Airlie Medical Practice

Flood Risk Assessment

PHB Group

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Acronyms and Abbreviations

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
BREEAM	Building Research Establishment Environmental Assessment Method
CC	Climate Change
CFB	Coastal Flood Boundary
DTM & DSM	Digital Terrain Model, Digital Surface Model
FFL	Finished Floor Level
FRA	Flood Risk Assessment
HPC (TUFLOW)	Heavily Parallelised Compute
HT	Head-Time
LiDAR	Light Detection and Ranging
NPF4, NPF3	National Planning Framework 4, 3
NGR	National Grid Reference
PVA	Potentially Vulnerable Area
OS	Ordnance Survey
QA	Quality Assurance
RCP	Representative Concentration Pathway
SEPA	Scottish Environment Protection Agency
SGS	Sub-grid sampling
SPP	Scottish Planning Policy
UKCP18	United Kingdom Climate Projections –2018 dataset
2D	Two-Dimensional

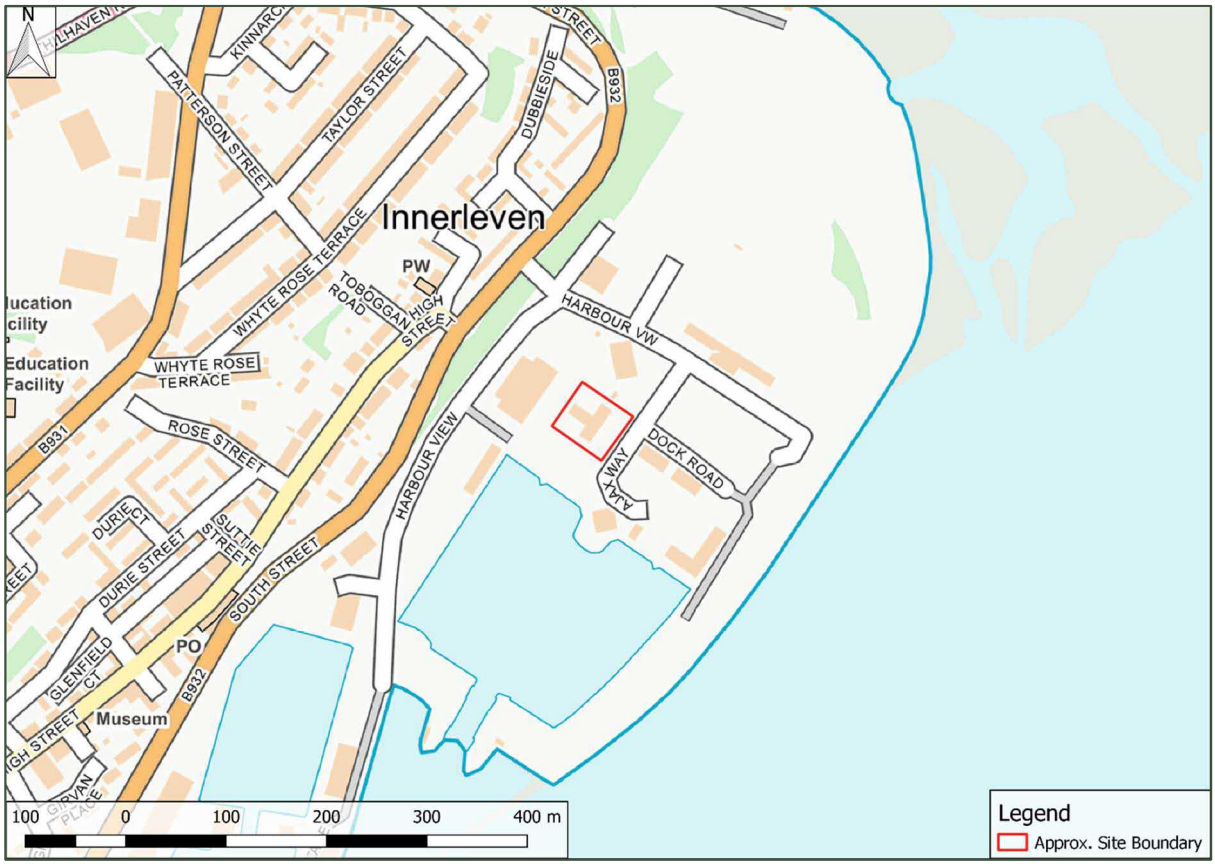
1.0 Background

1.1 Introduction

SLR Consulting Limited (SLR) was commissioned by PHB Group to produce a Flood Risk Assessment (FRA) for Airlie Medical Practice in Leven ('the Site'), as part of a planning application for a proposed extension to the existing medical centre. The FRA will also support a BREEAM assessment.

The Site is located off Ajax Way at Methil Docks, and is centred at National Grid Reference (NGR) NT 37922 99929. The Site is bounded to all sides by a mixture of undeveloped grassland and industrial buildings. The Methil Docks, opening to the Firth of Forth, are located immediately southwest of the Site. The Site location is indicated in Figure 1-1 below.

Figure 1-1 –Site Location



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1.2 Existing Site and Surrounding Terrain

A field inspection of the Site and surrounding area was carried out by two experienced SLR hydrologists on 30th November 2023.

Access to the Site is afforded from Ajax Way at the southeast corner of the Site. The Site comprises the constructed Airlie Medical Practice, associated parking, and an area of undeveloped grassland. Photograph 1 shows the front of the building as viewed from the vehicular entrance off Ajax Way. A view towards the building from the edge of the dock basin is shown in Photograph 2.

Photograph 1 : Airlie Medical Practice as viewed from entrance (facing NW)

Photograph 2 : View towards Airlie Medical Practice from docks (facing N)

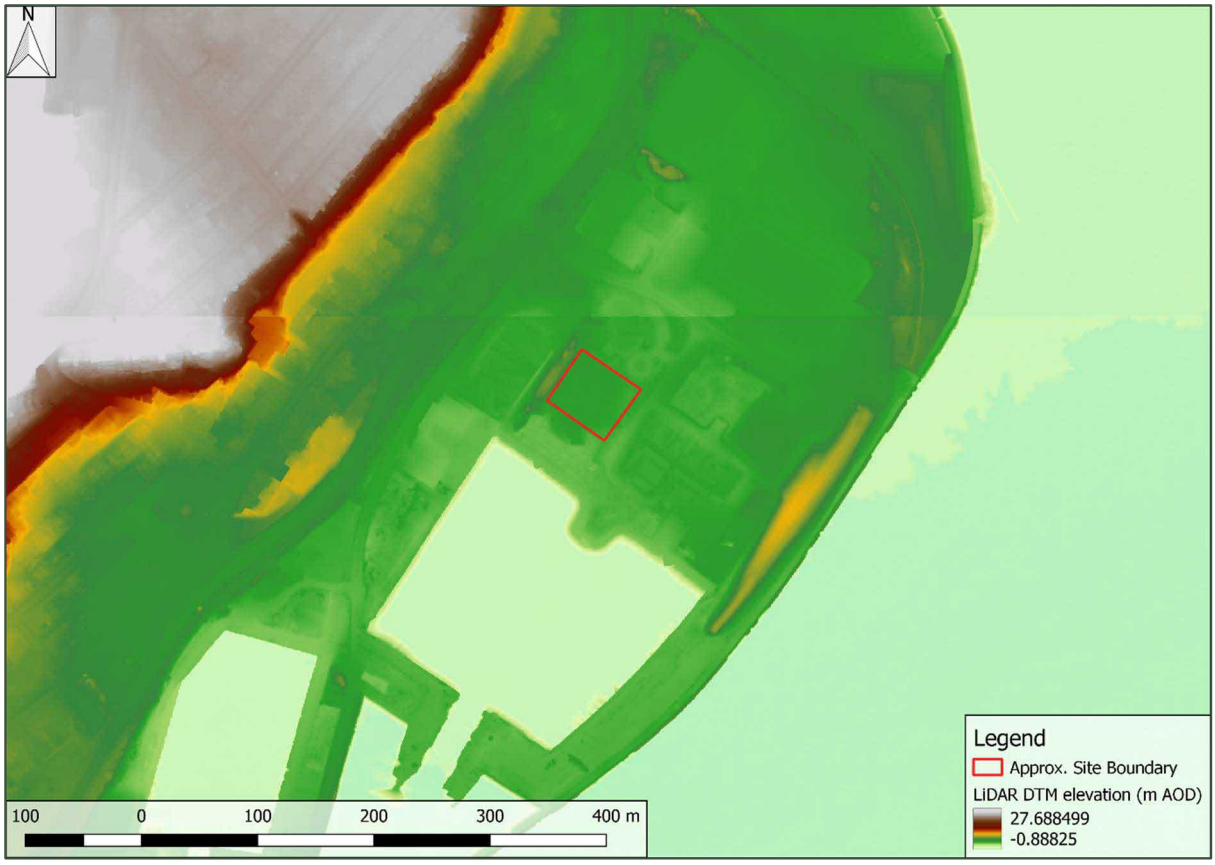
1.3 Site Topography

The Site slopes southwards, with elevations of approximately 5 m Above Ordnance Datum (AOD) in the northern corner and approximately 4.1 m AOD in the southern corner.

