PINNACLE
CONSULTING ENGINEERS

Flood Risk Assessment

Peartree Lane Welwyn Garden City

One YMCA

3 June 2020

Prepared for:

Saunders Architects

STRUCTURAL • CIVIL • DUE DILIGENCE • ENGINEERING MASTERPLANNING
FLOOD MANAGEMENT • INFRASTRUCTURE DESIGN
PRE-DEVELOPMENT ENGINEERING • BIM • TRANSPORTATION

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APPROVALS

	Name	Position	Date
Prepared by	James Cahuzac	Graduate Civil Engineer	03/06/2020
Reviewed by	Jawsy Jabbar	Associate	03/06/2020
Approved by	David spacey	Technical Director	03/06/2020

VERSIONS

Number	By	Date	Context
1.0	James Cahuzac	22/05/2020	For Comment
2.0	James Cahuzac	03/06/2020	Updated to include Executive Summary

CONTENT

1 EXECUTIVE SUMMARY

The flood risk assessment for the proposed development has incorporated the following:

- The existing 0.671ha development consists of a hostel and maintenance/office units with adjacent car parks with an access onto Peartree Lane.
- Existing levels fall towards the centre.
- Ground conditions are composed of Lowestoft Formation superficial deposits, with Lewes Nodular Chalk Formation and Seaford Chalk Formation composing the bedrock.
- The existing surface water management system primarily discharges into the public surface water sewer under Peartree Farm and Peartree Lane, with apartments at the front of the site infiltrating through a soakaway.
- The site impermeable area will decrease by 416m², from 5,083m² to 4,667m².
- The scheme proposed for this site comprised of 100 bed YMCA hostel and 43 residential dwellings with demolishment of existing buildings.
- The site is in Flood Zone 1 – little or no risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000-year).
- The site has a low risk of surface water flooding across hardstanding areas with a medium to high risk along Peartree Farm.
- The risk of groundwater flooding is very low.
- The risk of flooding from artificial sources is very low.
- The site is categorised as “More Vulnerable” in Flood Zone 1. Based on this, the Sequential Test is deemed to be passed and the Exception test is not required.
- Local policy includes provisions for the incorporation of SuDS whenever necessary to manage surface water on site, as close to the source as possible.
- The FFL should be set at the existing level or above the 1 in 100-year undefended flood level, inclusive of a 40% Climate Change allowance.
- From a hydraulic modelling study carried out by JBA Consulting Engineers:
  - The hostel building FFL should be set at 83.300m AOD with a flood door on the western elevation.
  - The proposed residential blocks are to have an FFL of 83.600m AOD with flood door access along the eastern elevation of the building.
  - During a 100-year + 40% CC storm event, water pools along the western boundary up to a depth of 0.62m, with flood levels between 83.00m and 83.75m.
  - Post-development modelling indicates that the proposed development will not have a detrimental impact on third party land, reduce flood risk to third party land in the north-east of the site.
  - A minimum 300mm flood resilience wall is proposed (up to 83.600m AOD) along the hostel’s western and southern building elevations and (up to 83.900m AOD) along the residential’s eastern building elevation.

- Water pooling along the western edge of the hostel to be dealt with a filter drain around the building to collect and discharge back into the ground via filtration.
- These measures will provide safe access and egress during a pluvial flood event.
- Surface water is proposed to be managed via SuDS device to reduce peak runoff.
- The proposed development will not have a detrimental impact on surrounding third party land.

2 INTRODUCTION

Pinnacle Consulting Engineers Ltd have been commissioned by Saunders Architects on behalf of YMCA to carry out a Flood Risk Assessment report (FRA) for a proposed development of a site at One YMCA, 90 Peartree Lane, Welwyn Garden City, AL7 3UL. A site location plan is enclosed in Appendix A.

With reference to the indicative flood maps published by the Environment Agency, the site appears to lie in Flood Zone 1, with a medium to high risk of surface water flooding. This FRA report has been prepared in accordance with the requirements contained within the National Planning Policy Framework (NPPF, Feb 2019) and the associated Planning Practice Guidance. The guidance refers to the Environment Agency's "standing advice" on flood risk. Based on requirements set by the Environment Agency, a Flood Risk assessment is needed to support the planning application.

This report has been prepared in accordance with (i) National Planning Policy Framework (NPPF), (Department for Communities and Local Government, Feb 2019) and the accompanying (ii) Planning Practice Guidance (Ministry of Housing, Communities and Local Government, March 2014); and (iii) Level 1 and 2 Strategic Flood Risk Assessment (SFRA) undertaken on behalf of Welwyn Hatfield Borough Council, 2015] (iv) Other statutory laws and local bylaws and rules.

It is stated in Paragraph 30 of the Flood Risk and Coastal Change chapter within the Planning Practice Guidance that "a site-specific flood risk assessment is carried out by (or on behalf of) a developer to assess the flood risk to and from a development site. Where necessary the assessment should accompany a planning application submitted to the local planning authority. The assessment should demonstrate to the decision-maker how flood risk will be managed now and over the development's lifetime, taking climate change into account, and with regard to the vulnerability of its users".

This report has been prepared to address the requirements of the NPPF and has derived the following data/information from various sources including:

- Information published or explicitly provided by the Environment Agency;
- Information published by the Local Planning Authority, including the SFRA;
- A site-specific topographical survey; and
- Specific design works carried out for this report.

3 EXISTING SITE CONDITIONS

3.1 Site description

The proposed development is located at National Grid Reference (NGR) [524409mE, 212593mN] at One YMCA, 90 Peartree Lane, Welwyn Garden City, AL7 3UL. The existing brownfield site comprises single-storey and double-storey buildings with car parking at the north of the site.

The site can be accessed from Peartree Lane. The site is bounded to the North East by Peartree Farm, to the North-West by Carpark of another territory, to the South-West by Landscaping and Peartree Lane runs along its southwestern boundary.

Details of the existing development site are enclosed in Appendix A and illustrated in Figure 2.1 below.

Figure 2.1 – Aerial View of the existing development site (approximate site boundary edged red)

3.2 Topography

The development site has a relatively shallow slope falling in the centre of the site. The highest level is 85.80m AOD and the lowest is 82.20m AOD.

Details of existing development site levels are enclosed in Appendix B.

3.3 Geological ground conditions

Geological conditions at the site are detailed below and are based on a British Geological Survey (BGS) map available on the website. The focus of an FRA study on geology is on the potential movement of water through Made Ground, Drift Geology and Solid Geology.

These strata are outlined in Table 2.1.

Formation	Description
Artificial Ground (Made Ground)	No artificial deposits have been delineated on the BGS site maps.
Superficial Deposits (Drift Deposits)	Lowestoft Formation - Diamicton. Superficial Deposits formed up to 2 million years ago in the Quaternary Period. Local environment previously dominated by ice age conditions (U). Ice age conditions (U). These sedimentary deposits are glaciogenic in origin. They are detrital, created by the action of ice and meltwater, they can form a wide range of deposits and geomorphologies associated with glacial and inter-glacial periods during the Quaternary.
Bedrock	Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated) - Chalk. Sedimentary Bedrock formed approximately 84 to 94 million years ago in the Cretaceous Period. Local environment previously dominated by warm chalk seas. These sedimentary rocks are shallow marine in origin. They are biogenic and detrital, generally comprising carbonate material (coccoliths), forming distinctive beds of chalk.

Table 2.1 – Geological Ground Conditions

The information contained in Table 2.1 provides little evidence of potential groundwater flooding problems, with the Lowestoft formation – Diamicton identified as a secondary (unidentified) aquifer.

3.4 Existing surface water management

A utility survey of the existing infrastructure within the site was conducted by Charted Land Surveyors on the 9th of August 2019. Utility survey records are attached in Appendix C of this report; the records delineate all observed surface water networks within the site. A series of surface water sewers are identified to be located around the site. Thames water surface water sewer is running along with Peartree Farm and Peartree Lane to the north-eastern part of the site. A major portion of surface water runoff from the car parks and existing residential building is collected by Thames water surface sewer system. For the apartments in the front of the site, the surface water runoff is infiltrated through Soakaway situated in the front of the site with existing Landscaping. Another surface water network is delineated for the north-western part of the building, but the outfall of this network is non-identified.

The existing finishing across the site was largely comprised of a large impermeable area with landscaping and vegetations roughly following its perimeter. The existing impermeable area which drained by the existing surface water sewers is approximately 5,083m². As part of the proposal, the impermeable area is expected to reduce to 4,667m². which is an overall reduction of 416m² (8.2%). An existing and proposed impermeable areas plan is included as Appendix D.

The Environmental Agency's Flood map for planning indicates that the site is located mostly in Flood Zone 1 - little or no risk, with an annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000-year rainfall event). The nearest river (River Lea) is approximately 2.1km to the south-west of the site.

4 PROPOSED DEVELOPMENT

The proposed development will comprise the demolition of the existing buildings and the erection of a 100 bed YMCA hostel and a 2, 3 and 4 storey building providing 43 residential apartments.

The proposed development plans are enclosed in Appendix E.

5 PROBABILITY OF FLOODING

The NPPF identifies six potential sources of flooding:-

- Flooding from rivers (fluvial flooding);
- Flooding from the sea (tidal flooding);
- Flooding from land;
- Flooding from sewers;
- Flooding from groundwater; and
- Flooding from reservoirs, canals, and other artificial sources.

These are considered below.

5.1 Flooding from rivers (fluvial flooding) & sea (tidal flooding)

The assessment of flood risk in this report is based on the definitions in Table 1 of the Flood Risk and Coastal Change, Planning Practice Guidance, which recognises the following Flood Zones:

- Flood Zone 1 - little or no risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000-year)
- Flood Zone 2 - low to medium risk, with annual probability of flooding between 0.1% and 1.0% from rivers and between 0.1% and 0.5% from the sea
- Flood Zone 3a - high risk of flooding with an annual probability of flooding of 1.0% or greater from rivers, and 0.5% or greater from the sea.
- Flood Zone 3b – the 'Functional Floodplain' with an annual probability of flooding of 5% or greater.

An extract from the Environment Agency's online flood map published on their website is shown in Figure 4.1 below, with Flood Zone 3a & 3b denoted by dark blue hatch and Flood Zone 2 a light blue.

The site is located within a Flood Zone 1 'Low Probability' area and therefore lies outside an area at risk of fluvial/tidal flooding.

Figure 4.1 – Environment Agency Online Flood Map Extract (Approximate Site Extents Edged Red)

5.2 Flooding from land & sewers

Figure 4.2 – Environment Agency Online Flood Map Extract (Approximate Site Extents Edged Red)

An extract from the Environment Agency's Online Flood Map is shown in Figure 4.2, with areas of high risk denoted by a dark blue hatch, medium risk by a blue hatch and a low risk by a light blue hatch.

The site has a low risk of flooding in several existing hard standing areas in the West portion of the site, with a medium to high risk of surface water flooding along with Peartree Farm.

A surface water hydraulic modelling study has been carried out by JBA Consulting Engineers to evaluate the surface water flood risk within the site and determine the finish floor levels for the proposed buildings. Refer to Appendix F for the report.

5.3 Flooding from groundwater

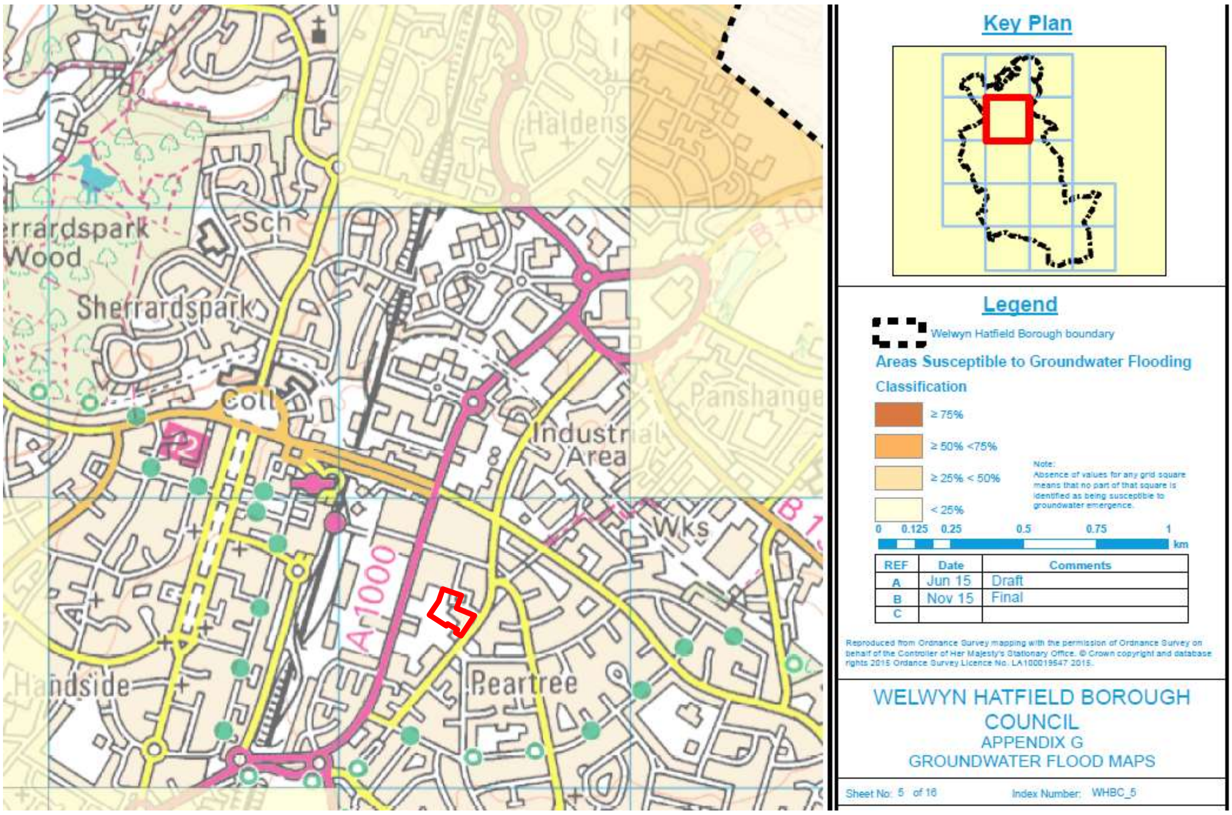


Figure 4.3 – *Appendix G* "Groundwater Flood Maps", Sheet 5 of the Welwyn Hatfield Borough Council Level 1 & 2 SFRA (Approximate Site Extents Edged Red)

As discussed in Section 2.3, there is little evidence of groundwater flooding at the site. With reference to *Appendix G, Sheet 5 of the Welwyn Hatfield Borough Council Level 1 & 2 Strategic Flood Risk Assessment (SFRA)*, the site lies outside an area at risk of any known potential and historical flooding from groundwater. Therefore, flooding from these is not considered to be a significant source of flooding at the site.

5.4 Flooding from reservoirs, canals, and other artificial sources

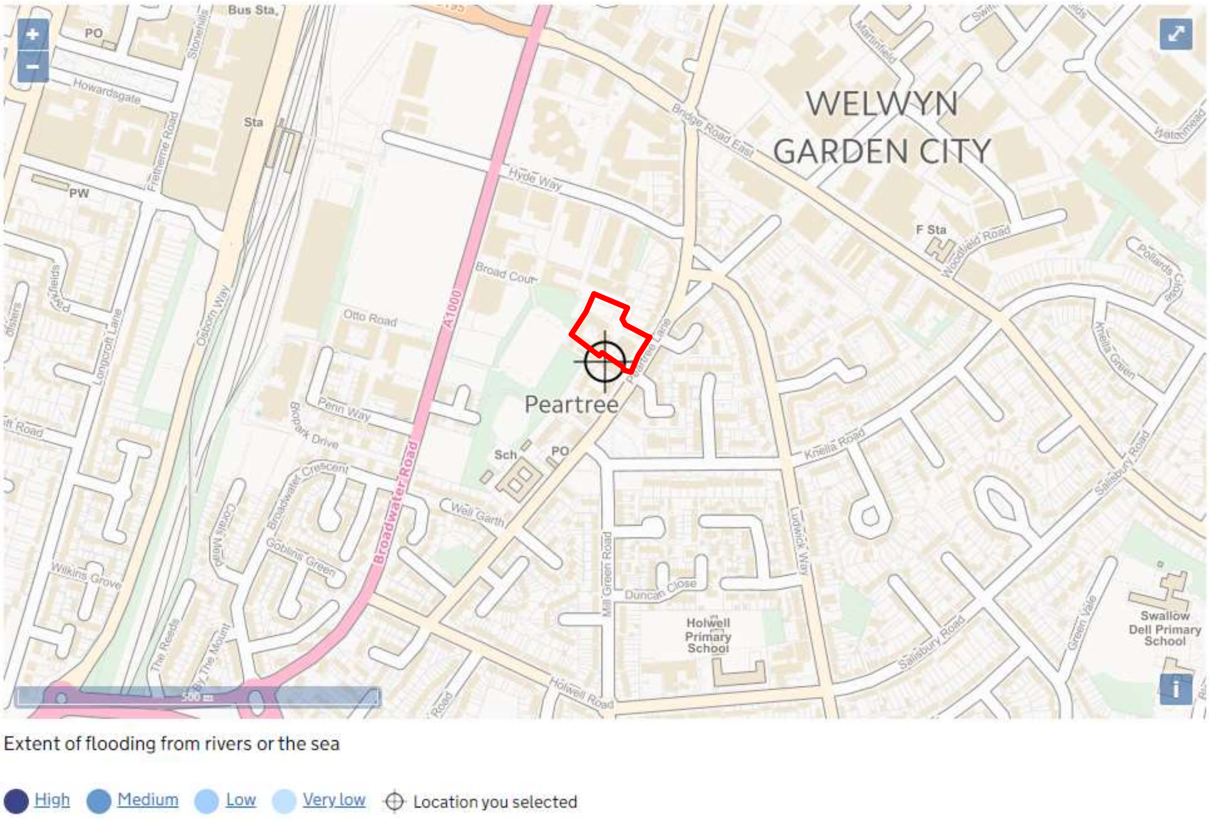


Figure 4.4 – Environment Agency Online Flood Map Extract (Approximate Site Extents Edged Red)

An extract from the Environment Agency's Online Flood Map is shown in Figure 4.4, with areas of high risk denoted by a dark blue hatch, medium risk by a blue hatch and a low risk by a light blue hatch. The site has a low risk of flooding from reservoirs, canals or other artificial sources.

6 POLICY STATUS FOR PROPOSED DEVELOPMENT

6.1 Vulnerability classification

The proposed development complies with the following principles:

- The proposed development lies within Flood Zone 1;
- The proposed development is classified as 'more vulnerable' in accordance with Table 2 of the Flood Risk and Coastal Change, Planning Practice Guidance (reproduced as Table 5.1 below).

