

Proposed Development

Boldon Golf Course

Flood Risk Assessment and Drainage Strategy

Reference	RWO/FRADS /24279
Client Name	Castle Design
Date	March 2025
Version	1

CONTENTS

Confidentiality Statement

Document History

1.0	EXECUTIVE SUMMARY	4
2.0	INTRODUCTION	5
3.0	THE SITE.....	6
4.0	EXISTING DRAINAGE.....	7
5.0	PROPOSED DEVELOPMENT	8
6.0	FLOOD RISK.....	9
7.0	FOUL WATER DRAINAGE	14
8.0	SURFACE WATER DRAINAGE	15
9.0	CONCLUSIONS	17

APPENDICES

APPENDIX A:	SITE LOCATION
APPENDIX B:	INDICATIVE SITE LAYOUT
APPENDIX C:	TOPOGRAPHICAL SURVEY
APPENDIX D:	EA FLOOD MAPS
APPENDIX E:	GREENFIELD RUNOFF CALCULATION
APPENDIX F:	ATTENUATION CALCULATIONS

CONFIDENTIALITY STATEMENT

This report is addressed to and may be relied upon by the following:

Castle Design

This report has been prepared for the sole use and reliance of the above-named parties. This report shall not be relied upon or transferred to any other parties without the express written authorisation of RWO Group. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party.

DOCUMENT HISTORY

VERSION	PURPOSE/DESCRIPTION	DATE
1	First Issue	12.03.2025

1.0 EXECUTIVE SUMMARY

This assessment has looked at the implications of a proposed residential development in relation to flood risk and found all published risks to be low. The site is in Flood Zone 1, placing the risk of flooding for the development as low.

The additional following risks have been assessed based on publicly available information and third-party professional reports;

- Pluvial Flooding – Low
- Groundwater Flooding – Low
- Flooding from Sewers – Low
- Flooding from Reservoirs, Canals and other artificial sources – Low

In order to ensure that the risk to third party land flooding is not increased the proposed drainage system will be designed in accordance with the requirements of Ofwat and shall demonstrate that:

- No surcharge of pipes occurs in the 1 in 2-year rainfall event.
- No surface flooding occurs in 1 in 30-year rainfall event.
- No flooding to buildings and adjacent properties occurs in 1 in 100-year rainfall event with a 45% allowance for climate change.

Any flooding for the 100-year event with climate change will need to be stored on site to protect third party land from potential overland flows.

As surface water discharge from the site will be restricted, on site surface water attenuation will be required for all storms return periods up to and including the 100yr + 45 Climate event and will be accommodated on site.

Source control of pollutants to manage water quality have been included within the scheme, private parking areas will be constructed with permeable paving ensuring water quality is managed.

2.0 INTRODUCTION

RWO has been instructed by Castle Design to prepare a Flood Risk Assessment and Drainage Strategy Report to support a of Detailed Application 6 new residential dwellings located in Boldon,

It is understood the development will include the construction of new residential dwellings, highways, drainage including various SuDS features such as permeable paving, along with new site wide infrastructure to service the development.



3.0 THE SITE

The site is located in West Boldon, South Tyneside, with the centre of the site being located at nation grid reference 435740, 561038. The site has an approximate area of 0.16Ha and is brownfield in nature, currently utilised as part of the golf club facilities.

The surrounding areas to the is predominantly residential in nature with agricultural land and the golf course to the south of the proposed development site. There are no formal watercourses within the development site or adjacent, the nearest formal watercourse is the River Don located approximately 1km to the north of the site.

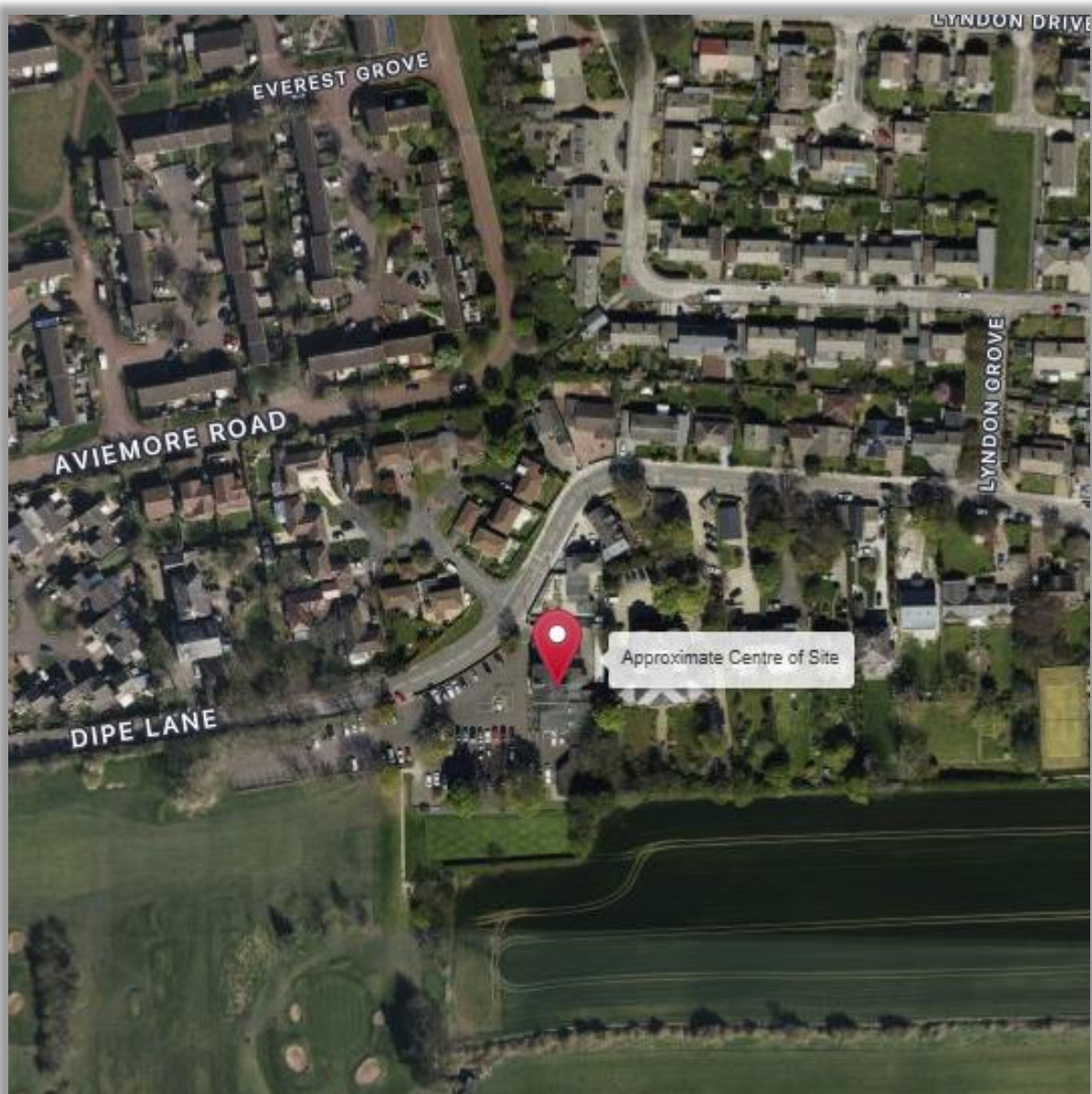


Figure 1 – Site location (Approximate Centre of Site indicated by Red Marker)

4.0 EXISTING DRAINAGE

PUBLIC SEWERAGE SYSTEM

Existing Northumbrian Water sewer records have been acquired for the site to assess development impacts on infrastructure and potential connection locations which can be seen in Appendix B. These show that there is a combined existing public sewer within Dipe Lane, which is it understand that the existing development discharge to.

WATERCOURSES

There are no watercourses within the site boundary or adjacent. There nearest main watercourse is the River Don, approximately 1km to the north of the development. There is an unnamed watercourse located approximately 600m to the east of the site, this conveys flows to the River Don.

