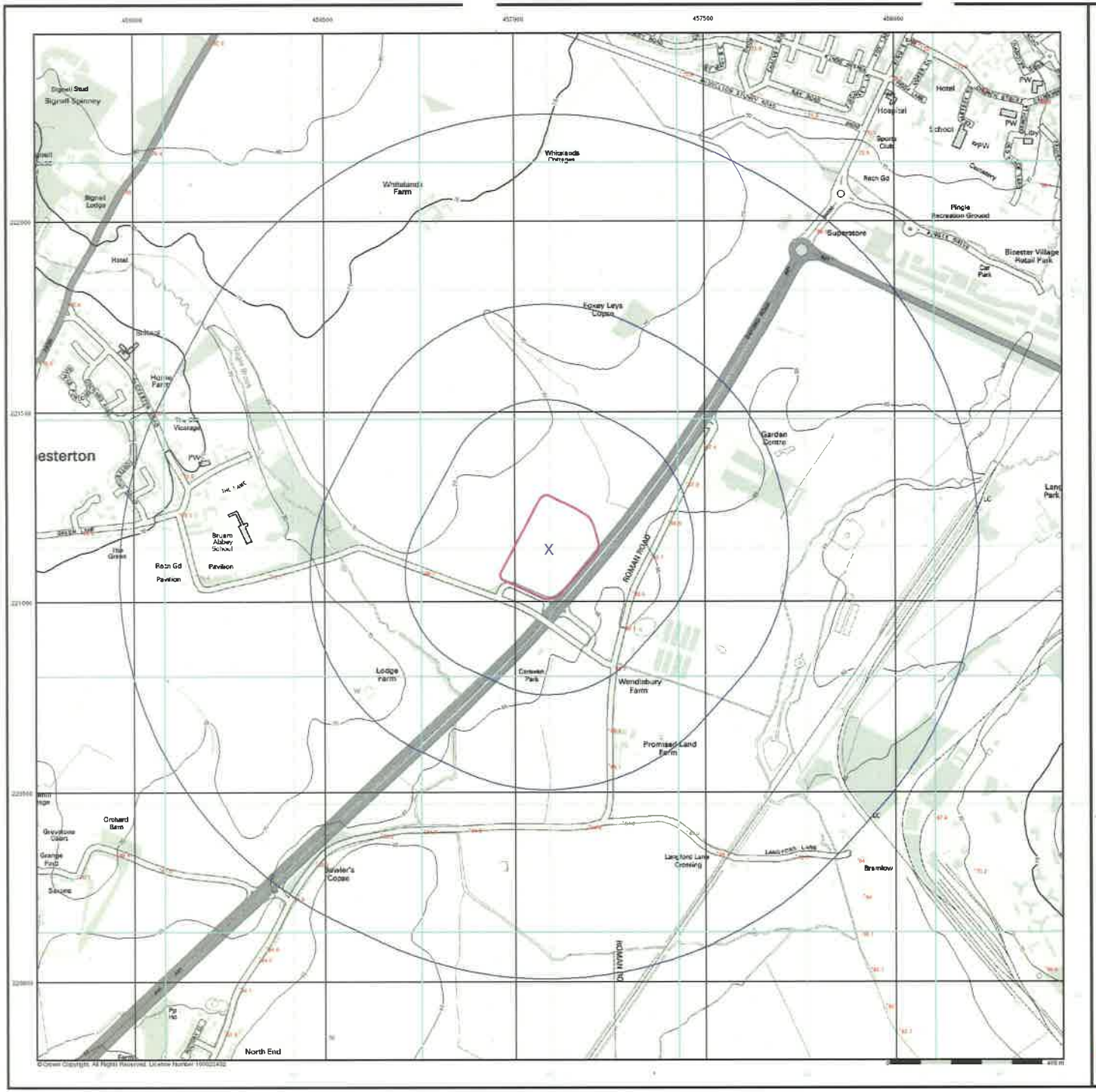
Search Buffer (m):	1000

Site Details

Site at 457100, 221130

Landmark Information
Tel 0844 844 9952
Fax 0844 844 9951
Web www.envirocheck.co.uk



ATKINS

EA Historic Flood Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID

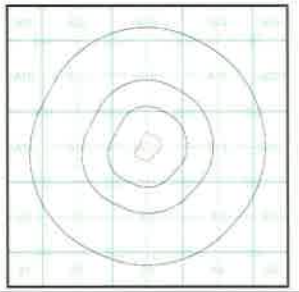
EA Historic Flood Events Data

- Channel Capacity Exceeded (no raised defences)
- Groundwater/High Water Table
- Local Drainage/Surface Water
- Mechanical Failure
- Obstruction/Blockage - Bridge
- Obstruction/Blockage - Channel
- Obstruction/Blockage - Culvert
- Obstruction/Blockage - Debris Screen
- Operational Failure/ Breach of Defence
- Other
- Overtopping of Defences
- Unknown
- Historical Flood Liabilities

Contours (height in metres)

Standard Contour
Index Contour
Spot Height
Air Height

EA Historic Flood Map - Slice A



Order Details

Order Number:	48704280_1_1
Customer Ref:	5124607.500
National Grid Reference:	457090, 221140
Slice:	A
Site Area (Ha):	4.4
Search Buffer (m):	1000

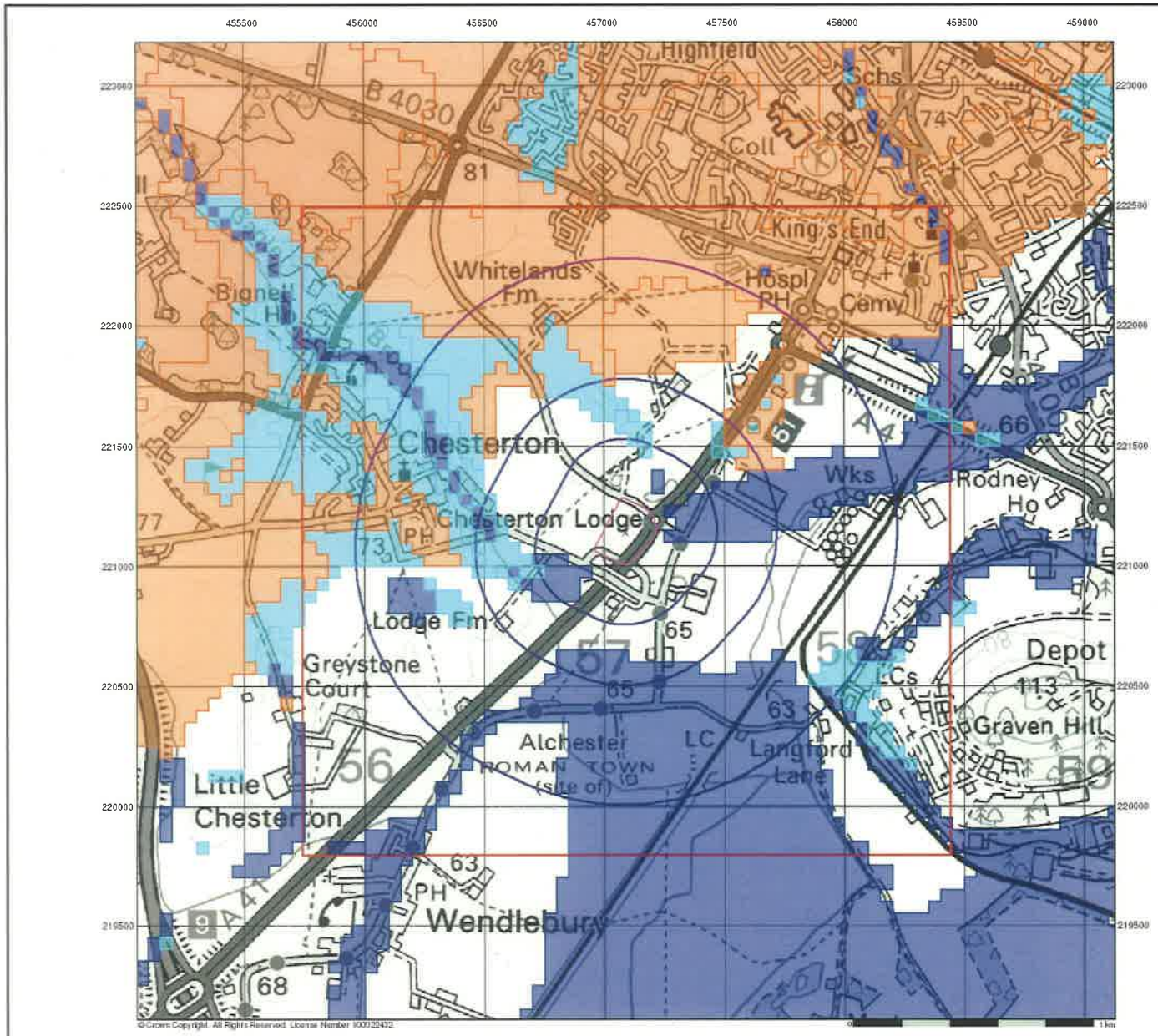
Site Details

Site at 457100, 221130

Landmark
Tel 0844 844 9952
Fax 0844 844 9951
Web www.envirocheck.co.uk

B.2. BGS Groundwater Flooding Susceptibility Data

- BGS Groundwater Flooding Susceptibility – Envirocheck Flood Screening Report (August 2013)
- BGS Geological Indicators of Flooding – Envirocheck Flood Screening Report (August 2013)



ATKINS

BGS Flood Data (1:50,000)

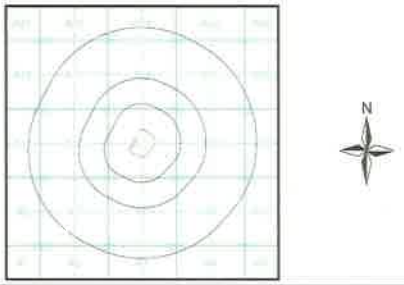
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

BGS Groundwater Flooding Susceptibility

- Potential for Groundwater Flooding to Occur at Surface
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Limited Potential for Groundwater Flooding to Occur

BGS Flood Data Map - Slice A



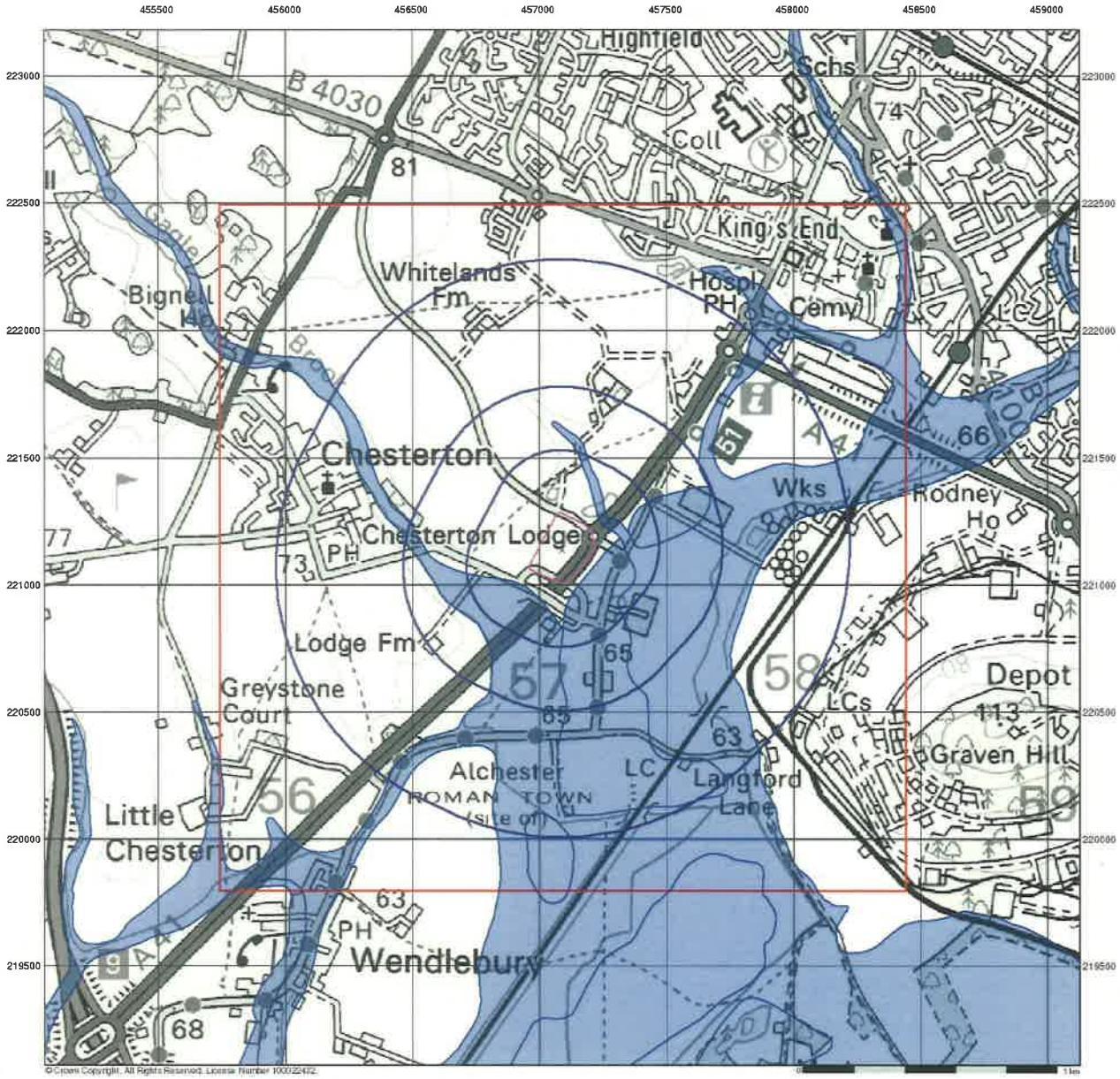
Order Details

Order Number:	48704280_1_1
Customer Ref:	5124607.500
National Grid Reference:	457090, 221140
Slice:	A
Site Area (Ha):	4.4
Search Buffer (m):	1000

Site Details

Site at 457100, 221130

Landmark
Tel 0844 844 9952
Fax 0844 844 9951
Web www.envirocheck.co.uk



ATKINS

BGS Flood Data (1:50,000)

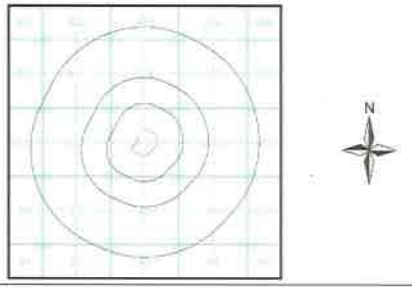
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

BGS Geological Indicators of Flooding

- Coastal
- Inland
- Bodies of Water

BGS Flood Data Map - Slice A



Order Details

Order Number:	48704280_1_1
Customer Ref:	5124607.500
National Grid Reference:	457090, 221140
Slice:	A
Site Area (Ha):	4.4
Search Buffer (m):	1000