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, Fire stations, Command Centres and telecommunications installations required to be operational during flooding Emergency dispersal points Basement dwellings Caravans, mobile homes and park homes intended for permanent residential use Installations requiring hazardous substances consent
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, subject to a specific warning and evacuation plan.
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 agriculture and forestry. Waste treatment (except landfill and hazardous waste facilities). Minerals working and processing (except for sand and gravel working). Water treatment plants and sewage treatment plants (if adequate pollution control measures are in place). Sewage treatment works (if adequate measures to control pollution and manage sewage during flood events are in place).
Water-compatible Development	Flood control infrastructure. Water transmission infrastructure, pumping stations. Sewage transmission infrastructure and pumping stations. Sand and gravel workings. Docks, marinas, wharves Navigation facilities.

	MOD defence installations. Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. Water-based recreation (excluding sleeping accommodation). Lifeguard and coastguard 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, subject to a specific warning and evacuation plan.
Notes 1 - This classification is based partly on Defra/Environment Agency research on Flood Risks to People (FD2321/TR2)21 and also on the need of some uses to keep functioning during flooding. 2 - Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity. 3 - The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.	

Table 5.1 – Flood Risk Vulnerability Classification

Vulnerability Classification		Essential Infrastructure	Water-compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test	✓	✓
	Zone 3a	Exception Test	✓	×	Exception Test	✓
	Zone 3b	Exception Test	✓	×	×	×
Key ✓ Development is appropriate × Development should not be permitted						

Table 5.2 – Flood Risk Vulnerability and Flood Zone 'Compatibility'

The proposed development is appropriate in accordance with Table 3 of the Flood Risk and Coastal Change, Planning Practice Guidance, reproduced in Table 5.2 above.

6.2 Sequential Test & Exception Test

The NPPF requires that all development is sequential tested to steer new development to areas at the lowest probability of flooding (Flood Zone 1). The Sequential Test would normally be completed by the Local Planning Authority (LPA) to inform the preparation of the Local Development Framework (LDF), where one exists. However, where this process has not yet been completed the onus for the provision of evidence demonstrating successful application of the Sequential Test falls to the developer or promoter of the site. The NPPF also requires the layout of a site to be sequentially tested to locate the most vulnerable land uses in the areas at the lowest risk of flooding.

The NPPF Planning Practice Guidance acknowledges that in some circumstances it may not be possible to locate development in areas of low or appropriate (considering development vulnerability) flood risk or that there may be other valid reasons for development to take place within the floodplain. In these circumstances, it is necessary to apply the Exception Test to clearly demonstrate that the benefits for the development of a site outweigh the flood risks to the development and its occupants. Table 3 of the Flood Risk and Coastal Change, Planning Practice Guidance (reproduced in Table 5.2 above) indicates when the Exception Test is required.

The proposed development site falls entirely into Flood Zone 1, meaning the Sequential Test is deemed to be passed and the Exception Test is not required.

6.3 Local Policy

Planning is determined on the saved policies from the Welwyn Hatfield Borough Council Core Strategy, which was adopted in 2009. The following policy is applicable to flood risk and drainage:

Policy 4.103

> *"Climate change may result in higher rainfall at certain times of the year and increasingly violent storms, resulting in an increased risk of more instances of flooding in the borough. It will therefore be important to avoid development in flood plains, consider the need for any new flood storage areas and ensure that development incorporates sustainable drainage systems (SuDs) wherever necessary. SuDs seek to ensure that surface water run-off does not increase by managing surface water from development as close to its source as possible. They can include a range of techniques appropriate to the particular site conditions and development proposals such as water butts, green roofs, permeable pavements, swales (grassed depressions) and soak-a-ways to ponds and wetlands."*

7 FLOOD RISK MANAGEMENT STRATEGY

7.1 Public Safety Issues

As part of the Flood Management Strategy, it is recommended that the Finished Floor Level (FFL) of a proposed development be set at the existing ground level or above the 1 in 100-year undefended flood level, inclusive of an allowance for climate change (+ 40%), for a retail site at risk of pluvial flooding.

A surface water hydraulic modelling study has been carried out by JBA Consulting Engineers to evaluate the surface water flood risk within the site and determine the finish floor levels for the proposed buildings. Refer to Appendix F for the report.

The hydraulic modelling study summary is provided below.

The baseline model results indicate that;

- The proposed development site is partially at risk of flooding from the 30-year, 100-year, 100-year plus 40% climate change and the 1,000-year storm events;
- During the 100-year plus 40% climate change event, with water pooling towards the western side of the site. Maximum flood depths of 0.62m occurs along the western site boundary;
- Flood levels within the site during the 100-year plus 40% climate change event are between 83.00m AOD and 83.75m AOD;
- Results from the sensitivity analysis indicate that the model results within the site are relatively insensitive to changes in roughness values.

The impact of the proposal was modelled during the 100-year with (+40%) climate change storm event. Post-development model results indicate that:

- The proposal will generate no detrimental impacts across third-party land.
- The proposal will reduce flood risk third-party land located to the north-east of the site.
- The peak water levels along the proposed buildings vary between 83.01 and 83.89m, as shown in Figure 6-1.

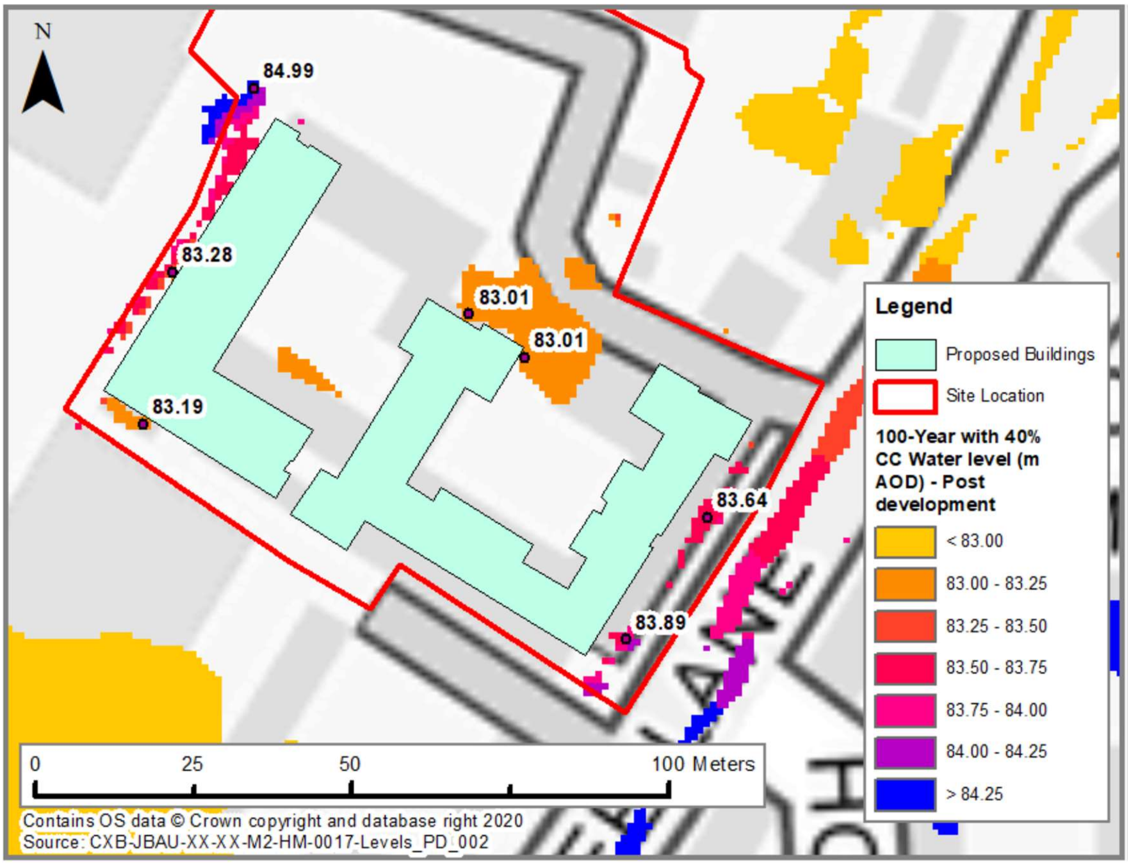


Figure 6-1: Model extent

Based on the above hydraulic modelling study results, it is proposed to set the finish floor levels (FFL) of the building and the flood resilience measures as follows.

- Proposed hostel building will have an FFL of 83.300m AOD with a flood door for access/egress on the western elevation.
- Flood resilient wall to be proposed minimum of 300mm high (up to 83.600m AOD) along the western and southern elevation of the hostel building.
- Water pooling along the western edge of the hostel building to be dealt with a filter drain around the building to collect and discharge back into the ground via filtration.
- Proposed residential blocks will have FFL of 83.600m AOD with flood door for access/egress on the eastern elevation.
- Flood resilient wall to be proposed minimum of 300mm high (up to 83.900m AOD) along the eastern elevation of the residential building.

7.2 Safe Access/Egress

As the proposed site lies into the flood zone 1 and the pluvial (surface water) flooding is managed by the above measures, safe access/egress will be retained during a flood event.

7.3 Surface water management strategy

It can be seen from enclosed drawing (Appendix D) that the existing impervious area for the site and therefore the existing positively drained area is 5,083m^2. The proposed impervious area is 4,667m^2 resulting in a reduction of 416m^2. Surface water runoff will be managed with SuDS devices to reduce the peak runoff. Refer to the Drainage Strategy report prepared by Pinnacle Consulting Engineers for the surface water runoff management form the development.

7.4 Flood Risk Elsewhere

Based on the surface water hydraulic modelling study, the proposed development will not make any detrimental impacts on third-party land.

8 CONCLUSION

The development site has a relatively shallow slope falling in the centre of the site. The highest level is 85.80m AOD and the lowest is 82.20m AOD.

With reference to the indicative flood maps published by the Environment Agency, the site appears to lie in Flood Zone 1, with a medium to high risk of surface water flooding. This has been confirmed by the site-specific flood risk assessment as detailed at Section 4.1.

The site has a low risk of flooding in several existing hard standing areas in the West portion of the site, with a medium to high risk of surface water flooding along with Peartree Farm.

With reference to Appendix G, Sheet 5 of the Welwyn Hatfield Borough Council Level 1 & 2 Strategic Flood Risk Assessment (SFRA), the site lies outside an area at risk of any known potential and historical flooding from groundwater.

The site has a low risk of flooding from reservoirs, canals or other artificial sources.

The proposed development is classified as 'more vulnerable' in accordance with Table 2 of the Flood Risk and Coastal Change, Planning Practice Guidance.

The proposed development site falls entirely into Flood Zone 1, meaning the Sequential Test is deemed to be passed and the Exception Test is not required.

It is recommended that the Finished Floor Level (FFL) of a proposed development be set at the existing ground level or above the 1 in 100-year undefended flood level, inclusive of an allowance for climate change (+ 40%), for a retail site at risk of pluvial flooding.

A surface water hydraulic modelling study has been carried out by JBA Consulting Engineers to evaluate the surface water flood risk within the site and determine the finish floor levels for the proposed buildings.

Based on the baseline hydraulic model, the proposed development site is partially at risk of flooding and shows water pooling along with the western side of the site with a maximum of 0.62m flood depth. Flood levels within the site during the 100-year plus 40% climate change event are between 83.00m AOD and 83.75m AOD and the results from the sensitivity analysis indicate that the model results within the site are relatively insensitive to changes in roughness values.

Based on the post-development hydraulic model, the proposed development will not generate any detrimental impacts across the third-party land and will reduce flood risk on the third-party land located to the north-east of the site. The peak water levels along the proposed buildings vary between 83.01 and 83.89 during 1 in 100-year plus 40%climate change event.

It is proposed to set the finish floor levels (FFL) of the building and the flood resilience measures as follows.

Proposed hostel building will have an FFL of 83.300m AOD with a flood door for access/egress on the western elevation.

Flood resilient wall to be proposed minimum of 300mm high (up to 83.600m AOD) along the western and southern elevation of the hostel building.

Water pooling along the western edge of the hostel building to be dealt with a filter drain around the building to collect and discharge back into the ground via filtration.

Proposed residential blocks will have FFL of 83.600m AOD with flood door for access/egress on the eastern elevation.

Flood resilient wall to be proposed minimum of 300mm high (up to 83.900m AOD) along the eastern elevation of the residential building.

As the proposed site lies into the flood zone 1 and the pluvial (surface water) flooding is managed by the above measures, safe access/egress will be retained during a flood event.

Appendix A – Site Location Plan

GENERAL NOTES

1. DO NOT SCALE THIS DRAWING. WORK ONLY TO FIGURED DIMENSIONS.
2. FOR ALL RELEVANT NOTES, REFER TO STRUCTURAL AND CIVIL ENGINEERING PERFORMANCE SPECIFICATION.
3. ANY DISCREPANCIES ARE TO BE REPORTED TO PINNACLE CONSULTING ENGINEERS IMMEDIATELY.
4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT ENGINEERS, ARCHITECTS AND SUB-CONTRACTORS DRAWINGS AND DETAILS.

LEGEND

SITE BOUNDARY

0 50MM ON A1 DWG. 50

REV	DESCRIPTION	BY	CHK	DATE
P01	PRELIMINARY	SS	JJ	01.10.2019

CLIENT
SAUNDERS ARCJITECTS

PROJECT
WGC-ONE YMCA
PEARTREE LANE

DRAWING TITLE
SITE LOCATION PLAN

PINNACLE
CONSULTING ENGINEERS

ALCHEMY,
BESSEMER ROAD,
WELWYN GARDEN CITY,
HERTS,
AL7 1HE. TELEPHONE: 01707 527 630
NORWICH | LONDON | DUBLIN | THE HAGUE

DRAWING STATUS
PRELIMINARY

SCALE @ A1	DATE	DRAWN BY	CHECKED
1:250	OCT'19	SS	JJ

DRG NO. C190906-PIN-XX-XX-DR-C-0204
REVISION P01

REF: 190906

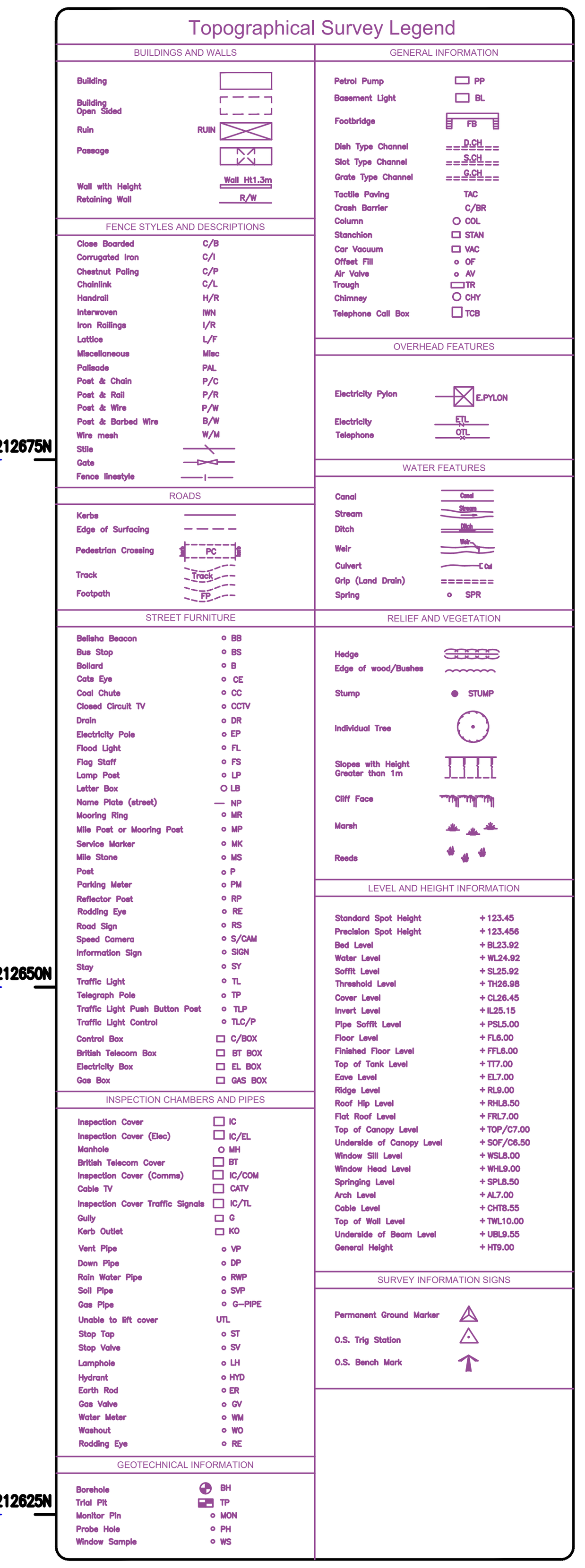
Appendix B – Topographic Survey

Survey Notes

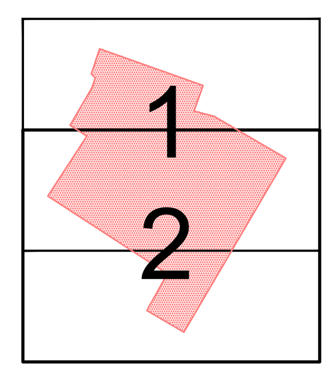
Grid: Local, plane, metric fixed to National Grid fixed at Stn SC5

Levels: OS datum from GNSS positioning converted using the National Geoid Model OSGM15