5.0 PROPOSED DEVELOPMENT

The development consists of a rectangular shaped piece of with a total area of circa 0.16Ha. It is proposed develop 6 new residential dwellings. An inductive site layout is included in Appendix C and a topographical survey in Appendix D.

It is understood the development will include the construction of new residential dwellings, highways, drainage including various SuDS features such as permeable paving, along with new site wide infrastructure to service the development.



6.0 FLOOD RISK

The site under consideration is located within Flood Zones 1 on the latest version of the Indicative Floodplain Maps produced by the Environment Agency (EA) a copy of the flood map is provided in Appendix D.

Flood Zone 1 (FZ1) is defined in Planning Practice Guidance as a low-risk area, which comprises land assessed as having less than 1 in 1,000 annual probabilities of river or sea flooding (0.1%).

Flood Zone 2 (FZ2) is defined as a medium-risk area, which comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1-0.1%), or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5-0.1%) in any year.

Technical Guidance to the National Planning Policy Framework (NPPF) advises that *'buildings used for residential dwellings'* are appropriate in Flood Zones 1.

The proposed site usage falls within the 'less vulnerable' category as identified in the Technical Guidance to the National Planning Policy Framework (NPPF) Table 3: Flood Risk Vulnerability and Flood Risk Classification. As such the exception test, will not be required based on NPPF Table 3.

Essential infrastructure • Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind Turbines.
Highly Vulnerable • Police stations, ambulance stations and fire stations and command centres and telecommunication installations required to be operational during flooding. • Emergency disposal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”).
More vulnerable • Hospitals. • Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non-residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, <i>subject to a specific warning and evacuation plan</i>.
Less vulnerable • Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non-residential institutions not included in “more vulnerable”, and assembly and leisure. • Land and buildings used for agricultural and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals workings and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewerage treatment works (if adequate measures to control pollution and manage sewerage during flooding events are in place).
Water-compatible development • Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of defence installations. • Ship building, repairing, dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water based recreation (excluding sleeping accommodation). • Lifeguard and coastal stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, <i>subject to specific warning and evacuation plan</i>.

Table 1 – ‘NPPF Table 2: Flood Risk Vulnerability Classification’

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	x	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	x	x	x	✓*

Key:

✓ Development is appropriate

x Development should not be permitted.

**Table 2 – Technical Guidance to the National Planning Policy Framework (NPPF) Table 3
‘Flood Risk Vulnerability and Flood Zone Classification’**

SURFACE WATER FLOODING

The online Environment Agency surface water flood risk maps have been reviewed and show there is no surface water flood risk associated with development site.

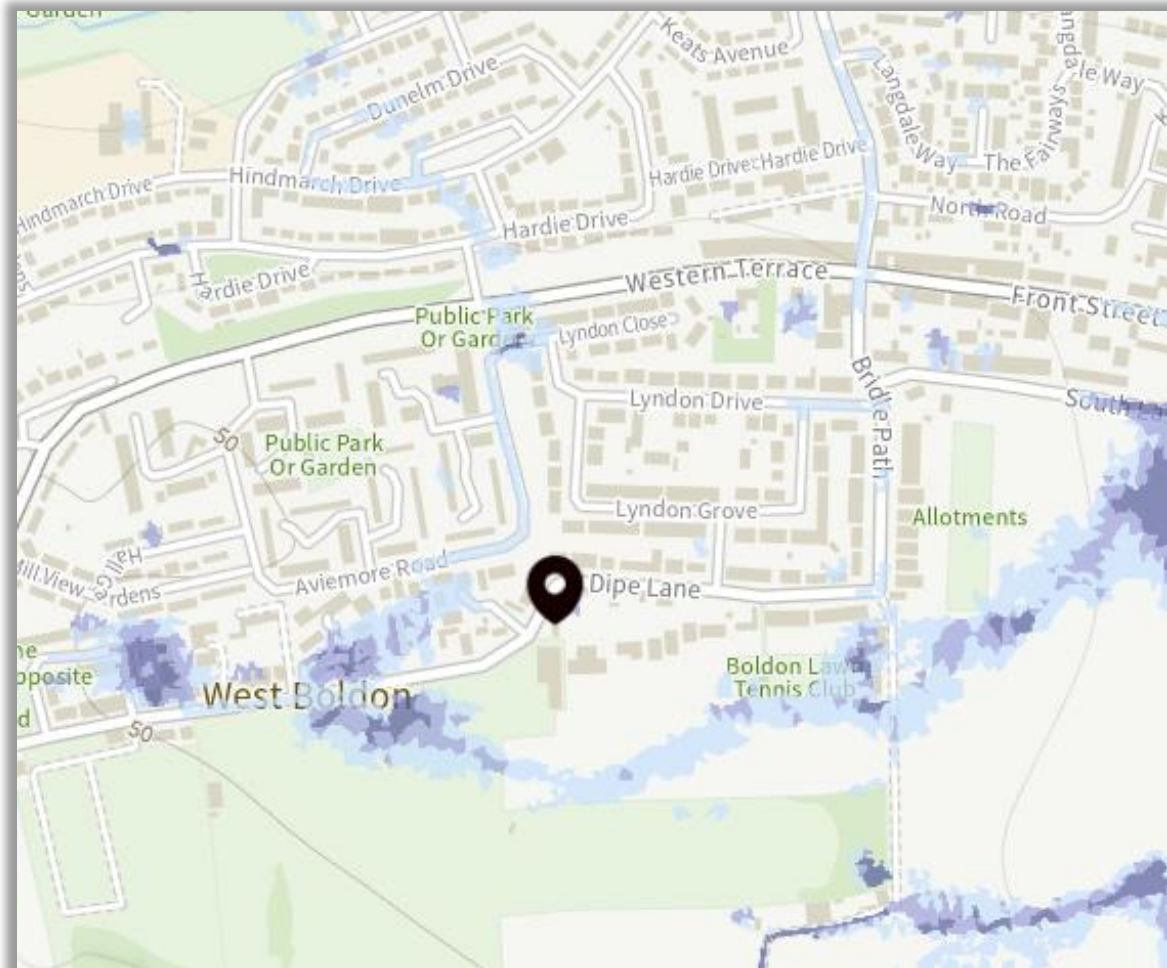


Figure 1 – Surface Water (Pluvial) Flood Map Extract

Based on the publicly available information the risk of surface water flooding is low.

GROUNDWATER FLOODING

The Environment Agency flood risks have been reviewed to give an understanding of the risk associated with Groundwater.

Other flood risks

[More about groundwater and reservoirs](#)

Groundwater

Flooding from groundwater is unlikely in this area.

Reservoirs

Flooding from reservoirs is unlikely in this area.

Extract 1 – Groundwater Flood Risk from Roberts Environmental Report

Based on the available information the risk of groundwater flooding is considered low.

FLOODING FROM SEWERS

There are no public sewers within the site or on the boundaries. All new sewers will be designed to accommodate flows to meet with local and national standards to ensure flood risk is managed and future maintenance is achieved to minimise the risk of system failure. A copy of the public sewer plan is provided in Appendix E.

There are no known surface water sewers in the immediate vicinity of the site.

The risk of flooding from sewers is deemed low.

FLOODING FROM RESERVOIRS, CANALS AND ARTIFICIAL SOURCES

The Environment Agency flood risks have been reviewed to give an understanding of the risk associated with flooding from reservoirs and canals, see Extract 1 above. The risk of flooding from reservoir, canals and artificial sources is deemed low.

7.0 FOUL WATER DRAINAGE

Foul water from the development site is proposed to discharge without restriction into existing public combined sewer.



8.0 SURFACE WATER DRAINAGE

The proposed site drainage will comprise of a separate surface and foul water drainage system.

The following summarises the requirements for the discharge of surface and foul water from the site.