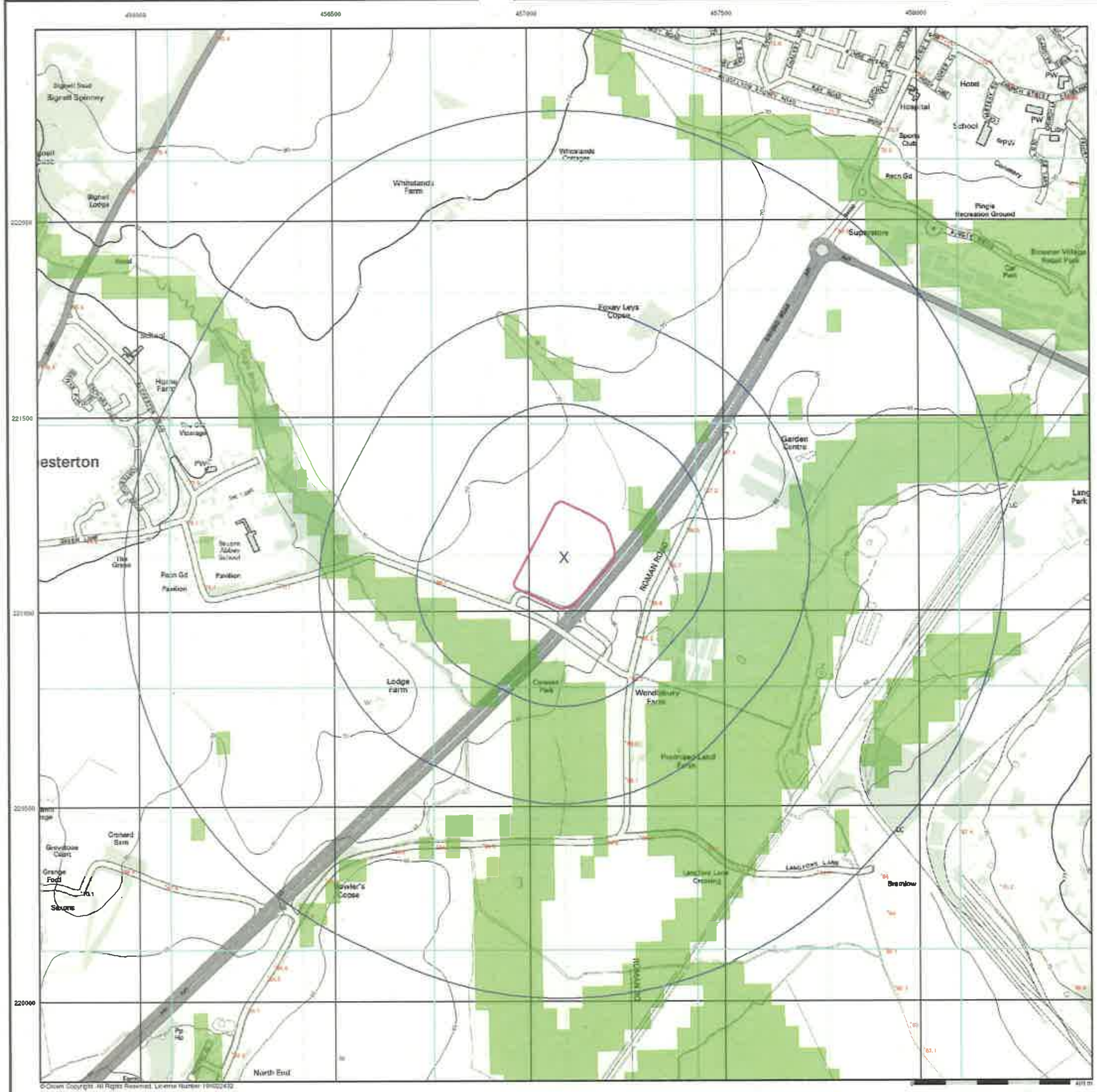
Site Details

Site at 457100, 221130

Landmark Information Group
Tel 0844 844 9952
Fax 0844 844 9951
Web www.envirocheck.co.uk

B.3. RMS 75, 100 and 1000 Year Flood Return Maps

- RMS 75 year Return Flood Map – Envirocheck Flood Screening Report (August 2013)
- RMS100 year Return Flood Map – Envirocheck Flood Screening Report (August 2013)
- RMS 1000 year Return Flood Map – Envirocheck Flood Screening Report (August 2013)



ATKINS

RMS 75 year Return Flood Map (1:10,000)

General

Specified Site

Specified Buffer(s)

X Bearing Reference Point

RMS 75 year Return Flood Data

Flood Depth (mm)	Defended Flood	Undefended Flood	Pluvial & Minor River Flood (flood depth n/a)
0 - 200			
201 - 500			
501 - 2000			
2001 +			

Flood Type

Contours (height in metres)

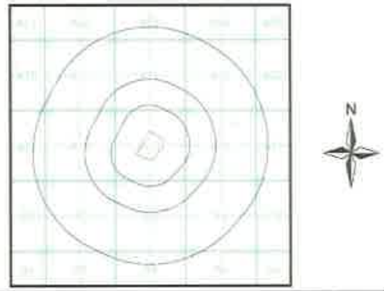
Standard Contour — 105

Index Contour — 100

·167.3 Spot Height

·45.8 Air Height

RMS 75 year Return Flood Map - Slice A



Order Details

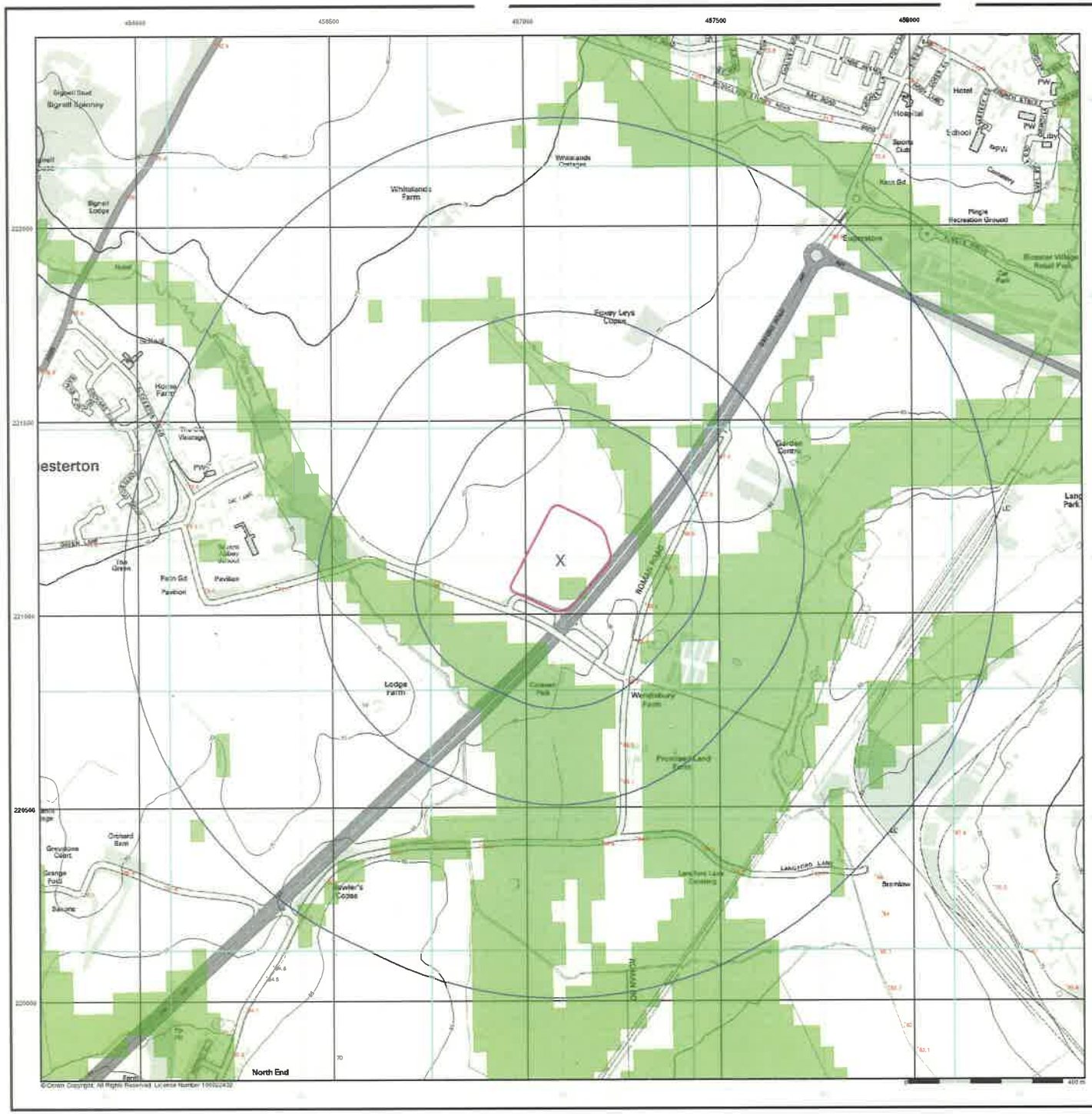
Order Number: 48704280_1_1
Customer Ref: 5124607.500
National Grid Reference: 457090, 221140
Slice: A
Site Area (Ha): 4.4
Search Buffer (m): 1000

Site Details

Site at 457100, 221130

Landmark Information Group

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



ATKINS

RMS 100 year Return Flood Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

RMS 100 year Return Flood Data

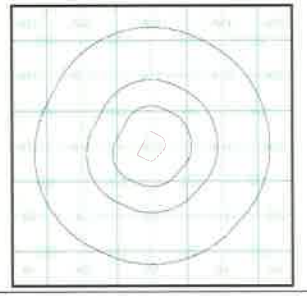
Flood Depth (mm)	Flood Type: Defended Flood	Flood Type: Undefended Flood	Pluvial & Minor River Flood (flood depth n/a)
0 - 200			
201 - 500			
501 - 2000			
2001 +			

Contours (height in metres)

Standard Contour — 167.3 Spot Height

Index Contour — 45.8 Air Height

RMS 100 year Return Flood Map - Slice A

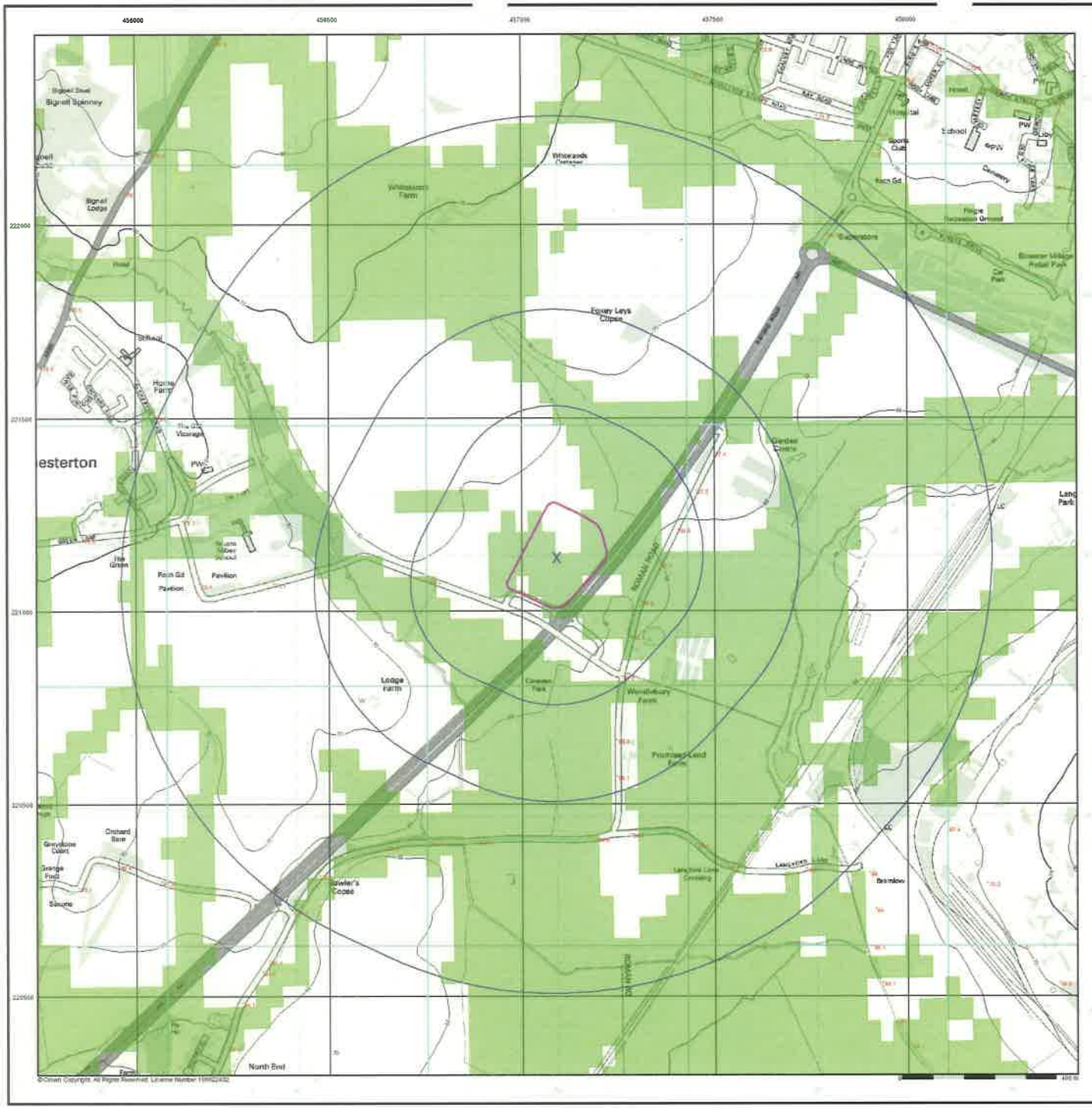


Order Details

Order Number:	48704280_1_1
Customer Ref:	5124607.500
National Grid Reference:	457090, 221140
Slice:	A
Site Area (Ha):	4.4
Search Buffer (m):	1000

Site Details

Site at 457100, 221130



ATKINS

RMS 1000 year Return Flood Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- X Bearing Reference Point

RMS 1000 year Return Flood Data

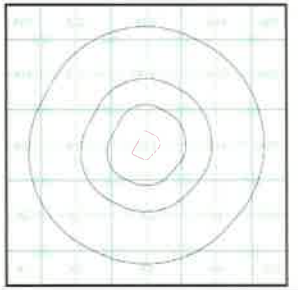
Flood Depth (mm)	Flood Type: Defended Flood	Flood Type: Undefended Flood	Pluvial & Minor River Flood (flood depth rule)
0 - 200			
201 - 500			
501 - 2000			
2001 +			

Contours (height in metres)

Standard Contour — 167.3 Spot Height

Index Contour — 45.8 Air Height

RMS 1000 year Return Flood Map - Slice A



Order Details

Order Number:	48704280_1_1
Customer Ref:	5124607.500
National Grid Reference:	457090, 221140
Slice:	A
Site Area (Ha):	4.4
Search Buffer (m):	1000

Site Details

Site at 457100, 221130

Landmark Information Group
Tel: 0844 844 9952
Fax. 0844 844 9951
Web: www.envirocheck.co.uk

Appendix C. **TW Existing Services**

C.1. Thames Water Development Sewer Records

A copy of the TW sewer records that were provided are included overpage:

Cascade Rainfall Details for Pond_JAV221013.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Cascade Model Details for Pond JAV221013.srcx