Local elevations decrease towards the Methil Docks, with a ground level of approximately 3.6 m AOD along the edge of the docks. Otherwise, local elevations are fairly uniform in the area surrounding the docks. Elevations increase sharply to the northwest of the Site at Whyte Rose Terrace.

The local topography is indicated in Figure 1-2, using 50 cm spatial resolution LiDAR DTM data downloaded from the Scottish Remote Sensing Portal[1].

Figure 1-2 –Elevation data

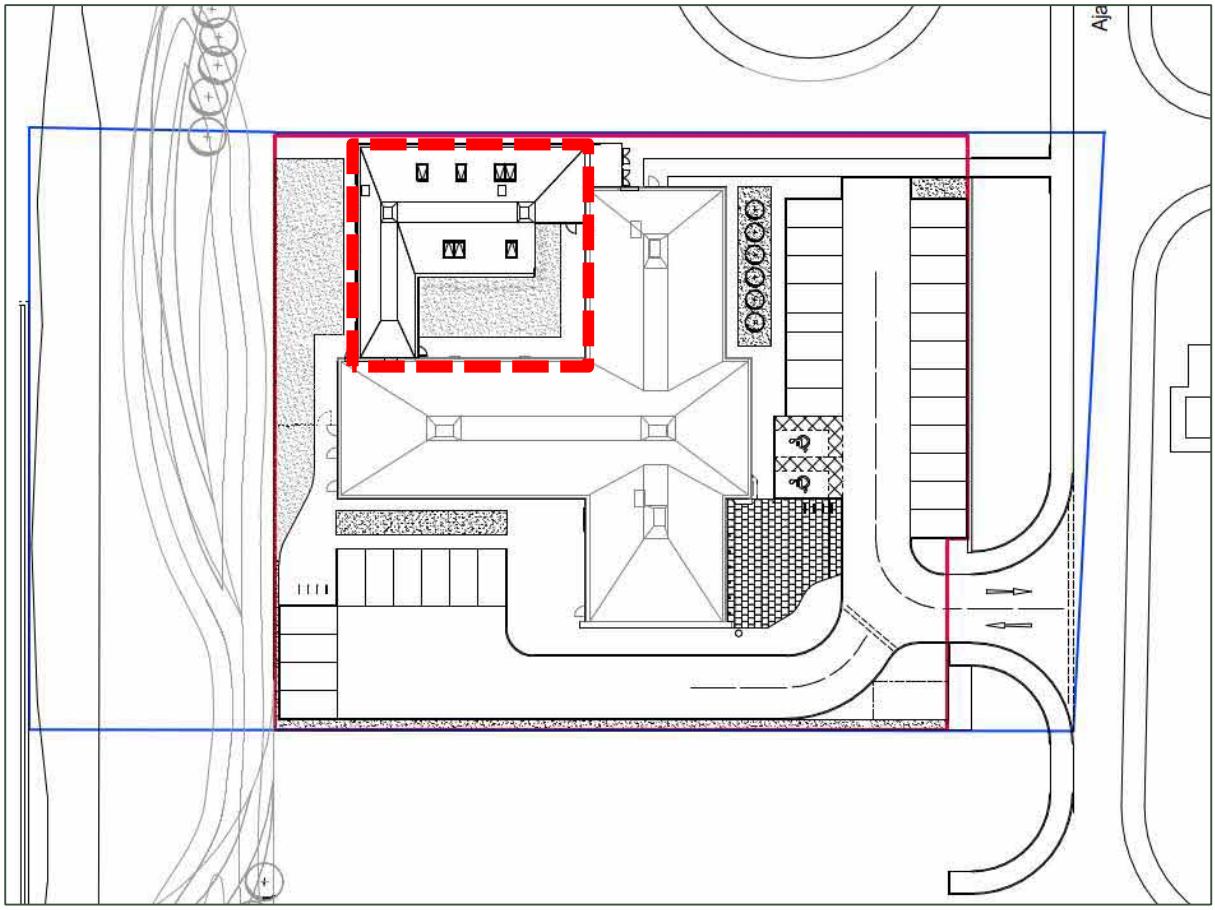


1.4 Proposed Development

The proposed development comprises an extension to the existing medical practice building. The development boundary is indicated by the dashed red line on Figure 1-3 below, which is an excerpt of the full plan included in Appendix A.

[1] Scottish Government (2023), Scottish Remote Sensing Portal, accessible at: https://remotesensingdata.gov.scot/, last accessed 14/12/23

Figure 1-3 –Proposed Development



1.5 Local Hydrology

The Site lies approximately 50 m northeast of the tidal water in the Methil Docks at its closest extent. At the time of the Site inspection, the dock gates were observed allowing free movement of tidal water from the Firth of Forth into the docks.

The Site lies just outwith the catchment of the River Leven, which flows eastwards to the north of the Site, discharging to the Firth of Forth some 400 m northeast of the Site.

The Site does not lie in the catchment of any minor watercourse.

1.6 Historical Land Use

Historical mapping[2] from 1854 indicates that the Site was previously the undeveloped Innerleven Links. Mapping from 1895 shows the development of a railway running from southwest to northeast immediately south of the as-existing South Street. 1914 shows the appearance of the docks at the Site, along with the extension of the railway line and the

[2] National Library of Scotland, Map Finder, available at: https://maps.nls.uk/geo/find/marker/#zoom=15&lat=55.7119&lon=-4.7163&f=0&z=1&marker=55.7132,-4.7175&from=1450&to=1972 (Accessed December 2023)

construction of a hydraulic power station. The most recent historical mapping, from 1969, indicates no changes to the Site from its use as an active dockyard.

1.7 Flood Risk Terminology

Flood risks are typically expressed by the probability of the occurrence of a flood event (maximum flood height or other such indicator) of stated magnitude or greater in any one year –termed the Annual Exceedance Probability (AEP). This may be expressed as a percentage (such as 1%, 0.5%, etc.) or by the equivalent chance of occurrence (1:100, 1:200, etc.). For convenience, the latter approach is used in this report.

Where flood events have a Climate Change factor included, the flood event is denoted in this report by “+CC”. For example, the 1:200 AEP flood event with Climate Change included is denoted “1:200+CC”.

2.0 Flood Risk Review –Sources of Information

2.1 National Floodplain Mapping and Risk Assessment

Strategic level information regarding the tidal, fluvial and surface water flood risk at the Site has been obtained from SEPA via the online SEPA Flood Maps[3].