Sustainable Urban Drainage Systems (SUDS)

Sustainable Urban Drainage System (SUDS) may be used in conjunction with conventional drainage systems to improve water quality as well as manage surface water discharge. The following audit has been carried out relating to suitability of SuDS systems:

Drainage Method	Description/Suitability	Proposal/Feasibility
1. Infiltration.	Not suitable	Not applicable
2. Ponds and wetlands.	Suitable subject to land being made available & ground water levels.	Not applicable. Limited space.
3. Infiltration Basins.	Not suitable	Not applicable
4. Attenuation Basins.	Suitable subject to land being made available & ground water levels.	Not applicable. Limited space.
5. Swale.	May be utilised convey water/improve water quality.	Applicable but not required.
6. French/Filter drain.	May be utilised convey water/improve water quality.	Applicable but not required.
7. Pervious/Permeable Pavement.	Not suitable unless tanked.	Applicable. On the basis they are positively drained.
8. Geocellular Systems/Tank systems.	May be used as surface water attenuation.	Applicable.
9. Oversized pipes.	May be used as surface water attenuation.	Applicable.
10. Box culverts.	May be used as surface water attenuation.	Applicable but not required.
11. Purpose designed tanks.	May be used as surface water attenuation.	Applicable but not required.

Surface Water Drainage

The disposal of surface water shall be in accordance with the Requirement H3 of Building Regulations 2010. This establishes a preferred hierarchy for surface water disposal. Consideration should firstly be given to discharge to soakaway/infiltration system, watercourse, and public sewer in that priority order.

A discharge via infiltration has been excluded on the anticipated ground conditions. As per section 4.0 of this report, the nearest watercourses are 600m and 1 km from the site, with third party and ownership issues, as such a discharge to watercourse has been excluded. It is proposed to discharge surface water drainage to the public sewer on Dipe Lane, as per the existing connections.

It is understood the existing development has a free discharge to the public sewer, in accordance with the LLFA guidance this will need to be restricted to a greenfield rate of discharge, this is included in Appendix E, with a runoff rate 0.26 l/s. In accordance with good practice a minimum orifice size of 75mm should be utilised to avoid blockage and increased risk of flooding, as such it is proposed to discharge surface water at 3.5 l/s, subject to relevant consents and approvals.

Source control of pollutants in high-risk car parking areas will be provided by permeable paving ensuring water quality is managed for the development site.

The main consideration in terms of flood risk is to third party land. In order to ensure that the risk to third party land flooding is not increased the proposed drainage system will be designed in accordance with the requirements of Ofwat and shall demonstrate that:

- No surcharge of pipes occurs in the 1 in 2-year rainfall event.
- No surface flooding occurs in 1 in 30-year rainfall event.
- No building or third-party flooding for the 1 in 100-year event with a 45% allowance for climate change

Any flooding for the 100-year event with climate change will need to be stored on site to protect third party land from potential overland flows.

A storage calculation has been prepared to size the surface water attenuation, this is included in Appendix F. The calculation is based on a discharge rate of 3.5 l/s with an impermeable area of 0.96Ha, as measured from the site layout, this gives a required attenuation volume of 41 cubic metres.

A maintenance regime and strategy will be required to determine the details for inspection and maintenance specification for sustainable drainage systems (SuDS) maintained by a management company on behalf of the developer if they are not to be adopted by the Local Authority or Water Authority. The principles form the basis of the Surface Water Management Plan (SWMP) and will ensure that surface water from the development site will be collected, attenuated and conveyed in such a way that it manages the flows in accordance with best practices.

9.0 CONCLUSIONS

This assessment has looked at the implications of a proposed residential development in relation to flood risk and found all published risks to be low. The site is in Flood Zone 1, placing the risk of flooding for the develop as low.

The additional following risks have been assessed based on publicly available information and third-party professional reports;

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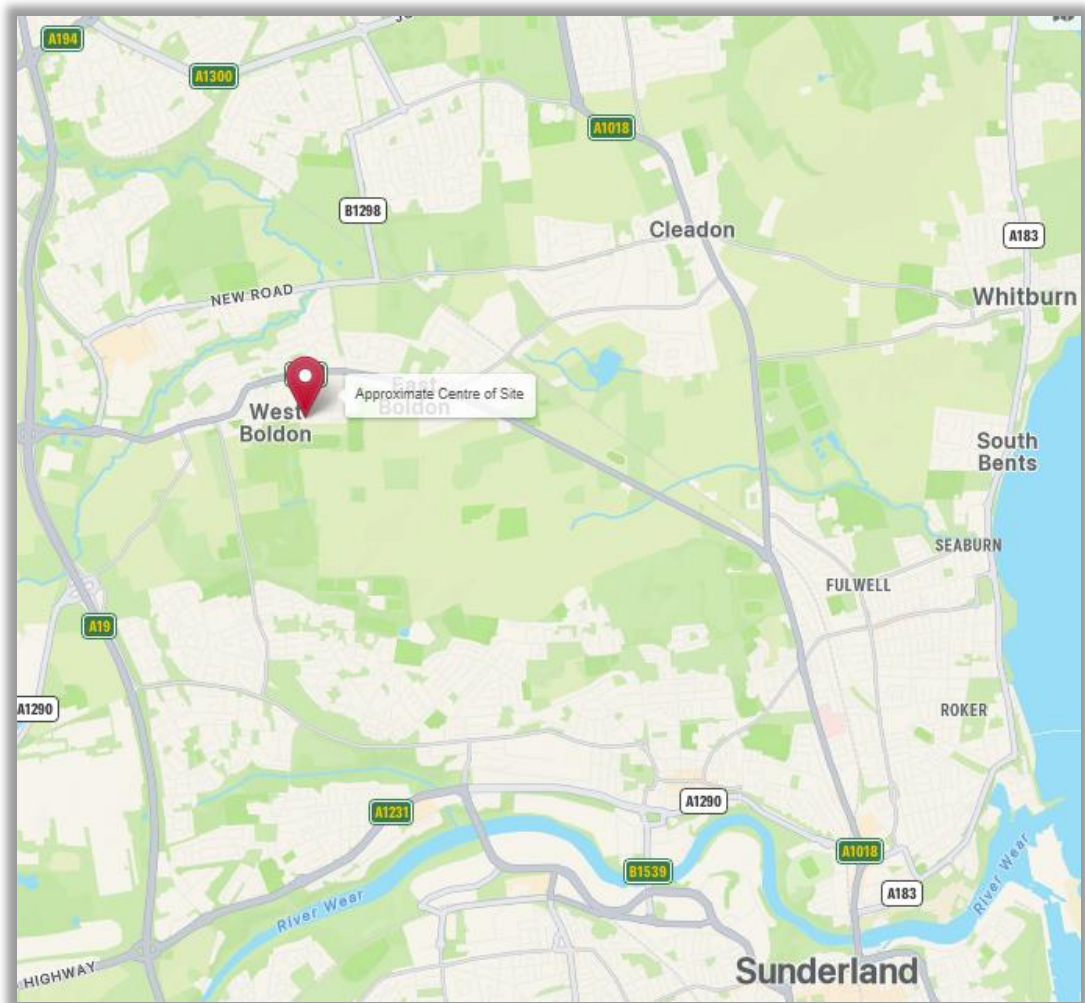
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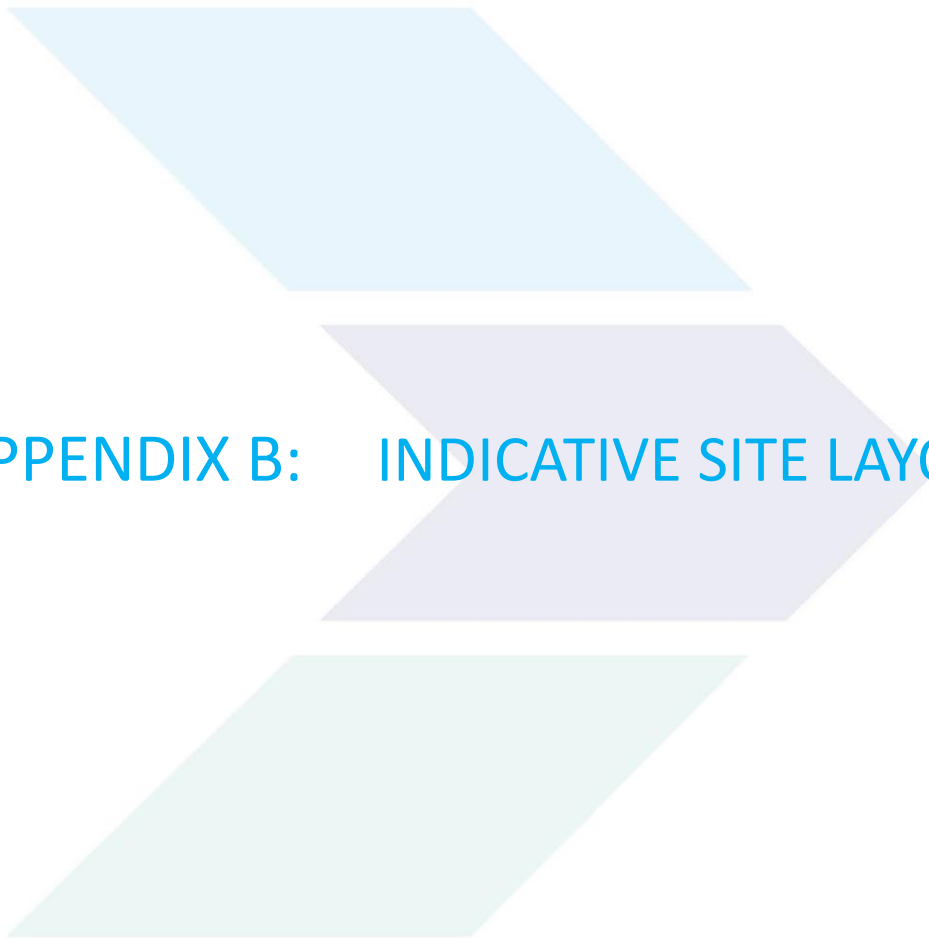
Source control of pollutants to manage water quality have been included within the scheme, private parking areas will be constructed with permeable paving ensuring water quality is managed.

