

TECHNICAL NOTE

DATE:	01 November 2022	CONFIDENTIALITY:	Public
SUBJECT:	Site A – Response to Drainage Officer Comments		
PROJECT:	Bognor Golf Course	AUTHOR:	Andy Smith

INTRODUCTION

This Technical Note has been produced to provide a detailed response to the Drainage Officers comments on the surface water drainage strategy for Site A which was developed to support the Hallam Land Management Ltd's planning application for the redevelopment and relocation of the existing Golf Course (planning app ref: M/16/22/PL and FP/274/21/OUT).

QUESTIONS AND RESPONSES

The Drainage Officers questions are in black and bold and the WSP response is in purple / italics.

1 - Confirmation from the Environment Agency that the proposed land raising and remodelling of the 100 yr plus c/c is accepted;

The Applicant has submitted a response to the Environment Agency on 6th October 2022 to address their outstanding queries with regard to the Flood Risk Assessment. The technical note demonstrates that through the additional model results and the associated model/hydrology review spreadsheets the clarification points have been addressed and all outstanding issues and comments are considered resolved. Following the resolution of these comments the Applicant anticipates that the Flood Risk Assessment to be agreed with the Environment Agency.

2 - The Modelling report (March 2022) appears to be mixing the fluvial modelling climate change requirements with surface water climate change requirements. DEFRA guidance requires peak rainfall intensity to be considered for 100-year lifetime for a residential development and as since this takes the life of the development beyond 2100 should be using the upper end factor of 45% not 25%.

The planning applications were validated on 11 February 2022 prior to the updated of the Environment Agency / Defra climate change allowances in May 2022. Therefore, the Scheme should be assessed against those in place at the time of the application which was 40% for the surface water drainage strategy. The wider catchment modelling, detailed within the hydraulic modelling report utilises a runoff rate of 25% (central allowance), in accordance with the peak river flow climate change guidance.

However, in the interests of a best practise, site safety and the desire to optimise the design to ensure no offsite impacts, the design of the drainage system has been reviewed to ensure that the proposed system can meet the requirements of the latest climate change allowances. This increase can be accommodated within the existing design, as detailed in the later sections.

There are differences in the approach to the calculation of storage volumes between the Surface Water Drainage Strategy submitted at the time of the planning application and this revised strategy, which has been updated to reflect the latest guidance and the advice from the LLFA. The main difference is an increase in storage volume from 6,428m³ to 7,619m³, which reflects changes in the peak discharge rate,

climate change allowances and inclusion of a complex control. A complex control is now incorporated within the design to ensure that the runoff from the impermeable areas is attenuated to greenfield rates and that the runoff from the remaining permeable areas within the development area (i.e. that between the northern berm and the southern road) can also be discharged at the greenfield rates, as there is no requirement to attenuate the runoff from permeable areas (as the pre and post scheme runoff rates would not be altered).

3 - No clear surface water drainage proposals are provided for either site. We appreciate that proposed 3D ground modelling is provided but more information needs to be provided on where the proposed development impermeable areas are draining to, attenuation provisions and where the surface water is ultimately being discharge to. The surface water calculations need to be provided to demonstrate that the run-off from these areas can be accommodated within the proposed attenuation features. In addition, clear information on the modelled fluvial flood level in relation to the attenuation features needs to be provided and surface water calculations need to demonstrate the impact of joint probability events. This is to ensure that the quantum of development proposed at outline stage is achievable and that the surface water drainage proposals comply in not increasing the risk of flooding elsewhere or onsite. In addition to this the locations of the proposed SuDS must clearly be outside of the impacts of the modelled fluvial flood extents.

Description of the Surface Water Drainage System

For ease of interpretation the surface water drainage strategy is described below and shown on an attached plan:

- The flood management strategy removes any off site flood waters from the development platform, through the use of a berm to the north and a realigned watercourse / raised site access road to the south. Any waters remaining are minor and can easily be addressed at the detailed design stage through one or more of lowering the adjacent road, slightly raising the impacted development parcel, creating a bund and swale, if any inundation remains once further consideration has been given to the proposed levels;;
- Surface water runoff from the development parcels drains into a network of swales and ditches through the site (these will be enhanced as required, which may include re-grading, widening etc);
- These swales direct water to a series of ponds;
- The Pond A is the attenuation basin which discharges the runoff at controlled rates into the rife
- Pond B is an additional pond which supplements the attenuation storage available in Pond A during outfall locking events; and
- Ponds C and D provide additional attenuation and water quality treatment for the development parcels to the north and the south which cannot connect to Pond A.

Approach to Storage Calculations

The MicroDrainage calculations are appended to supplement those in the Surface Water Drainage Strategy to demonstrate the storage requirements with the latest climate change allowances. These calculations are based upon the following assumptions:

- An impermeable area of 7ha based upon a development area of 11.06ha (Figure 1) and an impermeable coefficient of 60% based upon the guidance in CIRIA SuDS Manual C753 (paragraph 24.6.2) and Table 11.2 of Urban Drainage, Third Edition, Spon Text. The 60% is based upon a 55% PIMP for dense housing and a 10% allowance for urban creep. It is likely that this scheme will be significantly lower than this density.

Figure 1 – Proposed Development Extents



Storage Requirements

The storage required for the various design scenarios is detailed below:

EVENT	DISCHARGE	STORAGE REQUIRED
100 Year +40% climate change	23l/s	7,297m ³
	0 l/s	10,800m ³
100 Year +45% climate change	23l/s	7,619m ³
	0 l/s	11,186m ³

Assuming a joint probability scenario of the river being in flood during the onsite 100 year storm and the valve stays closed for the full duration of the onsite storm with no discharge the maximum storage required is **11,186m³**.

Storage Locations

The Surface Water Drainage Strategy, Masterplan and 3D Ground model (as appended) were sequentially developed through the masterplanning stage to accommodate the impacts of joint probability events, i.e. when the fluvial flood event occurs at the same time as extreme rainfall on the site, which prevents the outfall from the attenuation pond (Pond A) from discharging to the Rife at the designed rates, perhaps even stopping discharge at the most extreme end of the joint probability scenario. This joint probability event was considered by sequentially steering the attenuation ponds to be close to the river, thus providing space across the landscaped / wooded parts of the site for any exceedance water to inundate before starting to raise near the platforms. Furthermore, the platforms have been raised above design water levels for this extreme scenario.