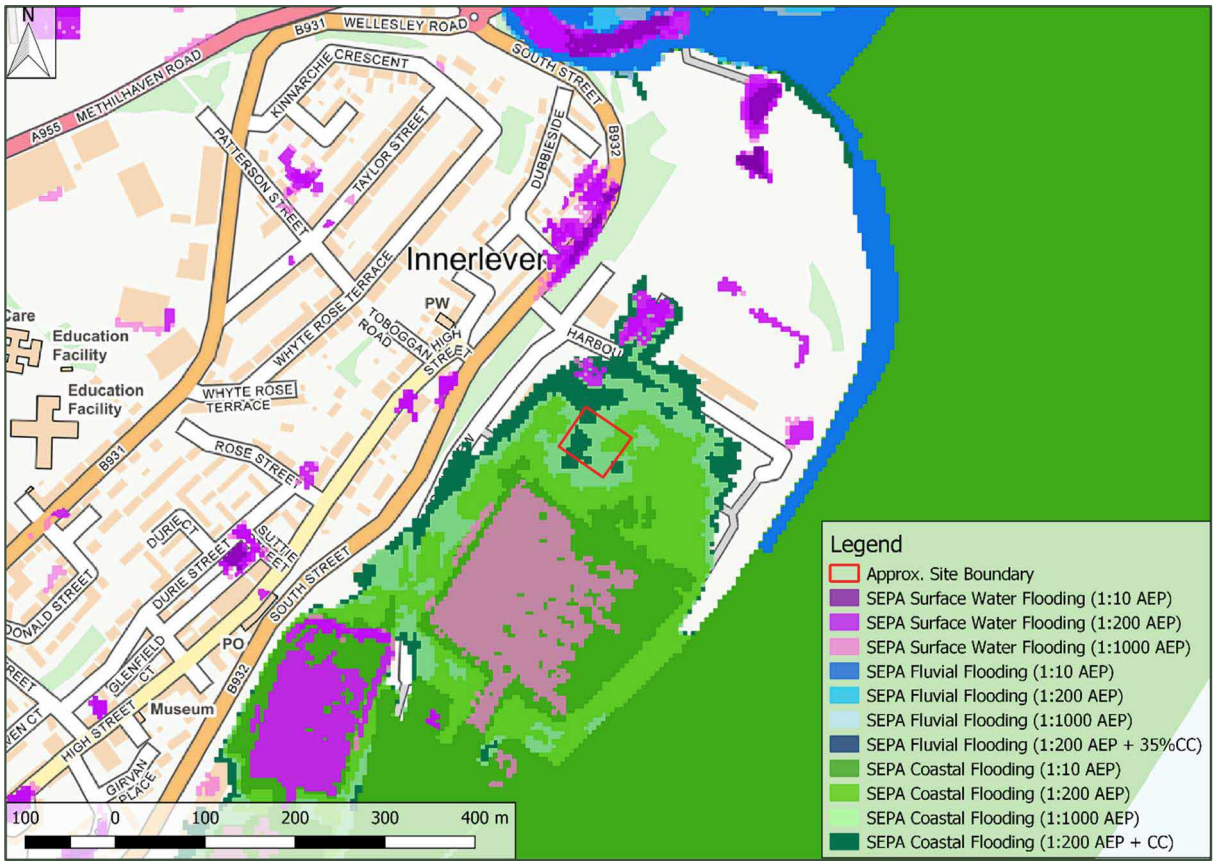
Information on potential groundwater flood risk has been obtained from the SEPA Flood Risk Management Maps[4].

The SEPA mapping for the Site and surrounds is shown in Figure 2-1 below. The Site is shown to lie outwith the floodplain of the River Leven, which discharges into the Firth of Forth to the north of the Site.

No surface water flood risk is indicated on the Site, though the risk of minor pockets of surface water pooling are indicated around the industrial estate.

The Site is shown to lie within a region of predicted coastal flooding for the 1:200 AEP event and above.

Figure 2-1 –SEPA Flood Mapping at Site Location



[3] Scottish Environment Protection Agency (2022) SEPA Flood Maps, available online at https://scottishepa.maps.arcgis.com/apps/webappviewer/index.html, (Accessed December 2023)

[4] Scottish Environment Protection Agency (2016) Online Flood Risk Management Maps, available at: http://map.sepa.org.uk/floodmap/map.htm, (Accessed December 2023)

2.2 Mapping and Terrain Data

Aerial imagery, 50 cm resolution LiDAR DTM data obtained from the Scottish Remote Sensing Portal[5], a site specific topographic survey provided by the client, and the site inspection referred to above have been used to assess the context of the Site and its surrounds.

2.3 Flood History and Records

Within the Scottish Flood Risk Management Strategies, the Site is located within the 2018 Kirkcaldy Potentially Vulnerable Area (PVA) (02/10/04)[6]. The area is designated as a PVA due to flood risk to Kirkcaldy itself, from surface water, river, and coastal sources. There is no mention of flooding in the vicinity of the Site itself.

[5] Scottish Government (2024), Scottish Remote Sensing Portal, accessible at: https://remotesensingdata.gov.scot/, last accessed January 2024

[6] Scottish Environment Protection Agency (2018) Potentially Vulnerable Areas (2018), accessible at: https://www.sepa.org.uk/data-visualisation/nfra2018/, last accessed January 2024

3.0 Planning Context

3.1 National Planning Framework 4

National Planning Framework 4 (NPF4) was introduced in February 2023 and supersedes National Planning Framework 3 (NPF3) and Scottish Planning Policy (SPP) 2014. Flood risk is addressed in Policy 22 of NPF4, which states the following:-

a) Development proposals at risk of flooding or in a flood risk area will only be supported if they are for:

i. essential infrastructure where the location is required for operational reasons;

ii. water compatible uses;

iii. redevelopment of an existing building or site for an equal or less vulnerable use;

or,

iv. redevelopment of previously used sites in built up areas where the LDP has identified a need to bring these into positive use and where proposals demonstrate that long term safety and resilience can be secured in accordance with relevant SEPA advice.

The protection offered by an existing formal flood protection scheme or one under construction can be taken into account when determining flood risk. In such cases, it will be demonstrated by the applicant that:

- all risks of flooding are understood and addressed;
- there is no reduction in floodplain capacity, increased risk for others, or a need for future flood protection schemes;
- the development remains safe and operational during floods;
- flood resistant and resilient materials and construction methods are used; and
- future adaptations can be made to accommodate the effects of climate change.

Additionally, for development proposals meeting criteria part iv), where flood risk is managed at the site rather than avoided these will also require:

- the first occupied/utilised floor, and the underside of the development if relevant, to be above the flood risk level and have an additional allowance for freeboard; and
- that the proposal does not create an island of development and that safe access/ egress can be achieved.

b) Small scale extensions and alterations to existing buildings will only be supported where they will not significantly increase flood risk.

c) Development proposals will:

i. not increase the risk of surface water flooding to others, or itself be at risk.

ii. manage all rain and surface water through sustainable urban drainage systems (SUDS), which should form part of and integrate with proposed and existing blue green infrastructure. All proposals should presume no surface water connection to the combined sewer;

iii. seek to minimise the area of impermeable surface.

d) Development proposals will be supported if they can be connected to the public water mains. If connection is not feasible, the applicant will need to demonstrate that water for drinking water purposes will be sourced from a sustainable water source that is resilient to periods of water scarcity.

e) Development proposals which create, expand or enhance opportunities for natural flood risk management, including blue and green infrastructure, will be supported.

NPF4 defines an area at risk of flooding as follows:

For planning purposes, at risk of flooding or in a flood risk area means land or built form with an annual probability of being flooded of greater than 0.5% (1:200 AEP) which must include an appropriate allowance for future climate change.

This risk of flooding is indicated on SEPA's future flood maps or may need to be assessed in a flood risk assessment. An appropriate allowance for climate change should be taken from the latest available guidance and evidence available for application in Scotland. The calculated risk of flooding can take account of any existing, formal flood protection schemes in determining the risk to the site.

Where the risk of flooding is less than this threshold, areas will not be considered 'at risk of flooding' for planning purposes, but this does not mean there is no risk at all, just that the risk is sufficiently low to be acceptable for the purpose of planning. This includes areas where the risk of flooding is reduced below this threshold due to a formal flood protection scheme.

3.2 Local Plan

The Fife Council Local Development Plan, **'FIFEplan'**[7] (2017) sets out broad guidance to inform local planning. Fife Council are currently in the process of developing a new local development plan.

Policy 12 '*Flooding and the Water Environment*' indicates the following:

Development proposals will only be supported where they can demonstrate that they will not, individually or cumulatively:

> *1. increase flooding or flood risk from all sources (including surface water drainage measures) on the site or elsewhere;*
>
> *2. reduce the water conveyance and storage capacity of a functional flood plain;*
>
> *3. detrimentally impact on ecological quality of the water environment, including its natural characteristics, river engineering works, or recreational use;*
>
> *4. detrimentally impact on future options for flood management;*
>
> *5. require new defences against coastal erosion or coastal flooding; and*
>
> *6. increase coastal erosion on the site or elsewhere.*

To ascertain the impact on flooding, developers may be required to provide a flood risk assessment addressing potential sources of flooding and the impact on people, properties, or infrastructure at risk.

In medium to high flood risk areas – an annual probability of flooding greater than 0.5% (1:200 years) – a flood risk assessment is required.