Notes



Sheet Index



Rev.	Date	Description

MALCOLM HUGHES CHARTERED LAND SURVEYORS

65 Cross Street, Sale, Manchester M33 7HF, Tel: 0161 905 1265
www.malcolmhughes.co.uk
survey@mhls.co.uk

Accreditations

FS 14126

Client

SAUNDERS PARTNERSHIP
STUDIO FOUR, 37 BROADWATER ROAD
WELWYN GARDEN CITY, AL7 3AX

Project

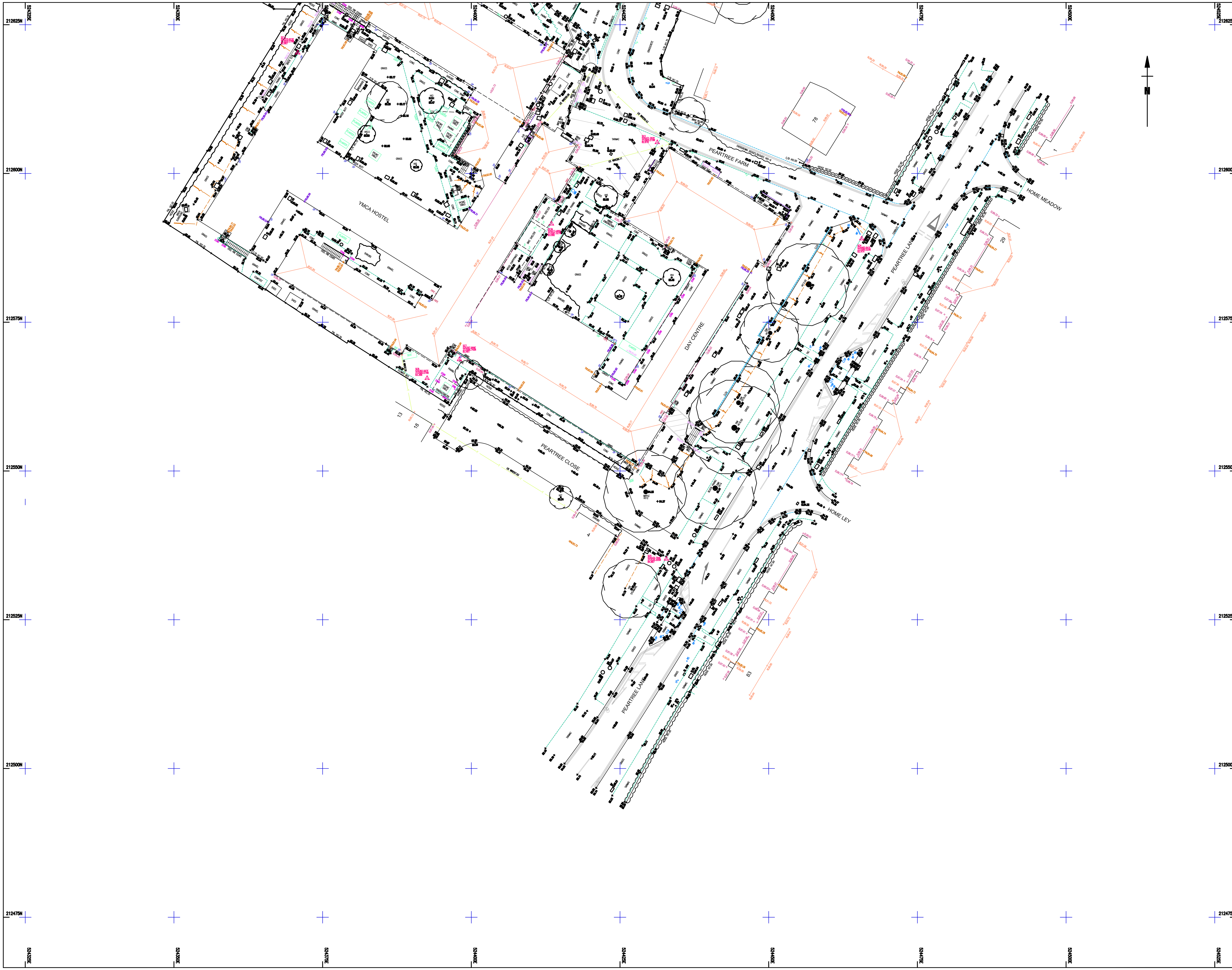
ONE YMCA, PEARTREE LANE
WELWYN GARDEN CITY
AL7 3UL

Drawing Title

TOPOGRAPHICAL SURVEY

Drawn By	CPT	28/07/19	Survey Date	June 2019
Checked by	SC	28/07/19	Scale	1:200 @ A0

Drawing No: 53948-1 — Revision:



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Levels: OS datum from GNSS positioning converted using the National Geoid Model OSGM15

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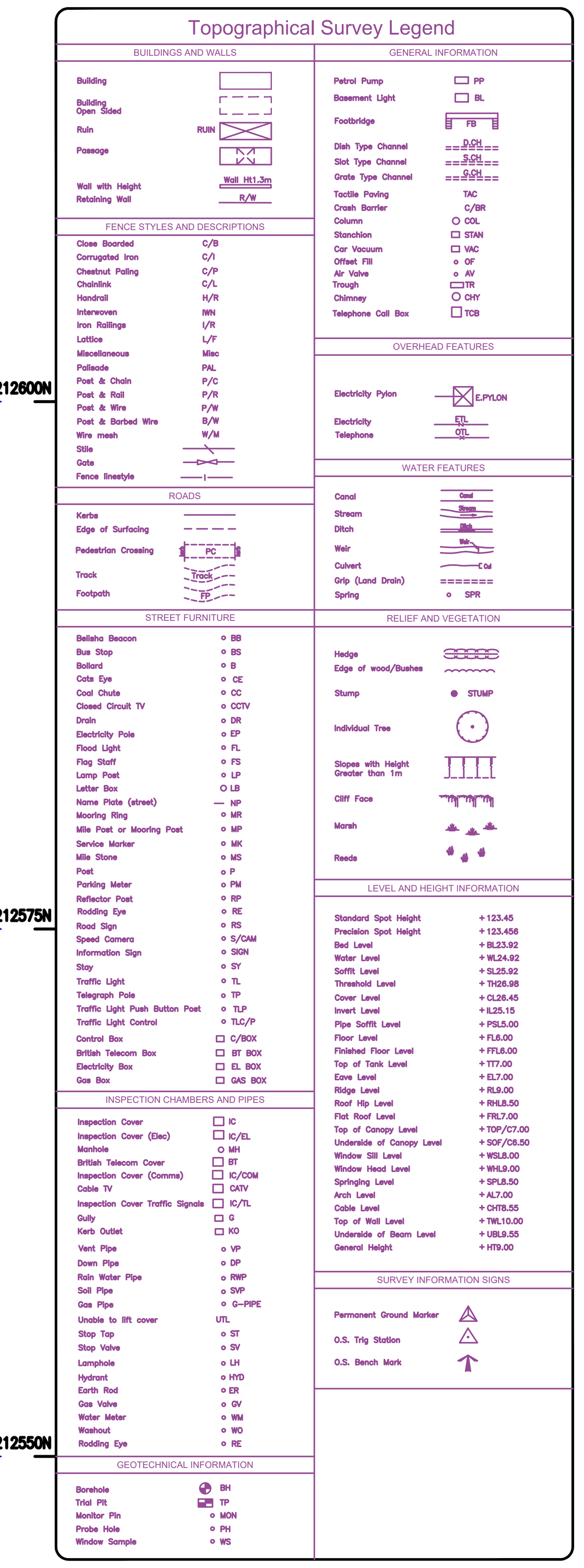
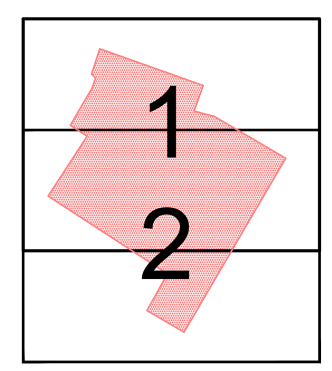


Sheet Index



Rev.	Date	Description

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Accreditations
FS 14126

Client
SAUNDERS PARTNERSHIP
STUDIO FOUR, 37 BROADWATER ROAD
WELWYN GARDEN CITY, AL7 3AX

Project
ONE YMCA, PEARTREE LANE
WELWYN GARDEN CITY
AL7 3UL

Drawing Title
TOPOGRAPHICAL SURVEY

Drawn By: CPT 28/07/19
Checked by: SC 28/07/19
Survey Date: June 2019
Scale: 1:200 @ A0
Drawing No: 53948-2
Revision:

Appendix C – Utility Survey Records

UNDERGROUND SERVICES KEY

A	Abandoned
AD	Acid drain
BT	British telecom
TV	Cable TV
CM	Communication cables
C	Sewer combined
S	Sewer surface water
F	Sewer foul
DU	Ducting
E	Electric cables
EF	Effluent pipes
FU	Fuel line
GA	Fuel gauge line
V	Fuel vent line
G	Gas pipes
H	Heating pipes
TL	Traffic light cables
VR	Vapour recovery pipes
W	Water pipes
U	Unidentified GPR or electro location trace
	Rising main
	Scar trace
AC	Alarm cables
CC	CCTV cables
CH	Chemical pipes
CA	Compressed air pipes
CU	Culvert
CO	Sewer combined overflow
HV	Electric HV cables
P	Electric pilot cables
EA	Earth cables
FO	Fibre optic cables
LG	LPG pipes
OP	Oil pipes
SM	Sludge main
T	Telemetry cables
VD	Vehicle detection pad
W W	Wash water pipes
	End of trace
E	Group of services representation
E TFR	Taken from records (Not proven on site)
E AR	Assumed route
	Services survey boundary

AR	Assumed Route
BD	Backdrop
CR	Cable Riser
d	Depth
PR	Pipe Riser
OF	Offset Fill
T	Tank
VR	Vapour Recovery Point
UTL	Unable To Lift
GPR	Ground Penetrating Radar
TFR	Taken From Records
PE	Polyethylene Pipe
UTS	Unable To Survey
UR	Unable To Rod
UT	Unable To Trace
NVP	No Visible Pipes

DISCLAIMER

Electromagnetic and ground penetrating radar techniques have been used in the location of underground services shown on this survey plan. These are interpretive procedures and we recommend that trial excavations should be undertaken to to confirm identification, location and depth of services where these are critical.

Please note that not all buried pipes, cable and ducts can be detected and mapped in consideration of their depth, location, material type, geology and proximity to other utilities.

All reasonable effort and care has been made in searching available record drawings. The completeness of the underground service information supplied to and by us cannot be guaranteed.

NOTES

Where services are non-metallic or not proven on site, positions are taken from records, trench scars & surface detail.

Where stated, depth estimations are typically to the centre or top of the service. Depths to gravity sewers and drains are typically to invert levels, unless otherwise stated.

Where Ground Penetrating Radar (GPR) is quoted the depth is recorded to the assumed external crown of the feature.

The diagram below describes the depth information in more detail.

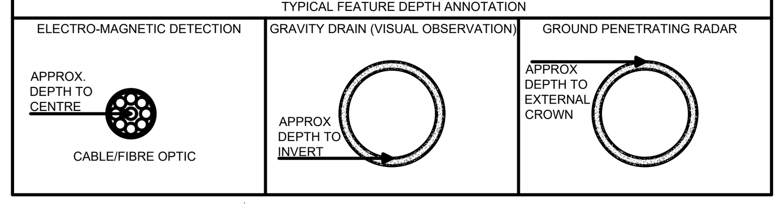
Where the precise position or depths of these features are critical to the design or siteworks they must be verified by the use of trial excavations.

Pipe sizes which cannot be obtained by visual survey are taken from utilities record drawings or marker plates where available.

Services shown as TFR (Taken From Records) have not been proven on site.

The CAD layering may contain further information.

TYPICAL FEATURE DEPTH ANNOTATION

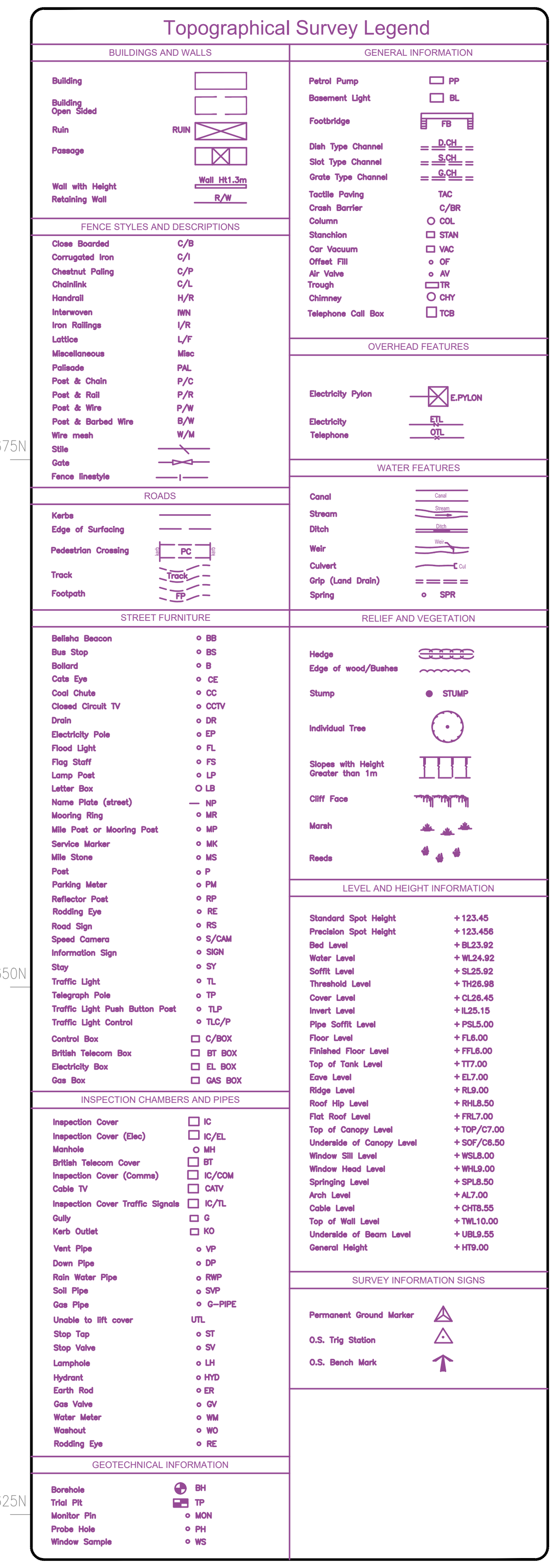


Survey Notes

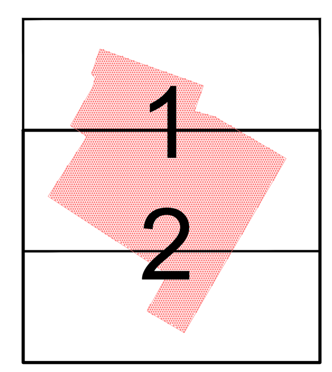
Grid: Local, plane, metric fixed to National Grid fixed at Stn SC5

Levels: OS datum from GNSS positioning converted using the National Geoid Model OSGM15

Notes



Sheet Index



Rev.	Date	Description

MALCOLM HUGHES
CHARTERED LAND SURVEYORS
65 Cross Street, Sale, Manchester
M33 7HF, Tel: 0161 905 1265
www.malcolmhughes.co.uk
survey@mhls.co.uk

Accreditations

Client
SAUNDERS PARTNERSHIP
STUDIO FOUR, 37 BROADWATER ROAD
WELWYN GARDEN CITY, AL7 3AX

Project
ONE YMCA, PEARTREE LANE
WELWYN GARDEN CITY
AL7 3UL

Drawing Title
UTILITY SURVEY

Drawn By	CPT	09/08/19	Survey Date	August 2019
Checked by	DJ	09/08/19	Scale	1:200 @ A0

Drawing No: 53948/UG1

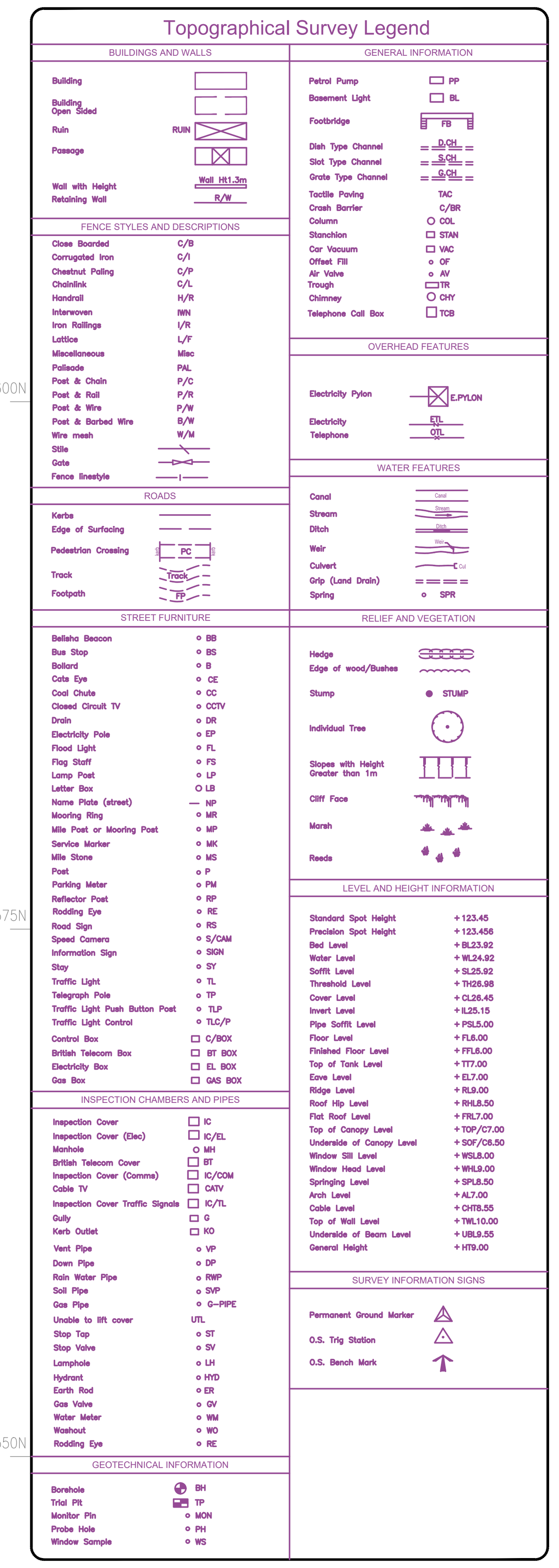
Revision:

Survey Notes

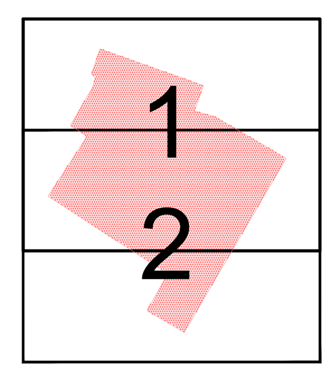
Grid: Local, plane, metric fixed to National Grid fixed at Stn SC5

Levels: OS datum from GNSS positioning converted using the National Geoid Model OSGM15

Notes



Sheet Index



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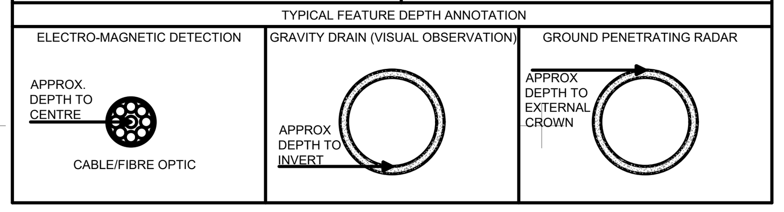

Rev.	Date	Description

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M33 7HF, Tel: 0161 905 1265
www.malcolmhughes.co.uk
survey@mhls.co.uk