The approach to providing the required storage across the site is:

- Sequentially locating the attenuation ponds, to ensure that they are outside of the floodplain, as close to the source as possible and do not impact on trees across the site;
- As such the ponds have been developed to provide maximum storage for each catchment, but in areas some of the footprints have been limited by other constraints;
- Attenuation for the whole of the impermeable area of the development (7ha) can be provided within Pond A, the discharge from which will be restricted by a complex control to facilitate the attenuation of the runoff from the impermeable areas and the continuing discharge of the existing permeable areas within the surface water drainage catchment;
- Additional storage is provided in
 - Pond B, particularly during large / outfall locked events;
 - Ponds C and D, which compliments the storage in Pond A, as these areas cannot discharge to Pond A, due to the presence of berms and watercourses. Ponds C and D are included to provide attenuation / water quality treatment closer to the source;
 - Within the swales / ditches.

The storage available across the site is as follows:

- The maximum volume of storage achievable within the ponds, swales and other depressions on the site surface to the maximum elevation of 1.225 mAOD is **19,443m³** including the attenuation pond storage (further information is provided below and a breakdown of depth and volume is provided on attached drawings);
- The attenuation capacity across the site is as follows:

POND	CAPACITY [M ³]
A ⁺	7,742
B ⁻	2,650
C	320
D	160
Total Storage in Ponds*	10,872
Available storage across the site below 1.225mAOD**	19,443

Notes:

+ Attenuation Pond A has a capacity (including freeboard allowance) of 7,742m³ (as demonstrated in the appendix) to a top water level of 1.00 mAOD, the design includes a further 300mm freeboard;

-The volumes provided for Pond B are based upon the maximum storage available in the pond once the surface water drainage system backs up.

*Additional storage is available in the network of swales / ditches which are proposed across the development area

**The available storage across the site below 1.225mAOD, is that which is below the lowest platform elevation and includes all ponds, swales and ditch features, along with other depressions etc.

The table above demonstrates that the storage available within pond A is 7,741.6m³ this is greater than the 7,619m³ of storage required for 100year +40% event with a Q_{bar} discharge of 23l/s for 7ha impermeable area.

Surcharged Storage

Additional storage would be required when the outfall from Pond A into the Rife is surcharged, due to high water levels in the Rife, preventing the discharge of water from the attenuation pond. The design is based upon this occurring for the whole storm event, thus discharge would be likely to occur, however, it is demonstrated here that sufficient attenuation is available across the site for this event. As the attenuation pond (Pond A) outfall invert level is 0.00 mAOD, water will be discharged freely below this level and constrained up to 1.225 mAOD as pressure from water head in pond will be able to open valve and start releasing water.

The maximum allowable flood level is the level below which the lowest platforms (in mAOD) are inundated, this is 1.225 mAOD. Noting that the proposed properties will have additional freeboard (150mm) above the minimum platform level, as detailed within the FRA.

The storage calculations demonstrate that 11,186m³ of attenuation storage is required in the site for the 1 in 100 year plus 45% climate change event with 0 l/s discharge. This storage requirement is substantially below that provided within the site between the northern and southern berms (19,443m³). The extents of which are shown in the image below (full drawing is appended).



Flood Mapping

The flood modelling, which is currently being approved by the Environment Agency (point 1) demonstrates that all the ponds (A, B, C and D) are not at risk of fluvial / pluvial flooding for the design event including the latest climate change allowances. The flood maps are appended, whilst ponds C and D are shown to be dry, water is shown to be within ponds A and B due to their size and the direct rainfall nature of the flood model which applies rainfall to the whole catchment (including the site), the result is that some water directly falls onto the ponds whereas other flows in through the ditch network.

Summary

The calculations show that the surface water drainage strategy provides in excess of the required storage volumes for the proposed development for both the design and locked outfall scenarios.

4 -The current strategy outlines that run-off from the site will be restricted to greenfield rates to the existing watercourse but does not explore the opportunity for on-site infiltration. A Hierarchical approach to the disposal of surface water should be undertaken with priority to infiltration of surface water. Infiltration testing must be carried out to assess the opportunities for infiltration to ground. Winter infiltration testing is required to support infiltration drainage techniques and should be carried out in January/February (subject to agreement) and at agreed locations/depths. Furthermore winter groundwater monitoring is required to support the basins designs and ensure there is no loss in attenuation capacity as a result of high groundwater levels.

The available BGS borehole records show that the site is underlain by clay, as such it is considered that infiltration based SuDS are not feasible on these sites. Therefore, a larger pond size has been included within the design to ensure that the restricted discharge rates to surface water receptors can be incorporated within the masterplan.

It also needs to be considered that the ponds on Site A are to be located adjacent to the watercourse, so groundwater will likely be in hydraulic connectivity further limiting the infiltration rates. This means that it is likely that the ponds will be lined to prevent groundwater ingress. However, this is a matter for detailed design.

It is considered that both winter infiltration testing and groundwater monitoring can be undertaken prior to the RMA / detailed design, to review the potential for discharge to ground.

All the outstanding requirements for this comment can be secured via an appropriately worded condition(s).

5 - The current greenfield estimation for the residential development site is over-estimated as it is taken for 15ha, whilst the development proposals only assume 7ha of impermeable contributing area. The greenfield run-off (if infiltration is proven unsuitable) must be adjusted to reflect the actual contributing impermeable areas.

The greenfield runoff rates have been adjusted to ensure that 7ha of impermeable contributing area is accounted for in the attenuation pond size, however, the 15ha area was originally included to allow for routing of the entire catchment area falling towards the pond given flood management approach. However, it is recognised that a complex outfall can be used that will control flows to provide attenuation for the impermeable area with its Q_{bar} discharge rate only at the base of the pond. At the top of the pond a spillway can discharge the flow from the remainder of the catchment. The greenfield runoff calculations are provided in Appendix A

6 - Once further information is provided on the risk of surface water flooding and impact to the surrounding areas, as well as clarity on the development surface water drainage proposals then we will be able to review the proposals further.

It should be noted that as the planning application is for outline consent, aspects of the Proposed Scheme, such as bridges and culverts have yet to be designed.

It is considered that the additional clarification provided in this note demonstrates that the Proposed Scheme is to be served by an appropriate drainage strategy, the design of which can be secured by appropriately worded condition(s) which will allow the drainage officer to remove their objection.