[7] Fife Council (2017), FIFEplan, accessible at: https://fife-consult.objective.co.uk/kse/event/30240/section/4395822, last accessed December 2023

In low to medium flood risk areas – annual probability of coastal or watercourse flooding is between 0.1% and 0.5% (1:1,000 to 1:200 years) – a flood risk assessment may be required at the upper end of the probability range, and for essential infrastructure and the most vulnerable uses.

Flood risk assessments should:

- *highlight the measures proposed to mitigate the flood risk and the timescales to implement those measures; and*
- *include an assessment of potential impacts on water quality and the water environment.*

Section 3 of the Fife Council supplementary guidance document 'Design criteria guidance on flooding and surface water management plan requirements'[8] states the following with regard to flood risk:

An FRA will be required for construction adjacent to coastal waters and/or below the 6mAOD contour.

The extent of a 1 in 200 year flood event must be a minimum of 300mm below the lowest garden ground level and 600mm below the lowest property finished floor level (FFL).

Section 5 of the same document states the below requirement for a third-party check certificate for FRAs:

Where a Flood Risk Assessment is submitted, Fife Council require the developer, or their suitably qualified Agent, to certify that the Flood Risk Assessment has been prepared in accordance with the reporting requirements for Flood Risk Assessments issued by SEPA by providing:

- *a Flood Risk Assessment Compliance Certificate in accordance with the attached proforma in Appendix 3; and*
- *A Flood Risk Assessment Independent Check Certificate in accordance with the attached pro-forma in Appendix 4.The design and independent check certificates cannot be signed by the same signatory. The signatory may be an employee within the same company holding the appropriate qualifications and who has not been involved in the design.*

3.3 SEPA Flood Risk and Land Use Vulnerability Guidance

This guidance[9] outlines how SEPA assess vulnerability of flooding of different land uses with the following Categories:

- Most Vulnerable Uses;
- Highly Vulnerable Uses;
- Least Vulnerable Uses;
- Essential Infrastructure; and
- Water Compatible Uses.

[8] Fife Council (2022), Design criteria guidance on flooding and surface water management plan requirements, accessible at: https://www.fife.gov.uk/__data/assets/pdf_file/0012/160122/FC-Flooding-and-SWMP-Guidance-v2.1.pdf, last accessed January 2024

[9] Land use vulnerability guidance (sepa.org.uk)

With reference to Table 1 of the guidance, the proposed extension is considered to remain in the **Highly Vulnerable Uses** Category as '*non-residential uses for health service'.* It should be noted that the guidance available at time of writing has not been updated to reflect NPF4 although, the classification is still relevant.

3.4 SEPA Climate Change Guidance

The SEPA Climate change allowances[10] for flood risk assessment in land use planning version 3, April 2023 was used to inform the appropriate climate change allowances. SEPA allowances are based on the climate predictions (UKCP18). The SEPA guidance is based upon UKCP18 data, using Representative Concentration Pathway 8.5 (RCP 8.5), which assumes limited efforts to mitigate climate change, so that greenhouse gas levels in the atmosphere will continue to increase.

The allowances used for this FRA are as follows:

- Peak river flow, +53%
- Cumulative sea level rise 2017 to 2100, +0.85m
- Peak rainfall intensity allowance, +39%

[10] climate-change-guidance.pdf (sepa.org.uk)

4.0 Flood Risk Screening

A screening review has been completed as below to identify whether there are any potential sources of flooding at the Site which warrant detailed assessment and /or mitigation.

A summary of the potential sources of flooding and a review of the potential risk posed by each source to the Site is presented in Table 4-1 overleaf.

4.1 Screening Study

Potential Sources of flooding include:

- Flooding from the sea or tidal flooding;
- Flooding from rivers or fluvial flooding;
- Flooding from surface water and overland flow;
- Flooding from groundwater;
- Flooding from sewers;
- Flooding from reservoirs, canals, and other artificial sources; and,
- Flooding from infrastructure failure.

Flood ‘risk’ definitions within the screening assessment are based on a qualitative technical assessment considering the information reviewed, risk to site users and the development itself.

Table 4-1 : Flood Risk Screening

Source of Flood Risk	Description	Flood Risk Assessment
Tidal	• The Site is located some 50 m northeast of the Methil Docks, which appeared to be in tidal continuity with the Firth of Forth. SEPA flood risk mapping indicates that the Site lies within an area at risk of coastal flooding for the 1:200 AEP event and above. • Due to the extent, orientation and elevation of sea wall and the distance from the open coast, c.200m and 60m from the dock no3. There is a negligible risk of wave overtopping affecting the current of proposed building. • Tidal flooding is therefore considered for further review, with hydraulic modelling required to simulate the risk of flooding for extreme water levels.	Further Review
Fluvial	• The Site lies approximately 400 m from the River Leven at its closest extent, where the River Leven discharges to the Firth of Forth. The River Leven is unconstrained as it discharges into the Firth of Forth, and no backing up of flows would be expected. • SEPA flood mapping (Figure 2-1) indicates that the Site is not at risk of fluvial flooding up to and including the 1:1000 AEP event. • It is therefore considered that fluvial flooding does not pose a risk to this Site.	Negligible Risk
Pluvial (i.e., direct rainfall)	• The Site elevations are graded towards the southeast, and are slightly higher than surrounding elevations. • Any excess flows resulting from direct rainfall would be expected to migrate offsite to the southeast. There are no apparent trapped low points and the Site design will have considered direct runoff in its drainage design. • It is therefore considered that the site is not at significant pluvial flood risk.	Negligible Risk
Surface Water Flows	• SEPA flood mapping indicates that there is no risk of surface water flooding at the Site up to and including the 1:1000 AEP event. • Inspection of local topography and surrounds suggests that the Site is slightly elevated compared with its surrounds. The Site topography is such that flows would be expected to travel uninhibited south-eastwards overland, ultimately discharging into the Methil Docks. • Surface water flooding is therefore considered of negligible risk to the Site.	Negligible Risk

Source of Flood Risk	Description	Flood Risk Assessment
Groundwater	• The site is underlain by bedrock of the Scottish Coal Measures Group[11], which is classed as a moderately productive aquifer. It is noted that the aquifer is generally low yield except where mined. • SEPA flood mapping indicates that the Site is not at risk from any wider area groundwater flood risk influences. It would be expected that the water table in the area is in some continuity with the tidal cycle, and groundwater would primarily be expected to discharge to the Firth of Forth. • Based on these considerations, there is a negligible risk of flooding from groundwater rise at the Site.	Negligible Risk
Sewers and Artificial Drainage Systems, and Water Supply	• The Site is served by an existing drainage system. In the instance that any surcharging of this system or drainage systems surrounding the Site were to occur, flows would be expected to follow natural topographic gradients towards the Methil Docks. • Based on these considerations, there is a negligible risk of flooding from this source.	Negligible Risk
Infrastructure Failure (i.e. reservoirs, canals, culvert blockage, etc.)	• SEPA Reservoirs Mapping[12] indicates that the Site lies just outwith the breach extents of 7 reservoirs discharging to the Firth of Forth via the River Leven. Failure of one of the dams that create these impoundments could create a flood wave that may threaten the Site surrounds. • Reservoirs in Scotland are regulated under the Reservoirs (Scotland) Act 2011 and there has been no loss of life in the UK as a result of reservoir flooding since 1925. • Given the location of the Site outwith the breach extents of the reservoirs, infrastructure failure is considered of negligible risk to the Site. If further certainty is required as to the breach extents of the individual dams, the reservoir managers would have access to detailed breach modelling.	Negligible Risk

[11] British Geological Survey (BGS) (2024), GeoIndex Onshore, accessible at: https://mapapps2.bgs.ac.uk/geoindex/home.html?layers=BGSBedEngGeol,BGSSupEngGeol,BGSEGFSReports,BGSUSAReports, last accessed January 2024

[12] Scottish Environment Protection Agency (2022) Reservoirs. Available at: Reservoirs | Scottish Environment Protection Agency (SEPA), last accessed 29/08/2023

5.0 Detailed Flood Risk Review

5.1 Model Build

This section of the report summarises the construction of the 2-Dimensional (2D) hydraulic model using TUFLOW HPC software to simulate the tidal flooding impacts for several flood events.