Storage is Online Cover Level (m) 65.900

Tank or Pond Structure

Invert Level (m) 64.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	510.0	1.400	1000.0	2.800	1000.0	4.200	1000.0
0.200	570.0	1.600	1000.0	3.000	1000.0	4.400	1000.0
0.400	635.0	1.800	1000.0	3.200	1000.0	4.600	1000.0
0.600	700.0	2.000	1000.0	3.400	1000.0	4.800	1000.0
0.800	770.0	2.200	1000.0	3.600	1000.0	5.000	1000.0
1.000	845.0	2.400	1000.0	3.800	1000.0		
1.200	920.0	2.600	1000.0	4.000	1000.0		

Hydro-Brake® Outflow Control

Design Head (m) 0.600 Hydro-Brake® Type Md5 SW Only Invert Level (m) 64.600
Design Flow (l/s) 7.2 Diameter (mm) 122

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	1.200	9.8	3.000	15.5	7.000	23.7
0.200	6.3	1.400	10.6	3.500	16.8	7.500	24.5
0.300	6.5	1.600	11.3	4.000	17.9	8.000	25.3
0.400	6.4	1.800	12.0	4.500	19.0	8.500	26.1
0.500	6.7	2.000	12.7	5.000	20.0	9.000	26.9
0.600	7.1	2.200	13.3	5.500	21.0	9.500	27.6
0.800	8.0	2.400	13.9	6.000	21.9		
1.000	9.0	2.600	14.4	6.500	22.8		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 0.125 Invert Level (m) 65.500

Cascade Summary of Results for Pond_JAV221013.srcx

	Upstream Structures	Outflow To	Overflow To
	CarPark_JAV221013.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	64.768	0.168	5.9	0.0	5.9	89.6	O K
30 min Summer	64.877	0.277	6.5	0.0	6.5	152.8	O K
60 min Summer	65.019	0.419	6.5	0.0	6.5	240.7	O K
120 min Summer	65.164	0.564	6.9	0.0	6.9	336.7	O K
180 min Summer	65.245	0.645	7.3	0.0	7.3	393.6	O K
240 min Summer	65.300	0.700	7.6	0.0	7.6	433.5	O K
360 min Summer	65.376	0.776	7.9	0.0	7.9	490.1	O K
480 min Summer	65.427	0.827	8.2	0.0	8.2	529.6	O K
600 min Summer	65.463	0.863	8.3	0.0	8.3	558.1	O K
720 min Summer	65.489	0.889	8.5	0.0	8.5	578.9	O K
960 min Summer	65.519	0.919	8.6	0.5	9.1	602.7	O K
1440 min Summer	65.525	0.925	8.6	0.8	9.5	607.8	O K
2160 min Summer	65.507	0.907	8.5	0.1	8.7	593.6	O K
2880 min Summer	65.475	0.875	8.4	0.0	8.4	567.9	O K
4320 min Summer	65.400	0.800	8.0	0.0	8.0	508.6	O K
5760 min Summer	65.320	0.720	7.7	0.0	7.7	448.4	O K
7200 min Summer	65.242	0.642	7.3	0.0	7.3	391.3	O K
8640 min Summer	65.167	0.567	6.9	0.0	6.9	338.7	O K
10080 min Summer	65.095	0.495	6.7	0.0	6.7	290.2	O K
15 min Winter	64.807	0.207	6.4	0.0	6.4	111.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	98.845	0.0	281.5	0.0	267
30 min Summer	64.348	0.0	386.2	0.0	332
60 min Summer	40.054	0.0	549.0	0.0	414
120 min Summer	24.199	0.0	672.0	0.0	476
180 min Summer	17.830	0.0	746.3	0.0	518
240 min Summer	14.293	0.0	799.4	0.0	562
360 min Summer	10.445	0.0	877.3	0.0	644
480 min Summer	8.357	0.0	934.9	0.0	728
600 min Summer	7.025	0.0	979.4	0.0	810
720 min Summer	6.094	0.0	1014.3	0.0	892
960 min Summer	4.866	0.0	1059.1	4.1	1048
1440 min Summer	3.540	0.0	1044.1	10.1	1352
2160 min Summer	2.572	0.0	1313.3	0.9	1752
2880 min Summer	2.050	0.0	1385.6	0.0	2136
4320 min Summer	1.487	0.0	1474.3	0.0	2908
5760 min Summer	1.183	0.0	1575.2	0.0	3680
7200 min Summer	0.990	0.0	1631.3	0.0	4440
8640 min Summer	0.856	0.0	1673.2	0.0	5216
10080 min Summer	0.757	0.0	1699.5	0.0	5984
15 min Winter	98.845	0.0	323.4	0.0	281

Cascade Summary of Results for Pond_JAV221013.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	64.946	0.346	6.5	0.0	6.5	194.6	O K
60 min Winter	65.105	0.505	6.7	0.0	6.7	297.1	O K
120 min Winter	65.260	0.660	7.4	0.0	7.4	404.5	O K
180 min Winter	65.347	0.747	7.8	0.0	7.8	468.3	O K
240 min Winter	65.406	0.806	8.1	0.0	8.1	513.0	O K
360 min Winter	65.486	0.886	8.4	0.0	8.4	576.6	O K
480 min Winter	65.533	0.933	8.7	1.3	10.0	614.6	O K
600 min Winter	65.556	0.956	8.8	2.8	11.6	633.8	O K
720 min Winter	65.571	0.971	8.8	4.0	12.8	645.6	O K
960 min Winter	65.585	0.985	8.9	5.3	14.1	657.2	O K
1440 min Winter	65.582	0.982	8.9	5.0	13.9	654.8	O K
2160 min Winter	65.568	0.968	8.8	3.8	12.6	643.4	O K
2880 min Winter	65.546	0.946	8.7	2.1	10.8	625.2	O K
4320 min Winter	65.453	0.853	8.3	0.0	8.3	550.2	O K
5760 min Winter	65.331	0.731	7.7	0.0	7.7	456.8	O K
7200 min Winter	65.215	0.615	7.2	0.0	7.2	372.5	O K
8640 min Winter	65.103	0.503	6.7	0.0	6.7	295.8	O K
10080 min Winter	64.989	0.389	6.5	0.0	6.5	221.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	64.348	0.0	439.2	0.0	370
60 min Winter	40.054	0.0	620.7	0.0	432
120 min Winter	24.199	0.0	758.4	0.0	484
180 min Winter	17.830	0.0	841.6	0.0	532
240 min Winter	14.293	0.0	900.9	0.0	576
360 min Winter	10.445	0.0	987.5	0.0	658
480 min Winter	8.357	0.0	1051.0	13.0	714
600 min Winter	7.025	0.0	1100.4	36.8	770
720 min Winter	6.094	0.0	1139.1	57.0	834
960 min Winter	4.866	0.0	1186.8	83.7	982
1440 min Winter	3.540	0.0	1175.2	100.8	1276
2160 min Winter	2.572	0.0	1479.9	74.2	1708
2880 min Winter	2.050	0.0	1562.4	35.4	2164
4320 min Winter	1.487	0.0	1665.0	0.0	3068
5760 min Winter	1.183	0.0	1780.1	0.0	3880
7200 min Winter	0.990	0.0	1846.2	0.0	4688
8640 min Winter	0.856	0.0	1896.6	0.0	5512
10080 min Winter	0.757	0.0	1930.9	0.0	6264

Cascade Rainfall Details for Pond_JAV221013.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Cascade Model Details for Pond_JAV221013.srcx

Storage is Online Cover Level (m) 65.900

Tank or Pond Structure

Invert Level (m) 64.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	510.0	1.400	1000.0	2.800	1000.0	4.200	1000.0
0.200	570.0	1.600	1000.0	3.000	1000.0	4.400	1000.0
0.400	635.0	1.800	1000.0	3.200	1000.0	4.600	1000.0
0.600	700.0	2.000	1000.0	3.400	1000.0	4.800	1000.0
0.800	770.0	2.200	1000.0	3.600	1000.0	5.000	1000.0
1.000	845.0	2.400	1000.0	3.800	1000.0		
1.200	920.0	2.600	1000.0	4.000	1000.0		

Hydro-Brake® Outflow Control

Design Head (m) 0.600 Hydro-Brake® Type Md5 SW Only Invert Level (m) 64.600
Design Flow (l/s) 7.2 Diameter (mm) 122

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	1.200	9.8	3.000	15.5	7.000	23.7
0.200	6.3	1.400	10.6	3.500	16.8	7.500	24.5
0.300	6.5	1.600	11.3	4.000	17.9	8.000	25.3
0.400	6.4	1.800	12.0	4.500	19.0	8.500	26.1
0.500	6.7	2.000	12.7	5.000	20.0	9.000	26.9
0.600	7.1	2.200	13.3	5.500	21.0	9.500	27.6
0.800	8.0	2.400	13.9	6.000	21.9		
1.000	9.0	2.600	14.4	6.500	22.8		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 0.125 Invert Level (m) 65.500

Cascade Summary of Results for Pond_JAV221013.srcx

	Upstream Structures	Outflow To	Overflow To
	CarPark_JAV221013.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	64.876	0.276	6.5	0.0	6.5	151.9	O K
30 min Summer	65.057	0.457	6.6	0.0	6.6	265.4	O K
60 min Summer	65.238	0.638	7.3	0.0	7.3	388.5	O K
120 min Summer	65.407	0.807	8.1	0.0	8.1	514.4	O K
180 min Summer	65.500	0.900	8.5	0.0	8.5	587.6	O K
240 min Summer	65.546	0.946	8.7	2.1	10.8	625.2	O K
360 min Summer	65.589	0.989	8.9	5.6	14.5	660.6	O K
480 min Summer	65.614	1.014	9.0	8.2	17.2	681.7	O K
600 min Summer	65.630	1.030	9.1	10.0	19.1	696.0	O K
720 min Summer	65.639	1.039	9.1	11.1	20.2	703.7	O K
960 min Summer	65.640	1.040	9.1	11.2	20.3	704.7	O K
1440 min Summer	65.636	1.036	9.1	10.7	19.8	701.3	O K
2160 min Summer	65.624	1.024	9.1	9.3	18.4	691.0	O K
2880 min Summer	65.610	1.010	9.0	7.7	16.7	678.4	O K
4320 min Summer	65.578	0.978	8.9	4.7	13.5	652.1	O K
5760 min Summer	65.542	0.942	8.7	1.8	10.5	621.6	O K
7200 min Summer	65.477	0.877	8.4	0.0	8.4	568.9	O K
8640 min Summer	65.395	0.795	8.0	0.0	8.0	504.6	O K
10080 min Summer	65.317	0.717	7.6	0.0	7.6	446.2	O K
15 min Winter	64.944	0.344	6.5	0.0	6.5	193.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	128.285	0.0	385.6	0.0	322
30 min Summer	84.226	0.0	512.5	0.0	406
60 min Summer	52.662	0.0	736.9	0.0	446
120 min Summer	31.800	0.0	897.8	0.0	506
180 min Summer	23.353	0.0	991.2	0.0	552
240 min Summer	18.644	0.0	1055.9	24.8	554
360 min Summer	13.543	0.0	1150.4	87.4	574
480 min Summer	10.792	0.0	1220.0	136.2	616
600 min Summer	9.043	0.0	1273.3	172.6	672
720 min Summer	7.823	0.0	1314.4	199.6	744
960 min Summer	6.219	0.0	1362.9	233.8	878
1440 min Summer	4.493	0.0	1353.2	256.1	1124
2160 min Summer	3.241	0.0	1674.2	229.7	1520
2880 min Summer	2.568	0.0	1758.4	189.1	1936
4320 min Summer	1.847	0.0	1858.1	106.4	2784
5760 min Summer	1.461	0.0	1975.3	32.9	3640
7200 min Summer	1.217	0.0	2038.9	0.0	4504
8640 min Summer	1.048	0.0	2086.1	0.0	5264
10080 min Summer	0.923	0.0	2115.0	0.0	6016
15 min Winter	128.285	0.0	438.6	0.0	360

Cascade Summary of Results for Pond_JAV221013.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	65.146	0.546	6.9	0.0	6.9	324.7	O K
60 min Winter	65.339	0.739	7.7	0.0	7.7	462.3	O K
120 min Winter	65.517	0.917	8.6	0.5	9.1	601.6	O K
180 min Winter	65.576	0.976	8.9	4.4	13.3	650.0	O K
240 min Winter	65.605	1.005	9.0	7.3	16.3	674.6	O K
360 min Winter	65.644	1.044	9.2	11.6	20.8	707.6	O K
480 min Winter	65.669	1.069	9.3	14.8	24.1	729.6	O K
600 min Winter	65.685	1.085	9.3	16.9	26.2	743.0	O K
720 min Winter	65.691	1.091	9.4	17.7	27.1	748.3	O K
960 min Winter	65.688	1.088	9.3	17.4	26.7	746.3	O K
1440 min Winter	65.681	1.081	9.3	16.4	25.7	739.6	O K
2160 min Winter	65.659	1.059	9.2	13.5	22.7	720.6	O K
2880 min Winter	65.635	1.035	9.1	10.5	19.7	699.8	O K
4320 min Winter	65.594	0.994	8.9	6.2	15.1	665.5	O K
5760 min Winter	65.554	0.954	8.8	2.7	11.4	631.5	O K
7200 min Winter	65.477	0.877	8.4	0.0	8.4	569.0	O K
8640 min Winter	65.361	0.761	7.9	0.0	7.9	478.7	O K
10080 min Winter	65.253	0.653	7.3	0.0	7.3	399.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	84.226	0.0	550.7	0.0	421
60 min Winter	52.662	0.0	830.9	0.0	462
120 min Winter	31.800	0.0	1010.2	3.6	512
180 min Winter	23.353	0.0	1115.5	65.4	490
240 min Winter	18.644	0.0	1188.6	119.2	488
360 min Winter	13.543	0.0	1294.9	200.5	516
480 min Winter	10.792	0.0	1373.4	259.7	570
600 min Winter	9.043	0.0	1433.4	303.2	636
720 min Winter	7.823	0.0	1479.6	335.7	714
960 min Winter	6.219	0.0	1534.3	377.2	838
1440 min Winter	4.493	0.0	1534.9	405.1	1102
2160 min Winter	3.241	0.0	1884.1	376.2	1516
2880 min Winter	2.568	0.0	1980.0	315.4	1936
4320 min Winter	1.847	0.0	2093.6	189.7	2824
5760 min Winter	1.461	0.0	2228.0	69.4	3744
7200 min Winter	1.217	0.0	2302.4	0.0	4744
8640 min Winter	1.048	0.0	2358.9	0.0	5528
10080 min Winter	0.923	0.0	2396.7	0.0	6312

Cascade Rainfall Details for Pond_JAV221013.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Cascade Model Details for Pond_JAV221013.srcx

Storage is Online Cover Level (m) 65.900

Tank or Pond Structure

Invert Level (m) 64.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	510.0	1.400	1000.0	2.800	1000.0	4.200	1000.0
0.200	570.0	1.600	1000.0	3.000	1000.0	4.400	1000.0
0.400	635.0	1.800	1000.0	3.200	1000.0	4.600	1000.0
0.600	700.0	2.000	1000.0	3.400	1000.0	4.800	1000.0
0.800	770.0	2.200	1000.0	3.600	1000.0	5.000	1000.0
1.000	845.0	2.400	1000.0	3.800	1000.0		
1.200	920.0	2.600	1000.0	4.000	1000.0		