Appendix A

Greenfield Discharge Rate

Rural Runoff Calculator

Micro Drainage

IH 124

IH 124 Input

Return Period (Years)

Area (ha)

SAAR (mm)

Soil

Growth Curve

Partly Urbanised Catchment (QBAR)

Urban

Region

Results

QBAR rural (l/s)

QBAR urban (l/s)

Return Period Flood

Region	QBAR (l/s)	Q (100yrs) (l/s)	Q (1 yrs) (l/s)	Q (2 yrs) (l/s)	Q (5 yrs) (l/s)	Q (10 yrs) (l/s)
Region 1	170.1	421.9	144.6	154.6	204.1	241.1
Region 2	170.1	447.4	148.0	155.5	200.7	241.1
Region 3	170.1	353.8	146.3	160.5	212.6	241.1
Region 4	170.1	437.2	141.2	152.5	209.2	241.1
Region 5	170.1	605.6	148.0	152.0	219.4	241.1
Region 6/Region 7	170.1	542.7	144.6	149.9	217.7	241.1
Region 8	170.1	411.7	132.7	150.3	209.2	241.1
Region 9	170.1	370.9	149.7	158.0	205.8	241.1

ICP SUDS

ADAS 345

FEH

ReFH2

Greenfield Volume

Greenfield Volume (ReFH2)

OK Cancel Help

Enter Return Period between 1 and 1000

Linearly interpolated for 7ha is Qbar is 23l/s

100 Year +40%- Discharge at 0l/s

Quick Storage Estimate

Micro Drainage

Variables

FSR Rainfall

Return Period (years) 100

Region England and Wales

Map M5-60 (mm) 19.000

Ratio R 0.350

Cv (Summer) 0.750

Cv (Winter) 0.840

Impervious Area (ha) 7.000

Maximum Allowable Discharge (l/s) 0.0

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 1.5

Climate Change (%) 40

Analyse OK Cancel Help

Enter Maximum Allowable Discharge between 0.0 and 999999.0

Quick Storage Estimate

Micro Drainage

Results

Global Variables require approximate storage of between 10800 m³ and 10800 m³.

These values are estimates only and should not be used for design purposes.

Analyse OK Cancel Help

Enter Maximum Allowable Discharge between 0.0 and 999999.0

100 Year +45%- Discharge at 0l/s

Quick Storage Estimate

Micro Drainage

Variables

FSR Rainfall

Return Period (years)

Region

Map

Ratio R

Cv (Summer)

Cv (Winter)

Impermeable Area (ha)

Maximum Allowable Discharge (l/s)

Infiltration Coefficient (m/hr)

Safety Factor

Climate Change (%)

Analyse OK Cancel Help

Enter Climate Change between -100 and 600

Quick Storage Estimate

Micro Drainage

Results

Global Variables require approximate storage of between 11186 m³ and 11186 m³.

These values are estimates only and should not be used for design purposes.

Analyse OK Cancel Help

Enter Climate Change between -100 and 600

100 Year +40%- Discharge at 23 l/s

Quick Storage Estimate

Micro Drainage

Variables

FSR Rainfall

Return Period (years) 100

Region England and Wales

Map

M5-60 (mm) 19.000

Ratio R 0.350

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 7.000

Maximum Allowable Discharge (l/s) 23.0

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 1.5

Climate Change (%) 40

Analyse OK Cancel Help

Enter Climate Change between -100 and 600

Quick Storage Estimate

Micro Drainage

Results

Global Variables require approximate storage of between 5222 m³ and 7297 m³.

These values are estimates only and should not be used for design purposes.

Analyse OK Cancel Help

Enter Climate Change between -100 and 600

100 Year +45%- Discharge at 23 l/s

Quick Storage Estimate

Micro Drainage

Variables

FSR Rainfall

Return Period (years) 100

Region England and Wales

Map M5-60 (mm) 19.000

Ratio R 0.350

Cv (Summer) 0.750

Cv (Winter) 0.840

Impermeable Area (ha) 7.000

Maximum Allowable Discharge (l/s) 23.0

Infiltration Coefficient (m/hr) 0.00000

Safety Factor 1.5

Climate Change (%) 45

Analyse OK Cancel Help

Enter Maximum Allowable Discharge between 0.0 and 999999.0

Quick Storage Estimate

Micro Drainage

Results

Global Variables require approximate storage of between 5472 m³ and 7619 m³.

These values are estimates only and should not be used for design purposes.

Analyse OK Cancel Help

Enter Maximum Allowable Discharge between 0.0 and 999999.0

Attenuation Pond volume to 1m deep

Surface Properties - vol pond south

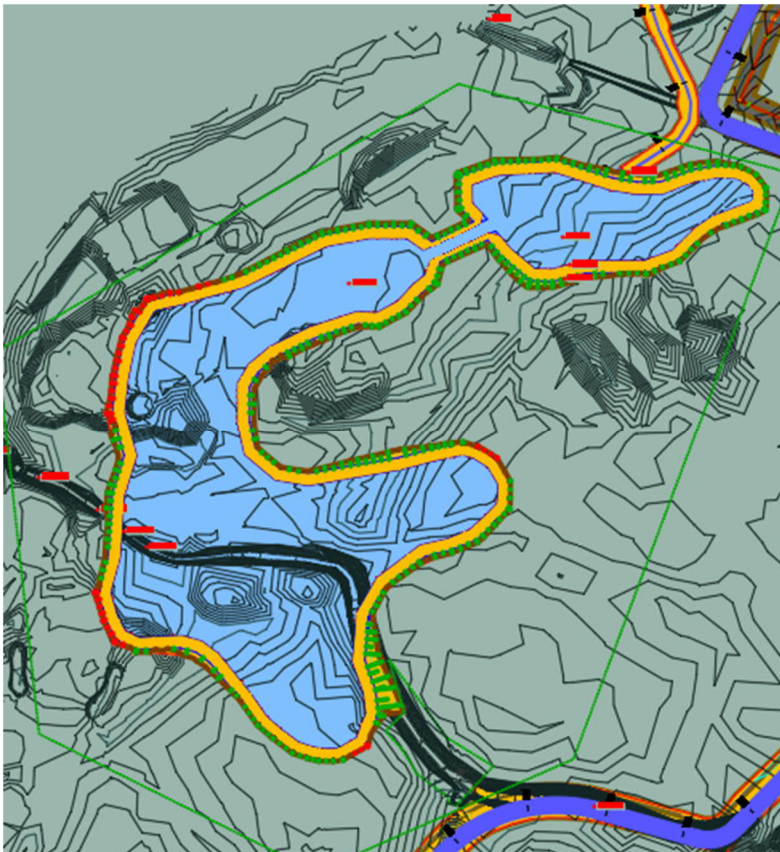
Information | Definition | Analysis | Statistics