Accreditations

FS 14126

Client

SAUNDERS PARTNERSHIP
STUDIO FOUR, 37 BROADWATER ROAD
WELWYN GARDEN CITY, AL7 3AX

Project

ONE YMCA, PEARTREE LANE
WELWYN GARDEN CITY
AL7 3UL

Drawing Title

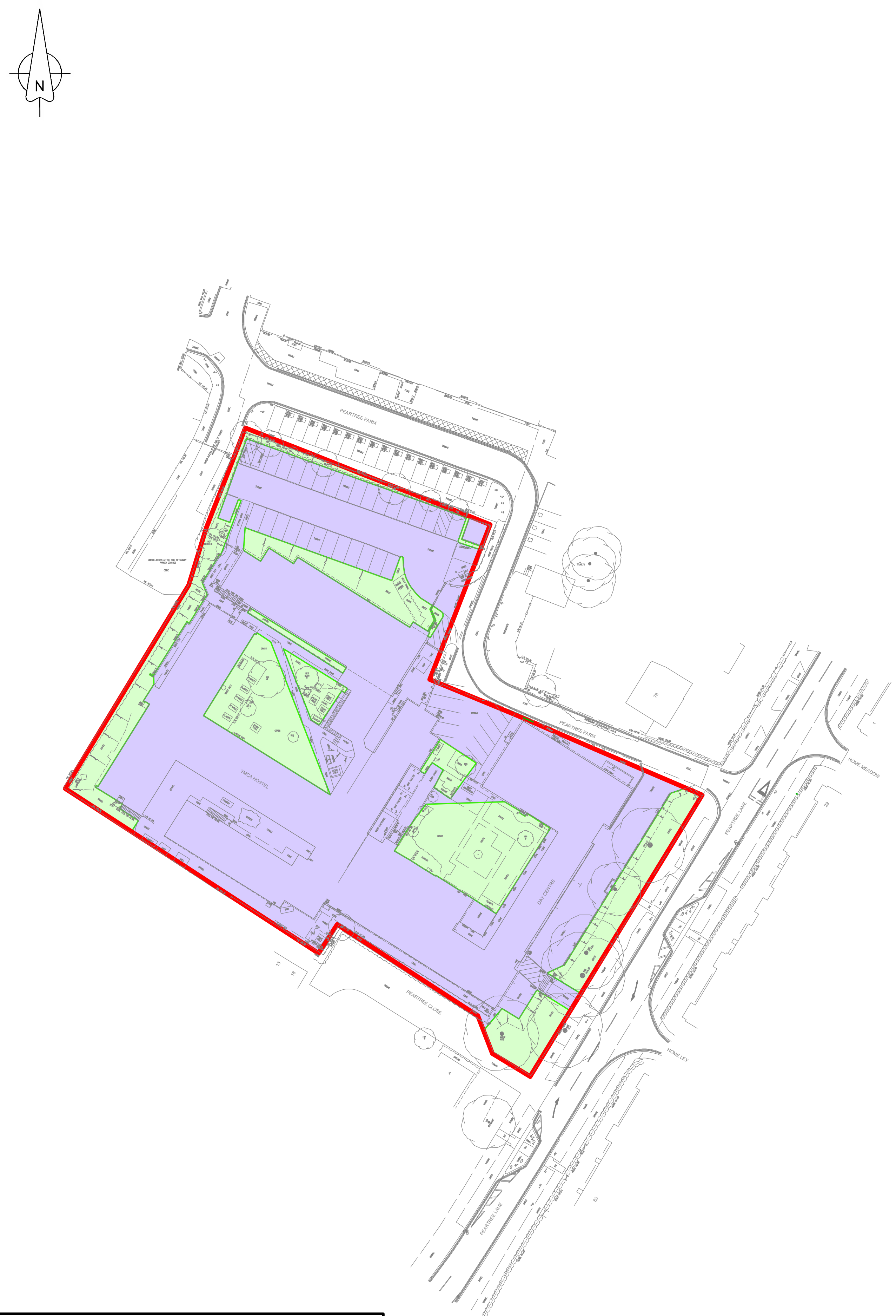
UTILITY SURVEY

Drawn By	CPT	09/08/19	Survey Date	August 2019
Checked by	DJ	09/08/19	Scale	1:200 @ A0

Drawing No: 53948/UG2

Revision:

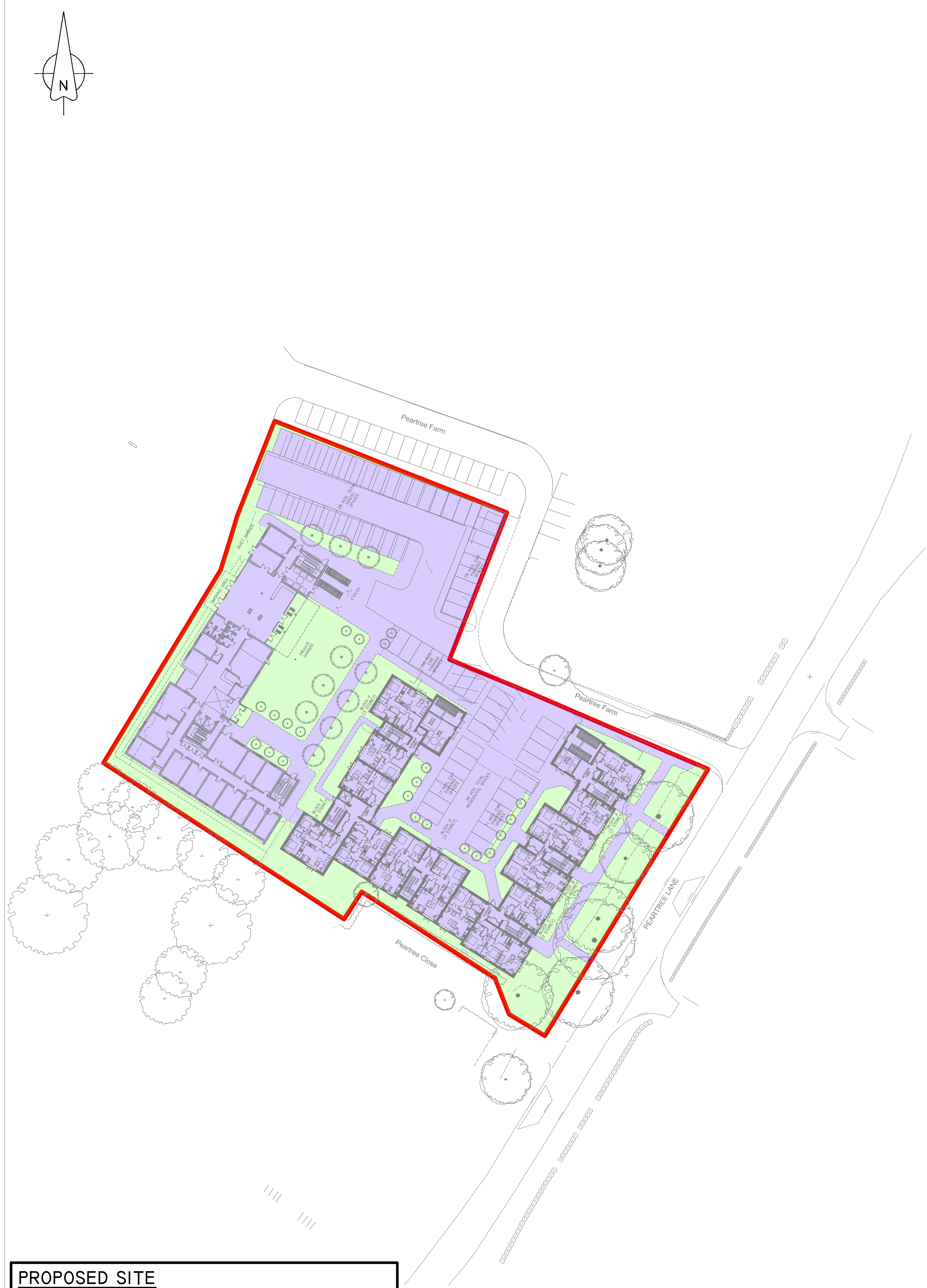
Appendix D – Existing & Proposed Impermeable Areas



EXISTING SITE

TOTAL IMPERMEABLE AREA = 5,083 M^2

TOTAL PERMEABLE AREA = 1633 M^2



PROPOSED SITE

TOTAL IMPERMEABLE AREA = 4,667 M^2

TOTAL PERMEABLE AREA = 2,049 M^2

GENERAL NOTES

1. DO NOT SCALE THIS DRAWING. WORK ONLY TO FIGURED DIMENSIONS.
2. FOR ALL RELEVANT NOTES, REFER TO STRUCTURAL AND CIVIL ENGINEERING PERFORMANCE SPECIFICATION.
3. ANY DISCREPANCIES ARE TO BE REPORTED TO PINNACLE CONSULTING ENGINEERS IMMEDIATELY.
4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT ENGINEERS, ARCHITECTS AND SUB-CONTRACTORS DRAWINGS AND DETAILS.

LEGEND

SITE BOUNDARY

PERMEABLE AREA

IMPERMEABLE AREA

0 50MM ON A1 DWG. 50

REV	DESCRIPTION	BY	CHK	DATE
P02	ISSUED FOR PLANNING	SS	JJ	09.10.2019
P01	INFPRMATION	SS	JJ	03.10.19

CLIENT

SAUNDERS ARCHITECTS ON BEHALF OF YMCA

PROJECT

WGC- ONE YMCA PEARTREE LANE

DRAWING TITLE

EXISTING AND PROPOSED IMPERMEABLE AREAS

PINNACLE CONSULTING ENGINEERS

ALCHEMY,
BESSEMER ROAD,
WELWYN GARDEN CITY,
HERTS,
AL7 1HE. TELEPHONE: 01707 527 630

NORWICH | LONDON | DUBLIN | THE HAGUE

DRAWING STATUS: INFORMATION

SCALE @ A1	DATE	DRAWN BY	CHECKED
1:500	OCT'19	SS	JJ

DRG NO. C190906-PIN-XX-XX-DR-C-0205 REVISION P02

REF: 190906

Appendix E – Proposed Development Plans

NOTES ©

This drawing to be read in accordance with the specification/Bills of Quantities and related drawings. No Dimensions to be scaled from this drawing. All stated dimensions to be verified on site and the Architect notified of any discrepancies.

0 — 50

Scale bar 50mm at 1:1

PRELIMINARY

REV	DATE	NOTE	IN
B	26.07.19	HOSTEL GIA AND UNITS INCREASED	SD
A	26.07.19	AMENDED PARKING NUMBERS AND REDLINE BOUNDARY	SD

Project

YMCA
PEARTREE LANE
WELWYN GARDEN CITY

Title

PROPOSED
SITE PLAN

Scale: 1:500 @A3
Date: JUL 2019
Drawn: SD
Checked: MB
Drawing Number: 8057 / SK27
Revision: B

Saunders
Architecture + Urban Design

saundersarchitects.com | 01707 385300 | London | Manchester | Bristol | Welwyn

Appendix F – Surface Water Modelling Study

Surface Water Modelling Study at YMCA 90 Peartree Lane

Final report

May 2020

www.jbaconsulting.com

Pinnacle Consulting Engineers
Alchemy
Bessemer Road
WELWYN GARDEN CITY
Buckinghamshire
AL7 1HE

JBA Project Manager

Olivier Saillofest
The Library
St Philips Courtyard
Church Hill
Coleshill
Warwickshire
UNITED KINGDOM
B46 3AD

Revision History

Revision Ref/Date	Amendments	Issued to
S3-P01 / Mar. 20	Draft Report	Iran Limbu, Pinnacle Consulting Engineers.
A1-P01 / Apr. 20	Final Report	Iran Limbu, Pinnacle Consulting Engineers.
A1-P02 / Apr. 20	Final Report (following client comments)	Iran Limbu, Pinnacle Consulting Engineers.
A1-P03 / May. 20	Final Report (following client comments)	Iran Limbu, Pinnacle Consulting Engineers.
A1-P04 / May. 20	Final Report (following client comments)	Iran Limbu, Pinnacle Consulting Engineers.

Contract

This report describes work commissioned by Pinnacle Consulting Engineers by an e-mail dated 17 February 2020. Pinnacle Consulting Engineers' representative for the contract was Iran Limbu. Ella Albrighton of JBA Consulting carried out this work.

Prepared by .... Ella Albrighton BSc

Technical Assistant

Reviewed by .... Olivier Saillofest BEng MSc CEng MCIWEM C.WEM

Technical Director

Purpose

This document has been prepared as a Final Report for Pinnacle Consulting Engineers. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the client for the purposes for which it was originally commissioned and prepared.

JBA Consulting has no liability regarding the use of this report except to Pinnacle Consulting Engineers.

Copyright

Carbon Footprint

A printed copy of the main text in this document will result in a carbon footprint of 58g if 100% post-consumer recycled paper is used and 73g if primary-source paper is used. These figures assume the report is printed in black and white on A4 paper and in duplex.

JBA is aiming to reduce its per capita carbon emissions.

Executive summary

Pinnacle Consulting Engineers commissioned JBA Consulting to assess surface water flood risk in relation to a proposed development site at YMCA Peartree Lane, Welwyn Garden City.

A rainfall-runoff model was created using the ESTRY-TUFLOW software to represent surface water flood mechanisms, calculate flood levels and assess the impact of the proposal. The model was run for the 30-year (3.3% AEP), 100-year (1% AEP), 100-year plus 40% climate change (1.4% AEP) and 1,000-year (0.1% AEP) rainfall-runoff events using the 1-hour critical (summer) storm duration.

The baseline model results indicate that

- The proposed development site is partially at risk of flooding from the 30-year, 100-year, 100-year plus 40% climate change and the 1,000-year storm events;
- During the 100-year plus 40% climate change event, with water pooling towards the western side of the site. Maximum flood depths of 0.62m occurs along the western site boundary;
- Flood levels within the site during the 100-year plus 40% climate change event are between 83.00m AOD and 83.75m AOD;
- Results from the sensitivity analysis indicate that the model results within the site are relatively insensitive to changes in roughness values.

The impact of the proposal was modelled during the 100-year with (+40%) climate change storm event. Post-development model results indicate that:

- The proposal will generate no detrimental impacts across third-party land.
- The proposal will reduce flood risk third-party land located to the north-east of the site.
- The peak water levels along the proposed buildings vary between 83.01 and is 83.89m, as shown in Figure 0-1.

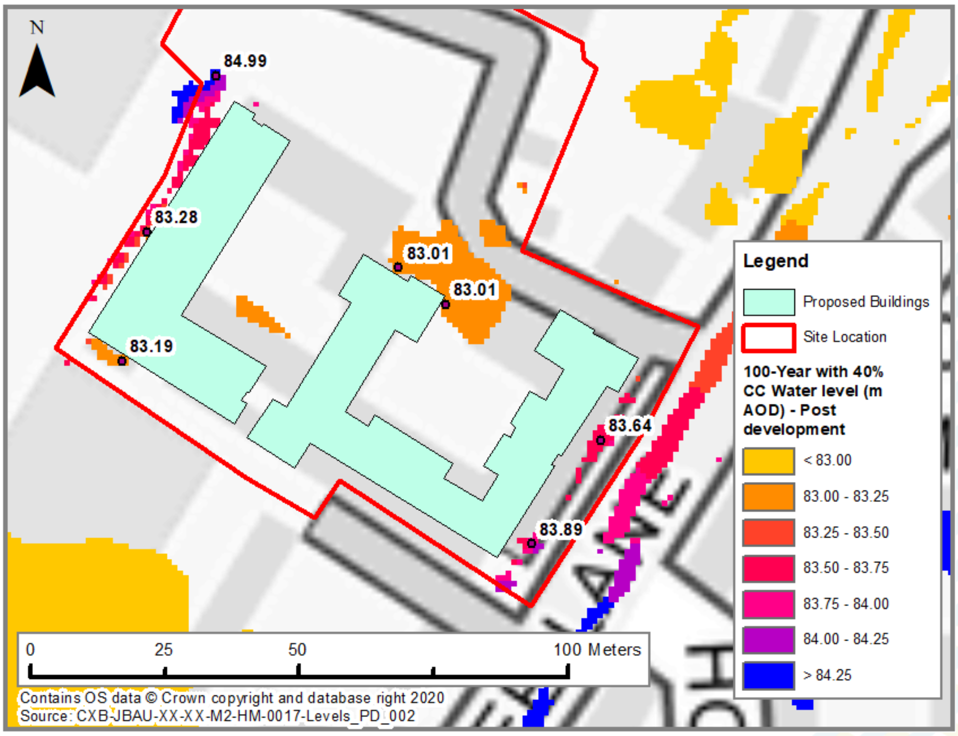


Figure 0-1: Model extent

It is recommended that results from this hydraulic modelling study are submitted to the Lead Local Flood Authority for validation prior to planning submission.

Contents

List of Figures

List of Tables

Abbreviations

2D	Two Dimensional
CC	Climate Change
DTM	Digital Terrain Model
EA	Environment Agency
ESTRY	Primary 1D engine used by TUFLOW.
FEH	Flood Estimation Handbook
FFL	Finished Floor Levels
GCS	Grantham Coates Surveyors
Ha	Hectares
HQ	Head-Flow
JBA	Jeremy Benn Associates
LiDAR	Light Detection and Ranging
m AOD	Metres Above Ordnance Datum
QMED	Median annual flow
QT	Flow-Time
ReFH	Revitalised Flood Hydrograph
TUFLOW	2D Hydraulic Modelling Software

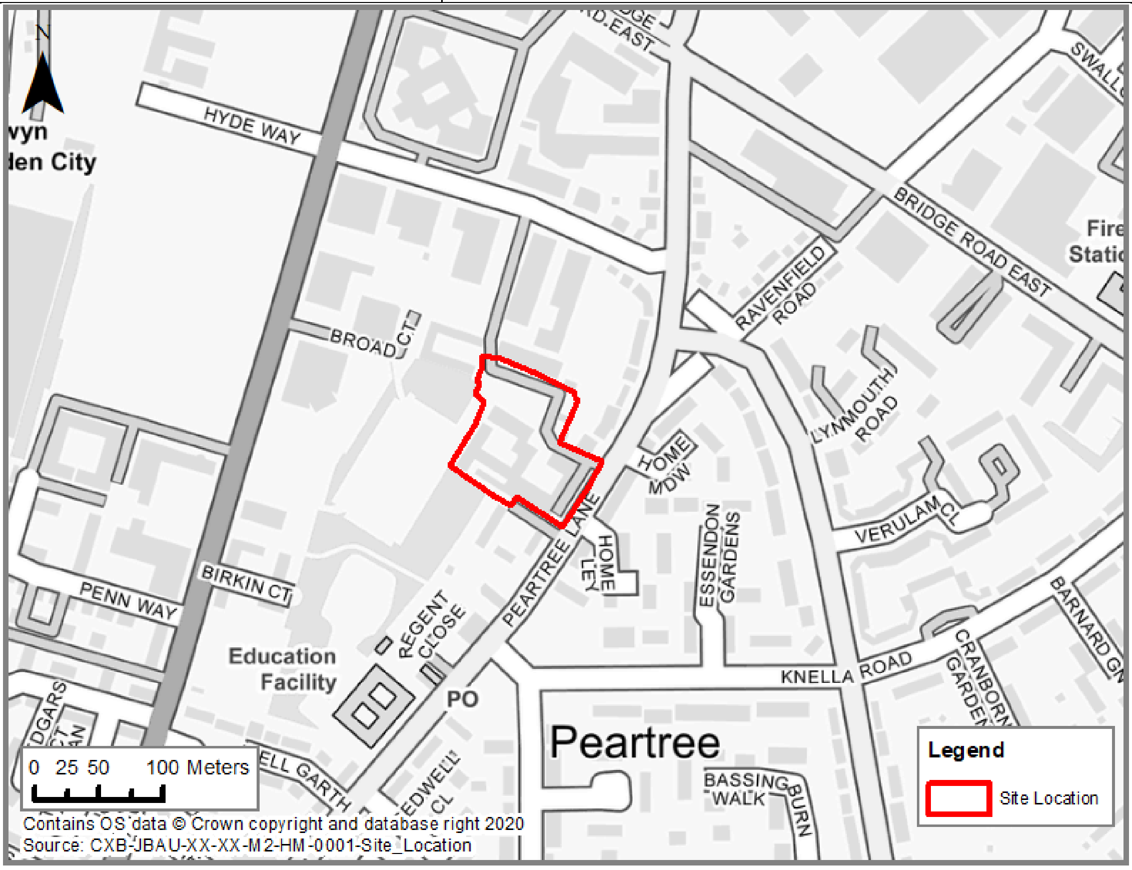
1 Introduction

1.1 Terms of reference

JBA Consulting (JBA) were commissioned by Pinnacle Consulting Engineers to undertake a surface water modelling study in relation to a proposed development site at 90 Peartree Lane, Welwyn Garden City.