RWO
March 2025

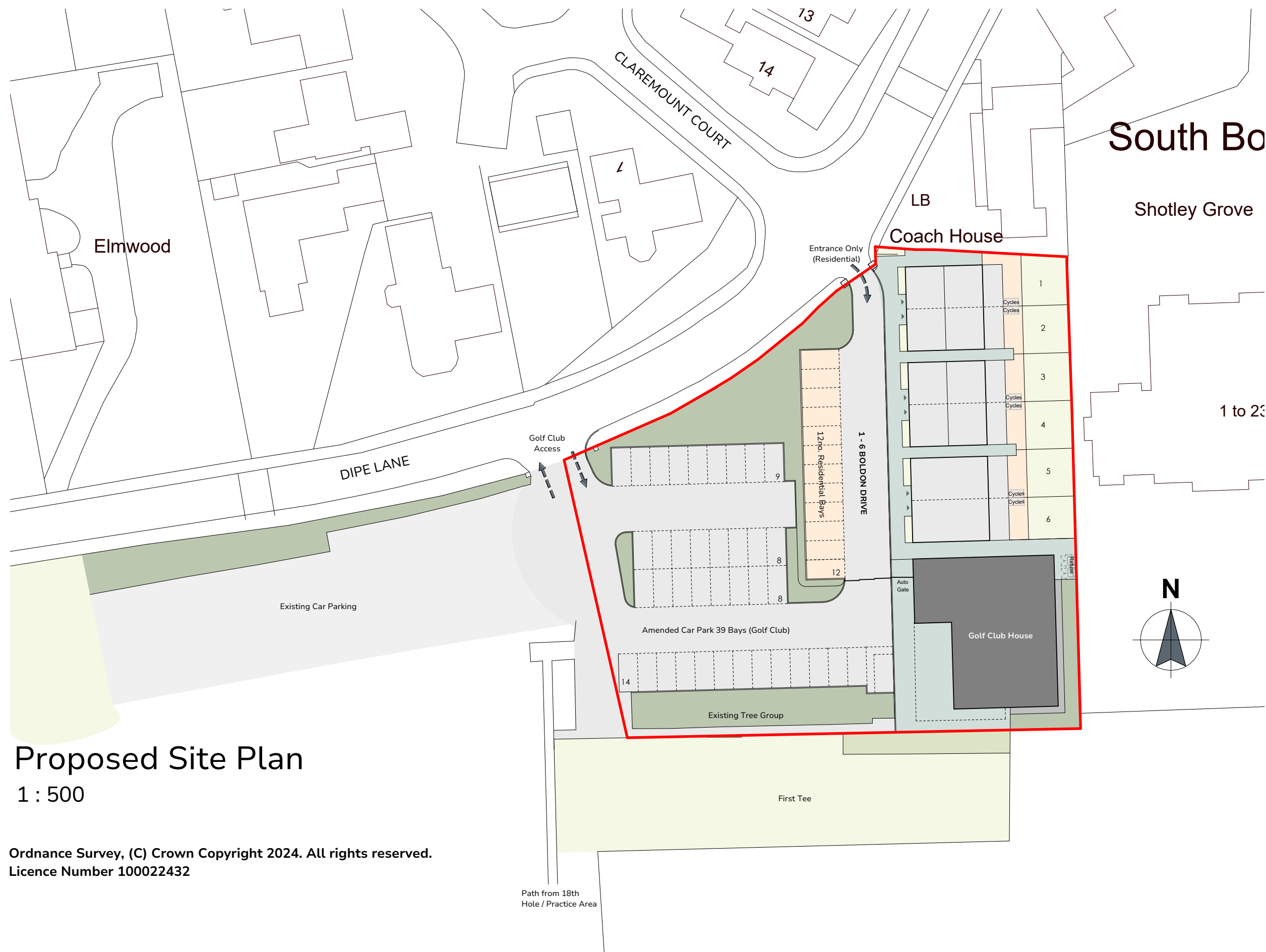


APPENDIX A: SITE LOCATION



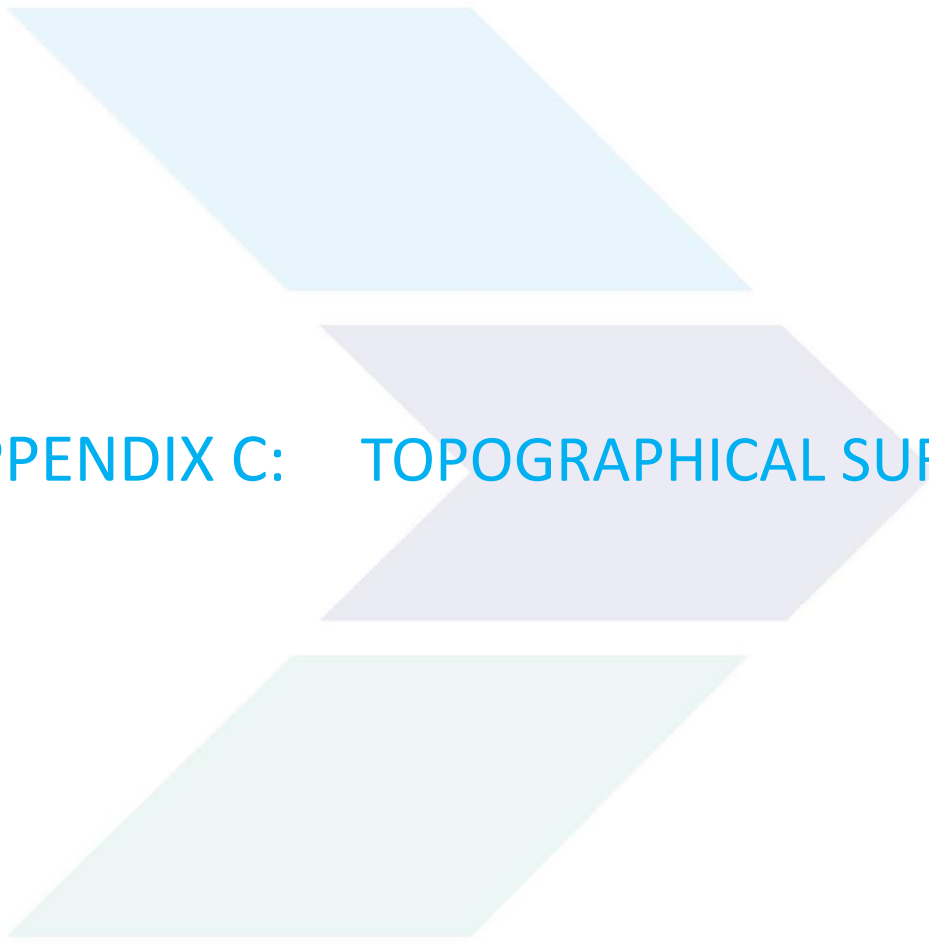


APPENDIX B: INDICATIVE SITE LAYOUT



Proposed Site Plan
1 : 500

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APPENDIX C: TOPOGRAPHICAL SURVEY

001



002



003

Castle Keep Surveys Drawing Legend

Topographical Line Types

.....	Road	.....	Wall
.....	Drop Kerb	.....	Sole Drain
.....	Top of Step	.....	AC/D Drain
.....	Bottom of Step	.....	Channel Drain
.....	Top of Bank	.....	How Surface Type
.....	Bottom of Bank	.....	Verge Line
.....	Building Line	.....	Tree Canopy Line
.....	Building Canopy	.....	Tree Canopy Line
.....	Track	.....	Tree Canopy Line
.....	Channel	.....	Tree Canopy Line
.....	Kerb	.....	Tree Canopy Line
.....	Concrete	.....	Tree Canopy Line
.....	Footpath	.....	Tree Canopy Line
.....	Surface Change	.....	Tree Canopy Line
.....	Tactile Paver	.....	Tree Canopy Line
.....	Barrier	.....	Tree Canopy Line
.....	Chain Fence	.....	Tree Canopy Line
.....	Post & Rail Fence	.....	Tree Canopy Line
.....	Wooden Fence	.....	Tree Canopy Line
.....	Overhead Drainage System	.....	Tree Canopy Line
.....	Overhead Electric	.....	Tree Canopy Line

Symbols

TP	Telegraph Pole	CL 000.000	Manhole
LP	Lamp Post	IL 000.000	Manhole
EP	Electric Post	IC 000.000	Inspection Chamber
TL	Traffic Light	CL 000.000	Cable TV Cover
FL	Fluorescent	CATV CL 000.000	PT Cover
CTV	Cable TV C	BT CL 000.000	PT Cover
SC	Stop Cock	SV CL 000.000	Stop Valve
GV	Gas Valve	VM CL 000.000	Water Meter
GU	Gully	AV CL 000.000	Air Valve
BOL	Bollard	FH CL 000.000	Fire Hydrant
0.000	Spot Level	OV CL 000.000	Gas Valve
Post	Post	Cabinet	Cabinet
Column	Column	CL 100.000	Circular Manhole
ER	Earth Road	CL 100.000	Transformer
GR	Gas Pipe	IL 000.000	Transformer
RWP	Rain Water Pipe	WSL 000.000	Water Spout Level
RS	Road Sign	IL 000.000	Insert Level
SIGN	Sign Post	EOS	Tree
SVP	Self Valve Pipe	EOS	End of Tapal
RSL	Road Sign Light	EOS	Spot
Tap	Tap	EOS	Tree Stump
Duct	Duct	EOS	Tree Hole
SIGN	Sign	EOS	Tree Hole
STAY	Stay	EOS	Tree Hole
PIPE	Pipe	EOS	Tree Hole
SWR	SWR Building Sign	EOS	Tree Hole
ngc	Building Floor Sign	EOS	Tree Hole
FFL	Finished Floor Level	EOS	Tree Hole
THL	Threshold Level	EOS	Tree Hole