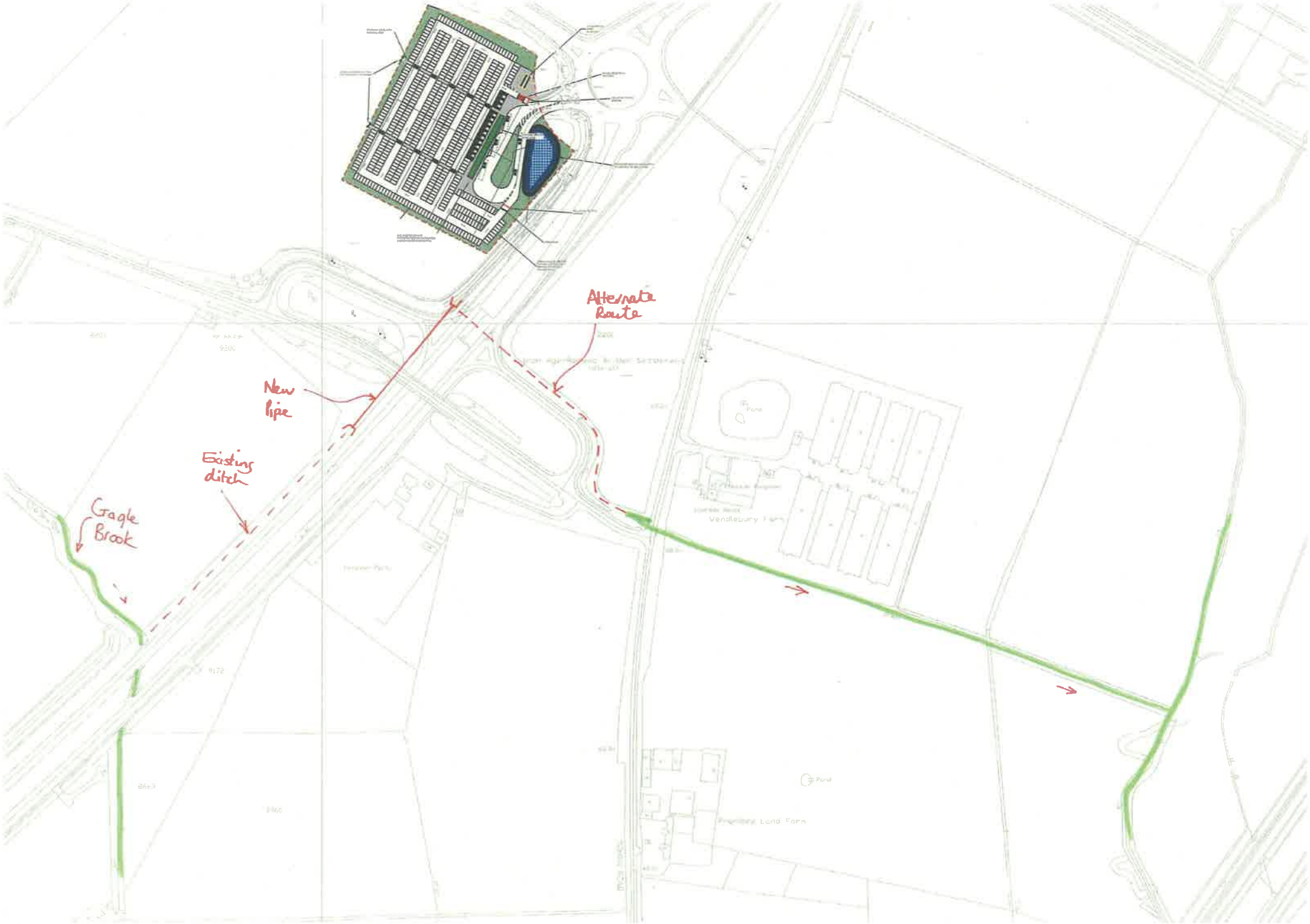
Hydro-Brake® Outflow Control

Design Head (m) 0.600 Hydro-Brake® Type Md5 SW Only Invert Level (m) 64.600
Design Flow (l/s) 7.2 Diameter (mm) 122

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	1.200	9.8	3.000	15.5	7.000	23.7
0.200	6.3	1.400	10.6	3.500	16.8	7.500	24.5
0.300	6.5	1.600	11.3	4.000	17.9	8.000	25.3
0.400	6.4	1.800	12.0	4.500	19.0	8.500	26.1
0.500	6.7	2.000	12.7	5.000	20.0	9.000	26.9
0.600	7.1	2.200	13.3	5.500	21.0	9.500	27.6
0.800	8.0	2.400	13.9	6.000	21.9		
1.000	9.0	2.600	14.4	6.500	22.8		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 0.125 Invert Level (m) 65.500


Alternate Route
New pipe
Existing ditch
Eagle Brook
Wendlebury Farm
Pond
Pond

Surface Water Storage Requirements for Sites

Site name:
Site location:
Site coordinates
Latitude: 51.88606 deg N
Longitude: 1.17096 deg W

Reference: 1379490901472
Date: 18/9/2013

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments" (2005), W5-074/A/TR1/1 rev. D and the CIRIA SUDS Manual (2007). It is not to be used for detailed design of drainage systems. It is recommended that detailed design of any drainage scheme uses hydraulic modelling software to finalise storage requirements before construction takes place.

- **Site Characteristics:**

Total site area	2.023	ha
Significant public open space		ha
Area positively drained	2.02	ha
Impermeable area	2.023	ha
Percentage of drained area that is impermeable	> 100%	%
Impervious area drained via infiltration	0.4	ha
Return period for infiltration system design	100	year
Impervious area drained to rainwater harvesting systems	0	ha
Return period for rainwater harvesting system design	10	year
Compliance factor for rainwater harvesting system design	70	%
Net site area for storage volume design	1.62	ha

- **Methodology:**

Greenfield runoff method	IH 124	
Volume control approach	Long Term Storage	

• **Hydrological Characteristics:**	**Automatic values**	**Editable values**	
HOST	25	25	
SPRHOST	0.5	0.5	
SAAR	617	617	mm
M5-60 Rainfall Depth	20	20	mm
'r' Ratio M5-60/M5-2 day	0.4	0.4	
FEH/FSR conversion factor	0.92	0.92	
Hydrological region	6	6	
Growth curve factor: 1 year	0.85	0.85	
Growth curve factor: 30 year	2.3	2.3	
Growth curve factor: 100 year	3.19	3.19	

- **Design Criteria:**

Climate change allowance factor	1.3	1.3	
Urban creep allowance factor	1.1	1.1	
Interception rainfall depth	5	5	mm

- **Greenfield Runoff Rates:**

Qbar	**9.62**	**9.62**	l/s
1 in 1 year	**8.18**	**8.18**	l/s
1 in 30 years	**22.13**	**22.13**	l/s
1 in 100 years	**30.7**	**30.7**	l/s

- **Estimated Storage Volumes:**

Interception storage	**80.76**	**80.76**	m^3
Attenuation storage	**456.93**	**456.93**	m^3
Long term storage	**383.04**	**383.04**	m^3
Treatment storage	**194.69**	**194.69**	m^3
Total storage	**920.73**	**920.73**	m^3

Please note that a minimum flow of 5 l/s applies to any site

HR Wallingford Ltd, the Environment Agency and any local authority are not liable for the performance of a drainage scheme which is based upon the output of this report.

Jack Downing
Atkins
The Axis
10 Holliday Street
Birmingham
B1 1TF

Jack.Downing@atkinsglobal.com
0121 483 5097

Appendix C. TW Existing Services

C.1. Thames Water Development Sewer Records

A copy of the TW sewer records that were provided are included overpage:

Asset Location Search

Thames Water Property Searches
12 Vastern Road
READING
RG1 8DB

Search address supplied Promised Land Farm
Wendlebury Road
Bicester
OX25 2PA

Your reference 5124607.500
Our reference ALS/ALS/24/2013_2559760

Search date 29 August 2013

You are now able to order your Asset Location Search requests online by visiting
www.thameswater-propertysearches.co.uk

searchcode

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0845 070 9148
E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Asset Location Search

Search address supplied: Promised Land Farm, Wendlebury Road, Bicester, OX25 2PA

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This search provides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0845 070 9148, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk
Web: www.thameswater-propertysearches.co.uk

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

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No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Asset Location Search

Waste Water Services

Please provide a copy extract from the public sewer map.

The following quartiles have been printed as they fall within Thames' sewerage area:

SP5620NE
SP5720NW
SP5621SE
SP5721SW

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended these details be checked with the developer.

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0845 070 9148
E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Clean Water Services

Please provide a copy extract from the public water main map.

The following quartiles have been printed as they fall within Thames' water

Asset Location Search

area:

SP5620NE
SP5720NW
SP5621SE
SP5721SW

Enclosed is a map showing the approximate positions of our water mains and associated apparatus. Please note that records are not kept of the positions of individual domestic supplies.

For your information, there will be a pressure of at least 10m head at the outside stop valve. If you would like to know the static pressure, please contact our Customer Centre on 0845 920 0800. The Customer Centre can also arrange for a full flow and pressure test to be carried out for a fee.

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Payment for this Search

A charge will be added to your suppliers account.

Thames Water Utilities Ltd

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PO Box 3189
Slough SL1 4WW

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Asset Location Search

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk

Should you require any further information regarding budget estimates, diversions or stopping up notices then please contact:

DevCon Team
Asset Investment
Thames Water
Maple Lodge STW
Denham Way
Rickmansworth
Hertfordshire
WD3 9SQ

Tel: 01923 898 072
Email: devcon.team@thameswater.co.uk

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

DX 151280 Slough 13

T 0845 070 9148
E searches@thameswater.co.uk
I www.thameswater-propertysearches.co.uk

Asset Location Search

Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0845 850 2777
Email: developer.services@thameswater.co.uk

Thames Water Utilities Ltd

Property Searches
PO Box 3189
Slough SL1 4WW

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T 0845 070 9148
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I www.thameswater-propertysearches.co.uk

Registered in England and Wales
No. 2366661, Registered office
Clearwater Court, Vastern Road
Reading RG1 8DB

Asset Location Search Sewer Map - ALS/ALS/24/2013_2559760 | **SP5620NE**

The width of the displayed area is 500m and the centre of the map is located at OS coordinates 456750,220750

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
9901	n/a	n/a

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Asset Location Search Sewer Map - ALS/ALS/24/2013_2559760

SP5720NW

The width of the displayed area is 500m and the centre of the map is located at OS coordinates 457250,220750

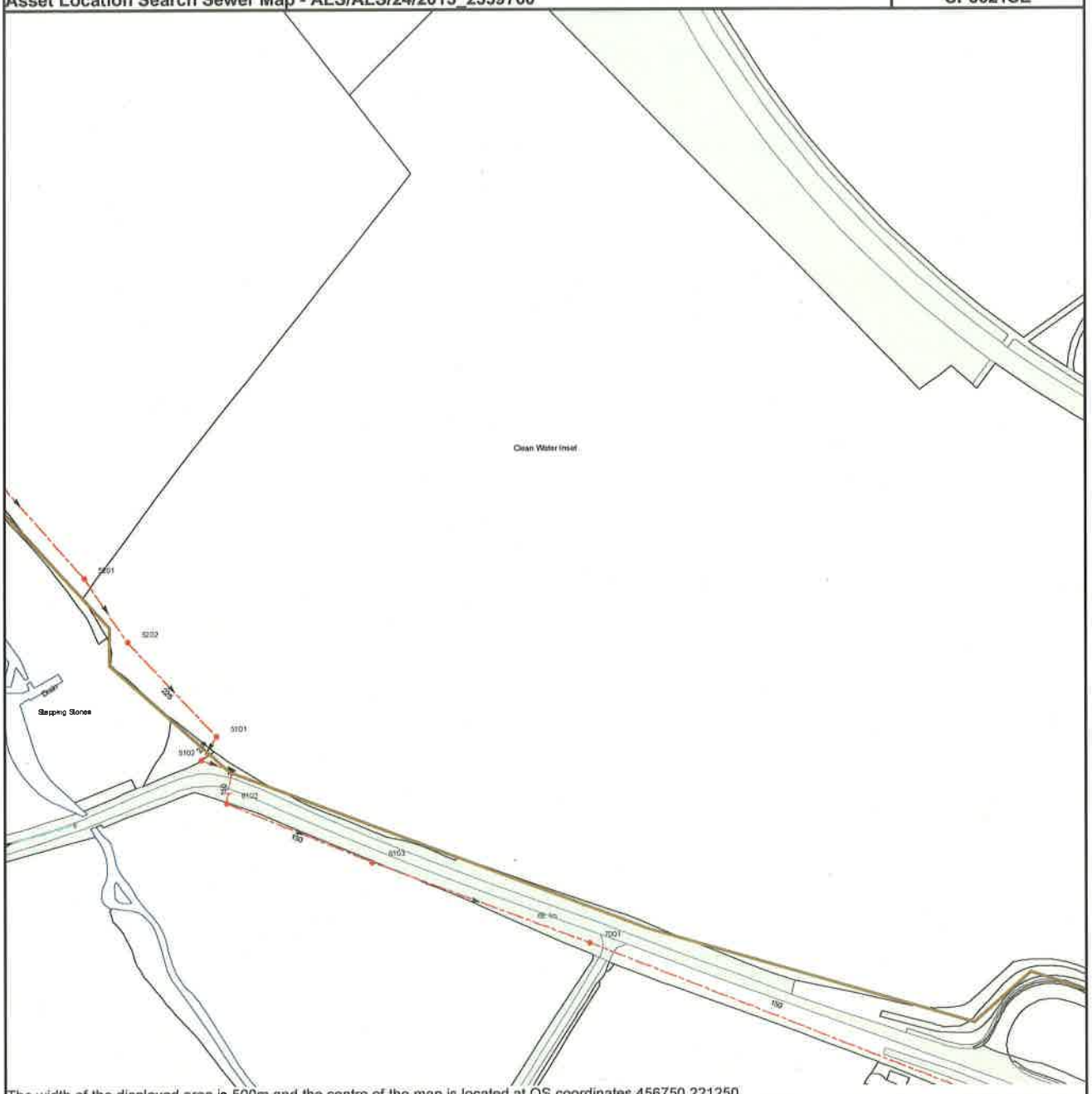
The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
0902	n/a	n/a
0901	n/a	n/a
0801	n/a	n/a
0903	n/a	n/a
1802	n/a	n/a
-	-	-
1801	n/a	n/a