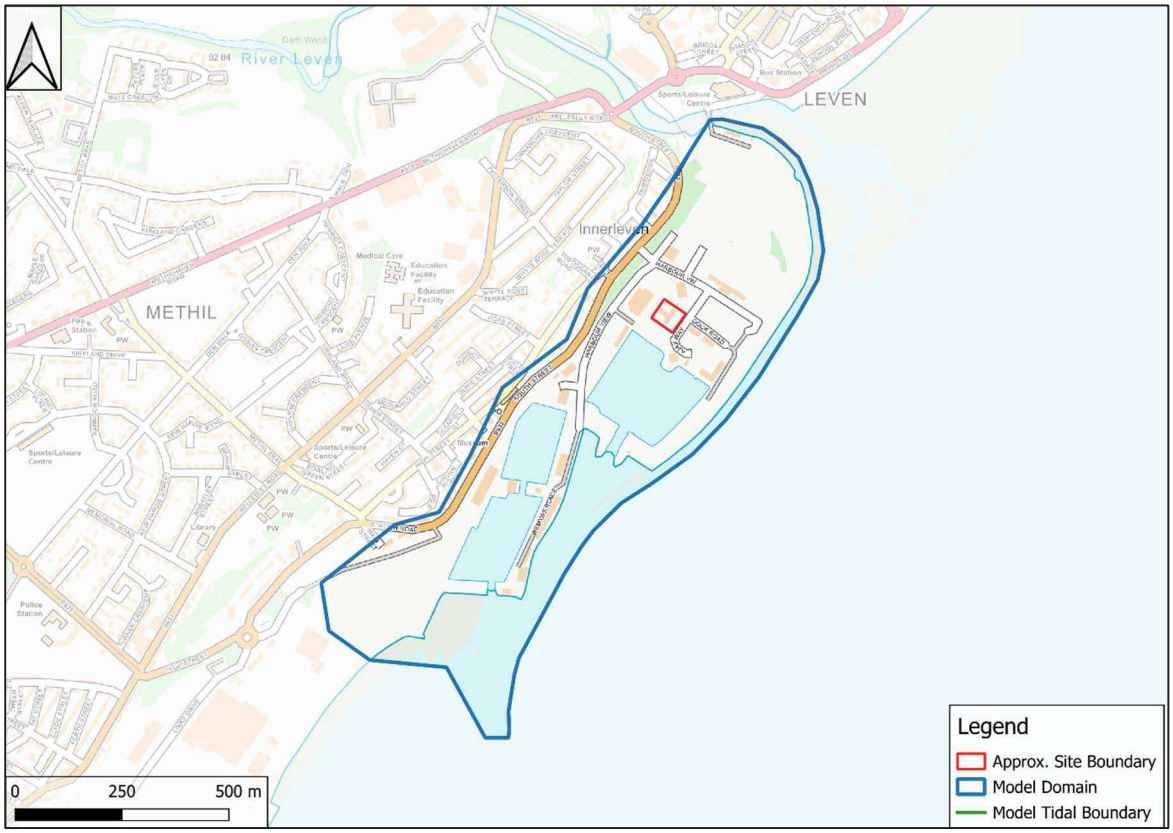
The construction of the 2D hydraulic model requires:

- Model extent;
- Model cell size;
- Topography;
- Hydraulic features;
- Hydraulic boundaries; and,
- Ground roughness (Manning's n).

5.1.1 Model Extent

The hydraulic model domain (extent) is shown in Figure 5-1.

Figure 5-1 –Hydraulic model domain (extent)



5.1.2 Topography

The underlying base of the topography comes from two sources:

- Phase 5 –DTM data obtained from the Scottish Remote Sensing Portal (Figure 5-1).
- Topographic survey, 61125_TO_01-Airlie Medical Centre.dwg, supplied by the client (Figure 5-2).

Figure 5-2 –Topographic Digital Terrain Model (DTM)

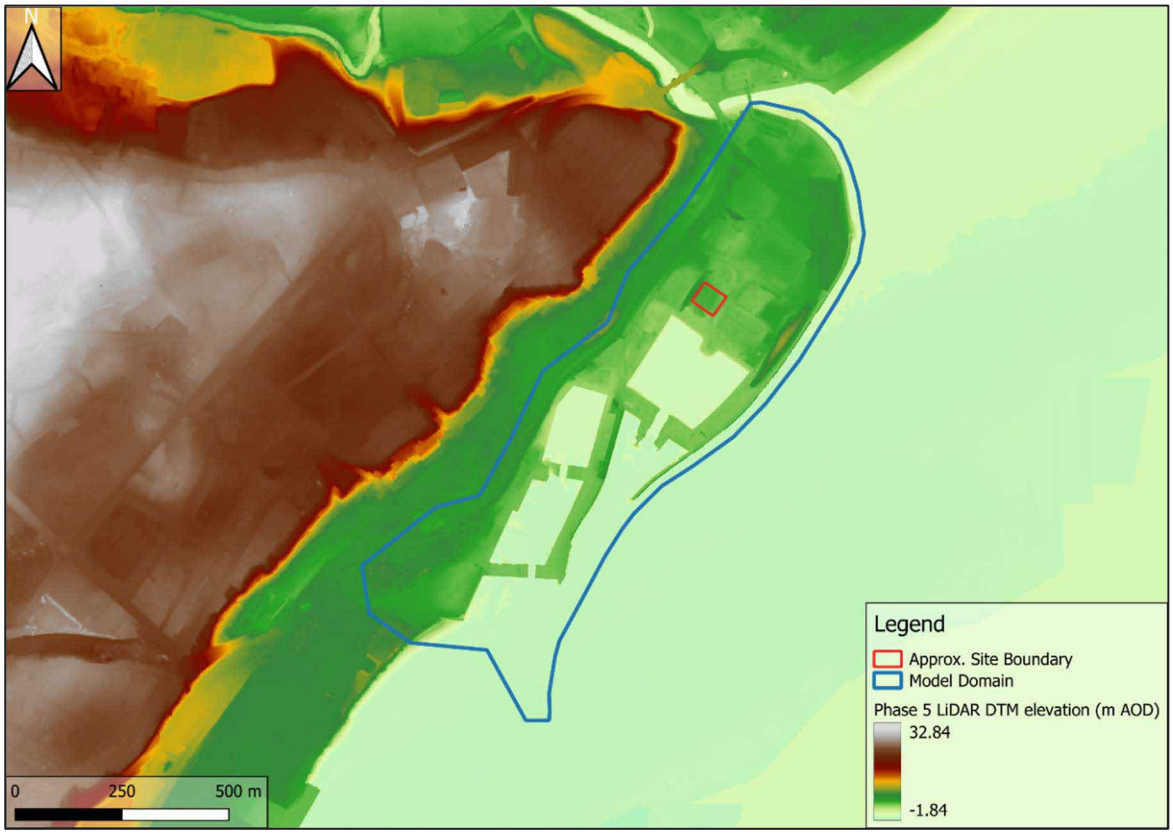
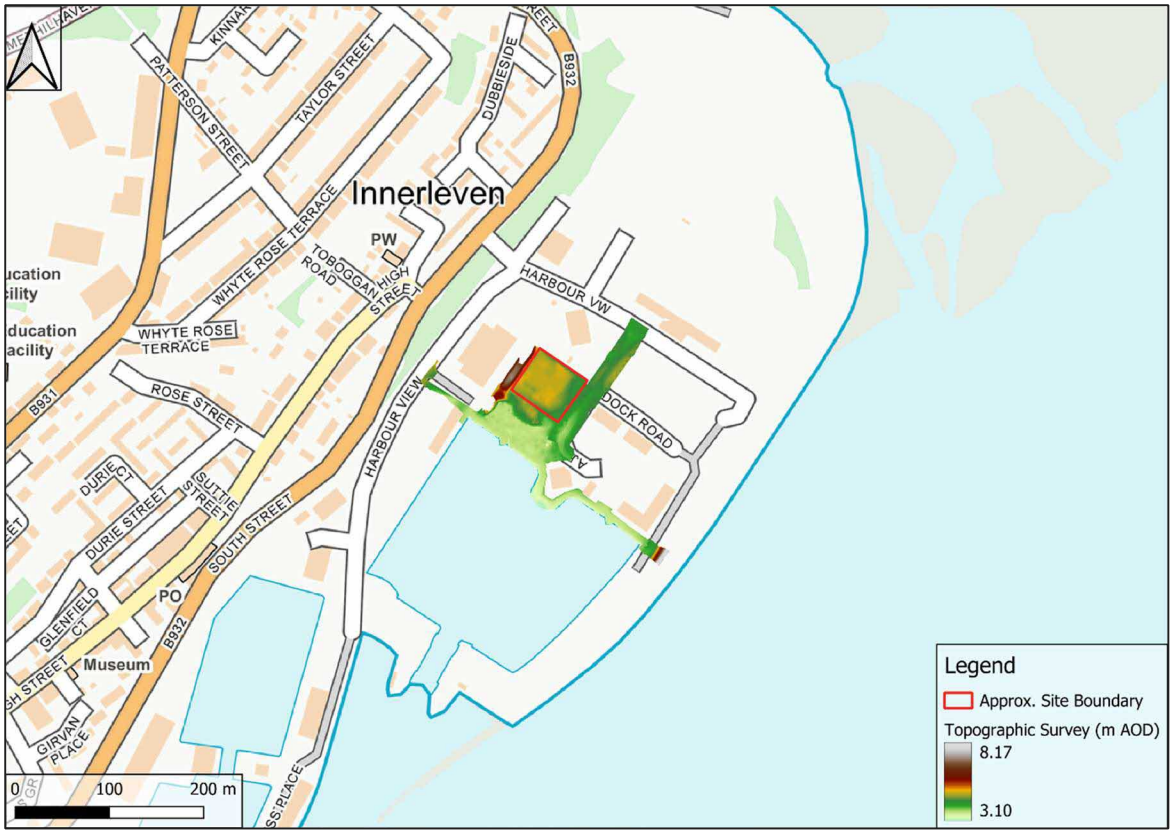