1.2 Site details

Table 1-1: Site details	
Site name	One YMCA 90 Peartree Lane, Welwyn Garden City
Site area	0.86ha
Existing land-use	Brownfield
OS NGR	TL 24423 12577
County	Hertfordshire
Country	England



1.3 Site description

The proposed development is off Peartree Lane, Welwyn Garden City and is currently occupied by hardstanding areas used for parking with a number of buildings in use on the site.

1.4 Existing flood data

It is our understanding the that the Environment Agency's RoFSW maps in relation to the site originates from broadscale modelling and does not account for the high capacity of the drainage network along Broadwater lane. Therefore, JBA Consulting has been commissioned to carry out a surface water modelling study in relation to the proposed development site.

1.5 General Approach

To support this assessment, a hydrological assessment was carried out to derive rainfall hyetographs and a 2D TUFLOW hydraulic model was produced to allow the accurate representation of flood depths, velocity and hazard within the site boundary.

The hydraulic model's sensitivity to roughness values was tested to improve confidence in the model results within the development site boundary.

2 Model approach

2.1 Model geometry

2.1.1 Data availability

LiDAR data was obtained from the Open Data website to represent ground levels within the floodplain. The LiDAR has a grid resolution of 1m and was last flown in 2011. To provide greater levels of detail, site topographic survey was also converted into a DTM and read into the model. The site topographic survey was collected by Malcom Hughes Chartered Land Surveyors in July 2019 and is included in Appendix A.

2.1.2 Input data quality assessment

Site topographic survey data collected by Malcolm Hughes Chartered Land Surveyors was compared with the 2011 LiDAR data (Appendix B). Overall, results show a good correlation between both datasets across most of the site. As a result, both datasets have been used in the simulation.

2.1.3 Model extend and build

The hydraulic model represents the surface water floodplain in the vicinity of the proposed site. The extent of the hydraulic model built is shown in Figure 2-1.

The 2D domain was built using TUFLOW (2018-03-AE-iDP-W64), LiDAR data and topographic survey data provided by the client. The 2D domain has an area of 52ha and a 2m grid resolution. The 2D domains can be seen in Figure 2-1.

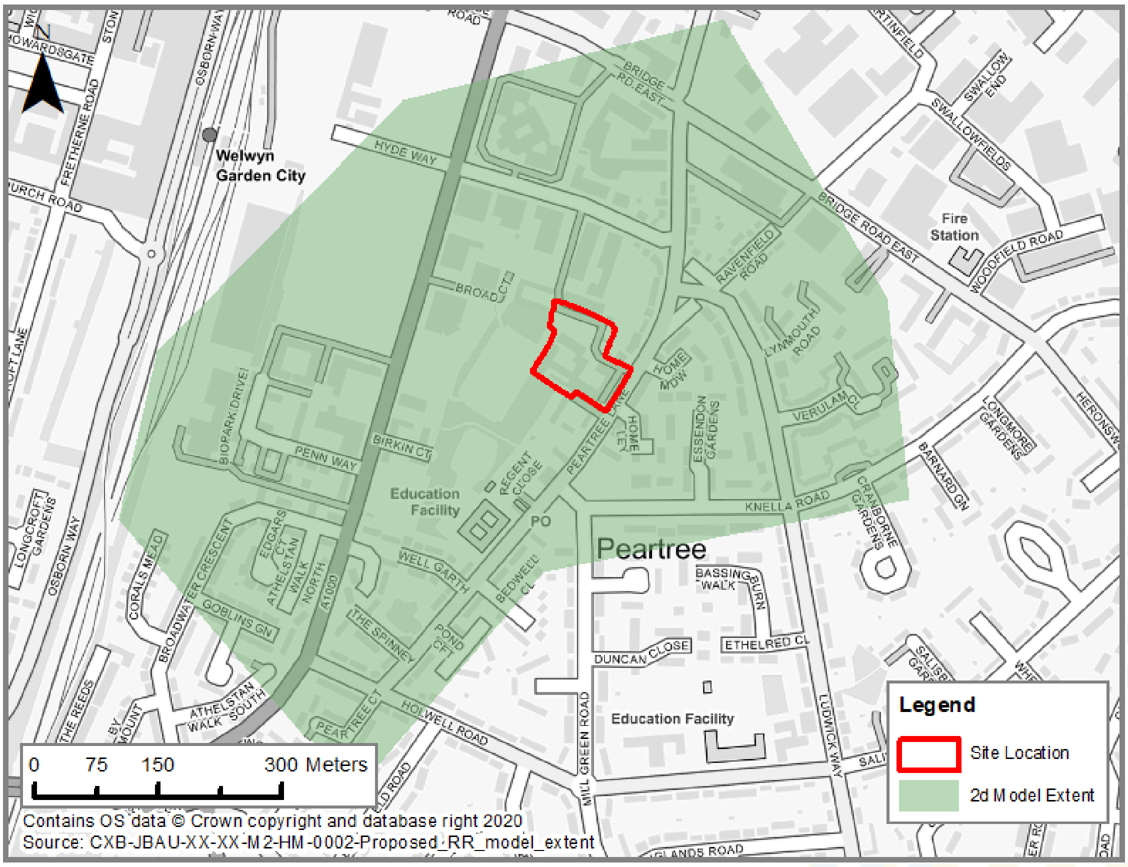


Figure 2-1: Model extent

2.1.4 Model roughness parameters

Manning's *n* was used to represent roughness values for the floodplain. Manning's *n* values in the floodplain were based on different land uses in the 2D domain. Land uses were defined using OS mapping and satellite imagery. Table 2-1 gives the range of Manning's *n* values used in the 2D domain.

Table 2-1: Manning's *n* range within the hydraulic model

General Surface	0.050
Less dense woodland	0.070
Dense woodland	0.100
Hedges	0.080
Roads and footpaths	0.025
Gravel roads	0.035
Buildings	0.300
Water	0.020
Rail	0.060

2.2 Model boundary conditions

2.2.1 Model inflows

A hydrological assessment was carried out to derive inputs for the surface water modelling. The hydrological assessment is documented in Appendix C.

Rainfall hyetographs for the 30-year (3.3% AEP), 100-year (1% AEP) and 1,000-year (0.1% AEP) flood events were generated by the ReFH2 rainfall-runoff model.

In line with the Environment Agency's guidance for rainfall-runoff modelling, a runoff coefficient of 70% (chosen for urban areas) was applied to the rainfall hyetographs and 18mm/hr has been subtracted from each time interval to account for the local drainage system. The revised rainfall hyetographs were then applied over the 2D hydraulic model domain.

In line with the new Guidance on Climate Change issued by the Environment Agency in February 2016[3], the effect of climate change was assessed by increasing the peak rainfall by 40% (Upper end allowance for the 2080s epoch).

Figure 2-2 below shows the extent of the flooding during the 100-year event during each of the storm durations tested.

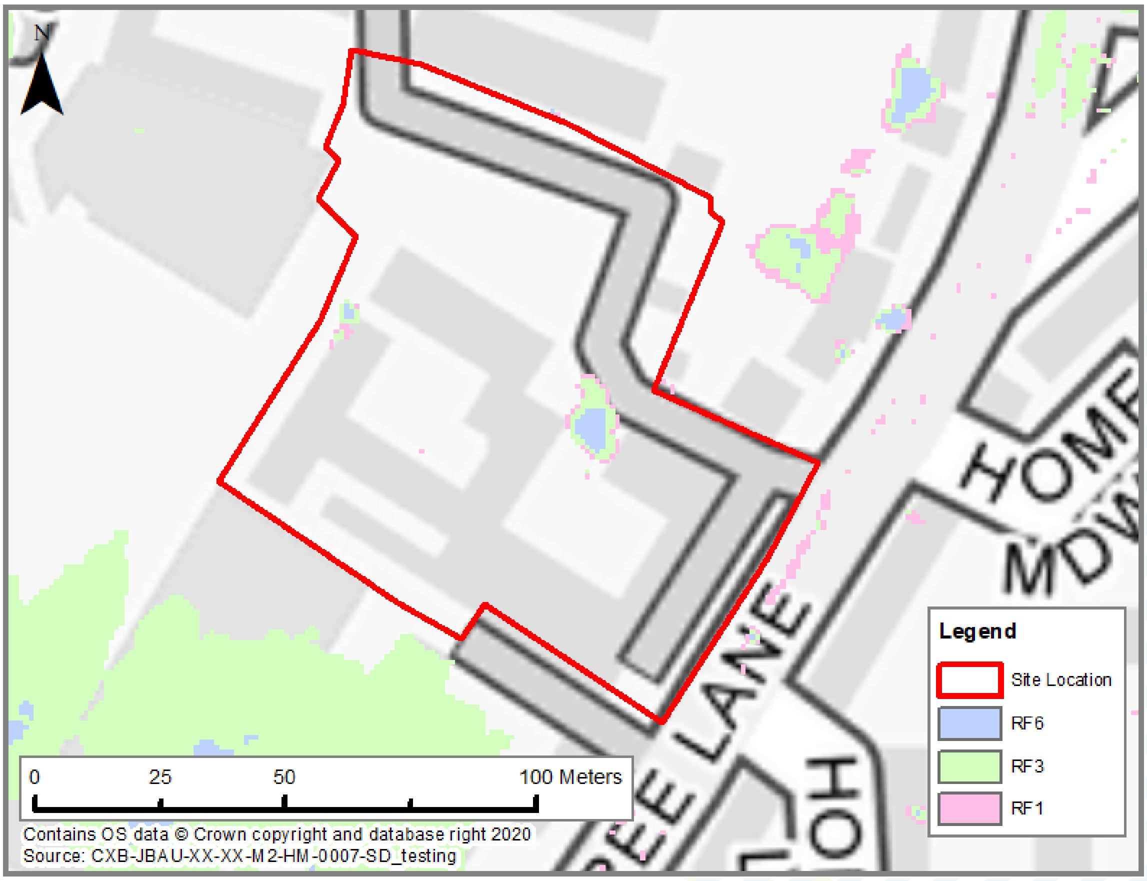


Figure 2-2: Storm duration test

Rainfall was estimated for a 1-hour, 3-hour and 6-hour storm duration for each event. A review of the initial model results indicated that the 1-hour storm duration generated the largest flood extents on site.

2.2.2 Downstream boundary conditions

In the 2D domain, one HQ line based on the average slope in the floodplain downstream was used to represent the downstream boundary conditions in the floodplain/2D domain.

2.3 Calibration

No specific flood levels or flow data could be found over the modelled extent. As a result, the model is uncalibrated.

2.4 Model Runs

2.4.1 Modelled Scenarios

The following flood scenarios were simulated by the model:

- **[Baseline scenario]** 30-year (3.3% AEP) flood event - existing condition scenario
- **[Baseline scenario]** 100-year (1% AEP) flood event - existing condition scenario
- **[Baseline scenario]** 100-year (1% AEP) plus Climate Change (40%) flood event - existing condition scenario
- **[Baseline scenario]** 1000-year (0.1% AEP) flood event - existing condition scenario
- **[Sensitivity analysis]** 100-year (1% AEP) flood event with +20% increase in roughness value
- **[Post Development scenario]** 30-year (3.3% AEP) flood event – proposed development scenario
- **[Post Development scenario]** 100-year (1% AEP) flood event - proposed development scenario
- **[Post Development scenario]** 100-year (1% AEP) plus Climate Change (40%) flood event - proposed development scenario
- **[Post Development scenario]** 1000-year (0.1% AEP) flood event - proposed development scenario.

3 Model validation

To confirm the validity of the model results and ensure the model is fit for purpose, the surface water modelling results were compared with the EA's Risk of Flooding from Surface Water (RoFfSW) maps in two return periods.

3.1 Comparison with the EA's 30-year surface water map

Figure 3-1 shows the EA's 30-year surface water extent compared to the 30-year surface water extent modelled as part of this study.

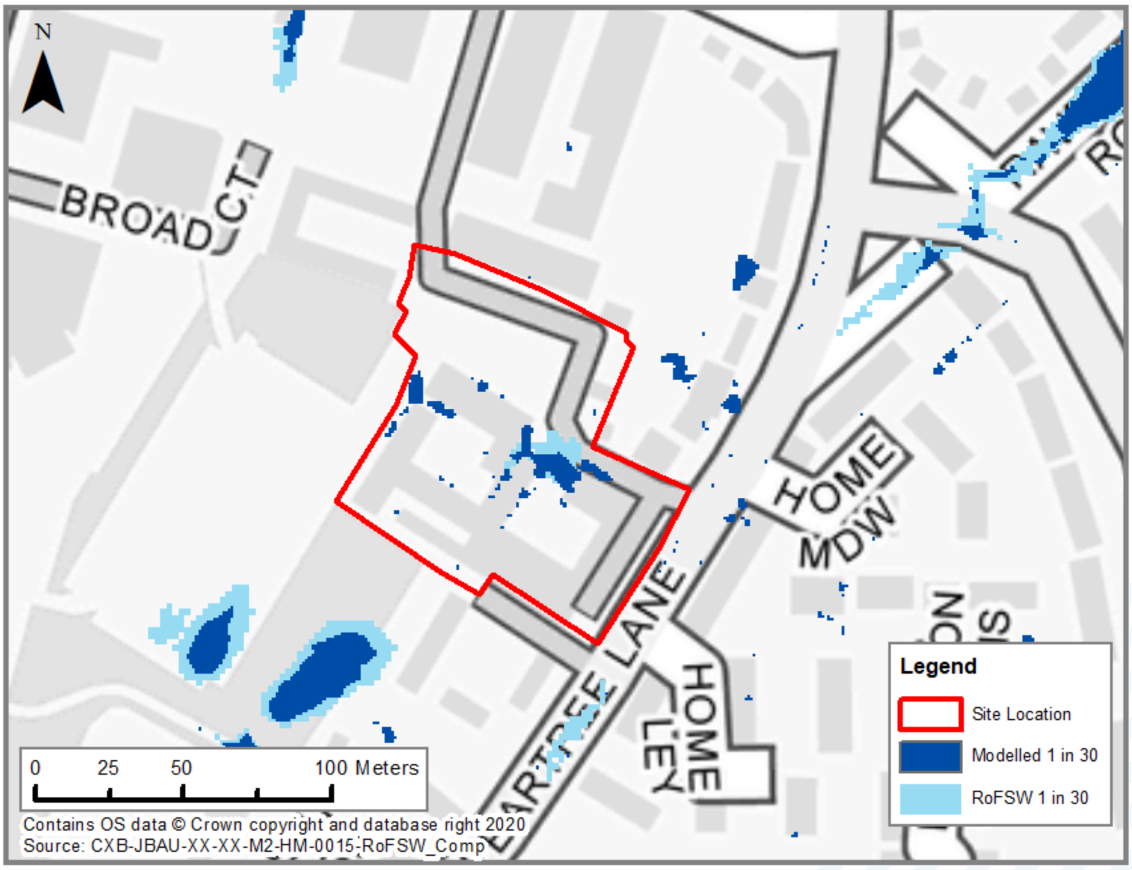


Figure 3-1: 1 in 30-year comparison

Figure 3-1 illustrates that in a 30-year surface water flooding event the model results and the EA's RoFSW show different flood extents surrounding the proposed site. The detailed model results show smaller flood extents than the EA surface water flood extents. This is due to the inclusion of a site topographic survey which will improve the accuracy of the ground levels when modelling the flood extent for the 1-hour storm event and the increase of rainfall captured within the local drainage system.

3.2 Comparison with the EA's 1 in 100-year surface water extent

Figure 3-2 shows the EA's 100-year surface water extent compared to the 100-year surface water extent modelled as part of this study.

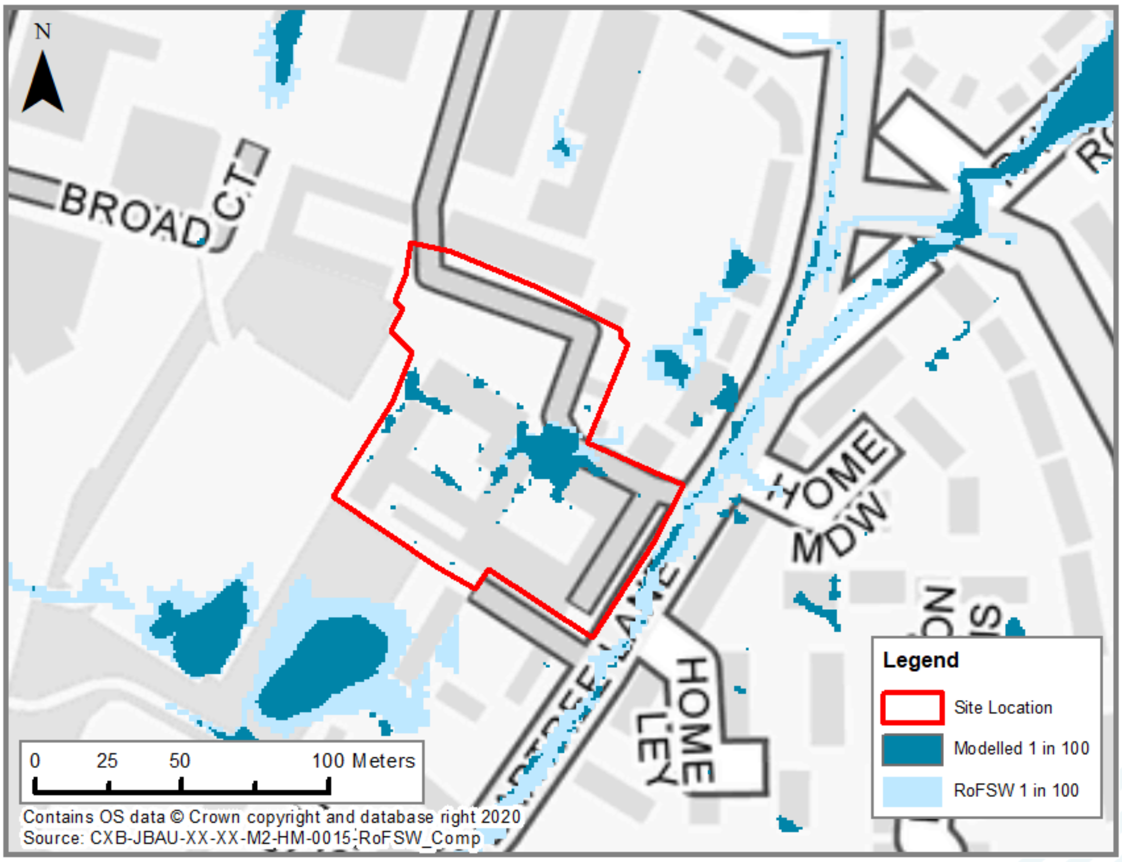


Figure 3-2: 1 in 100-year comparison

Figure 3-1 and Figure 3-2 indicate that the hydraulic modelling is able to provide reliable results and the model results are comparable with the EA's data. This model has the capacity to support the flood risk study in this project.