Asset Location Search Sewer Map - ALS/ALS/24/2013_2559760

SP5621SE



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 456750,221250

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

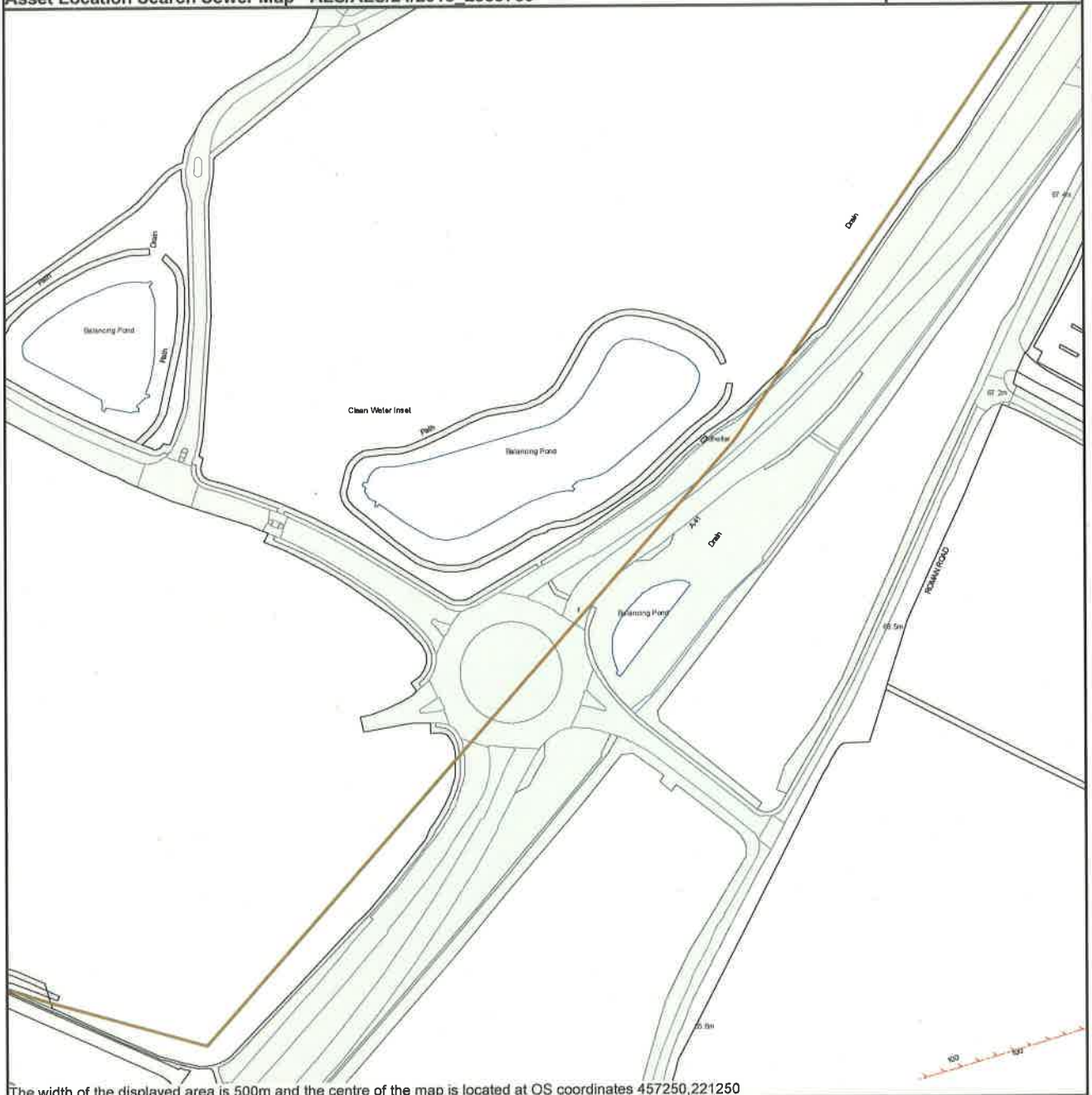
NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
5202	n/a	n/a
5201	n/a	n/a
5101	n/a	n/a
6102	n/a	n/a
6103	n/a	n/a
7001	n/a	n/a
-	-	-
5102	n/a	n/a

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Asset Location Search Sewer Map - ALS/ALS/24/2013_2559760

SP5721SW



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 457250,221250

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Based on the Ordnance Survey Map with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
N/a	n/a	n/a

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

- Trunk Surface Water
- Trunk Foul
- Storm Relief
- Trunk Combined
- Vent Pipe
- Bio-solids (Sludge)
- Proposed Thames Surface Water Sewer
- Proposed Thames Water Foul Sewer
- Gallery
- Foul Rising Main
- Surface Water Rising Main
- Combined Rising Main
- Sludge Rising Main
- Proposed Thames Water Rising Main
- Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

- Air Valve
- Dam Chase
- Fitting
- Meter
- Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

- Control Valve
- Drop Pipe
- Ancillary
- Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

- Outfall
- Undefined End
- Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

- Public/Private Pumping Station
- Change of characteristic indicator (C.O.C.I.)
- Invert Level
- Summit

Areas

Lines denoting areas of underground surveys, etc.

- Agreement
- Operational Site
- Chamber
- Tunnel
- Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

- Foul Sewer
- Surface Water Sewer
- Combined Sewer
- Gulley
- Culverted Watercourse
- Proposed
- Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Asset Location Search Water Map - ALS/ALS/24/2013_2559760

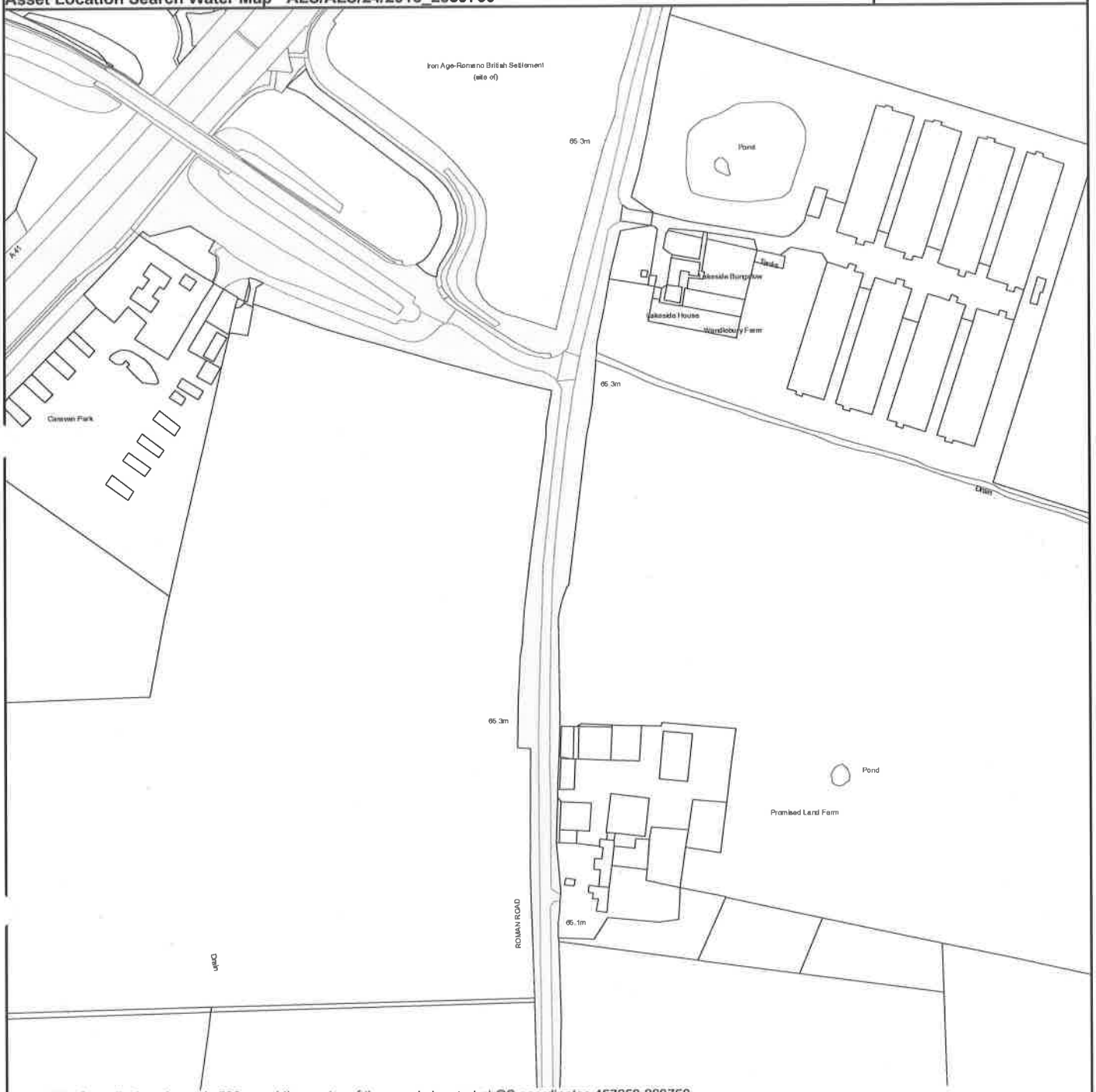
SP5620NE

The width of the displayed area is 500m and the centre of the map is located at OS coordinates 456750,220750

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Asset Location Search Water Map - ALS/ALS/24/2013_2559760

SP5720NW



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 457250,220750

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

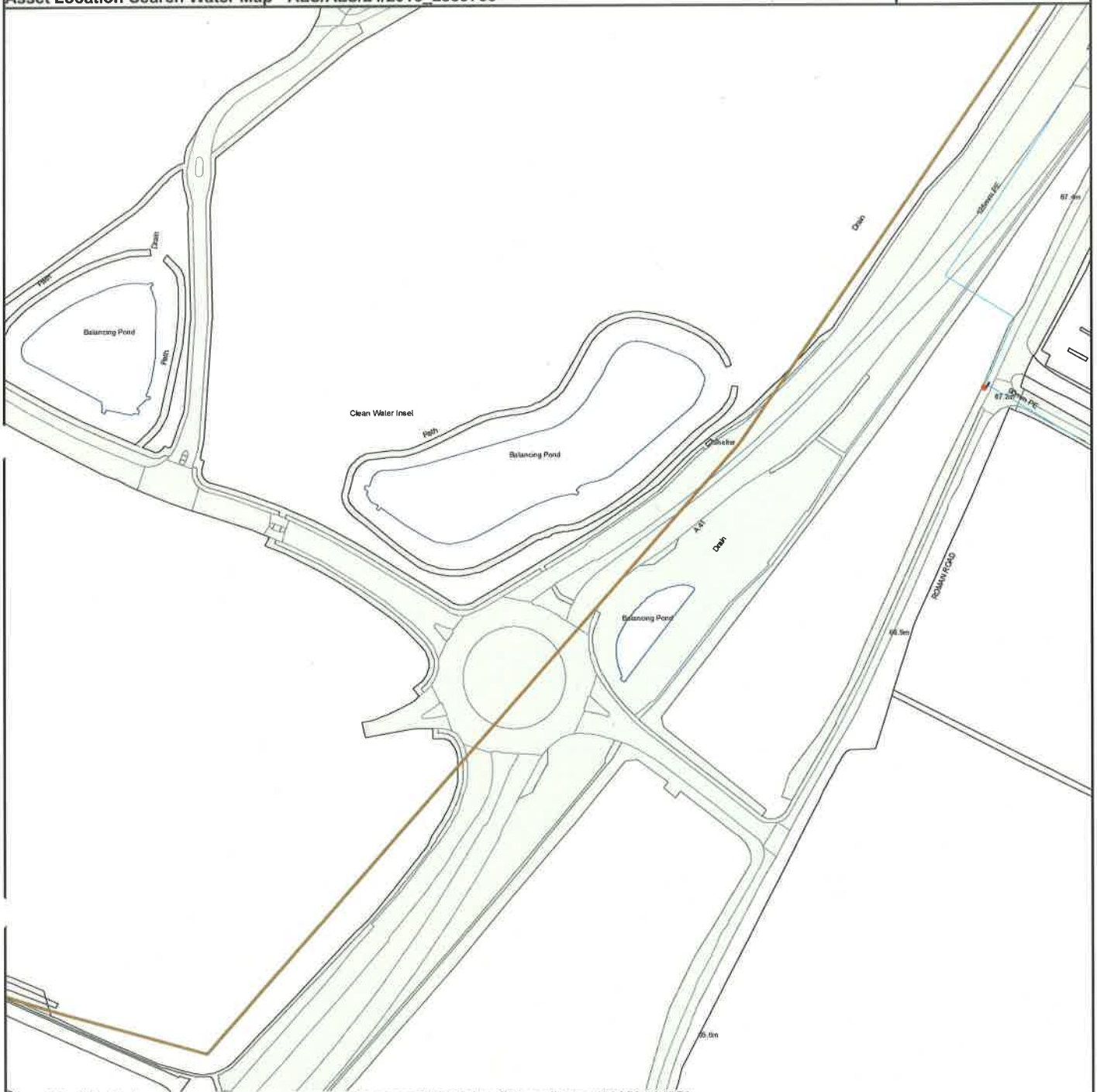
Asset Location Search **Water** Map - ALS/ALS/24/2013_2559760 | SP5621SE

The width of the displayed area is 500m and the centre of the map is located at OS coordinates 456750,221250

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Asset Location Search Water Map - ALS/ALS/24/2013_2559760

SP5721SW



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 457250,221250

ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

Distribution Main: The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.

16" **Trunk Main:** A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.

3" SUPPLY **Supply Main:** A supply main indicates that the water main is used as a supply for a single property or group of properties.

3" FIRE **Fire Main:** Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.

3" METERED **Metered Pipe:** A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.

Transmission Tunnel: A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.

Proposed Main: A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger

Other Water Pipes (Not Operated or Maintained by Thames Water)

Other Water Company Main: Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.

Private Main: Indiates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

Search Code

IMPORTANT CONSUMER PROTECTION INFORMATION

This search has been produced by Thames Water Property Searches, Clearwater Court, Vastern Road, Reading RG1 8DB, which is registered with the Property Codes Compliance Board (PCCB) as a subscriber to the Search Code. The PCCB independently monitors how registered search firms maintain compliance with the Code.

The Search Code:

- provides protection for homebuyers, sellers, estate agents, conveyancers and mortgage lenders who rely on the information included in property search reports undertaken by subscribers on residential and commercial property within the United Kingdom
- sets out minimum standards which firms compiling and selling search reports have to meet
- promotes the best practise and quality standards within the industry for the benefit of consumers and property professionals
- enables consumers and property professionals to have confidence in firms which subscribe to the code, their products and services.

By giving you this information, the search firm is confirming that they keep to the principles of the Code. This provides important protection for you.

The Code's core principles

Firms which subscribe to the Search Code will:

- display the Search Code logo prominently on their search reports
- act with integrity and carry out work with due skill, care and diligence
- at all times maintain adequate and appropriate insurance to protect consumers
- conduct business in an honest, fair and professional manner
- handle complaints speedily and fairly
- ensure that products and services comply with industry registration rules and standards and relevant laws
- monitor their compliance with the Code

Complaints

If you have a query or complaint about your search, you should raise it directly with the search firm, and if appropriate ask for any complaint to be considered under their formal internal complaints procedure. If you remain dissatisfied with the firm's final response, after your complaint has been formally considered, or if the firm has exceeded the response timescales, you may refer your complaint for consideration under The Property Ombudsman scheme (TPOs). The Ombudsman can award compensation of up to £5,000 to you if he finds that you have suffered actual loss as a result of your search provider failing to keep to the Code.

Please note that all queries or complaints regarding your search should be directed to your search provider in the first instance, not to TPOs or to the PCCB.