Top of Wall	Top of Wall Height	EOS	Tree Hole
Cape Level	Cape Level Height	EOS	Tree Hole

Approximate National Grid North

Job Title

Boldon Golf Club

Dipe Lane

East Boldon, NE36 0PQ

Client Name

Castle Design

Drawing Title

Topographical Survey

NTS @ A1

ER/BW

27/01/2025

BW

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Causton, Durham

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25017

OV

Project Number

Drawing No. Revision



Castle Keep Surveys Drawing Legend

Topographical Landmarks:

..... Road	 Drop Kerb	 Top of Step	 Bottom of Step	 Top of Bank	 Bottom of Bank	 Building Line	 Building Contour	 Track	 Channel	 Kerb	 Contour	 Fingering	 Surface Change	 Tactile Paving	 Barrier	 Chain Fence	 Metal Fence	 Plastic & Wire Fence	 Wooden Fence	 Overhead Drainage System	 Overhead Electric
..... Wall	 Skid Pan	 ACO Drain	 Channel Drain	 New Surface Type	 Vague Line	 Tree Canopy Line	 Tree Canopy Line	 Puddle	 Surface Feature	 Survey Station											

Symbol:

TP	Telegraph Pole	CL 000.000	Manhole	
LP	Lamp Post	IL 000.000	Inspection Chamber	
EP	Electric Pole	CL 000.000	Cable TV Cover	
TL	Traffic Light	CL 000.000	PT Cover	
FL	Fluorescent	CL 000.000	Road Gully	
CTV	Cable TV C	CL 000.000	Gully	
SC	Stop Cook	CL 000.000	Circular Gully	
GV	Gas Valve	CL 000.000	Circular Road Gully	
GU	Gully	CL 000.000	Stop Valve	
BOL	Bollard	CL 000.000	Water Meter	
0.000	Spot Level	CL 000.000	Column	
Post	Post	CL 000.000	AV	Air Valve
ER	Earth Road	CL 000.000	FH	Fire Hydrant
GR	Gas Pipe	CL 000.000	GV	Gas Valve
RWP	Rain Water Pipe	CL 000.000	Cabinet	Cabinet
RS	Road Sign	CL 000.000	CL 100.000	Circular Manhole
SIGN	Sign Post	CL 100.000	IL 000.000	Transformer
SVP	Self Valve Pipe	CL 100.000	IL 000.000	Transformer
RIS	Risking Fan	CL 100.000	IL 000.000	Transformer
Tap	Tap	CL 100.000	IL 000.000	Transformer
Duct	Duct	CL 100.000	IL 000.000	Transformer
SIGN	Sign	CL 100.000	IL 000.000	Transformer
STAY	Stay	CL 100.000	IL 000.000	Transformer
PIPE	Pipe	CL 100.000	IL 000.000	Transformer
SW/ES	SW/ES Building Site	CL 100.000	IL 000.000	Transformer
ngce	Building Site	CL 100.000	IL 000.000	Transformer
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Cope Level	Cope Level Height	CL 100.000	IL 000.000	Transformer