4 Hydraulic model results

4.1 Existing conditions/baseline scenarios

4.1.1 Flood extents

Figure 4-1 shows the baseline modelled surface water flood extents at the site.

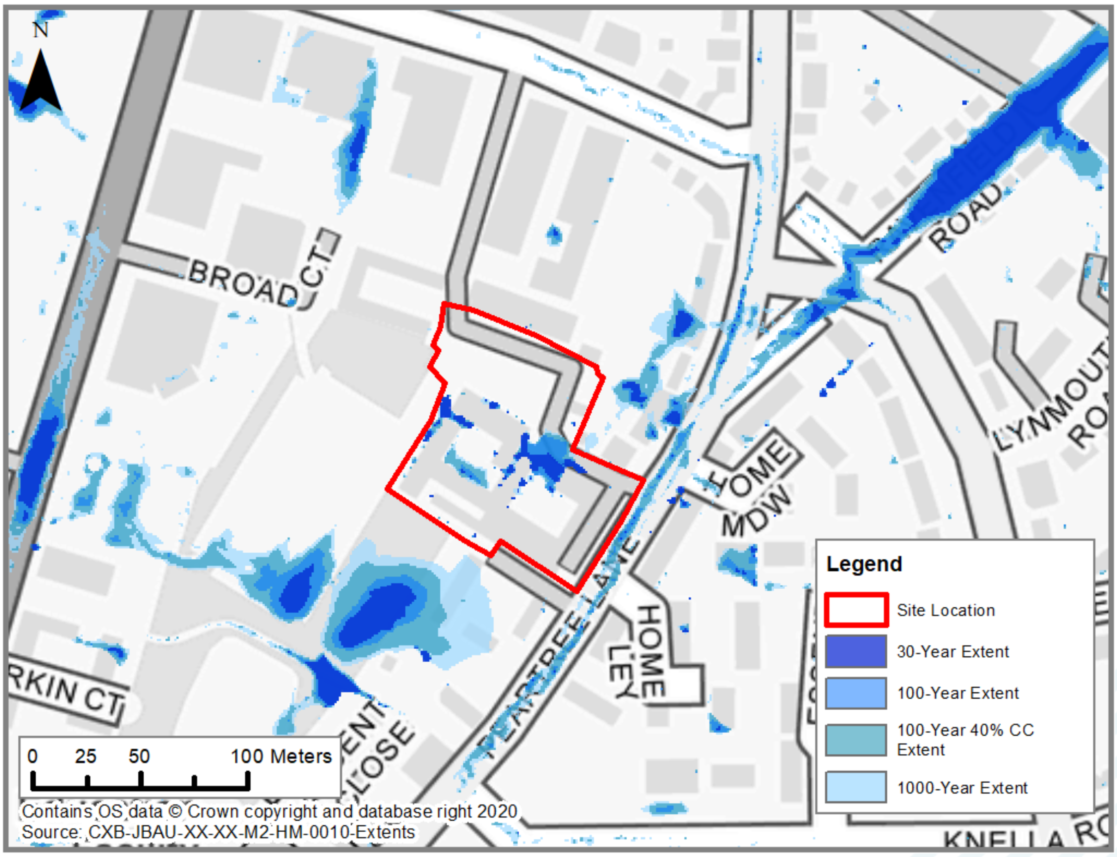


Figure 4-1: Baseline flood extents

Figure 4-1 shows that the surface water flooding within the site is from the 30-year event. It also shows that there is a depression south of the site which attenuates some of the surface water.

4.1.2 Flood depths

Figure 4-2 shows the depth of flooding within the site during the 100-Year with 40% climate change event for the baseline scenario.

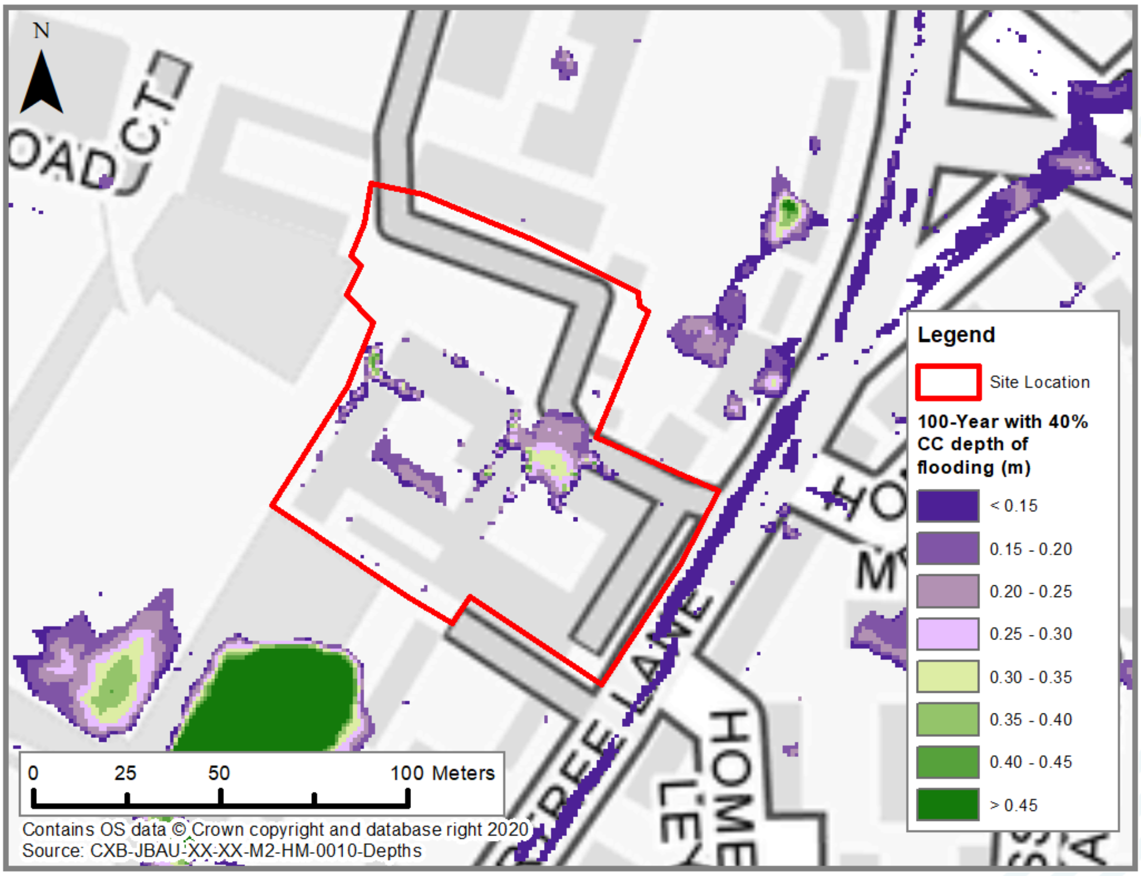


Figure 4-2: Baseline flood depths

Figure 4-2 shows that within the site the surface water flooding is mostly within the central areas of the site, around the existing buildings. The greatest depth within the site is 0.45m, which can be found within the area of deeper flood depths within the western area of the site. Within the centre of the site the greatest depth of flooding is 0.42m.

4.1.3 Flood levels

Modelled flood levels within the site boundary for the 100-year plus 40% climate change event are represented in Figure 4-3 below.

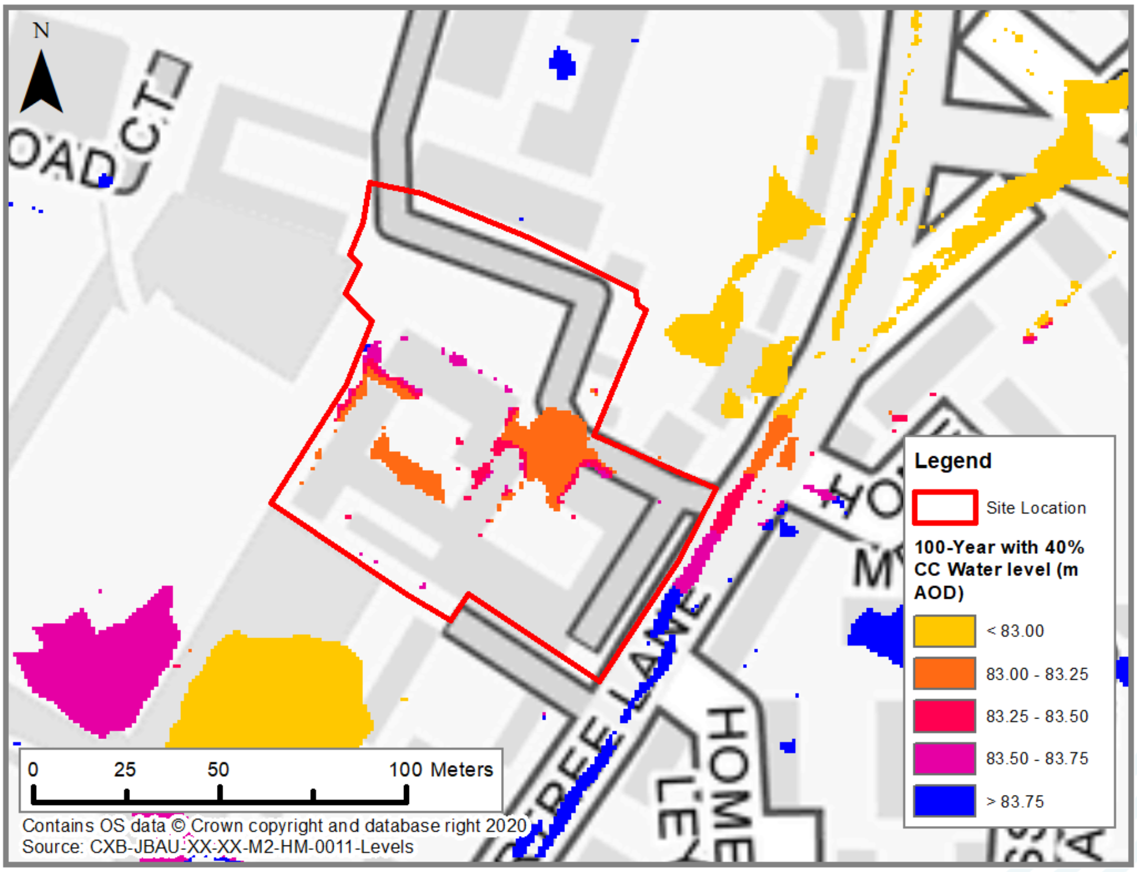


Figure 4-3: Baseline water levels

The maximum flood levels within the site during the 100-year plus 40% climate change event are approximately 83.95m AOD, this is found within the area of blue along the western boundary of the site.

4.2 Post-development

The post-development scenario has been modelled with the proposed buildings represented as being raised by 10m in order to 'glass wall' the development, representing the worst-case scenario within the site.

4.2.1 Flood extents

The extent of the flooding within each of the modelled return periods in the post-development scenario is shown within Figure 4-4 below.

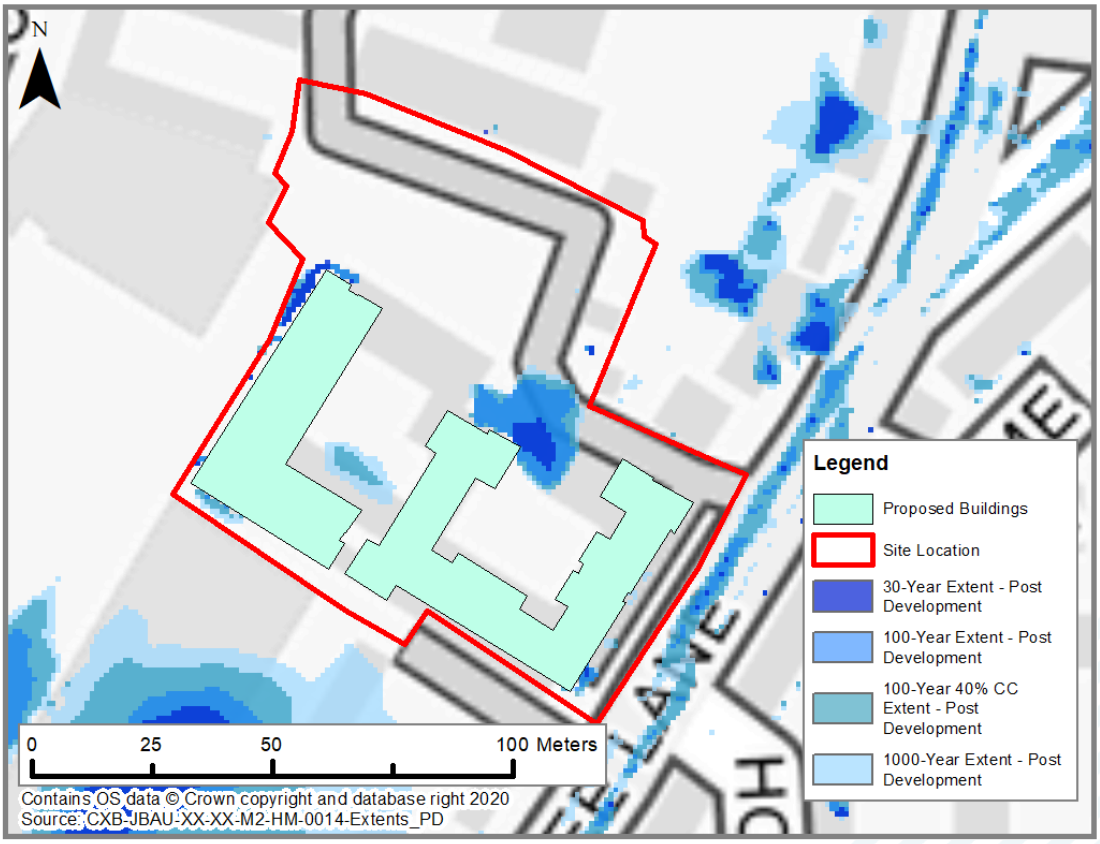


Figure 4-4: Post development flood extents

4.2.2 Flood depths

Figure 4-5 shows the depths of flooding within the site during the 100-year with 40% climate change event.

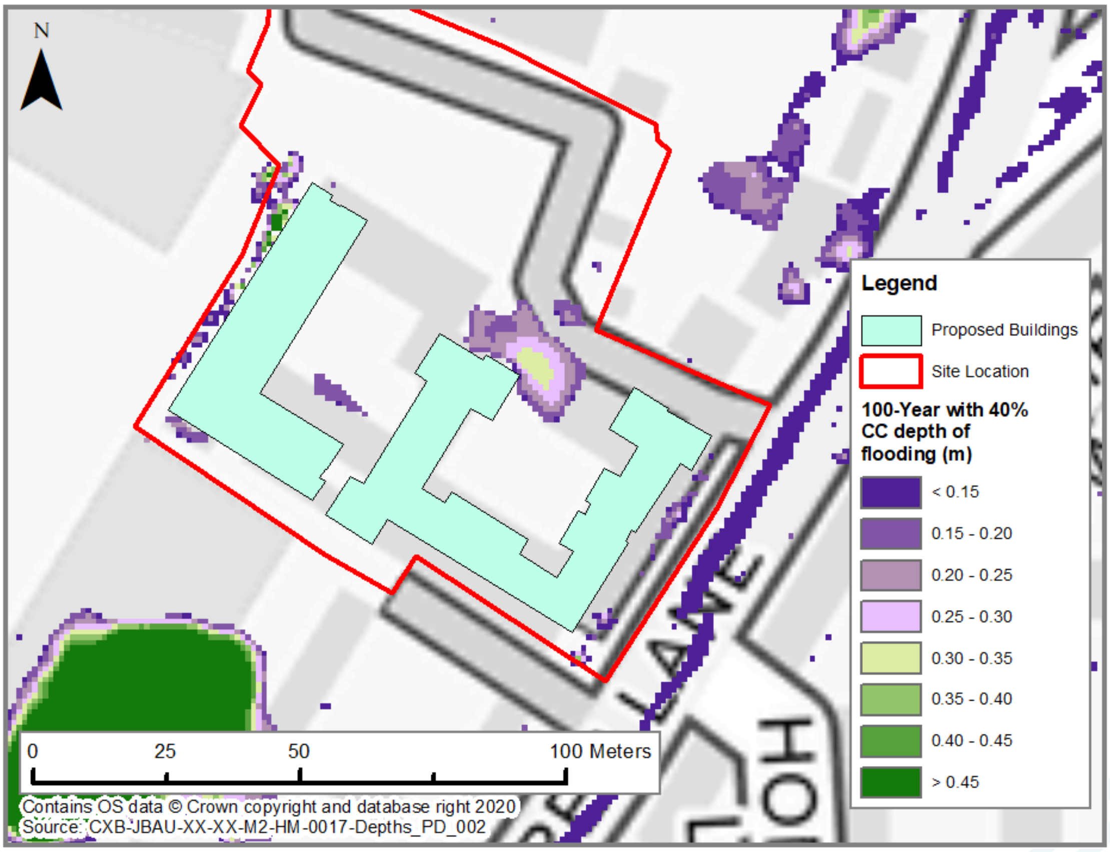


Figure 4-5: Post development flood depths

Figure 4-5 shows that the maximum flood depth within the site is located along the western boundary along the edge of one of the proposed buildings (0.62m), in the centre of the site the maximum depth of flooding is 0.34m.

4.2.3 Flood levels

Figure 4-6 shows the level of the surface water flooding within the site during the post-development 100-year with 40% climate change event.