TPOs Contact Details

The Property Ombudsman scheme
Milford House
43-55 Milford Street
Salisbury
Wiltshire SP1 2BP
Tel: 01722 333306
Fax: 01722 332296
Email: admin@tpos.co.uk

You can get more information about the PCCB from www.propertycodes.org.uk

PLEASE ASK YOUR SEARCH PROVIDER IF YOU WOULD LIKE A COPY OF THE SEARCH CODE

Appendix D. **EA Correspondence**

D.1. Pre-application enquiry response

D.2. West Thames – Surface Water Flood Risk Assessment (FRA) Guidance note and pro-forma for Development over 1ha

Mr Jack Downing
Atkins Environment
The Axis (10) Holliday Street
Birmingham
West Midlands
B1 1TF

Our ref: WA/2013/115914/01-L01
Your ref: 5124607/JD/CO

Date: 01 October 2013

Dear Mr Downing

PRE-APPLICATION ENQUIRY FOR PARK & RIDE SCHEME
LAND SOUTH OF VENDEE DRIVE, BICESTER, OXFORDSHIRE

Thank you for consulting us on this matter. We received the letter on 20 September 2013 and we are now in a position to respond.

We have no objection in principle with the above proposed development and we have the following advice:

The proposed development is located in Flood Zone 1 (low probability) based on our Flood Zone map. Whilst development may be appropriate in Flood Zone 1, paragraph 103 (footnote 20) of National Planning Policy Framework (NPPF) sets out a Flood Risk Assessment should be submitted for all developments over one hectare in size.

As a part of the Planning application you should therefore prepare a surface water drainage strategy for the site and include this within the Flood Risk Assessment.

We are operating a risk based approach to planning consultations where the site falls between 1 and 5 hectares and are not providing detailed comments on surface water. Instead we are issuing to Local Authorities a guidance note and pro-forma which the developer/applicant should complete. We would recommend you complete the pro-forma and submit this with your planning application. We have attached a copy of the guidance note and pro-forma.

The pro-forma asks the developer/applicant to confirm that the following surface water flood risk principles have been followed:

- That surface water runoff from the development will not increase flood risk to the development or third parties. The pro-forma asks for confirmation that surface

water discharge rates will not be increasing and how any increases in discharge volume are being attenuated etc.

- That Sustainable Drainage Systems (SuDS) have been explored and used to attenuate to at least pre-development discharge rates and volumes or where possible achieving betterment in the surface water runoff regime.

- That an allowance for climate change has been incorporated, which means adding an extra amount to peak rainfall (20% for commercial development, 30% for residential). See Table 5 of Technical Guidance for NPPF.

- That the residual risk of flooding has been addressed should failure or exceedence of the drainage system occur. This could include measures to manage residual risk such as raising ground or floor levels where appropriate.

We trust our advice in this letter will assist you in preparing the surface water strategy for the proposed development. We recommend that you liaise with the Local Authority Land Drainage Engineer if you have any additional queries in respect of surface water.

Yours sincerely,

Mr Jack Moeran
Planning Advisor

Direct dial 01491 828367
Direct e-mail planning-wallingford@environment-agency.gov.uk

Environment Agency

Environment Agency Standing Advice to Local Planning Authorities
Version 1.1

West Thames – Surface Water Flood Risk Assessment (FRA) Guidance note and pro-forma for Development over 1ha

To be acceptable as a FRA the applicant should confirm as a minimum:

1. That it will be feasible to balance surface water run-off to the Greenfield run-off rate for all events up to the 1 in 100 year storm (including additional climate change allowance*) and set out how this will be achieved, or if the development is Brownfield, achieve betterment in the surface water runoff regime; ensuring that surface water runoff will not increase flood risk to the development or third parties.

* *Climate Change* - An allowance for climate change needs to be incorporated, which means adding an extra amount to peak rainfall (20% for commercial development, 30% for residential).

2. How sustainable drainage system techniques (SuDS) will be used with any obstacles to their use clearly justified.

3. That the residual risk of flooding has been addressed should any drainage features fail or if they are subjected to an extreme flood event. Overland flow routes or above ground storage of water should not put people and property at unacceptable risk. This could include measures to manage residual risk such as raising ground or floor levels where appropriate.

The applicant should confirm these above points to you by using the pro-forma which is contained below. This should be completed by the developer and returned to you. The top part of the pro-forma includes a section where the developer can clearly state what the difference in rates and volumes as a result of the development will be. The lower sections are provided to show that the developer can explain how drainage rates and volumes are being dealt with on the site in order to not increase rates and volumes. The pro-forma includes a column where the developer should identify where the information is demonstrated. If the pro-forma is completed and signed by the developer, this can serve as a summary of the surface water strategy on the site and will allow them to demonstrate that they have complied with the Technical Guidance to the National Planning Policy Framework (NPPF).

INFORMATION

Climate Change

The NPPF provides advice on the impact of climate change. Table 5 of the Technical Guidance indicates that surface water FRAs should allow for an increase of 30% in peak rainfall intensity for developments still in existence by 2085 (20% for developments with a life expectancy which ends prior to 2085).

Sustainable Drainage Systems (SuDS)

Surface water run-off should be controlled as near to its source as possible through a sustainable drainage approach to surface water management. SuDS seek to mimic natural drainage systems and retain water on or near to the site, when rain falls, in contrast to traditional drainage approaches, which tend to pipe water off site as quickly as possible. SuDS therefore offer significant advantages over conventional piped drainage systems and will be applicable to most sites.

Government policy set out in paragraph 103 of the NPPF expects Local Planning Authorities (LPAs) to give priority to the use of SuDS in determining planning applications. Further support for SuDS is set out in chapter 5 of the Planning Policy Statement 25 (PPS25) Practice Guide.

Approved Document Part H of the Building Regulations 2010 also establishes a hierarchy for surface water disposal, which encourages a SuDS approach beginning with infiltration where possible e.g. soakaways or infiltration trenches. Where SuDS are used, it must be established that these options are feasible, can be adopted and properly maintained and would not lead to any other environmental problems.

Where the intention is to dispose to soakaway, these should be shown to work through an appropriate assessment carried out under Building Research Establishment Digest 365.

Further information and references on SuDS can be found in chapter 5 of the PPS25 Practice Guide. The Interim Code of Practice for Sustainable Drainage Systems provides advice on design, adoption and maintenance issues and a full overview of other technical guidance on SuDS. The Interim Code of Practice is available electronically on CIRIA's web site at:
http://www.ciria.com/suds/interim_code.htm.

Disposal of surface water to public sewer

Before disposal of surface water to the public sewer is considered all other options set out in Approved Document Part H of the Building Regulations 2010 should be exhausted. When no other practicable alternative exists to dispose of surface water other than the public sewer, the Water Company or its agents should confirm that there is adequate spare capacity in the existing system taking future development requirements into account.

Designing for exceedence

For on/near site flooding, the PPS25 Practice Guide at paragraph 5.51 states that:

"For events with a return-period in excess of 30 years, surface flooding of open spaces such as landscaped areas or car parks is acceptable for short periods, but the layout and landscaping of the site should aim to route water away from any vulnerable property, and avoid creating hazards to access and egress routes (further guidance in CIRIA publication C635 Designing for exceedence in urban

drainage - good practice). No flooding of property should occur as a result of a 1 in 100 year storm event (including an appropriate allowance for climate change). In principle, a well-designed surface water drainage system should ensure that there is little or no residual risk of property flooding occurring during events well in excess of the return-period for which the sewer system itself is designed. This is called designing for event exceedence."

The CIRIA publication `Designing for exceedence in urban drainage-good practice' can be accessed via the following link:
http://www.ciria.com/suds/ciria_publications.htm

For off-site flooding, the PPS25 Practice Guide states at paragraph 5.54:

"For the range of annual flow rate probabilities up to and including the one per cent annual exceedence probability (1 in 100 years) event, including an appropriate allowance for climate change, the developed rate of run-off into a watercourse, or other receiving water body, should be no greater than the existing rate of run-off for the same event. Run-off from previously-developed sites should be compared with existing rates, not greenfield rates for the site before it was developed. Developers are, however, strongly encouraged to reduce runoff rates from previously-developed sites as much as is reasonably practicable. Volumes of run-off should also be reduced wherever possible using infiltration and attenuation techniques. Interim guidance on calculation of site run-off rates can be found on the CIRIA website: http://www.ciria.org

Is the proposal part of a larger development site?

LPAs should be aware that some applications for smaller scale developments might be part of larger sites which already have outline permission. In such cases, the LPA should ensure that any conditions which were applied to the larger site, in relation to surface water drainage, are complied with.

Note:

Development which involves a culvert or an obstruction to flow on an Ordinary Watercourse will require consent under the Land Drainage Act 1991 and the Floods and Water Management Act 2010. In the case of an Ordinary Watercourse the responsibility for Consenting lies with the Lead Local Flood Authority (LLFA). An Ordinary Watercourse is defined as any watercourse not identified as a Main River on maps held by the Environment Agency and DEFRA. For further information on Ordinary Watercourses contact the LLFA. We would still wish to be consulted on any proposed culverting or an obstruction to flow on a Main River.

ENVIRONMENT AGENCY WEST THAMES - SURFACE WATER PRO-FORMA

This pro-forma accompanies our surface water guidance note on sites between 1 and 5 hectares. The developer should complete this form and return to the Local Planning Authority and indicate where the evidence is provided within their submission documents for the answers given

Site Name	
Site Size	
Development Type (Green/Brown field)	

Discharge Rates	**Existing**	**Proposed**	**Difference Between Existing and Proposed**	**Which Document or Plan is this information contained in**
1 in 1				
Qbar(1 in 2)				
1 in 30				
1 in 100				
1 in 100 +Climate change (proposed only)				
Discharge Volumes				
1 in 1				
Q Bar (1 in 2)				
1 in 30				
1 in 100				
Proposed 1 in 100 +Climate change				

The above section should only show small increases in discharge rate if an increase in discharge volume is shown – otherwise there should be no increase. Note that an increase in discharge volume may be shown in the above table - but how this is being attenuated on site and discharged so as to not increase flood risk should be set out below. If an increase in discharge rate or volume is shown, or if an increase was predicted but has been designed in to the system, please answer the following questions.

Discharge Rates (The final scheme should show no increase in discharge rates. If a small increase in rate is shown to address trickle or Q-Bar discharge, then this may be acceptable but should tie in with the information provided in the volumes section below.		**Which Document or Plan is this information contained in**
How are increases in discharge rate being dealt with?		
What storage volume is required as a result of restricting discharge rate?		
Where has this volume been provided on site?		

Discharge Volumes (Where an increase in volume is shown, that increase in volume must be either attenuated and trickle discharged at 2l/s/ha. Or, the whole of the sites discharge rate must be restricted to Qbar) (Qbar is the run off rate for the site as if it was a Greenfield site i.e. assuming it is undeveloped). Qbar will be higher if the geology of the site is less permeable.		**Which Document or Plan is this information contained in**
Which method has/will be used to control additional discharge volumes?		
What is the Qbar/Trickle Discharge Rate?		
As a result of restricting rate, what additional attenuation storage volume was/is required?		
Where on site will/has this attenuation be provided?		
How will rates be restricted (Hydrobrake etc)?		

Please also confirm		Which Document or Plan is this information contained in
No flooding of pipe network will occur in the 1 in 30 event		
Any flooding or exceedence outside the pipe network will be safely contained on site and not increase flooding elsewhere (please indicate on a plan the location of any flooding).		
Which SuDS methods have been used on site.		
If infiltration is proposed - That infiltration rates are acceptable (Provide rate).		
That infiltration devices or their attenuation areas are appropriately sized.		

The above form should be completed using evidence from the Flood Risk Assessment and site plans. It should serve as a summary sheet of the drainage proposals and should clearly show that the proposed rate and volume as a result of development will not be increasing. If there is an increase in rate or volume, the rate or volume section should be completed to set out how the additional rate/volume is being dealt with.

This form is completed using factual information from the Flood Risk Assessment and Site Plans and can be used as a summary of the surface water drainage strategy on this site.

Form Completed By.....,
Company.....,
Date:.....

Mr Jack Downing
Atkins Environment
The Axis (10) Holliday Street
Birmingham
West Midlands
B1 1TF

Our ref: WA/2013/115914/01-L01
Your ref: 5124607/JD/CO

Date: 01 October 2013

Dear Mr Downing

PRE-APPLICATION ENQUIRY FOR PARK & RIDE SCHEME
LAND SOUTH OF VENDEE DRIVE, BICESTER, OXFORDSHIRE

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As a part of the Planning application you should therefore prepare a surface water drainage strategy for the site and include this within the Flood Risk Assessment.

We are operating a risk based approach to planning consultations where the site falls between 1 and 5 hectares and are not providing detailed comments on surface water. Instead we are issuing to Local Authorities a guidance note and pro-forma which the developer/applicant should complete. We would recommend you complete the pro-forma and submit this with your planning application. We have attached a copy of the guidance note and pro-forma.

The pro-forma asks the developer/applicant to confirm that the following surface water flood risk principles have been followed:

- That surface water runoff from the development will not increase flood risk to the development or third parties. The pro-forma asks for confirmation that surface

water discharge rates will not be increasing and how any increases in discharge volume are being attenuated etc.

- That Sustainable Drainage Systems (SuDS) have been explored and used to attenuate to at least pre-development discharge rates and volumes or where possible achieving betterment in the surface water runoff regime.

- That an allowance for climate change has been incorporated, which means adding an extra amount to peak rainfall (20% for commercial development, 30% for residential). See Table 5 of Technical Guidance for NPPF.

- That the residual risk of flooding has been addressed should failure or exceedence of the drainage system occur. This could include measures to manage residual risk such as raising ground or floor levels where appropriate.

We trust our advice in this letter will assist you in preparing the surface water strategy for the proposed development. We recommend that you liaise with the Local Authority Land Drainage Engineer if you have any additional queries in respect of surface water.

Yours sincerely,

Mr Jack Moeran
Planning Advisor

Direct dial 01491 828367
Direct e-mail planning-wallingford@environment-agency.gov.uk

Appendix E. **Design Calculations**

E.1. Design basis and Calculations

Copy of the design basis document and of Windes Calculations.

ATKINS

Project	Job ref
BICESTER P&R	5124607
Part of structure: DRAINAGE.	Calc sheet no / rev: 1 / 1

Drawing ref.	Calc by	Date	Check by	Date
–	JAV	22/10/13	AC	24/10/13

Ref	Calculations	Output

Geology

BGS information shows the car park to be located over Kellaways Clay Member - Mudstone. At the Southern corner of the field where the P&R is located is the start of a Kellaways Sand Member - Sandstone and Siltstone.

On this basis infiltration drainage has been ruled out as the mudstone is not permeable enough.

Discharge

As the site is limited in available space to locate any storage a combination of porous paving with storage available in the sub-base and a pond will be used to attenuate discharge from the site to the pre-development greenfield run off rates. These have been calculated using the IH124 method as follows.