Approximate National Grid North

Castle Keep Surveys

Boldon Golf Club
Dipt Lane
East Boldon, NE36 0PQ

Castle Design

Topographical Survey

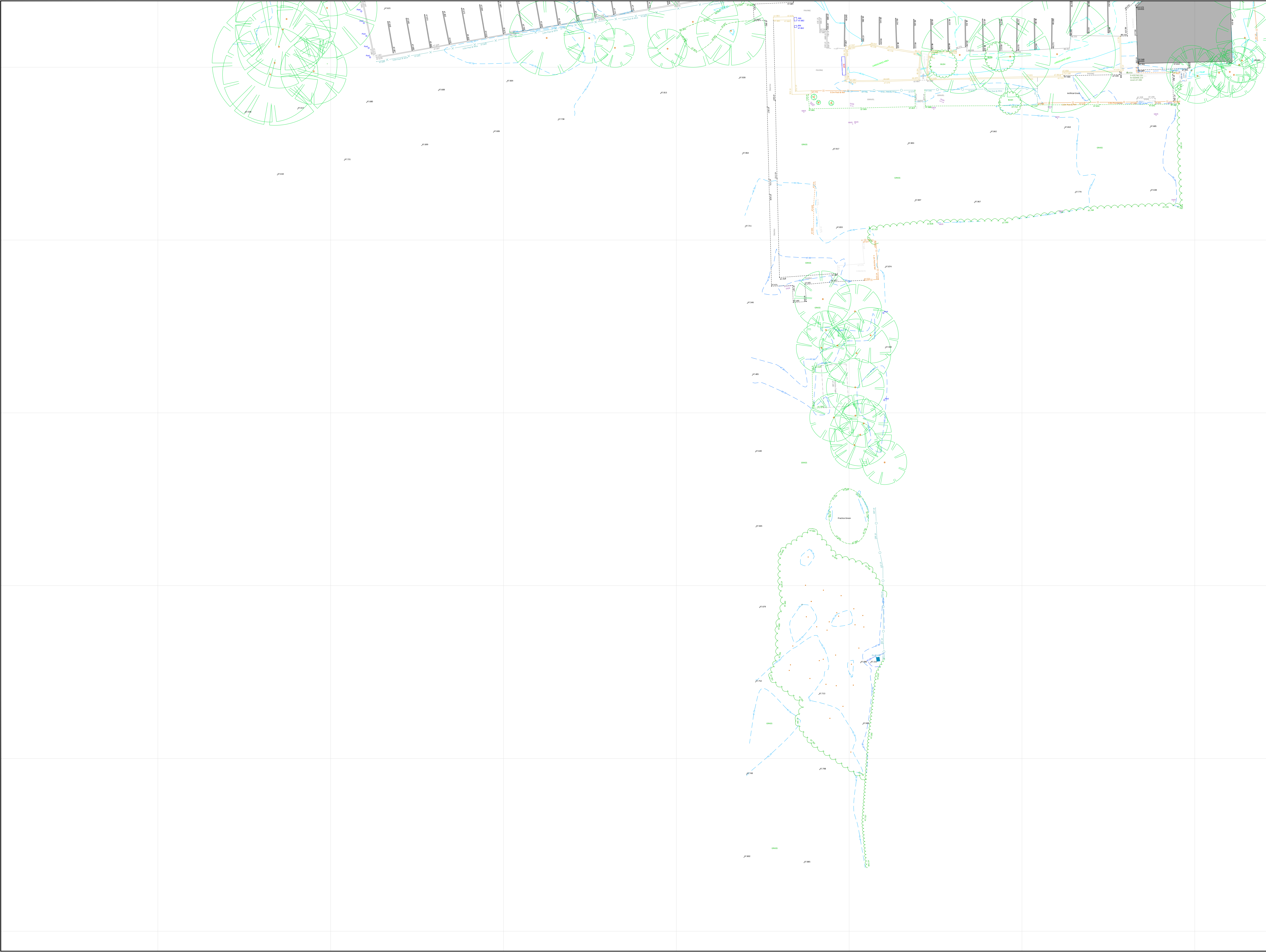
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25017
002

Project Number
Drawing No



Castle Keep Surveys Drawing Legend

Topographical Landmarks:

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Symbolic:

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BOL	Bollard	SV CL 000.000	Stop Valve
0.000	Spot Level	VW CL 000.000	Water Meter
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RS	Road Sign	IL 000.000	Insert Level
Tap	Tap	IL 000.000	Tree
Duct	Duct	EOS	End of Signal
SIG	Sign	SP	Spot
STAY	Stay	Tree Stump	Tree Stump
PIPE	Pipe	BORE HOLE	Bore Hole
cases	cases Building Sheet	Top of Wall Height	Scout
ngce	ngce Building Sheet	Level=000.000	Level=000.000
FFL	Flooded Floor Level	Level=000.000	Level=000.000
THL	THL Level	Level=000.000	Level=000.000
Top Of Wall	Top Of Wall Height	Level=000.000	Level=000.000
Cope Level	Cope Level Height	Level=000.000	Level=000.000

Approximate National Grid North

Castle Keep Surveys

Boldon Golf Club
Dipe Lane
East Boldon, NE36 0PQ

Castle Design

Topographical Survey

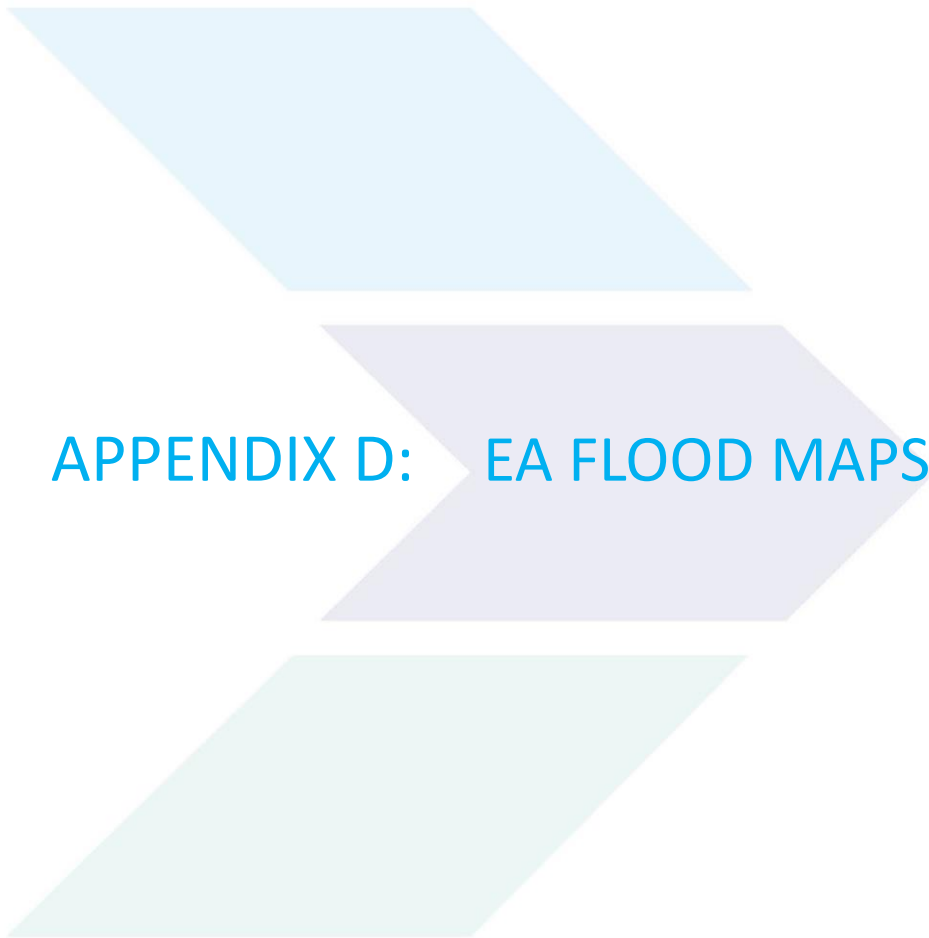
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25017
003

Project Number
Drawing No. Revision



APPENDIX D: EA FLOOD MAPS

Flood map for planning

Your reference
<Unspecified>

Location (easting/northing)
435743/561030

Created
12 Mar 2025 17:11

Your selected location is in flood zone 1, an area with a low probability of flooding.