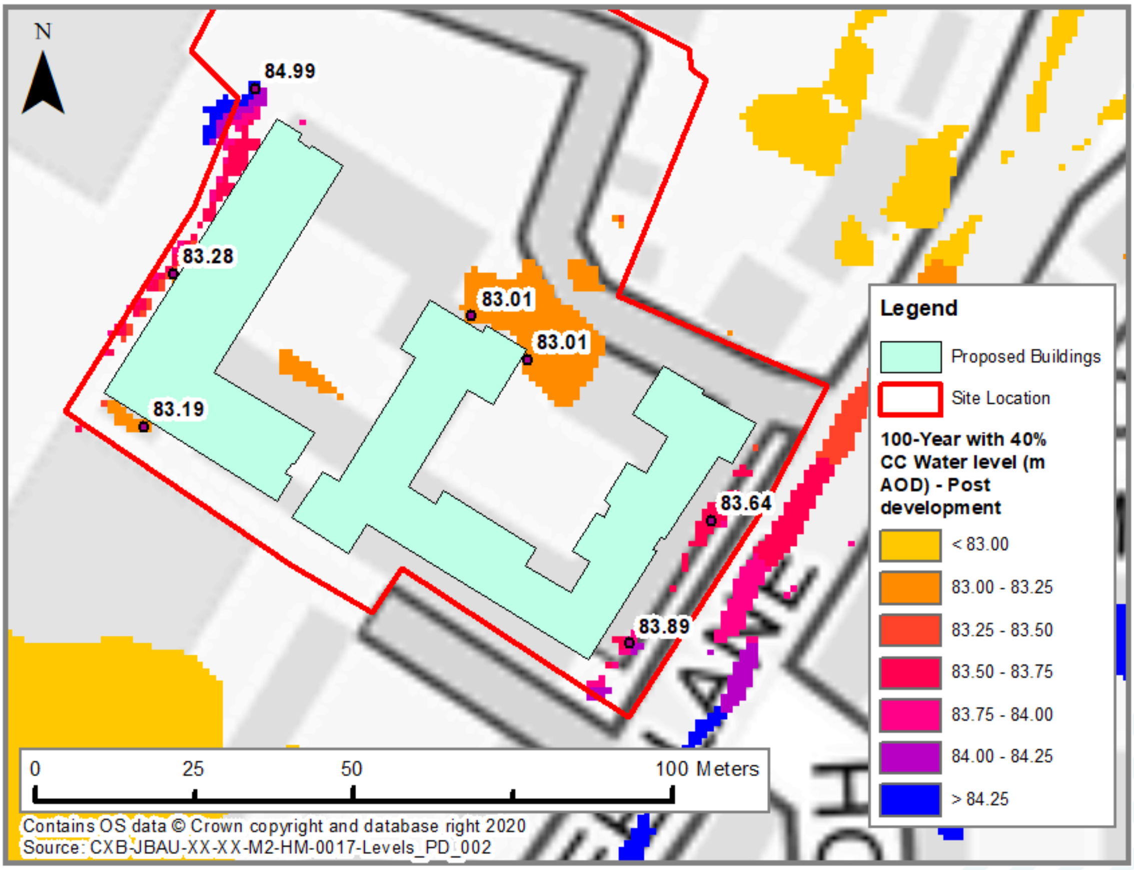


Figure 4-6: Post development water levels

The maximum water level on site, 84.99m AOD, occurs along the north-eastern site boundary, away from the proposed buildings and thus will not be taken into consideration as part of the design.

The peak water levels along the proposed buildings vary between 83.01 and is 83.89m.

4.2.4 Impact of proposal

The impact on flood depths from the proposal has been assessed for the 100-year with 40% climate change.

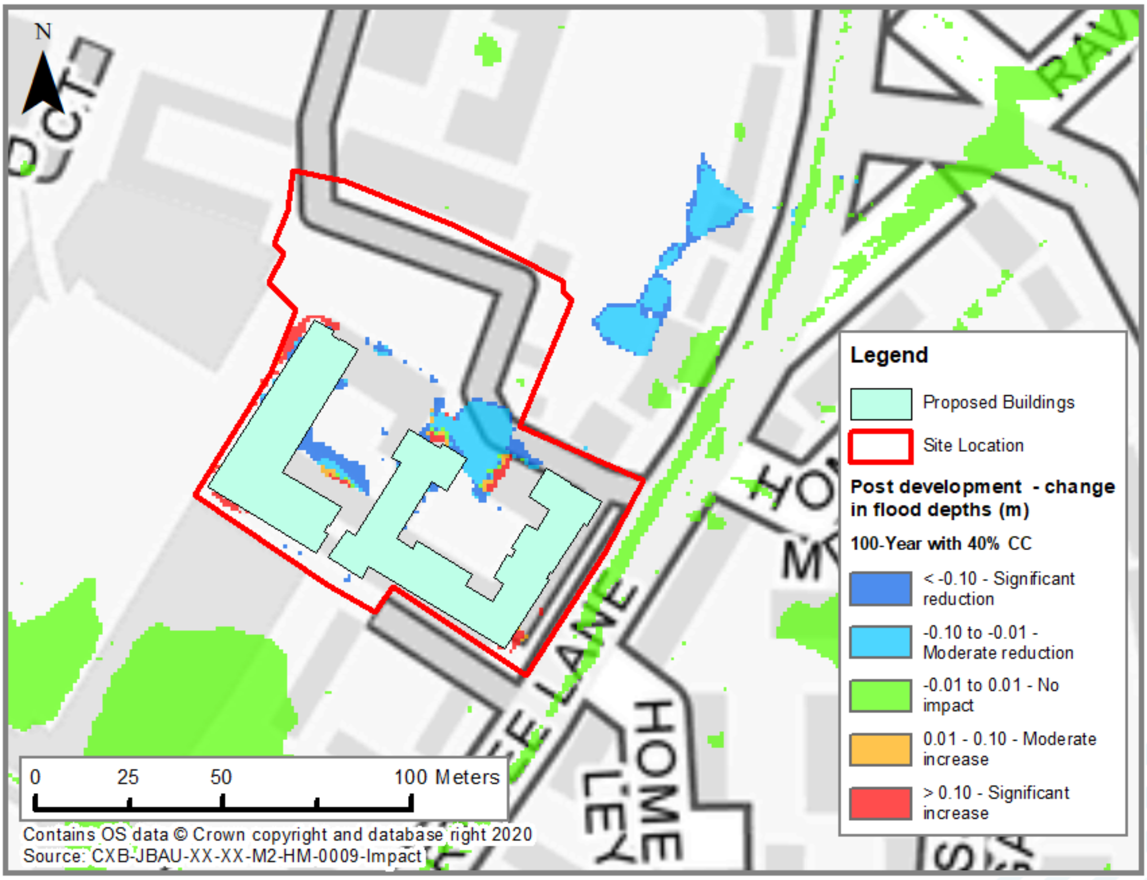


Figure 4-7: Post-development impact

Figure 4-7 shows that the proposed development does not have a detrimental impact on third-party land, there is in an area to the north of the site in which there is a significant reduction in the depth of flooding as a result of the proposed buildings.

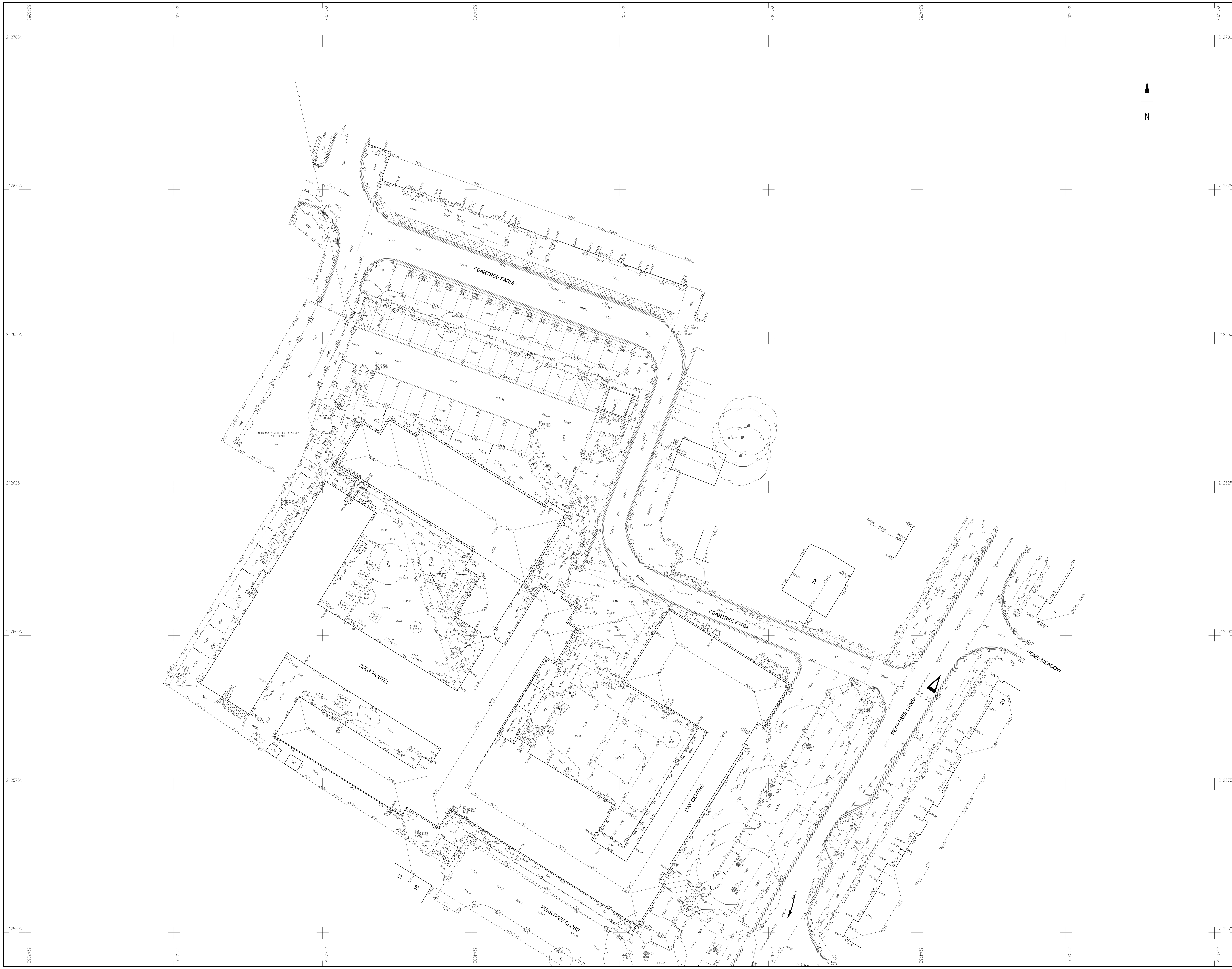
Within the site there are some areas with an increase in flooding, the area which has the maximum depth of flooding in Figure 4-5 has an increase in flood depth from the baseline.

5 Conclusions and Recommendations

- Pinnacle Consulting Engineers commissioned JBA Consulting to assess surface water flood risk in relation to a proposed development site at YMCA Peartree Lane, Welwyn Garden City.
- A rainfall-runoff model was created using the ESTRY-TUFLOW software to represent surface water flood mechanisms, calculate flood levels and assess the impact of the proposal. The model was run for the 30-year (3.3% AEP), 100-year (1% AEP), 100-year plus 40% climate change (1.4% AEP) and 1,000-year (0.1% AEP) rainfall-runoff events using the 1-hour critical (summer) storm duration.
- The baseline model results indicate that
    - The proposed development site is partially at risk of flooding from the 30-year, 100-year, 100-year plus 40% climate change and the 1,000-year storm events;
    - During the 100-year plus 40% climate change event, with water pooling towards the western side of the site. Maximum flood depths of 0.62m occurs along the western site boundary;
    - Flood levels within the site during the 100-year plus 40% climate change event are between 83.0m AOD and 84.48m AOD;
    - Results from the sensitivity analysis indicate that the model results within the site are relatively insensitive to changes in roughness values.
- The impact of the proposal was modelled during the 100-year with (+40%) climate change storm event. Post-development model results indicate that:
    - The proposal will generate no detrimental impacts across third-party land.
    - The proposal will reduce flood risk third-party land located to the north-east of the site.
    - The peak water levels along the proposed buildings vary between 83.01 and is 83.89m.
- It is recommended that the drainage system along the north-western side of the proposed western building is adequately sized/designed to prevent the build-up of surface water.
- It is recommended that results from this hydraulic modelling study are submitted to the Lead Local Flood Authority for validation prior to planning submission.

Appendices

A Appendix A – Topographic Survey

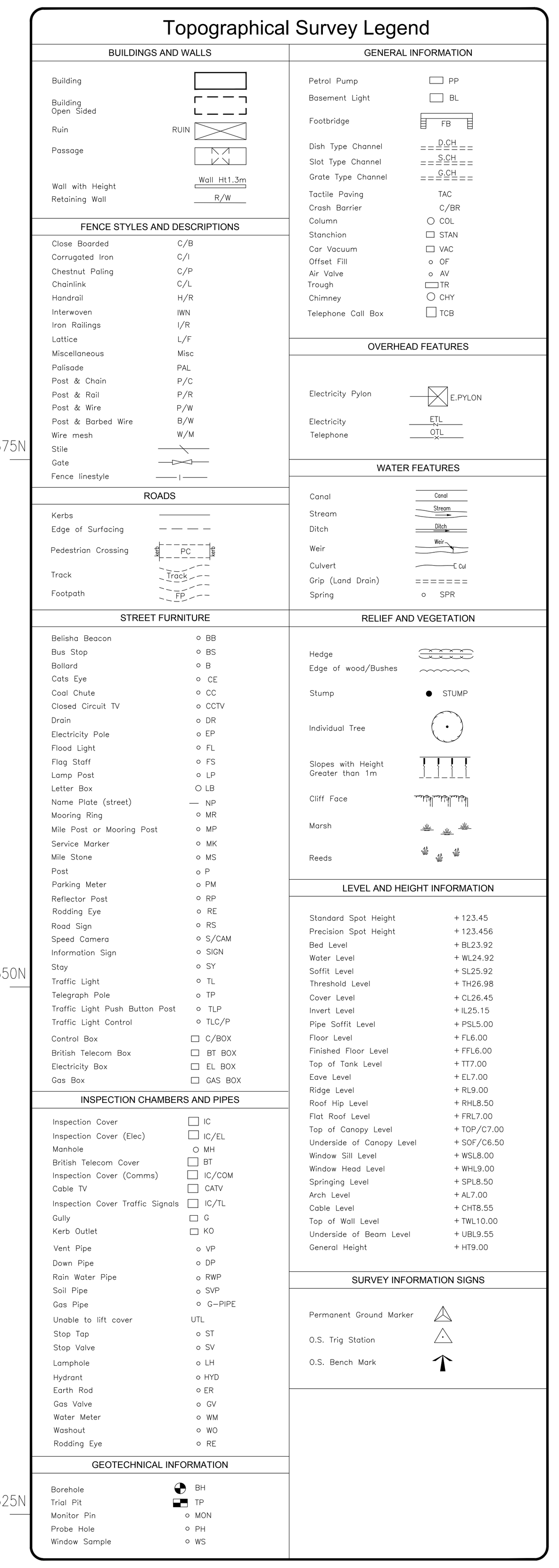


Survey Notes

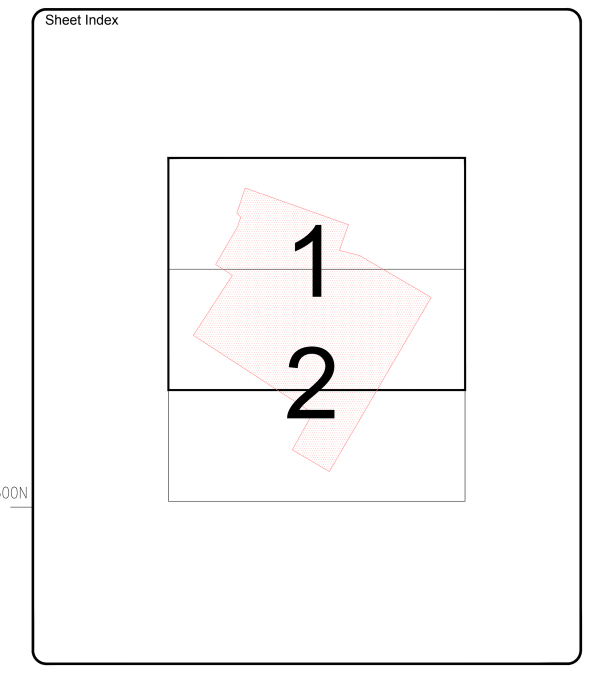
Grid: Local, plane, metric fixed to National Grid fixed at Stn SC5

Levels: OS datum from GNSS positioning converted using the National Geoid Model OSGM15

Notes



Sheet Index



Rev.	Date	Description

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Project

ONE YMCA, PEARTREE LANE
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AL7 3UL

Drawing Title

TOPOGRAPHICAL SURVEY

Drawn By	CPT	28/07/19	Survey Date	June 2019
Checked by	SC	28/07/19	Scale	1:200 @ A0

Drawing No	Revision
53948-1	

B Appendix B – Quality Assessment

B.1 Topographic survey vs. LiDAR

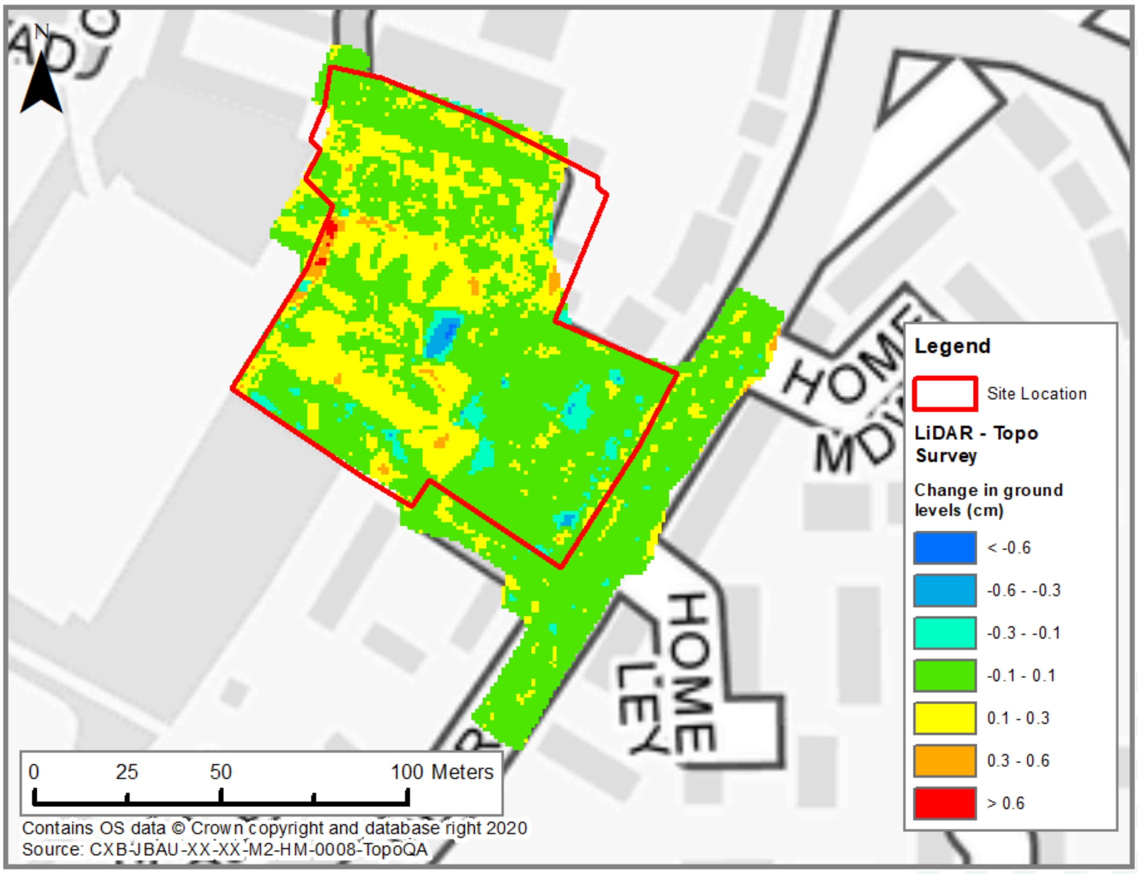


Figure C-1: Topographic survey vs LiDAR

Figure C-1 shows that there is generally a good correlation of elevations between the two DTMs, as a result both will be read into the model.