Figure 5-3 –Topographic Survey



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5.1.3 Topography Alterations

The following were also added to the base DTM to refine the detail to the 2D domain of the flood model:

- The sea wall along the shore frontage, as shown in Figure 5-4 . The elevations used for the defences were a combination of the DTM and DSM, Phase 5 LIDAR data. The DSM was required as the DTM filtered out the wall to the south of Dock no.3, the dock adjacent to the site. The feature was re-enforced in the model as a 2D ZSH layer to represent the sea wall.
- Two gates were also observed at Dock no.3, these were not included in the model as it was observed on site that the gates were allowing water to flow into the dock and that the structural integrity of the gates were not assessed. A precautionary approach was adopted and the gates were not included in the model. In addition, the surrounding ground at the gates is approximately 4 m AOD and the tidal design levels far exceed this elevation which would render the gates redundant for an extreme coastal flood event.

Figure 5-4 –Key Topographic Edits

5.1.4 Model Cell Size

A 2 m model grid cell size was utilised. This cell size has also been determined to be sufficient for incorporating important topographic details such as simulating flow paths around buildings, representation of roads and general topography in the modelled area. These factors were carefully considered to provide an accurate evaluation of the flood risk model grid cell size, ensuring a thorough and robust assessment of potential flood impacts. Sensitivity testing of the cell size was undertaken and the results are presented in Section 5.6.

5.1.5 Hydraulic Boundary

The boundary condition applied to the TUFLOW model was a Head-Time (HT) boundary placed east of the sea wall and general ground. This boundary is used to assign the tidal cycles for the 1 in 200 year (0.5% Annual Exceedance Probability (AEP), 1 in 1,000 year (0.1% AEP), 1 in 200 year plus an allowance for climate change and 1 in 1,000 year plus an allowance for climate change events.

The astronomical tide at Leith was used as the basis for the general shape of the tidal cycles. Four full tidal cycles were simulated in the model with the third tidal peak being the highest in elevation –to fit the design flood elevations. The magnitude of the tidal cycles were adjusted to fit the peak tidal levels as documented in Table 5-1. The Coastal Flood

Boundary Data (CFB)[13] dataset was used to determine the extreme water levels for the site. The CFB change 3388 was used as the appropriate assessment point. As the CFB base year is 2018, sea level rise of 5.2 mm/yr was added to the CFB levels to provide the best estimate of extreme water levels. This was only applied to the 1:200 and 1:1000 year water levels as the SEPA climate change allowance of 0.85 m is a cumulative sea level rise from 2017 –2100.

Table 5-1: Summary of Peak Tidal Levels

AEP%	CFB 2018 (m AOD)
1:200 (0.5% AEP)	3.946
1:200 (0.5% AEP) plus CC	4.770
1:1000 (0.1% AEP)	4.136
1:1000 (0.1% AEP) plus CC	4.960

5.1.6 Manning's N

The definition of the extent of each of the roughness values in the 2D domain was determined using the OS Opendata layers[14]. This information was verified by reviewing aerial imagery of the site and site visit observations.

The material roughness across the model domain has been read into the hydraulic model using a TUFLOW standard Material.csv with Manning's n values derived from Chow (1959)[15].

Table 5-2: Modelled material Properties

Material ID as referenced in GIS layer	Manning's n value	Land use type
1	0.04	General Roughness
10172	0.02	Roads
10021	0.100	Buildings

5.1.7 Software Version

In line with good modelling practice, the TUFLOW model was constructed using the latest commercially available software version at project outset: TUFLOW HPC 2023-03-AB (single precision).

[13] GOV.UK (2023), Coastal Design Sea Levels - Coastal Flood Boundary Extreme Sea Levels (2018), accessible at: https://www.data.gov.uk/dataset/73834283-7dc4-488a-9583-a920072d9a9d/coastal-design-sea-levels-coastal-flood-boundary-extreme-sea-levels-2018, last accessed January 2024

[14] Free OS OpenData Map Downloads | Free Vector & Raster Map Data | OS Data Hub

[15] Chow, V.T., (1959). Open-channel hydraulics, McGraw-Hill, New York

5.1.8 Modelling Parameters

The underlying 2D digital terrain model (DTM) was generated using the base Phase 5 LiDAR grid, complimented with topographic survey. Sub-grid sampling (SGS) testing was undertaken during the initial model build. It was decided to continue using HPC with SGS functionality in 2 m grid cell size.

All modelled scenarios have been simulated for 50 hours to allow for the inflow boundaries to complete four full tidal cycles, with the third tidal peak representing the peak design water level. The computational timesteps used by HPC are adaptive over the course of the simulation, with 2D time-varying outputs generated every 15 minutes.

5.2 Model Results

5.2.1 Baseline

Maximum flood extents and depths results for the areas on and surrounding the site are presented in Figure 5-5 through to Figure 5-8 below. Table 5-3 also compares the model maximum flood level to the lowest surveyed property levels. The threshold levels range from 5.01 m AOD to 5.04 m AOD. The results demonstrate that the building thresholds for all the modelled flood events are below the property thresholds, as presented in Table 5-3.

Table 5-3: Peak Water Levels across the Site

AEP%	Modelled (m AOD)	Building Threshold (m AOD)	Freeboard (m)
1:200 (0.5% AEP)	3.962	5.01	1.048
1:1000 (0.1% AEP)	4.151		0.859
1:200 (0.5% AEP) plus CC	4.785		0.225
1:1000 (0.1% AEP) plus CC	4.976		0.034