Statistics	Value
General	
TIN	
Volume	
Base Surface	waterline south
Comparison Surface	Pond-South
Cut Factor	1.000
Fill Factor	1.000
Cut volume (adjusted)	7741.598 Cu. M.
Fill volume (adjusted)	355.698 Cu. M.
Net volume (adjusted)	7385.900 Cu. M.<Cut>
Cut volume (unadjusted)	7741.598 Cu. M.
Fill volume (unadjusted)	355.698 Cu. M.
Net volume (unadjusted)	7385.900 Cu. M.<Cut>

Top water level = 1.00 mAOD

Pond Base = 0.00 mAOD

Storage volume = 7741.6m³





A	Drawing amended in line with revised flood mapping as provided by WSP	29 Nov 22
-	First Issue	05 Oct 22
rev	details	date

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client
Hallam Land Management

project
Existing Bognor Regis Golf Club

drawing title
Flood Risk Assessment
Figure 5 - Contextual Masterplan

drawing status
PLANNING

drawn by
LJM

checked by
NJE

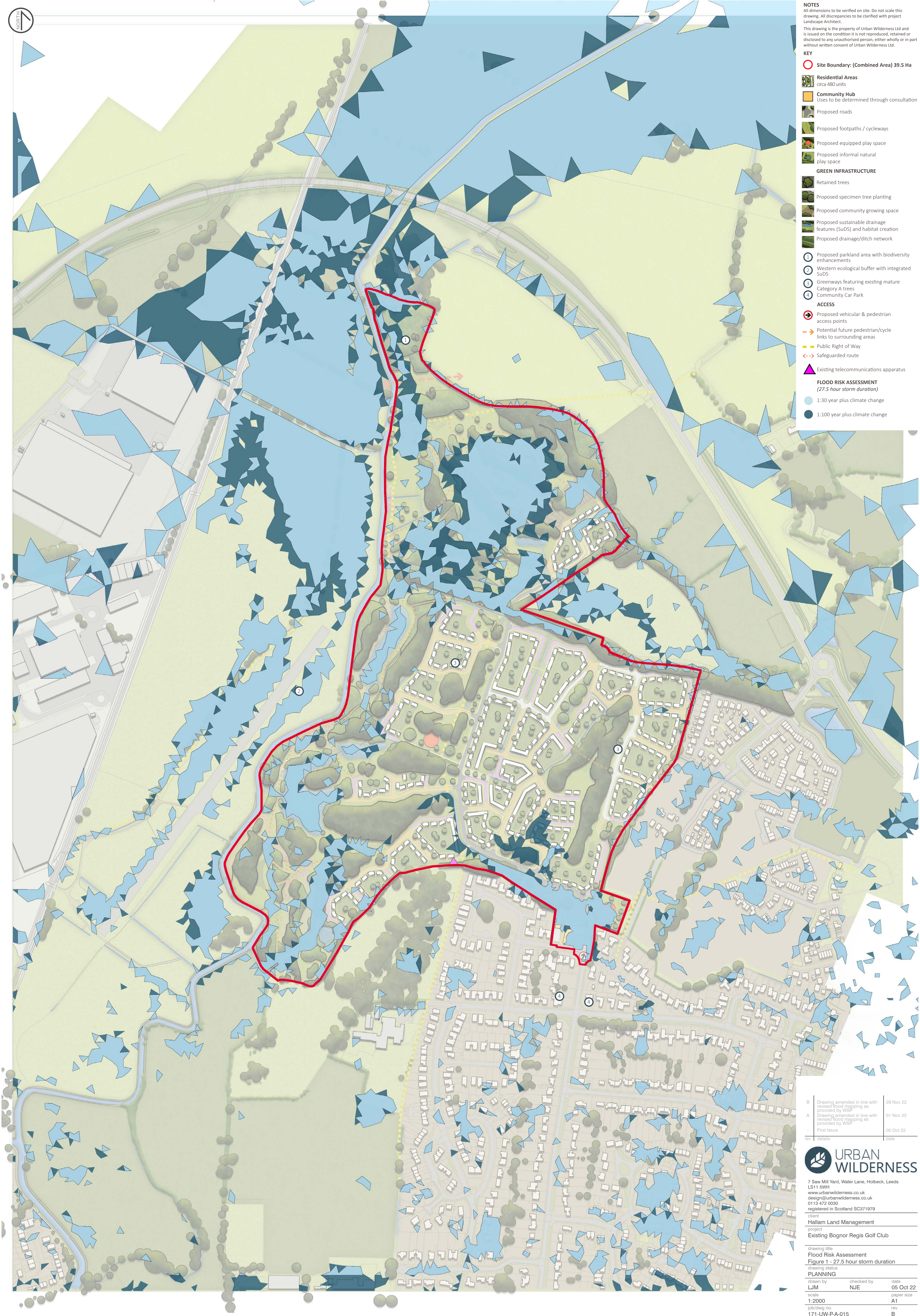
date
05 Oct 22

scale
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paper size
A1

job/dwg no.
171-UW-PA-014

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A



NOTES
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KEY

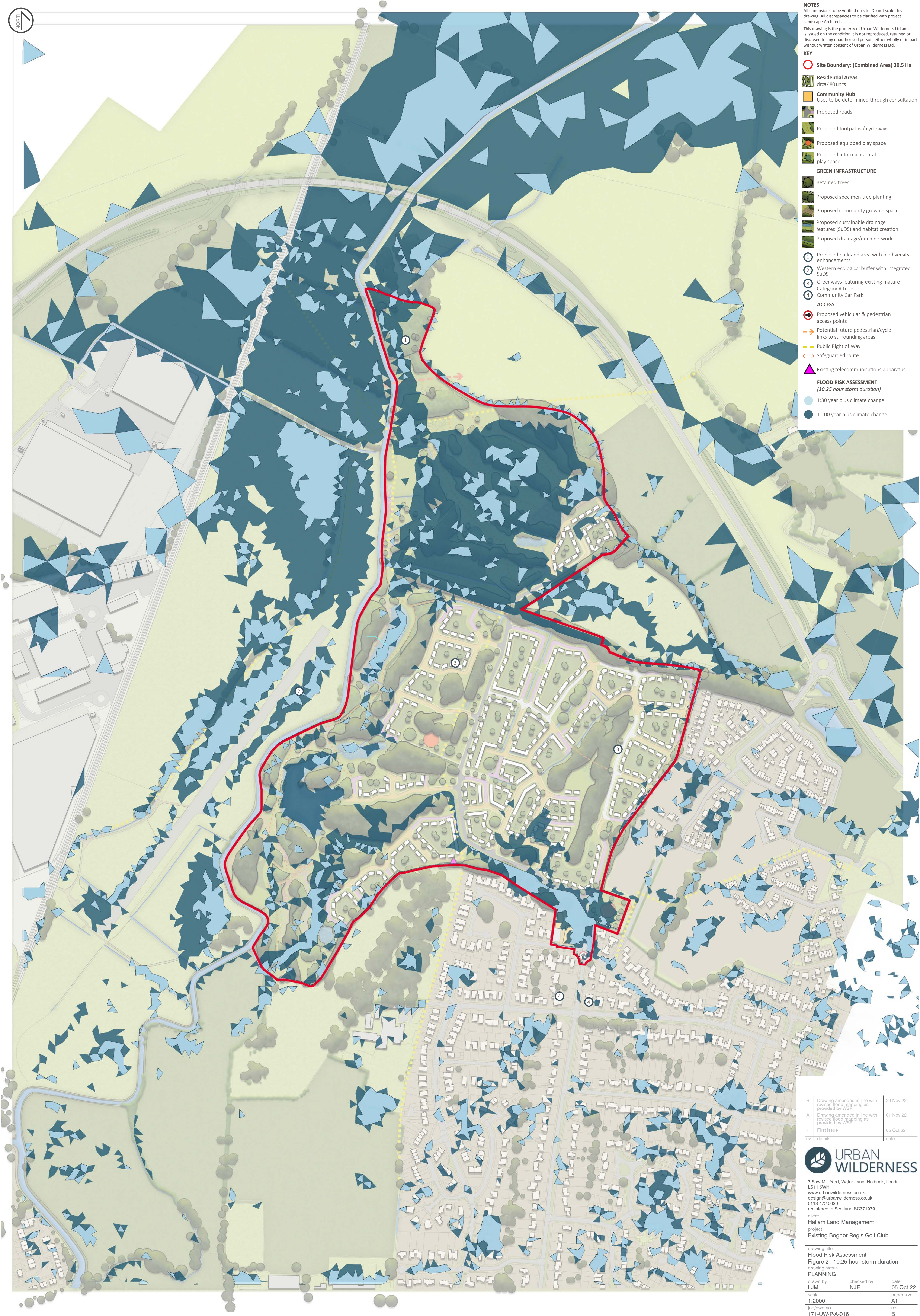
- Site Boundary: (Combined Area) 39.5 Ha
- Residential Areas**
circa 480 units
- Community Hub**
Uses to be determined through consultation
- Proposed roads
- Proposed footpaths / cycleways
- Proposed equipped play space
- Proposed informal natural play space
- GREEN INFRASTRUCTURE**
 - Retained trees
 - Proposed specimen tree planting
 - Proposed community growing space