1yr – 7.2 l/s
30yr – 19.3 l/s
100 yr – 27.1 l/s

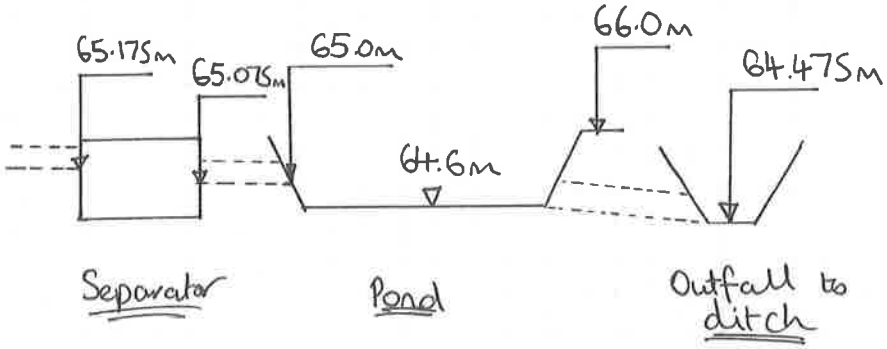
The existing field drains to a ditch located around the southeast to south-west boundary. Although no direct connection has been established at this stage between this ditch and any watercourses the site is within the catchment that drains to Gagle Brook to the South – approx 350m away. The is an existing ditch along the A41 that runs into gagle brook and proposal is to drain into this ditch. This will require a 150m length of pipe to connect the two ditches.

(an alternative to this is to connect to a different watercourse at E457255, N220848)

ATKINS	Project BICESTER P&R			Job ref 5124607	
	Part of structure DRAINAGE			Calc sheet no 2 / 1	rev 1
	Drawing ref. –	Calc by JKV	Date 22/10/13	Check by AC	Date 24/10/13

Ref	Calculations	Output

Drainage Design.



Inlet to pond to be 400mm above base/outlet to ensure discharge is free-flowing for a 1:1yr storm.

The minimum bank level around the pond is 66.0m based on the 1:100yr water level + 300mm freeboard.

Based on these levels the surface level of the Car Park needs to be set high enough to enable pipes that drain the porous paving to be laid with adequate cover (0.9m). Based on a 300mm dia pipe which is likely to be the largest required this gives a deep from invert to the surface of 1.2m

Based on a simple pipe network reaching the boundary of the car park a grid of critical surface levels is as follows.

E 457014.088 } 67.375m
N 221112.843 }

E 457124.349 } 66.750 m
N 221053.958 }

E 457086.393 } 67.375 m
N 221248.236 }

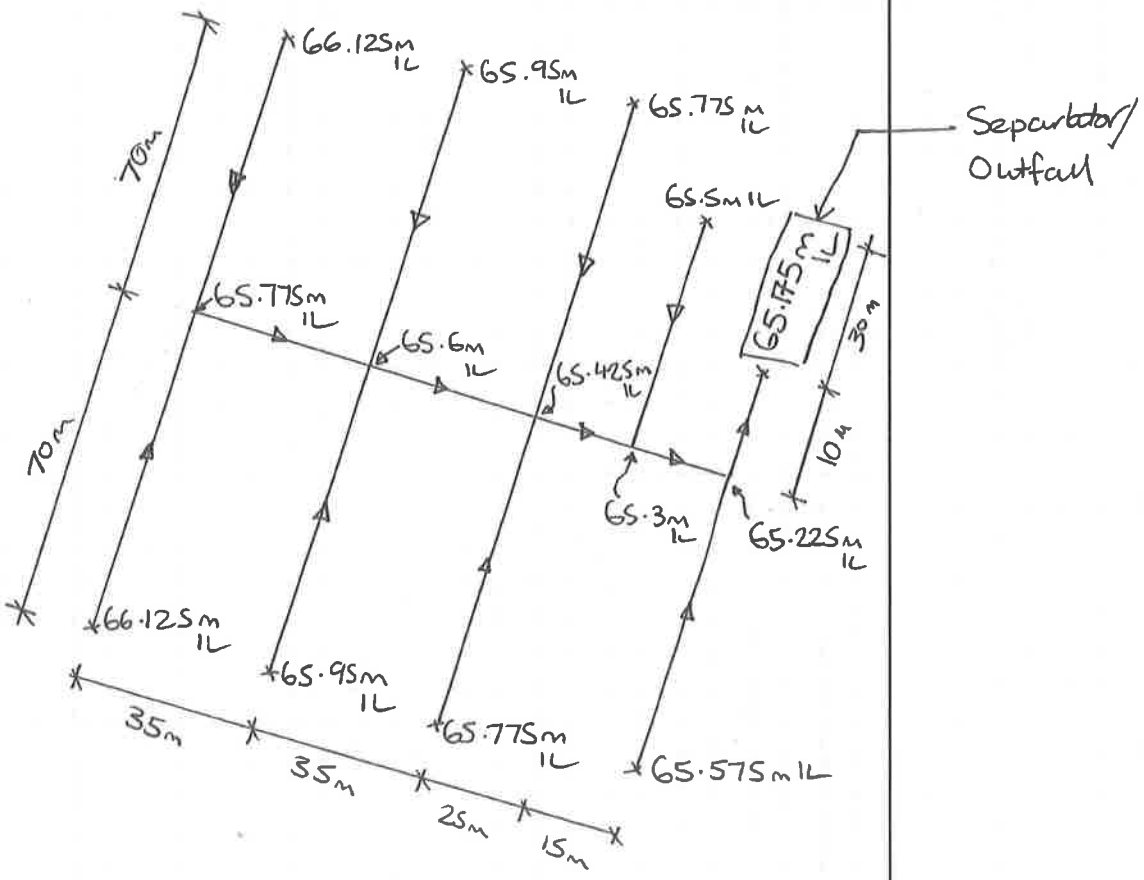
E 457196.655 } 66.750m
N 221189.352 }

* Note that the fall on the surface is perpendicular to the majority of the porous paving to maximise the available storage.

ATKINS

Project		Job ref
BICESTER P&R		5124607
Part of structure: DRAINAGE		Calc sheet no / rev: 3 / 1
Drawing ref.: —	Calc by: VKV, Date: 22/10/13	Check by: AL, Date: 24/10/13

Ref	Calculations	Output



Based on these levels the TWL in the pond for a 1:100yr storm will be approx. 1.0m lower than the lowest level in the Car Park and around 0.5m below the sub-base storage for the Porous Paving.

The critical surface levels are 1.3m and 1.1m above existing ground levels at the southwest and south-east corners of the car park respectively. At the northern end of the site levels are 0.7m and 0.9m above existing levels at the northwest and northeast corners respectively.

ATKINS

Project		Job ref
BICESTER P&R		5124607
Part of structure: DRAINAGE		Calc sheet no: 4 / 1 rev: /
Drawing ref.: —	Calc by: JSV, Date: 22/10/13	Check by: AL, Date: 24/10/13

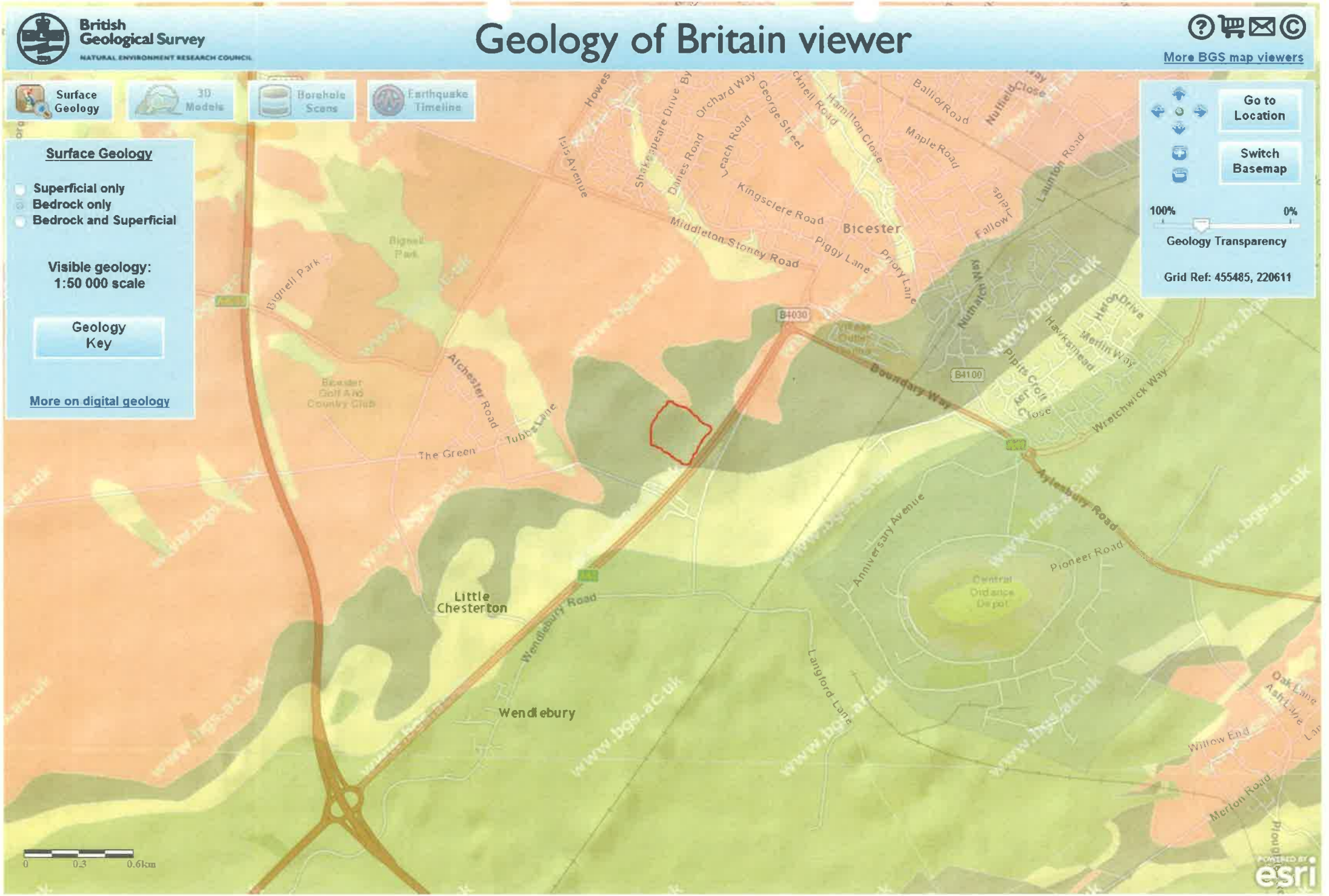
Ref	Calculations	Output

Ditch Capacity.

In order to carry the 1:100yr discharge the capacity of the ditch from the pond to the southern corner of the field has been checked and this has a calculated capacity of:-

1500 l/s.

The required capacity is 27.1 l/s which is 0.018% of the available flow.


British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL
Geology of Britain viewer
More BGS map viewers
Surface Geology
3D Models
Borehole Scans
Earthquake Timeline
Surface Geology
Superficial only
Bedrock only
Bedrock and Superficial
Visible geology: 1:50 000 scale
Geology Key
More on digital geology
Go to Location
Switch Basemap
100%
0%
Geology Transparency
Grid Ref: 455485, 220611
Bicester
Little Chesterton
Wendlebury
Middleton Stoney Road
Kingsclere Road
Piggy Lane
Priory Lane
Launton Road
Howes
Shakespeare Drive
Orchard Way
George Street
Leach Road
Hamilton Close
Maple Road
Ballior Road
Nutfield Close
Fallowfields
Bignell Park
Aylesbury Road
Boundary Way
Wretchwick Way
Merlin Way
Heron Drive
Pioneer Road
Anniversary Avenue
Central Distance Depot
Langford Lane
Willow End
Merton Road
Oak Lane
Ash Drive
Archester Road
Tubbs Lane
The Green
Bicester Golf And Country Club
B4030
B4100
A41
0
0.3
0.6km
www.bgs.ac.uk
esri

Greenfield Run-off for Small Rural Catchments using Institute of Hydrology Report No. 124 Flood Estimation for Small Catchments.

The Mean Flood Flow for a small rural catchment in cumecs is represented by $QBAR_{rural}$

$$QBAR_{rural} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$$

AREA = Catchment Area (km^2)

SAAR = Standard Average Annual Rainfall (mm)

SOIL = Soil Index derived from Flood Studies Report, Vol V, Figure I.4.18

Where the catchment area is less than 50 ha ($0.5km^2$), it is recommended that the analysis for determining greenfield discharge rate uses 50 ha in the formula and the flow linearly interpolated (National SUDS Working Group 2004 and CIRIA C697).

Growth Factors to convert Mean Flood Flow to other probabilities are derived from the Flood Studies Report, Figure 2, Supplementary Report 14, August 1983. To convert Mean Flood Flow to Annual Peak Flow use the factor in the 1yr return period column.

Region	Return Period (years)									
	1	2	5	10	20	25	30	50	100	200
1	0.85	0.91	1.20	1.44	1.71	1.81	1.89	2.12	2.48	2.81
2	0.87	0.91	1.18	1.42	1.71	1.81	1.90	2.17	2.63	2.98
3	0.86	0.94	1.25	1.45	1.64	1.71	1.76	1.89	2.08	2.36
4	0.83	0.90	1.23	1.49	1.78	1.88	1.96	2.20	2.57	3.02
5	0.87	0.89	1.29	1.65	2.09	2.26	2.40	2.84	3.56	4.19
6/7	0.85	0.88	1.28	1.62	2.00	2.15	2.27	2.62	3.19	3.75
8	0.78	0.88	1.23	1.49	1.75	1.84	1.91	2.12	2.42	2.85
9	0.88	0.93	1.21	1.42	1.63	1.70	1.76	1.94	2.18	2.47
10	0.87	0.93	1.19	1.38	1.57	1.64	1.70	1.85	2.08	2.36

Table 1. FSR Growth Factors

ATKINS	Project Bicester P&R			Job ref 5124607	
	Part of structure Greenfield Run-off			Calc sheet no 2 of 2 /	rev
	Drawing ref	Calc by RP/AL	Date 09/09/13	Check by JAV	Date 10/09/13

Ref	Calculations			Output		
	Catchment area ***AREA***	0.02	km^2			
	If *AREA* < 50 ha use 50 ha and interpolate?	Yes				
	Standard average annual rainfall ***SAAR***	680	mm			
	Soil index ***SOIL***	0.45				
	Mean Flood Flow to Annual Peak Factor ***G***	0.85				
	30yr Growth Factor G_{30}	2.27				
	100yr Growth Factor G_{100}	3.19				
	Calculation					
	Average Flow $QBAR_{rural} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$			=	0.0085	m^3/s
	Peak Annual Flow $Q_1 = QBAR_{rural} \times G$			Q_1 =	7.2	l/s
	30yr Return Period Flow $Q_{30} = QBAR_{rural} \times G_{30}$			Q_{30}=	19.3	l/s
	100yr Return Period Flow $Q_{100} = QBAR_{rural} \times G_{100}$			Q_{100}=	27.1	l/s