Figure 5-5 –1:200 (0.5% AEP) Flood Depths

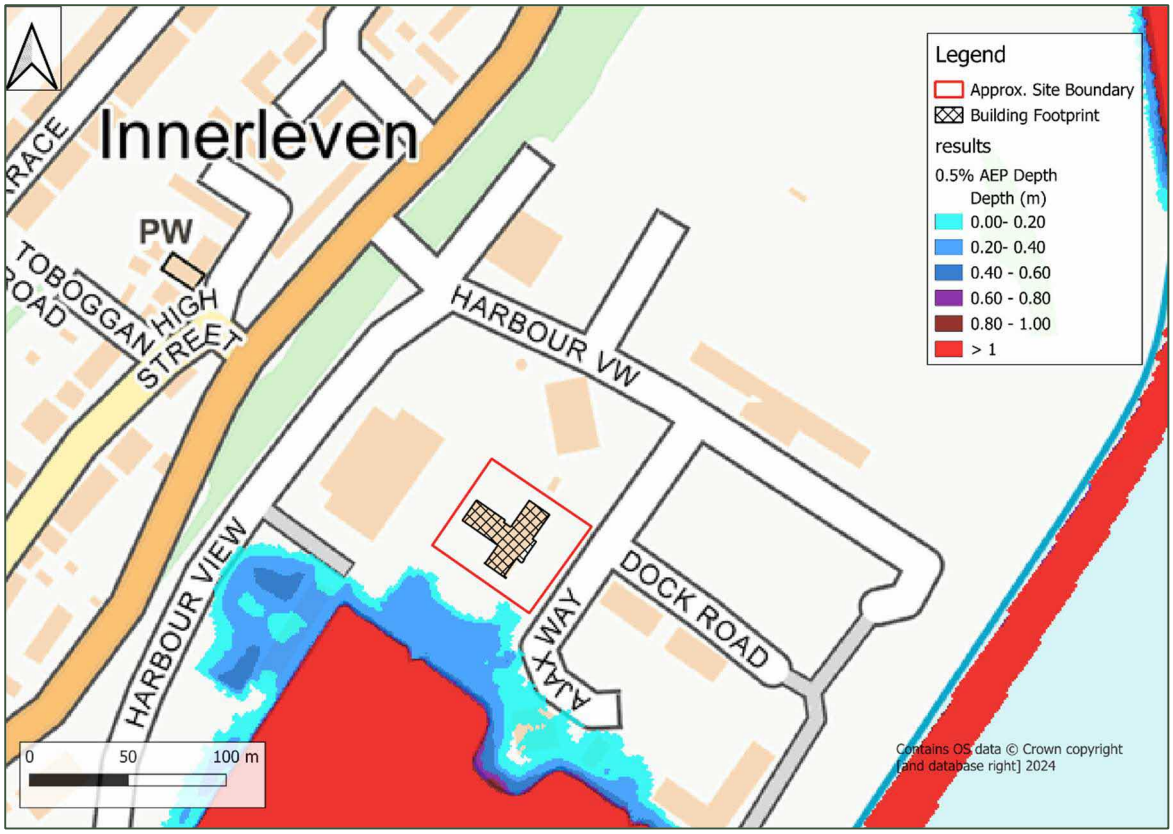


Figure 5-6 –1:1000 (0.1% AEP) Flood Depths

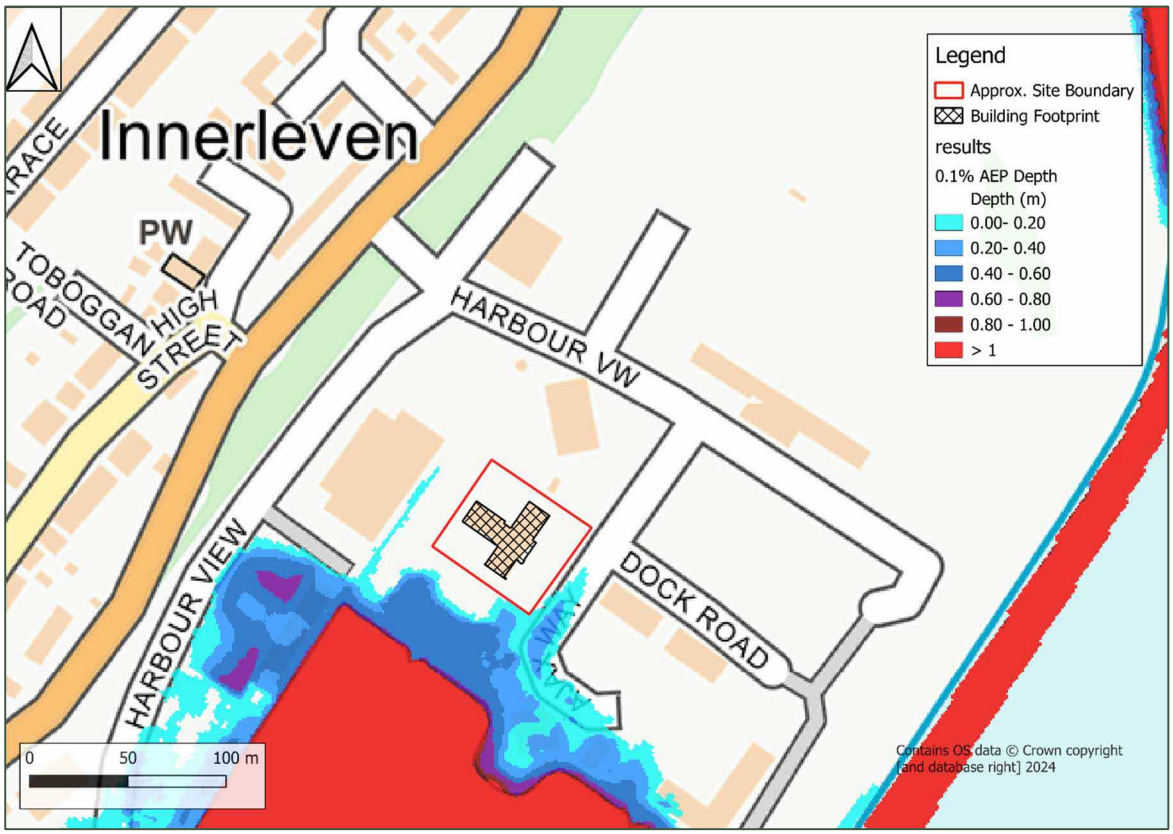


Figure 5-7 –1:200 (0.5% AEP) plus CC Flood Depths

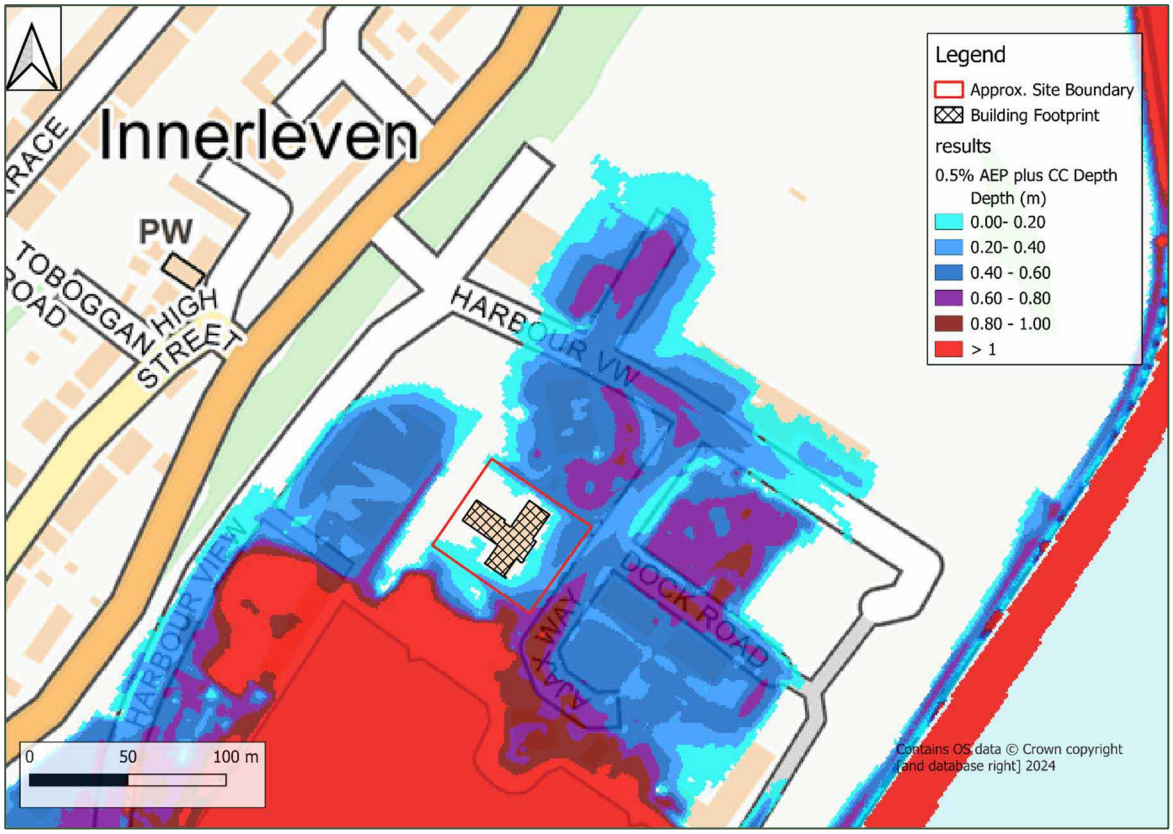
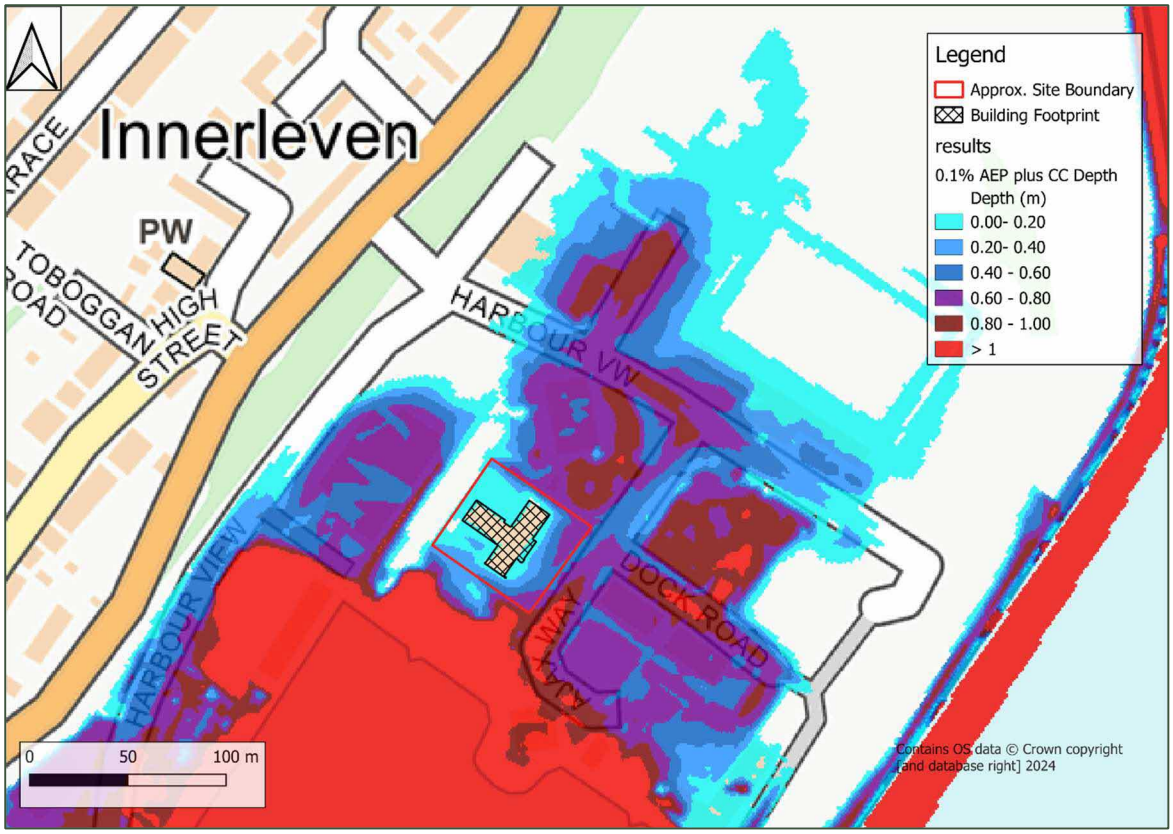