 - Proposed sustainable drainage features (SuDS) and habitat creation
 - Proposed drainage/ditch network
- Proposed parkland area with biodiversity enhancements
- Western ecological buffer with integrated SuDS
- Greenways featuring existing mature Category A trees
- Community Car Park
- ACCESS**
 - Proposed vehicular & pedestrian access points
 - Potential future pedestrian/cycle links to surrounding areas
 - Public Right of Way
 - Safeguarded route
- Existing telecommunications apparatus
- FLOOD RISK ASSESSMENT**
(27.5 hour storm duration)
 - 1:30 year plus climate change
 - 1:100 year plus climate change

B	Drawing amended in line with revised flood mapping as provided by WSP	29 Nov 22
A	Drawing amended in line with revised flood mapping as provided by WSP	01 Nov 22
-	First Issue	05 Oct 22
rev	details	date

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project
Existing Bognor Regis Golf Club

drawing title
Flood Risk Assessment
Figure 1 - 27.5 hour storm duration
drawing status
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LJM
checked by
NJE
scale
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job/dwg no.
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date
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paper size
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rev
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 - Public Right of Way
 - Safeguarded route
- Existing telecommunications apparatus
- FLOOD RISK ASSESSMENT**
(10.25 hour storm duration)
 - 1:30 year plus climate change
 - 1:100 year plus climate change