You will need to do a flood risk assessment if your site is **any of the following**:

- bigger than 1 hectare (ha)
- In an area with critical drainage problems as notified by the Environment Agency
- identified as being at increased flood risk in future by the local authority's strategic flood risk assessment
- at risk from other sources of flooding (such as surface water or reservoirs) and its development would increase the vulnerability of its use (such as constructing an office on an undeveloped site or converting a shop to a dwelling)

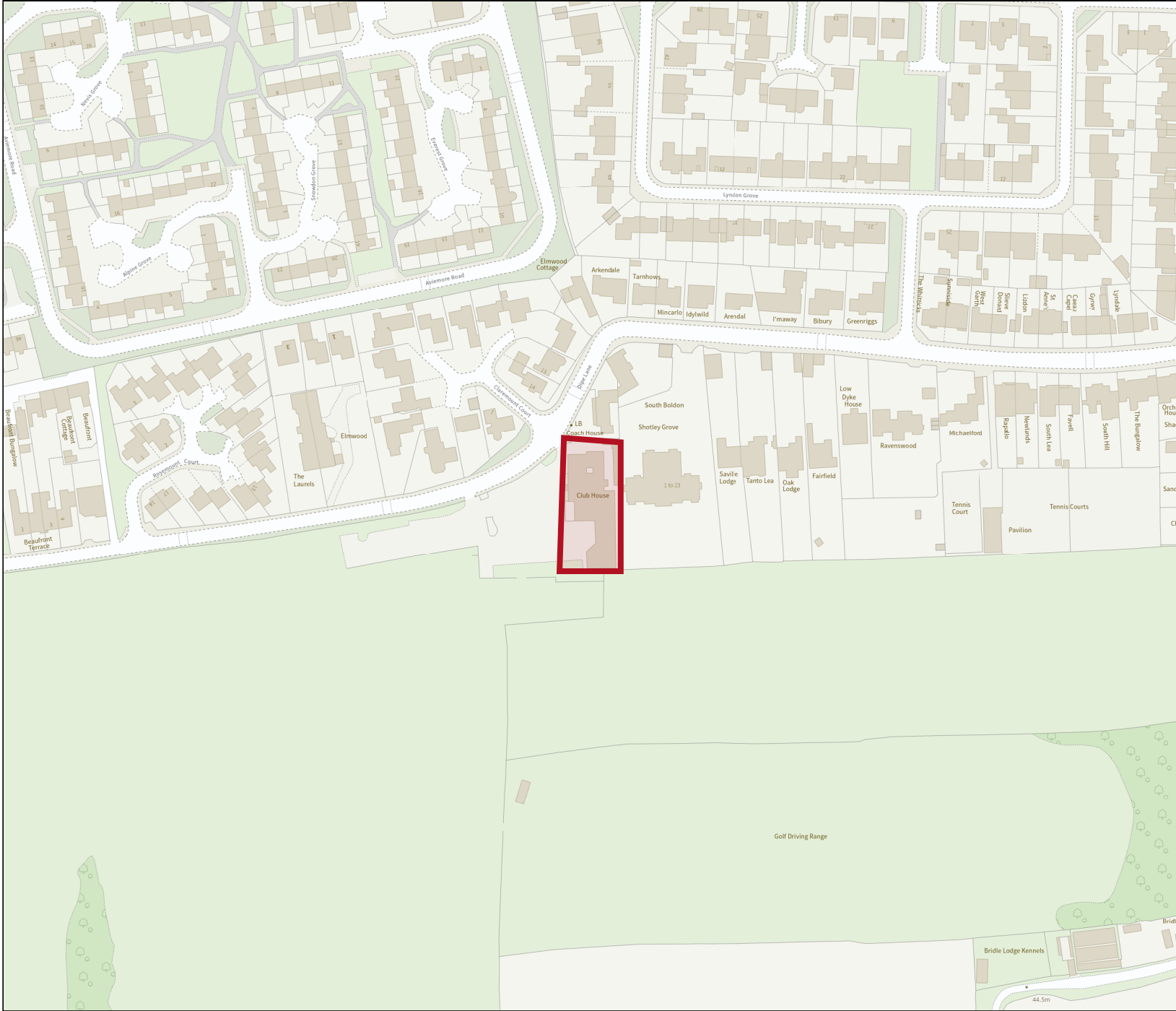
Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.

Flood risk data is covered by the Open Government Licence **which** sets out the terms and conditions for using government data. <https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

Use of the address and mapping data is subject to Ordnance Survey public viewing terms under Crown copyright and database rights 2024 OS AC0000807064. <https://flood-map-for-planning.service.gov.uk/os-terms>



Flood map for planning

Your reference
<Unspecified>

Location (easting/northing)
435743/561030

Scale
1:2500

Created
12 Mar 2025 17:11

-  Selected area
-  Flood zone 3
-  Flood zone 2
-  Flood zone 1
-  Flood defence
-  Main river
-  Water storage area

0 20 40 60m



APPENDIX E: GREENFIELD RUNOFF CALCULATION

Calculated by:	Ross Oakley
Site name:	Boldon
Site location:	Boldon

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	54.94266° N
Longitude:	1.44364° W
Reference:	2613703704
Date:	Mar 13 2025 17:22

Runoff estimation approach

IH124

Site characteristics

Total site area (ha):

0.16

Methodology

Q _{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

Hydrological characteristics

	Default	Edited
SAAR (mm):	633	633
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

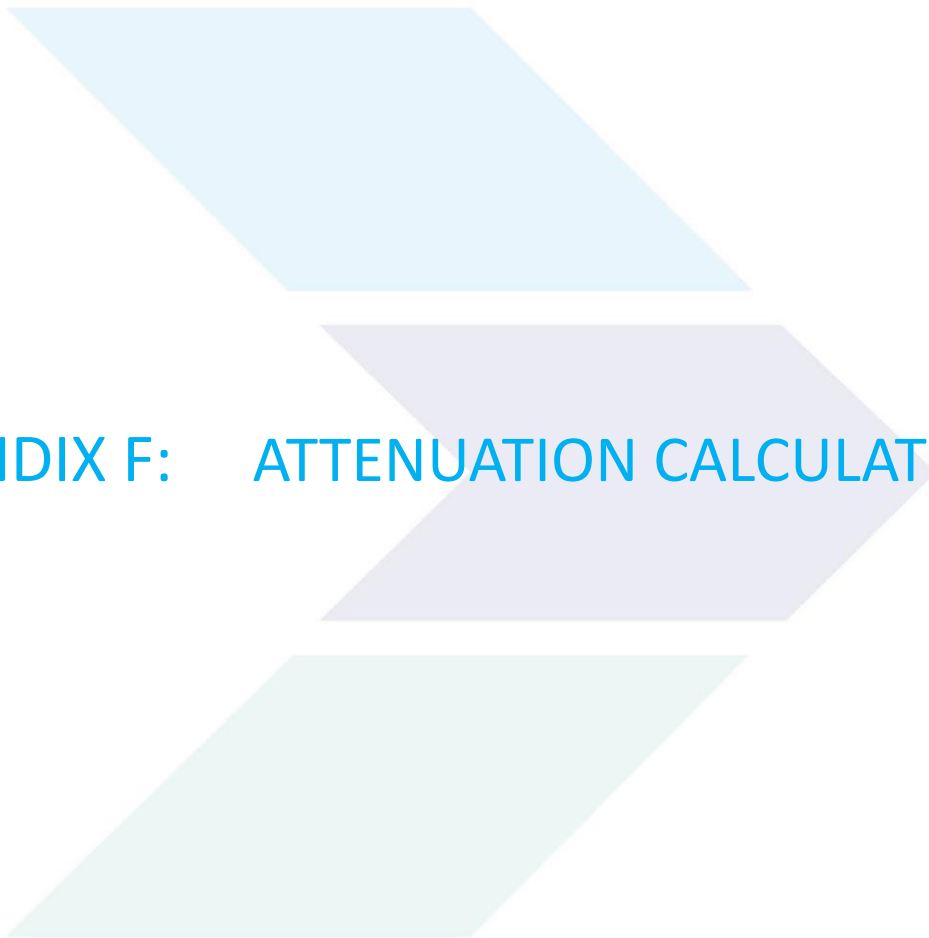
(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q _{BAR} (l/s):	0.26	0.26
1 in 1 year (l/s):	0.22	0.22
1 in 30 years (l/s):	0.45	0.45
1 in 100 year (l/s):	0.54	0.54
1 in 200 years (l/s):	0.61	0.61

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.