C Appendix C – Hydrological Assessment

Flood estimation report: Peartree Lane

Introduction

This report template is based on a supporting document to the Environment Agency's flood estimation guidelines. It provides a record of the hydrological context, the method statement, the calculations and decisions made during flood estimation and the results.

Contents

Approval

	Name and qualifications	Date
Method statement prepared by:	Bryony McLeod BSc MSc	28/02/2019
Method statement reviewed by:	Eva Kordomenidi BSc MSc MCIWEM CWEM , CSci	12/03/2020
Calculations prepared by:	Bryony McLeod BSc MSc	28/02/2019
Calculations reviewed by:	Eva Kordomenidi BSc MSc MCIWEM CWEM , CSci	12/03/2020

Revision History

Revision reference	Date issued	Amendments	Issued to

Abbreviations

AM........................Annual Maximum

AREA ....Catchment area (km^2)

BFI ....Base Flow Index

BFIHOST ....Base Flow Index derived using the HOST soil classification

CFMP ....Catchment Flood Management Plan

CPRE ....Council for the Protection of Rural England

FARL.......................FEH index of flood attenuation due to reservoirs and lakes

FEH ....Flood Estimation Handbook

FSR ....Flood Studies Report

HOST......................Hydrology of Soil Types

NRFA ....National River Flow Archive

POT ....Peaks Over a Threshold

QMED ....Median Annual Flood (with return period 2 years)

ReFH.......................Revitalised Flood Hydrograph method

SAAR ....Standard Average Annual Rainfall (mm)

SPR ....Standard percentage runoff

SPRHOST ....Standard percentage runoff derived using the HOST soil classification

Tp(0) ....Time to peak of the instantaneous unit hydrograph

URBAN ....Flood Studies Report index of fractional urban extent

URBEXT1990 ....FEH index of fractional urban extent

URBEXT2000 ....Revised index of urban extent, measured differently from URBEXT1990

WINFAP-FEH ....Windows Frequency Analysis Package – used for FEH statistical method

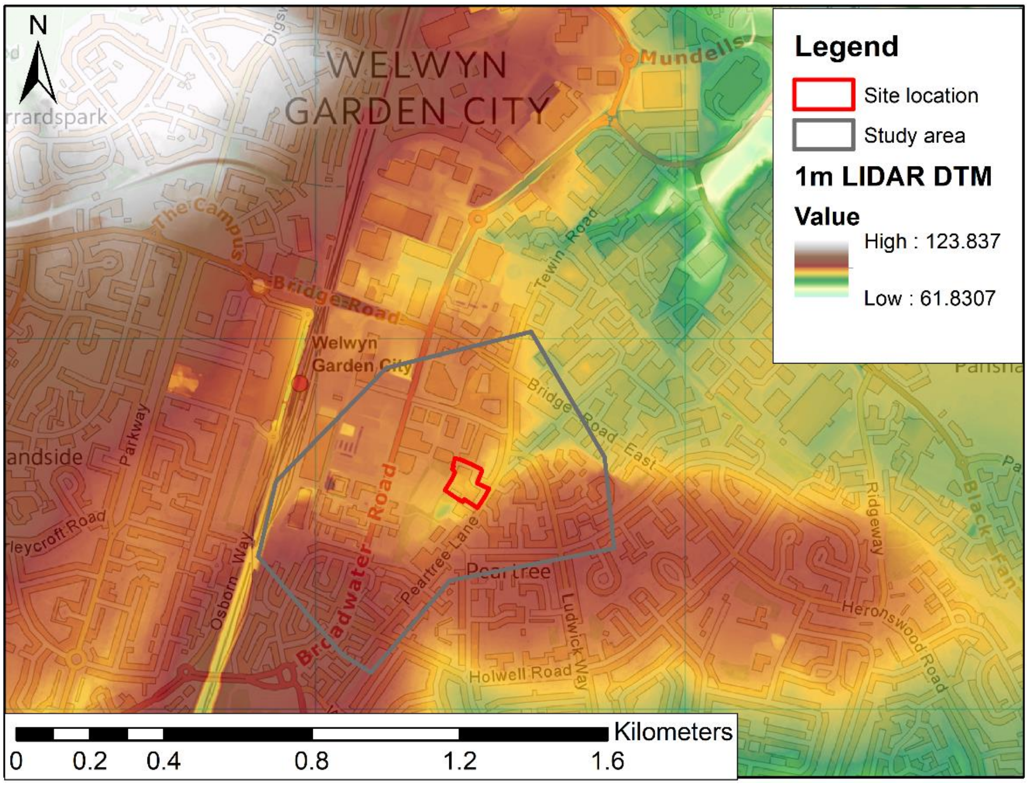
1 Method statement

1.1 Requirements for flood estimates

Overview • Purpose of study • Peak flows or hydrographs? • Range of return periods and locations	Rainfall hyetographs are required for a surface water model at One YMCA 90 Peartree Lane, Welwyn Garden City. The model will be developed using the methodology described in the EA's "Updated Flood Map for Surface Water – National Scale Surface Water Flood Mapping Methodology" and will provide a detailed assessment of surface water flood risk at the site. The modelled rainfall return period events will be 3.3%, 1% and 0.1%, with a 1-hour, 3-hour and 6-hour storm duration for each return period.

1.2 The study area

Map



Description Include topography, climate, geology, soils, land use and any unusual features that may affect the flood hydrology.	The study area is located in the centre of Welwyn Garden City and is predominantly urban. There doesn't appear to be any open watercourses within the study area, though LiDAR data indicated it is located in the middle of a natural drainage catchment. The site will drain away towards the north east of the study area. According to the EA's Risk of Flooding from Surface Water (RoFfSW) maps the site partially falls within an area at risk of flooding from a 30-year, 100-year and 1,000-year storm event. This is based on broadscale modelling.

1.3 Hydrological understanding of catchment

Outline the conceptual model, addressing questions such as: • Where are the main sites of interest? • What is likely to cause flooding at those locations? (peak flows, flood volumes, combinations of peaks, groundwater, snowmelt, tides…) • Might those locations flood from runoff generated on part of the catchment only, e.g. downstream of a reservoir? • Is there a need to consider temporary debris dams that could collapse?	The main site of interest is at the centre of the model domain, at the YMCA. Rainfall will be applied consistently across the whole model area.
Any unusual catchment features to take into account? e.g. • highly permeable – avoid ReFH if BFIHOST>0.65, consider permeable catchment adjustment for statistical method if SPRHOST<20% • highly urbanised – seek local flow data; consider method that can account for differing sewer and topographic catchments • pumped watercourse – consider lowland catchment version of rainfall-runoff method • major reservoir influence (FARL<0.90) – consider flood routing, extensive floodplain storage – consider choice of method carefully	The study area is predominantly urban, and therefore only an urban loss model will be used for the design rainfall hyetograph.

1.4 Initial choice of approach

Initial choice of method(s) and reasons How will hydrograph shapes be derived if needed? Will the catchment be split into sub-catchments? If so, how?	Hyetographs will be derived using ReFH2 with FEH2013 design rainfall for 1,3 and 6 hour storm durations for the 30-year, 100 and 100-year return periods and tested using the hydraulic model to determine the critical storm duration for each area.
Software to be used	FEH Web Service[1] /ReFH2.3

[1] CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, Oxon, UK.

2 Locations where flood estimates required

The table below lists the locations of subject sites. The site codes listed below are used in all subsequent tables to save space.

2.1 Summary of subject sites

Site code	Type of estimate L: Lumped catchment	Watercourse	Name or description of site	Easting	Northing	AREA on FEH CD-ROM (km^2)
YMCA	L	N/A	Catchment at YMCA site	524450	212600	0.615

2.2 Important catchment descriptors at each subject site (incorporating any changes made)

Site code	FARL	PROPWET	BFIHOST	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	URBEXT 2000	FPEXT
YMCA	1	0.3	0.498	0.93	19.1	656	0.7541	0.1504

2.3 Checking catchment descriptors

Record how catchment boundary was checked and describe any changes	Catchment boundary checked against LIDAR and appears appropriate.
Record how other catchment descriptors were checked and describe any changes.	Qualitative check on FARL and BFIHOST using mapping. No amendments were made.
Source of URBEXT	URBEXT2000

3 Rainfall hyetographs

Rainfall hyetographs are required as input to the surface water hydraulic model. The Updated Flood Map for Surface Water (uFMfSW) methodology has been followed to generate the hyetographs for this study.

In the uFMfSW method, the hyetographs were derived for rural and urban areas. Due to the highly urbanised nature of this study area only the urban losses approach is used in this case. The urban losses approach applies a runoff coefficient of 70% to the design rainfall hyetograph and the removes a drainage capacity of 12mm/hr.

Due to the age of the uFMfSW it is assumed they used FEH99 rainfall statistics for the design rainfall. Since this time the FEH13 rainfall statistics have been made available and it has been decided to use the values for this study.

Following the uFMfSW methodology an areal reduction factor (ARF) has not been applied to the data. This means in the ReFH2 software the ARF is set to 1, and the seasonal correction factor was left at the default value. This is due to there being no defined catchment into which the rain is falling, and so the direct rainfall is applied as point rainfall across the study area.

The storm profile has been set as the 50% summer profile, which is generally recommended for urban areas. In the uFMfSW this profile was chosen due to its peakier nature, so is more likely to be critical for surface water flooding.

Hyetographs for a 1.1hr, 3.1hr and 6.25hr storm duration were generated. ReFH2 requires the use of a data interval which gives an odd integer when divided by the storm duration. A data interval of 0.1 hours was used for the 1.1-hour and 3.1-hour storms and a timestep of 0.25 hours was used for the 6.25-hour storm. Multiple durations are chosen initially and the modelling determines the critical duration. The uFMfSW discusses how critical duration is linked to the topography, where low lying areas are linked to longer durations. Whereas this site is on a slope so will tend towards shorter duration.

The runoff coefficient for the urban runoff was chosen as 70% in the uFMfSW study. This was generalised for the nationwide study, so has been reviewed for this specific site. The site is a mixture of industrial land, car parks, suburban style housing (with gardens) and small wooded/park areas. Using OS OpenMap data and OS 50k mapping the impermeable area was calculated at 50-85%. The uFMfSW study quotes standard hydrology guidelines that city centre runoff coefficients are in the range 70-95% and suburban runoff coefficients are in the range 50-70%. Following these guidelines the runoff coefficient of 70% was verified as appropriate for this site.

3.1.1 Rainfall hyetographs

Using ReFH2 software the design rainfall hyetographs were generated for the site. To apply the urban losses each hyetograph was multiplied by 0.7 to represent the losses by infiltration. The loss of 12mm/hr to represent the drainage system was then applied to the resulting hyetograph. This loss was calculated as a depth for each time interval, for example, 0.1hr (6 minute) data interval has a loss of 1.2mm/6 minutes. If the hyetograph depth was already below the drainage capacity, then the depth was set to zero.

Time (hr)	Design rainfall (mm)	Rainfall with 70% runoff (mm)	Drainage capacity (mm)	Urban net rainfall (mm)
00:00:00	0.995	0.697	1.2	0
00:06:00	1.480	1.036	1.2	0
00:12:00	2.266	1.587	1.2	0.387
00:18:00	3.643	2.550	1.2	1.350
00:24:00	6.510	4.557	1.2	3.357
00:30:00	13.337	9.336	1.2	8.136
00:36:00	6.510	4.557	1.2	3.357
00:42:00	3.643	2.550	1.2	1.350
00:48:00	2.266	1.587	1.2	0.387
00:54:00	1.480	1.036	1.2	0
01:00:00	0.995	0.697	1.2	0
Total	43.124	30.187		18.322

Figure 3-1: Calculations used to generate the 100-year, 1-hour inflow rainfall hyetograph.

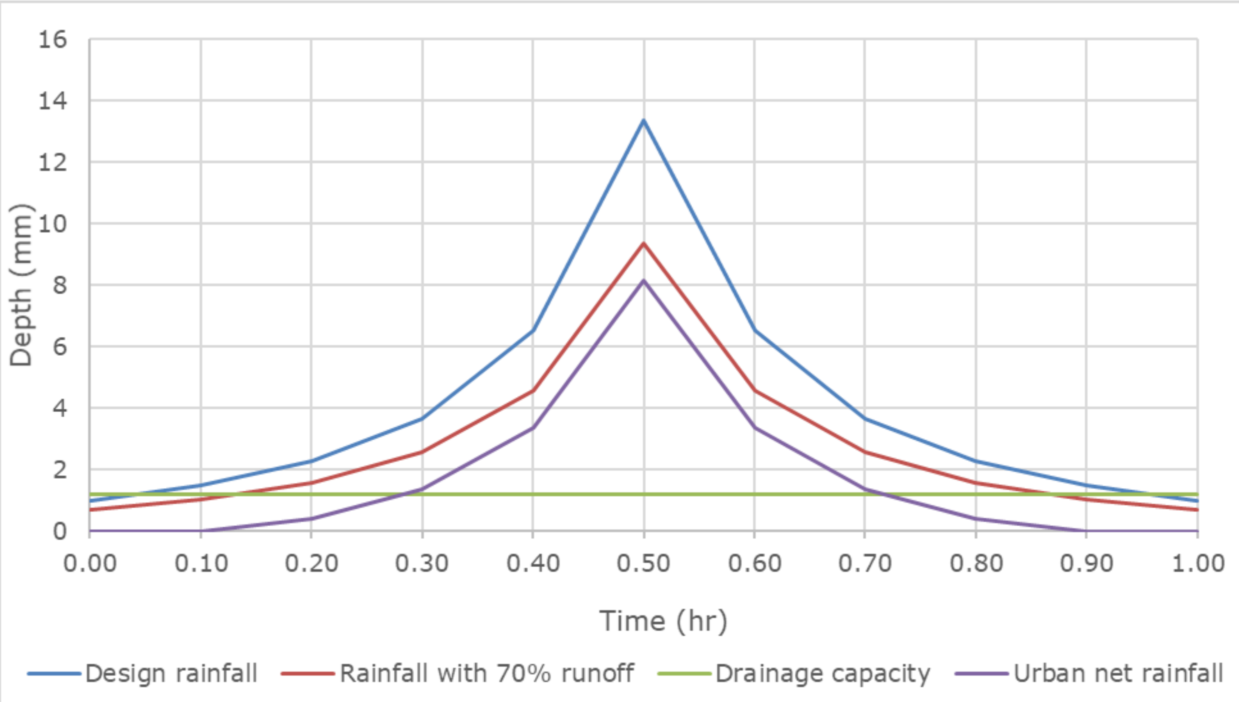


Figure 3-2: Graph illustrating the stages in hyetograph calculations, demonstrated using the 100-year, 1-hour storm.

4 Discussion and summary of results

4.1 Assumptions, limitations and uncertainty

List the main assumptions made (specific to this study)	It is assumed that the rainfall statistics give an accurate representation of rainfall over the study area.
Discuss any particular limitations, e.g. applying methods outside the range of catchment types or return periods for which they were developed.	There is no data for checking the rainfall depths against to verify their validity for the site.
Comment on the suitability of the results for future studies, e.g. at nearby locations or for different purposes.	It is emphasised that the results of the analysis should be considered in the context of the needs of this study. The results of this assessment should be revisited for use on future studies.

4.2 Final results

4.2.1 Rainfall

These are the peak rainfalls for each hyetograph, with urban losses applied, intended for use in the direct rainfall surface water modelling component.

Return Period	Peak Rainfall (mm)		
	1hr	**3hr**	**6hr**
1 in 30-year (3.3% AEP)	5.9	3.4	3.2
1 in 100-year (1% AEP)	8.1	4.8	5.2
1 in 1,000-year (0.1% AEP)	15.0	9.4	11.4

Rainfall hyetographs for the next stage of the study are provided:	Rainfall hyetographs are required for the direct rainfall component of this study. These are provided in a separate file.

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D Appendix D – Sensitivity analysis

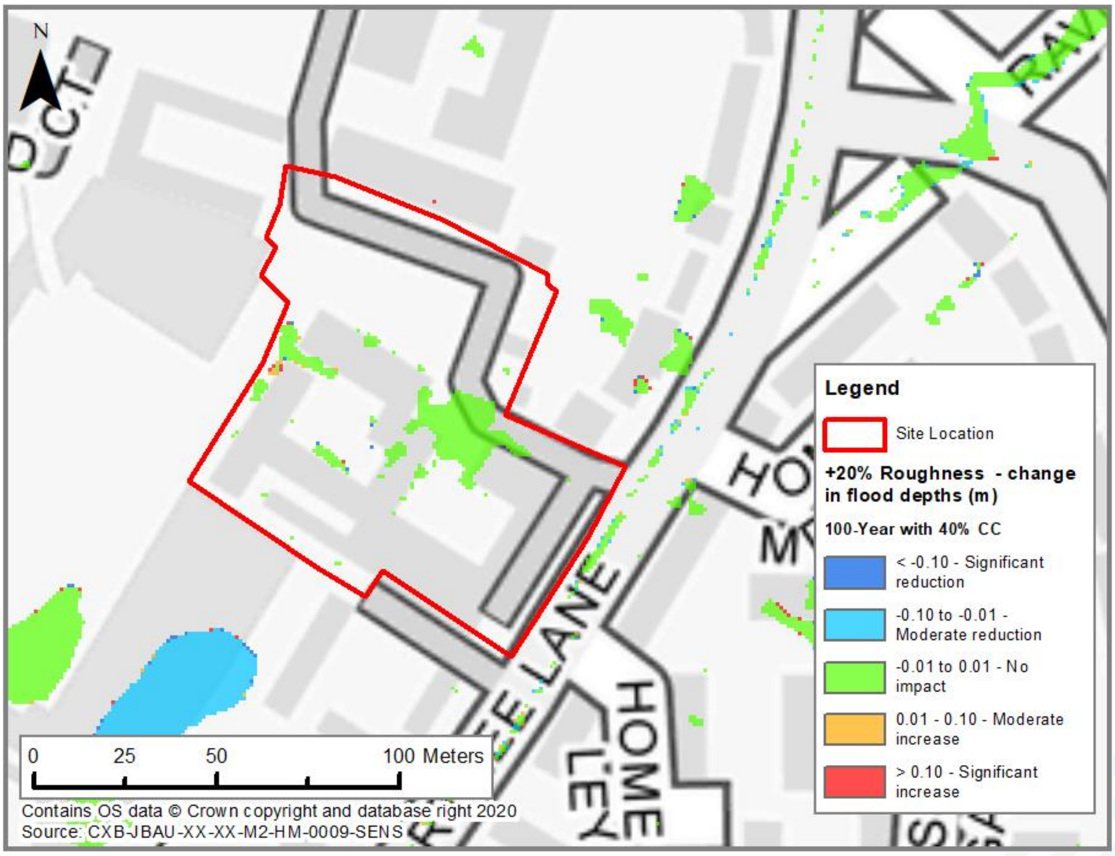

Figure E-2: Sensitivity to an increase in roughness

Figure E-1 shows the impact on flood depths within the site when the Manning's 'n' values are increased by 20%. It shows that within the site flood depths are relatively insensitive to model roughness changes.

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