B	Drawing amended in line with revised flood mapping as provided by WSP	29 Nov 22
A	Drawing amended in line with revised flood mapping as provided by WSP	01 Nov 22
-	First Issue	05 Oct 22
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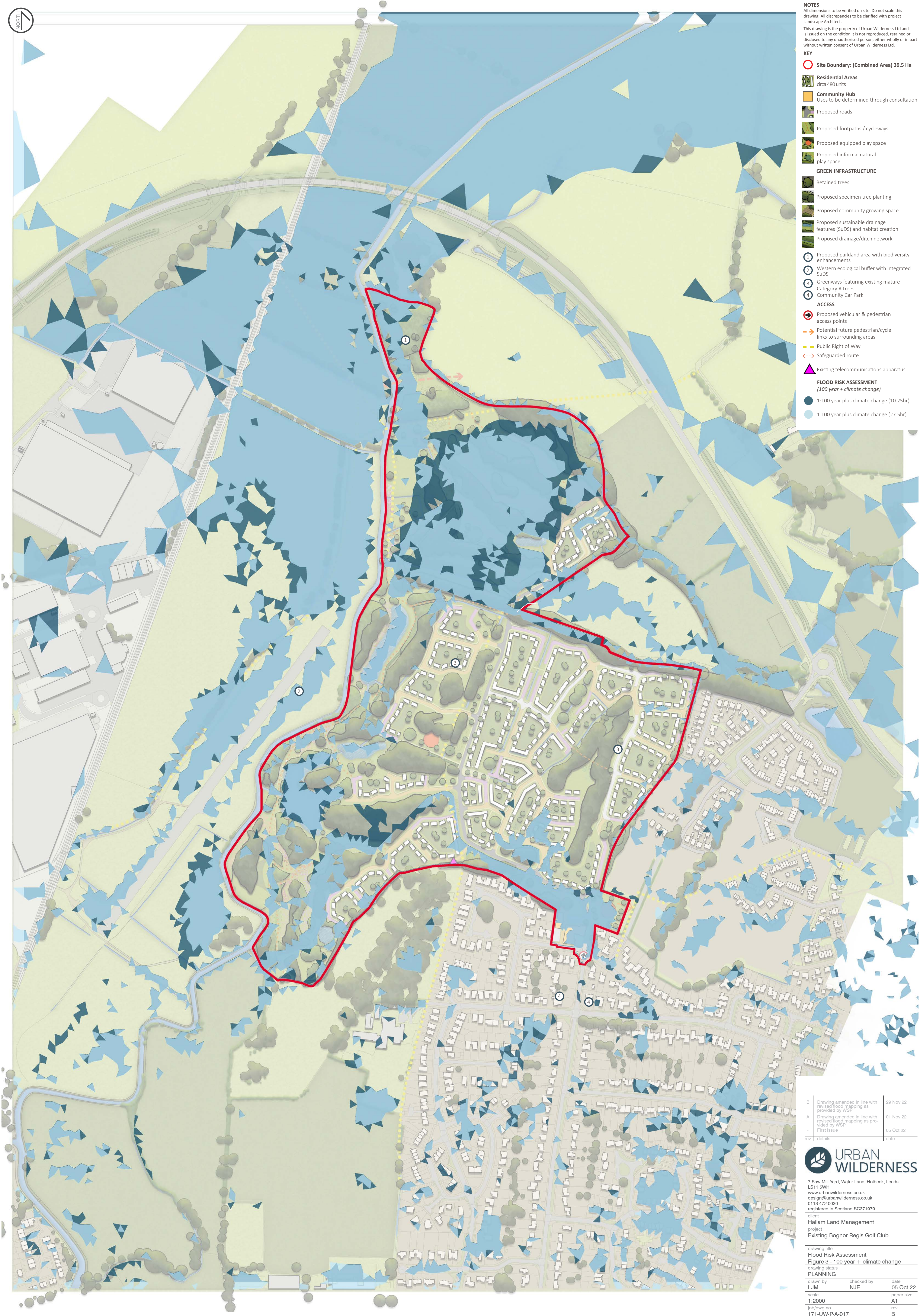
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drawing title
Flood Risk Assessment
Figure 2 - 10.25 hour storm duration

drawing status
PLANNING

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 - ACCESS**
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 - Potential future pedestrian/cycle links to surrounding areas
 - Public Right of Way
 - Safeguarded route
 - Existing telecommunications apparatus
 - FLOOD RISK ASSESSMENT (100 year + climate change)**
 - 1:100 year plus climate change (10.25hr)
 - 1:100 year plus climate change (27.5hr)

B	Drawing amended in line with revised flood mapping as provided by WSP	29 Nov 22
A	Drawing amended in line with revised flood mapping as provided by WSP	01 Nov 22
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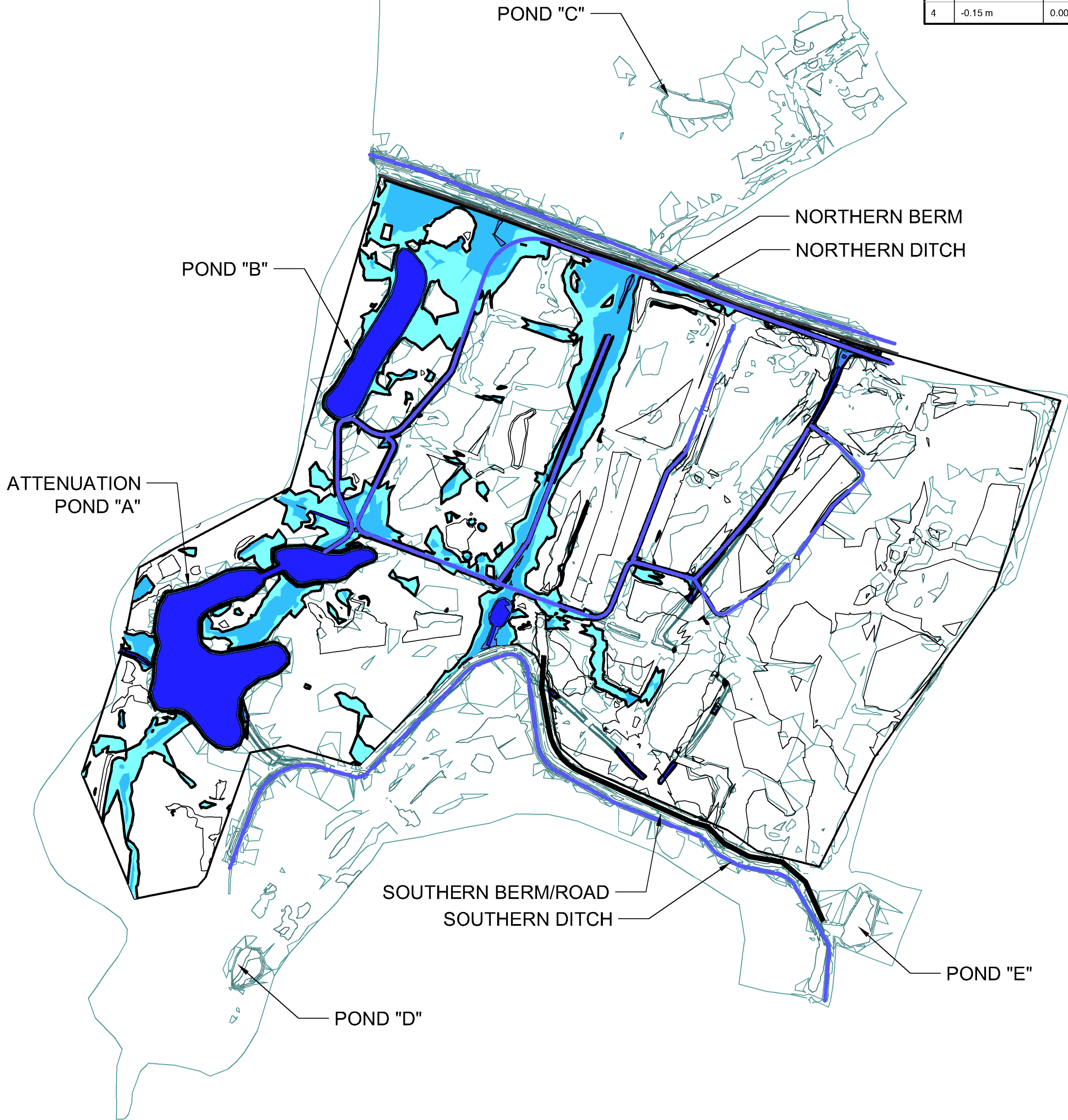
drawing title
Flood Risk Assessment
Figure 3 - 100 year + climate change
drawing status
PLANNING