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 189 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	65.707	0.207	0.0	24.8	24.8	431.1	O K
30 min Summer	65.765	0.265	0.0	36.6	36.6	561.8	O K
60 min Summer	65.813	0.313	0.0	46.6	46.6	671.6	O K
120 min Summer	65.842	0.342	0.0	50.6	50.6	735.0	O K
180 min Summer	65.851	0.351	0.0	51.6	51.6	756.4	O K
240 min Summer	65.855	0.355	0.0	52.0	52.0	764.2	O K
360 min Summer	65.854	0.354	0.0	52.0	52.0	763.1	O K
480 min Summer	65.849	0.349	0.0	51.4	51.4	751.8	O K
600 min Summer	65.842	0.342	0.0	50.6	50.6	735.4	O K
720 min Summer	65.834	0.334	0.0	49.7	49.7	716.8	O K
960 min Summer	65.817	0.317	0.0	47.5	47.5	680.1	O K
1440 min Summer	65.789	0.289	0.0	41.7	41.7	617.1	O K
2160 min Summer	65.757	0.257	0.0	35.0	35.0	545.0	O K
2880 min Summer	65.734	0.234	0.0	30.2	30.2	492.2	O K
4320 min Summer	65.702	0.202	0.0	23.8	23.8	419.7	O K
5760 min Summer	65.679	0.179	0.0	19.4	19.4	370.1	O K
7200 min Summer	65.662	0.162	0.0	16.9	16.9	330.9	O K
8640 min Summer	65.649	0.149	0.0	15.0	15.0	301.4	O K
10080 min Summer	65.639	0.139	0.0	13.5	13.5	278.5	O K
15 min Winter	65.731	0.231	0.0	29.7	29.7	487.0	O K
30 min Winter	65.796	0.296	0.0	43.1	43.1	633.2	O K
60 min Winter	65.852	0.352	0.0	51.7	51.7	758.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	128.285	0.0	406.3	18
30 min Summer	84.226	0.0	552.7	33
60 min Summer	52.662	0.0	744.8	62
120 min Summer	31.800	0.0	907.3	106
180 min Summer	23.353	0.0	1002.7	136
240 min Summer	18.644	0.0	1069.0	170
360 min Summer	13.543	0.0	1166.3	238
480 min Summer	10.792	0.0	1239.5	304
600 min Summer	9.043	0.0	1297.6	372
720 min Summer	7.823	0.0	1345.9	436
960 min Summer	6.219	0.0	1422.8	568
1440 min Summer	4.493	0.0	1529.6	822
2160 min Summer	3.241	0.0	1677.6	1192
2880 min Summer	2.568	0.0	1763.5	1556
4320 min Summer	1.847	0.0	1874.2	2292
5760 min Summer	1.461	0.0	1976.2	3048
7200 min Summer	1.217	0.0	2040.6	3752
8640 min Summer	1.048	0.0	2089.6	4496
10080 min Summer	0.923	0.0	2123.6	5152
15 min Winter	128.285	0.0	462.5	18
30 min Winter	84.226	0.0	627.0	32
60 min Winter	52.662	0.0	839.4	60

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	65.886	0.386	0.0	55.3	55.3	835.3	O K
180 min Winter	65.893	0.393	0.0	56.0	56.0	851.0	O K
240 min Winter	65.894	0.394	0.0	56.1	56.1	852.9	O K
360 min Winter	65.886	0.386	0.0	55.3	55.3	834.8	O K
480 min Winter	65.873	0.373	0.0	54.0	54.0	805.9	O K
600 min Winter	65.859	0.359	0.0	52.4	52.4	773.5	O K
720 min Winter	65.844	0.344	0.0	50.9	50.9	741.2	O K
960 min Winter	65.819	0.319	0.0	47.8	47.8	683.6	O K
1440 min Winter	65.781	0.281	0.0	39.9	39.9	598.5	O K
2160 min Winter	65.742	0.242	0.0	31.9	31.9	510.4	O K
2880 min Winter	65.715	0.215	0.0	26.5	26.5	450.5	O K
4320 min Winter	65.681	0.181	0.0	19.7	19.7	373.0	O K
5760 min Winter	65.656	0.156	0.0	16.0	16.0	316.7	O K
7200 min Winter	65.639	0.139	0.0	13.5	13.5	278.9	O K
8640 min Winter	65.628	0.128	0.0	11.8	11.8	254.7	O K
10080 min Winter	65.621	0.121	0.0	10.4	10.4	238.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
120 min Winter	31.800	0.0	1021.5	114
180 min Winter	23.353	0.0	1128.5	142
240 min Winter	18.644	0.0	1202.9	180
360 min Winter	13.543	0.0	1312.2	256
480 min Winter	10.792	0.0	1394.5	328
600 min Winter	9.043	0.0	1460.0	398
720 min Winter	7.823	0.0	1514.4	464
960 min Winter	6.219	0.0	1601.3	596
1440 min Winter	4.493	0.0	1722.8	852
2160 min Winter	3.241	0.0	1887.6	1232
2880 min Winter	2.568	0.0	1985.4	1612
4320 min Winter	1.847	0.0	2113.6	2376
5760 min Winter	1.461	0.0	2228.8	3104
7200 min Winter	1.217	0.0	2304.2	3816
8640 min Winter	1.048	0.0	2362.3	4496
10080 min Winter	0.923	0.0	2404.8	5240

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 2.000

Time (mins) From:	To:	Area (ha)
0	4	2.000

Model Details

Storage is Online Cover Level (m) 66.100

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	500.0
Membrane Percolation (mm/hr)	400	Length (m)	15.0
Max Percolation (l/s)	833.3	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	65.500	Cap Volume Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.225 Discharge Coefficient 0.600 Invert Level (m) 65.500

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
30 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
60 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
120 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
180 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
240 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
360 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
480 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
600 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
720 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
960 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
1440 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
2160 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
2880 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
4320 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
5760 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
7200 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
8640 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
10080 min Summer	64.600	0.000	0.0	0.0	0.0	0.0	O K
15 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
30 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
60 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
120 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	128.285	0.0	0.0	0.0	0
30 min Summer	84.226	0.0	0.0	0.0	0
60 min Summer	52.662	0.0	0.0	0.0	0
120 min Summer	31.800	0.0	0.0	0.0	0
180 min Summer	23.353	0.0	0.0	0.0	0
240 min Summer	18.644	0.0	0.0	0.0	0
360 min Summer	13.543	0.0	0.0	0.0	0
480 min Summer	10.792	0.0	0.0	0.0	0
600 min Summer	9.043	0.0	0.0	0.0	0
720 min Summer	7.823	0.0	0.0	0.0	0
960 min Summer	6.219	0.0	0.0	0.0	0
1440 min Summer	4.493	0.0	0.0	0.0	0
2160 min Summer	3.241	0.0	0.0	0.0	0
2880 min Summer	2.568	0.0	0.0	0.0	0
4320 min Summer	1.847	0.0	0.0	0.0	0
5760 min Summer	1.461	0.0	0.0	0.0	0
7200 min Summer	1.217	0.0	0.0	0.0	0
8640 min Summer	1.048	0.0	0.0	0.0	0
10080 min Summer	0.923	0.0	0.0	0.0	0
15 min Winter	128.285	0.0	0.0	0.0	0
30 min Winter	84.226	0.0	0.0	0.0	0
60 min Winter	52.662	0.0	0.0	0.0	0
120 min Winter	31.800	0.0	0.0	0.0	0

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
180 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
240 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
360 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
480 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
600 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
720 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
960 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
1440 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
2160 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
2880 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
4320 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
5760 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
7200 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
8640 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K
10080 min Winter	64.600	0.000	0.0	0.0	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
180 min Winter	23.353	0.0	0.0	0.0	0
240 min Winter	18.644	0.0	0.0	0.0	0
360 min Winter	13.543	0.0	0.0	0.0	0
480 min Winter	10.792	0.0	0.0	0.0	0
600 min Winter	9.043	0.0	0.0	0.0	0
720 min Winter	7.823	0.0	0.0	0.0	0
960 min Winter	6.219	0.0	0.0	0.0	0
1440 min Winter	4.493	0.0	0.0	0.0	0
2160 min Winter	3.241	0.0	0.0	0.0	0
2880 min Winter	2.568	0.0	0.0	0.0	0
4320 min Winter	1.847	0.0	0.0	0.0	0
5760 min Winter	1.461	0.0	0.0	0.0	0
7200 min Winter	1.217	0.0	0.0	0.0	0
8640 min Winter	1.048	0.0	0.0	0.0	0
10080 min Winter	0.923	0.0	0.0	0.0	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.000

Time (mins) From:	To:	Area (ha)
0	4	0.000

Model Details

Storage is Online Cover Level (m) 65.900

Tank or Pond Structure

Invert Level (m) 64.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	510.0	1.400	1000.0	2.800	1000.0	4.200	1000.0
0.200	570.0	1.600	1000.0	3.000	1000.0	4.400	1000.0
0.400	635.0	1.800	1000.0	3.200	1000.0	4.600	1000.0
0.600	700.0	2.000	1000.0	3.400	1000.0	4.800	1000.0
0.800	770.0	2.200	1000.0	3.600	1000.0	5.000	1000.0
1.000	845.0	2.400	1000.0	3.800	1000.0		
1.200	920.0	2.600	1000.0	4.000	1000.0		

Hydro-Brake® Outflow Control

Design Head (m) 0.600 Hydro-Brake® Type Md5 SW Only Invert Level (m) 64.600
Design Flow (l/s) 7.2 Diameter (mm) 122

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	1.200	9.8	3.000	15.5	7.000	23.7
0.200	6.3	1.400	10.6	3.500	16.8	7.500	24.5
0.300	6.5	1.600	11.3	4.000	17.9	8.000	25.3
0.400	6.4	1.800	12.0	4.500	19.0	8.500	26.1
0.500	6.7	2.000	12.7	5.000	20.0	9.000	26.9
0.600	7.1	2.200	13.3	5.500	21.0	9.500	27.6
0.800	8.0	2.400	13.9	6.000	21.9		
1.000	9.0	2.600	14.4	6.500	22.8		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 0.125 Invert Level (m) 65.500

Cascade Summary of Results for Pond_JAV221013.srcx

	Upstream Structures	Outflow To	Overflow To
	CarPark_JAV221013.srcx	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	64.648	0.048	1.5	0.0	1.5	24.8	O K
30 min Summer	64.667	0.067	2.3	0.0	2.3	35.0	O K
60 min Summer	64.692	0.092	3.5	0.0	3.5	48.1	O K
120 min Summer	64.724	0.124	4.8	0.0	4.8	65.4	O K
180 min Summer	64.749	0.149	5.5	0.0	5.5	79.1	O K
240 min Summer	64.771	0.171	6.0	0.0	6.0	91.5	O K
360 min Summer	64.806	0.206	6.4	0.0	6.4	111.1	O K
480 min Summer	64.831	0.231	6.5	0.0	6.5	125.5	O K
600 min Summer	64.849	0.249	6.5	0.0	6.5	136.3	O K
720 min Summer	64.862	0.262	6.5	0.0	6.5	143.9	O K
960 min Summer	64.877	0.277	6.5	0.0	6.5	152.7	O K
1440 min Summer	64.890	0.290	6.5	0.0	6.5	160.6	O K
2160 min Summer	64.889	0.289	6.5	0.0	6.5	159.8	O K
2880 min Summer	64.873	0.273	6.5	0.0	6.5	150.3	O K
4320 min Summer	64.830	0.230	6.5	0.0	6.5	125.1	O K
5760 min Summer	64.793	0.193	6.2	0.0	6.2	104.1	O K
7200 min Summer	64.768	0.168	5.9	0.0	5.9	89.8	O K
8640 min Summer	64.750	0.150	5.6	0.0	5.6	79.6	O K
10080 min Summer	64.736	0.136	5.2	0.0	5.2	72.3	O K
15 min Winter	64.656	0.056	1.8	0.0	1.8	28.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	40.288	0.0	83.3	0.0	371
30 min Summer	26.279	0.0	121.6	0.0	331
60 min Summer	16.640	0.0	201.3	0.0	308
120 min Summer	10.325	0.0	259.2	0.0	332
180 min Summer	7.772	0.0	297.4	0.0	364
240 min Summer	6.347	0.0	326.8	0.0	404
360 min Summer	4.740	0.0	369.2	0.0	492
480 min Summer	3.843	0.0	400.4	0.0	582
600 min Summer	3.265	0.0	425.5	0.0	674
720 min Summer	2.858	0.0	446.6	0.0	764
960 min Summer	2.317	0.0	480.3	0.0	930
1440 min Summer	1.724	0.0	526.3	0.0	1184
2160 min Summer	1.284	0.0	618.3	0.0	1564
2880 min Summer	1.040	0.0	660.7	0.0	1944
4320 min Summer	0.774	0.0	713.0	0.0	2684
5760 min Summer	0.627	0.0	775.4	0.0	3416
7200 min Summer	0.533	0.0	809.2	0.0	4128
8640 min Summer	0.467	0.0	834.4	0.0	4824
10080 min Summer	0.418	0.0	851.1	0.0	5528
15 min Winter	40.288	0.0	98.3	0.0	344

Cascade Summary of Results for Pond JAV221013.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	64.678	0.078	2.8	0.0	2.8	40.6	O K
60 min Winter	64.707	0.107	4.2	0.0	4.2	56.5	O K
120 min Winter	64.748	0.148	5.5	0.0	5.5	78.7	O K
180 min Winter	64.782	0.182	6.1	0.0	6.1	97.8	O K
240 min Winter	64.812	0.212	6.4	0.0	6.4	114.5	O K
360 min Winter	64.857	0.257	6.5	0.0	6.5	140.7	O K
480 min Winter	64.889	0.289	6.5	0.0	6.5	160.2	O K
600 min Winter	64.914	0.314	6.5	0.0	6.5	174.9	O K
720 min Winter	64.931	0.331	6.5	0.0	6.5	185.6	O K
960 min Winter	64.951	0.351	6.5	0.0	6.5	197.6	O K
1440 min Winter	64.955	0.355	6.5	0.0	6.5	200.4	O K
2160 min Winter	64.934	0.334	6.5	0.0	6.5	187.5	O K
2880 min Winter	64.895	0.295	6.5	0.0	6.5	163.4	O K
4320 min Winter	64.816	0.216	6.4	0.0	6.4	117.3	O K
5760 min Winter	64.769	0.169	5.9	0.0	5.9	90.6	O K
7200 min Winter	64.742	0.142	5.4	0.0	5.4	75.2	O K
8640 min Winter	64.725	0.125	4.8	0.0	4.8	65.9	O K
10080 min Winter	64.713	0.113	4.4	0.0	4.4	59.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	26.279	0.0	142.4	0.0	311
60 min Winter	16.640	0.0	230.7	0.0	302
120 min Winter	10.325	0.0	295.9	0.0	328
180 min Winter	7.772	0.0	338.9	0.0	370
240 min Winter	6.347	0.0	372.0	0.0	418
360 min Winter	4.740	0.0	419.9	0.0	520
480 min Winter	3.843	0.0	455.1	0.0	616
600 min Winter	3.265	0.0	483.6	0.0	710
720 min Winter	2.858	0.0	507.6	0.0	800
960 min Winter	2.317	0.0	546.1	0.0	982
1440 min Winter	1.724	0.0	599.0	0.0	1274
2160 min Winter	1.284	0.0	701.5	0.0	1672
2880 min Winter	1.040	0.0	750.6	0.0	2064
4320 min Winter	0.774	0.0	813.0	0.0	2796
5760 min Winter	0.627	0.0	884.9	0.0	3488
7200 min Winter	0.533	0.0	925.9	0.0	4152
8640 min Winter	0.467	0.0	957.3	0.0	4856
10080 min Winter	0.418	0.0	979.5	0.0	5560