APPENDIX F: ATTENUATION CALCULATIONS

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 101 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	8.501	0.501	0.0	3.5	3.5	23.8	O K
30 min Summer	8.665	0.665	0.0	3.5	3.5	31.6	O K
60 min Summer	8.798	0.798	0.0	3.5	3.5	37.9	O K
120 min Summer	8.858	0.858	0.0	3.5	3.5	40.8	O K
180 min Summer	8.857	0.857	0.0	3.5	3.5	40.7	O K
240 min Summer	8.838	0.838	0.0	3.5	3.5	39.8	O K
360 min Summer	8.782	0.782	0.0	3.5	3.5	37.2	O K
480 min Summer	8.721	0.721	0.0	3.5	3.5	34.3	O K
600 min Summer	8.657	0.657	0.0	3.5	3.5	31.2	O K
720 min Summer	8.580	0.580	0.0	3.5	3.5	27.6	O K
960 min Summer	8.452	0.452	0.0	3.5	3.5	21.5	O K
1440 min Summer	8.277	0.277	0.0	3.5	3.5	13.1	O K
2160 min Summer	8.151	0.151	0.0	3.2	3.2	7.2	O K
2880 min Summer	8.106	0.106	0.0	2.9	2.9	5.0	O K
4320 min Summer	8.079	0.079	0.0	2.1	2.1	3.7	O K
5760 min Summer	8.067	0.067	0.0	1.7	1.7	3.2	O K
7200 min Summer	8.059	0.059	0.0	1.4	1.4	2.8	O K
8640 min Summer	8.054	0.054	0.0	1.3	1.3	2.6	O K
10080 min Summer	8.050	0.050	0.0	1.1	1.1	2.4	O K
15 min Winter	8.501	0.501	0.0	3.5	3.5	23.8	O K
30 min Winter	8.665	0.665	0.0	3.5	3.5	31.6	O K
60 min Winter	8.799	0.799	0.0	3.5	3.5	38.0	O K
120 min Winter	8.862	0.862	0.0	3.5	3.5	40.9	O K
180 min Winter	8.850	0.850	0.0	3.5	3.5	40.4	O K
240 min Winter	8.820	0.820	0.0	3.5	3.5	39.0	O K
360 min Winter	8.731	0.731	0.0	3.5	3.5	34.7	O K
480 min Winter	8.621	0.621	0.0	3.5	3.5	29.5	O K
600 min Winter	8.503	0.503	0.0	3.5	3.5	23.9	O K
720 min Winter	8.407	0.407	0.0	3.5	3.5	19.3	O K
960 min Winter	8.263	0.263	0.0	3.5	3.5	12.5	O K
1440 min Winter	8.126	0.126	0.0	3.1	3.1	6.0	O K
2160 min Winter	8.086	0.086	0.0	2.4	2.4	4.1	O K
2880 min Winter	8.072	0.072	0.0	1.9	1.9	3.4	O K
4320 min Winter	8.058	0.058	0.0	1.4	1.4	2.7	O K
5760 min Winter	8.051	0.051	0.0	1.1	1.1	2.4	O K
7200 min Winter	8.046	0.046	0.0	0.9	0.9	2.2	O K
8640 min Winter	8.042	0.042	0.0	0.8	0.8	2.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	113.668	0.0	27.2	24
30 min Summer	76.685	0.0	36.8	37
60 min Summer	49.529	0.0	47.5	64
120 min Summer	31.008	0.0	59.5	110
180 min Summer	23.283	0.0	67.0	142
240 min Summer	18.888	0.0	72.5	176
360 min Summer	13.935	0.0	80.2	246
480 min Summer	11.204	0.0	86.0	316
600 min Summer	9.462	0.0	90.8	386
720 min Summer	8.238	0.0	94.9	448
960 min Summer	6.614	0.0	101.6	566
1440 min Summer	4.845	0.0	111.6	794
2160 min Summer	3.541	0.0	122.4	1128
2880 min Summer	2.832	0.0	130.5	1472
4320 min Summer	2.062	0.0	142.5	2204
5760 min Summer	1.645	0.0	151.5	2912
7200 min Summer	1.379	0.0	158.8	3664
8640 min Summer	1.193	0.0	165.0	4312
10080 min Summer	1.056	0.0	170.2	5000
15 min Winter	113.668	0.0	27.2	24
30 min Winter	76.685	0.0	36.8	37
60 min Winter	49.529	0.0	47.5	64
120 min Winter	31.008	0.0	59.5	116
180 min Winter	23.283	0.0	67.0	148
240 min Winter	18.888	0.0	72.5	186
360 min Winter	13.935	0.0	80.2	264
480 min Winter	11.204	0.0	86.0	338
600 min Winter	9.462	0.0	90.8	398
720 min Winter	8.238	0.0	94.9	458
960 min Winter	6.614	0.0	101.6	568
1440 min Winter	4.845	0.0	111.6	774
2160 min Winter	3.541	0.0	122.4	1108
2880 min Winter	2.832	0.0	130.5	1464
4320 min Winter	2.062	0.0	142.5	2204
5760 min Winter	1.645	0.0	151.5	2904
7200 min Winter	1.379	0.0	158.8	3584
8640 min Winter	1.193	0.0	165.0	4376

Summary of Results for 100 year Return Period (+45%)

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
10080 min Winter	8.039	0.039		0.0	0.7	0.7	1.9 O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.056	0.0	170.3	5048

Rainfall Details

Rainfall Model	FSR	Ratio R	0.345	Cv (Winter)	1.000
Return Period (years)	100	Summer Storms	Yes	Shortest Storm (mins)	15
Region	England and Wales	Winter Storms	Yes	Longest Storm (mins)	10080
M5-60 (mm)	17.000	Cv (Summer)	1.000	Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.096

Time (mins)			Time (mins)			Time (mins)		
From:	To:	Area (ha)	From:	To:	Area (ha)	From:	To:	Area (ha)
0	4	0.032	4	8	0.032	8	12	0.032

Model Details

Storage is Online Cover Level (m) 10.000

Cellular Storage Structure

Invert Level (m) 8.000 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	50.0	50.0	1.000	50.0	50.0	1.001	0.0	50.0

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0089-3500-1000-3500 Sump Available Yes
Design Head (m) 1.000 Diameter (mm) 89
Design Flow (l/s) 3.5 Invert Level (m) 8.000
Flush-Flo™ Calculated Minimum Outlet Pipe Diameter (mm) 150
Objective Minimise upstream storage Suggested Manhole Diameter (mm) 1200
Application Surface

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.5	Kick-Flo®	0.632	2.8
Flush-Flo™	0.300	3.5	Mean Flow over Head Range	-	3.1

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.7	0.600	3.0	1.600	4.3	2.600	5.4	5.000	7.4	7.500	9.0
0.200	3.4	0.800	3.1	1.800	4.6	3.000	5.8	5.500	7.7	8.000	9.2
0.300	3.5	1.000	3.5	2.000	4.8	3.500	6.2	6.000	8.1	8.500	9.5
0.400	3.4	1.200	3.8	2.200	5.0	4.000	6.7	6.500	8.4	9.000	9.8
0.500	3.3	1.400	4.1	2.400	5.2	4.500	7.0	7.000	8.7	9.500	10.0