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scale 1:2000		paper size A1
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DO NOT SCALE

WATER DEPTH/VOLUME TO ELV 1.225					
No.	MIN CUT/FILL	MAX CUT/FILL	RANGE AREA	RANGE VOL.	COL.
1	-2.11 m	-1.00 m	10596.22 m²	1770.592 m³	
2	-1.00 m	-0.50 m	3604.25 m²	6060.808 m³	
3	-0.50 m	-0.15 m	12232.98 m²	6514.883 m³	
4	-0.15 m	0.00 m	16765.27 m²	5057.741 m³	



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TITLE:

FLOOD TO ELEVATION 1.225

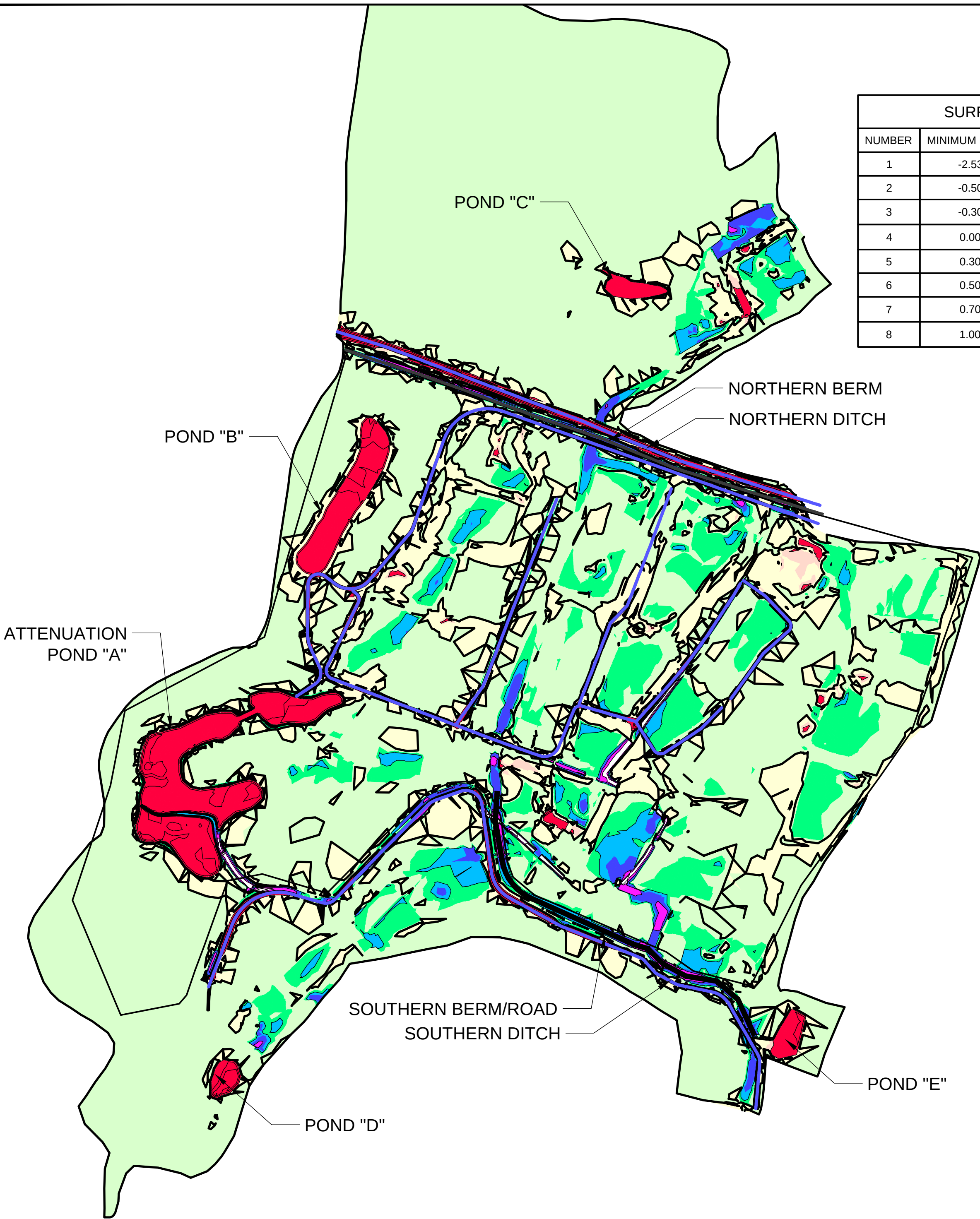
SCALE @ A2: 1:2500	CHECKED: B BUTLER	APPROVED: ANDY SMITH
PROJECT No:	DESIGNED: T BUTTON	DRAWN: T BUTTON
	DATE: October 22	

DRAWING No: WSP-DR-501	REV: P01
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File name \\CORP-PBW\NET\CENTRAL_DATA\PROJECTS\43100XXX\43102245 - BOGNOR GOLF COURSE\43 CIV02-CADD\01-CURRENT\02-MODEL\FG - BOGNOR COMP20221026.DWG, printed on Wednesday, 02 November 2022 08:57:36, by Button, Taryn

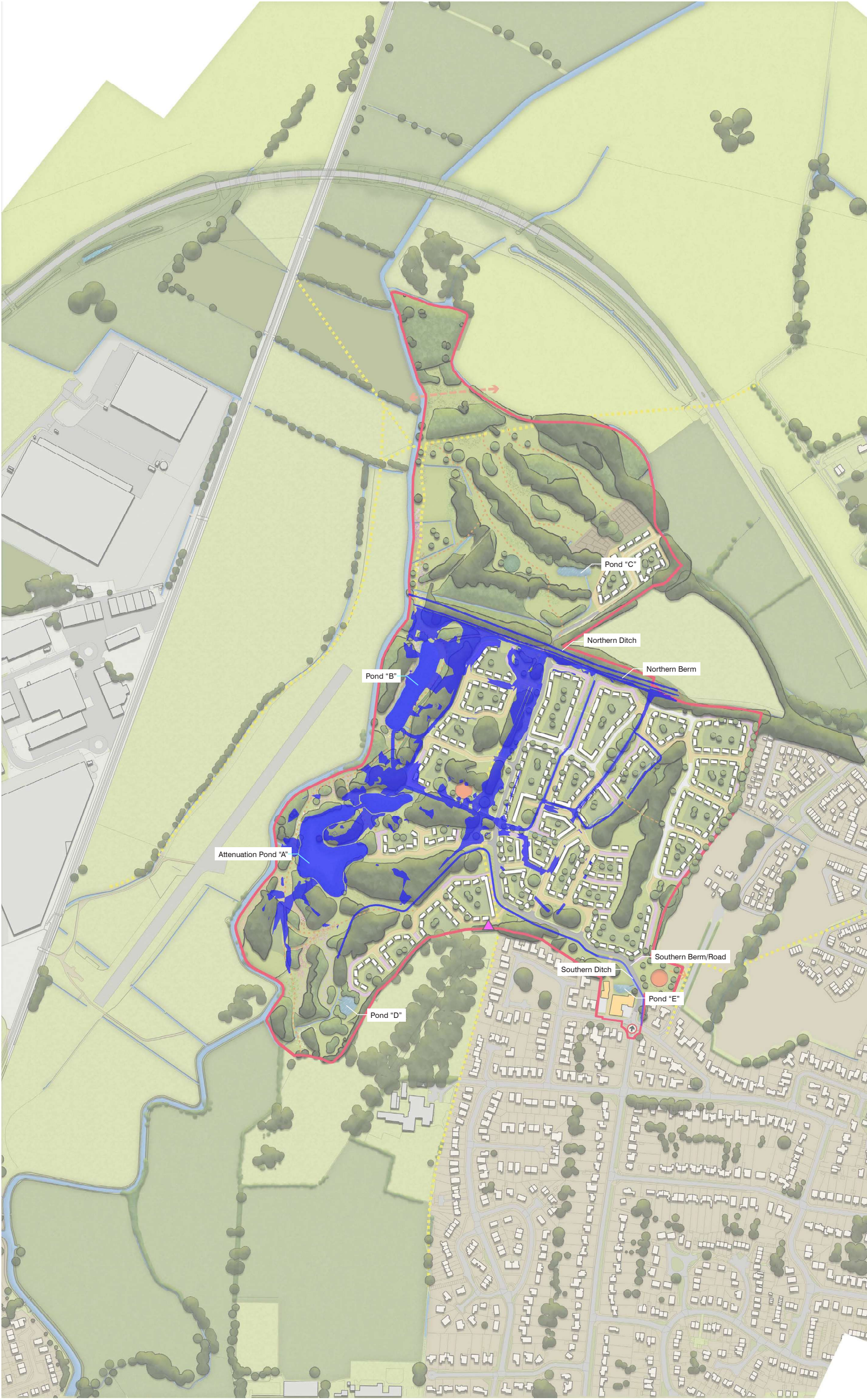
DO NOT SCALE



SURFACE LEVEL DATA			
NUMBER	MINIMUM LEVEL	MAXIMUM LEVEL	COLOUR
1	-2.53	-0.50	
2	-0.50	-0.30	
3	-0.30	0.00	
4	0.00	0.30	
5	0.30	0.50	
6	0.50	0.70	
7	0.70	1.00	
8	1.00	1.50	

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P01	01/01/1901	XXX	FIRST ISSUE	XXX	XXX
REV	DATE	BY	DESCRIPTION	CHK	APP
DRAWING STATUS:					
S0 - WORK IN PROGRESS					
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CLIENT:					
ARCHITECT:					
PROJECT:					
TITLE:					
EARTHWORKS ANALYSIS					
SCALE @ A2: 1:2500		CHECKED: B BUTLER		APPROVED: ANDY SMITH	
PROJECT No:		DESIGNED: T BUTTON		DRAWN: T BUTTON	
DRAWING No:		XXX-WSP-XXX-XXX			REV: P01
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- NOTES**
All dimensions to be verified on site. Do not scale this drawing. All discrepancies to be clarified with project Landscape Architect.
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- KEY**
- Site Boundary: (Combined Area) 39.5 Ha
 - Residential Areas**
circa 480 units
 - Community Hub**
Uses to be determined through consultation
 - Proposed roads
 - Proposed footpaths / cycleways
 - Proposed equipped play space
 - Proposed informal natural play space
 - GREEN INFRASTRUCTURE**
 - Retained trees
 - Proposed specimen tree planting
 - Proposed community growing space
 - Proposed sustainable drainage features (SuDS) and habitat creation
 - Proposed drainage/ditch network
 - Proposed parkland area with biodiversity enhancements
 - Western ecological buffer with integrated SuDS
 - Greenways featuring existing mature Category A trees
 - Community Car Park
 - ACCESS**
 - Proposed vehicular & pedestrian access points
 - Potential future pedestrian/cycle links to surrounding areas
 - Public Right of Way
 - Safeguarded route
 - Existing telecommunications apparatus
 - Lockoutfall scenario- maximum surface water extents
 - Proposed drainage ditch

B	Key amended in line with WSP comments	05 Dec 22
A	Drawing amended in line with revised flood mapping as provided by WSP	01 Nov 22
-	First Issue	05 Oct 22
rev	details	date

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client

Hallam Land Management

project

Existing Bognor Regis Golf Club

drawing title

Flood Risk Assessment

Figure 4 - Cut and Fill

drawing status

PLANNING

drawn by

LJM

checked by

NJE

date

05 Oct 22

scale

1:2000

paper size

A1

job/dwg no.

171-UW-P-A-018

rev

B