Figure 5-8 –1:1000 (0.1% AEP) plus CC Flood Depths



5.2.1.1 Access and Egress

For the current building there is flood free access up to the 1:1000 year event. From the 1:1000 year event, there is a maximum depth of flooding at the access junction to the medical practice of 0.277 m with the extent of flooding continuing for approximately 30 m to the north of the access. The pedestrian access and wider route is flood free towards the B932 (South Street). The routes are presented in Figure 5-12.

For the climate change scenarios, for the 1:200 year plus CC event there is a maximum modelled depth of 0.907 m. This increases to 1.10 m for the 1:1000 year plus CC event. For these events there is extensive flooding as presented in Figure 5-7 and Figure 5-8.

5.2.2 Proposed extension

The proposed medical practice extension is highlighted in the dash red line in Figure 5-9. It adjoins the existing building and provides additional General Practitioner space. Based on the existing 1:200 year plus CC flood extent, there is a minor encroachment into the floodplain that results in a loss of floodplain of 3.9 m^3 –with the maximum depth of displaced flood water being approximately 181 mm. The hydraulic modelling of the proposed extension demonstrates that the building remains free from flooding with a freeboard of 225mm –the same as the existing building.

The modelling also demonstrates that any displaced water does not increase flood risk as there is no change to the baseline scenario flood extents or depths, as demonstrated in Table 5-4, Figure 5-10 and Figure 5-11.

Figure 5-9 –Proposed development

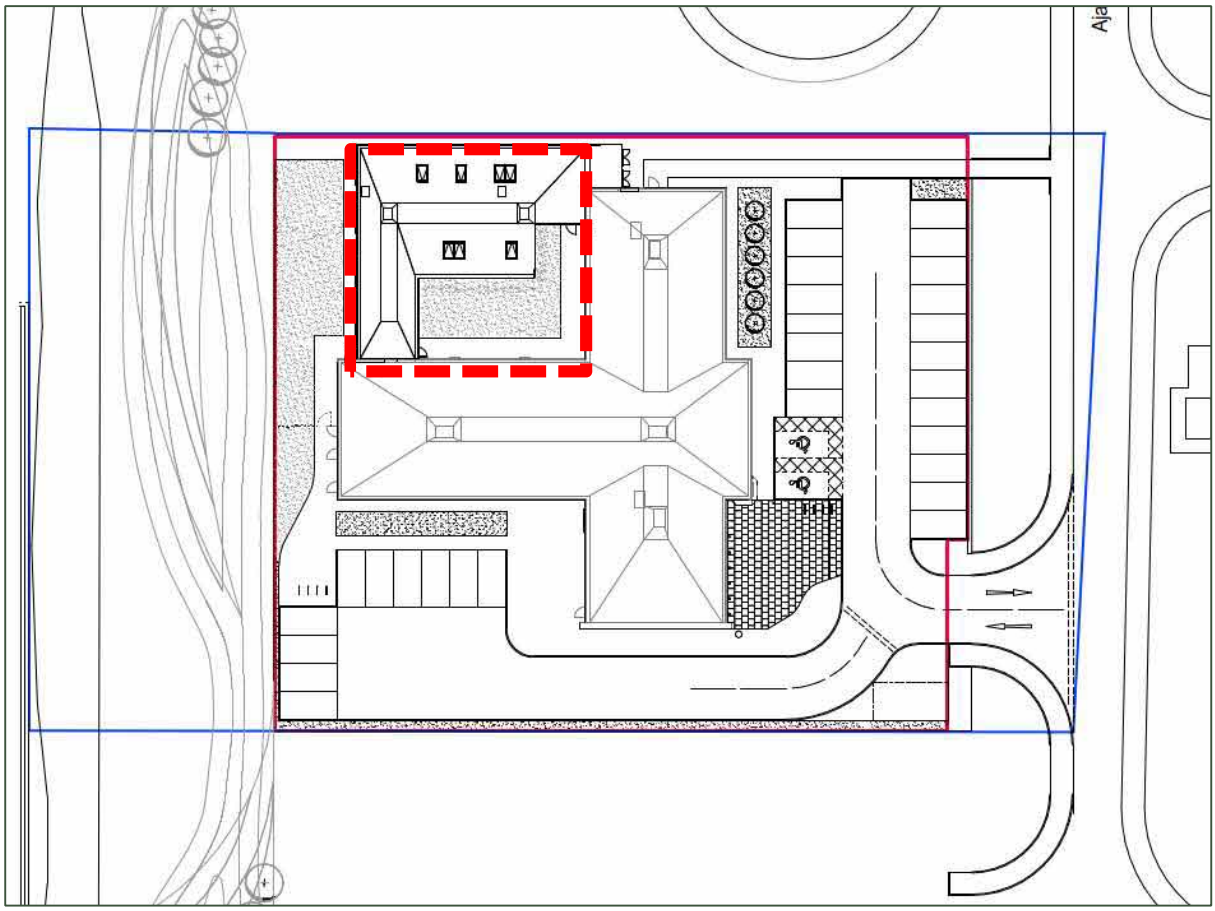


Table 5-4: Peak Water Levels across the Site

AEP%	Baseline (m AOD)	Extension (m AOD)	Building Threshold (m AOD)	Freeboard (m)
1:200 (0.5% AEP)	3.962	3.962	5.01	1.048
1:1000 (0.1% AEP)	4.151	4.151		0.859
1:200 (0.5% AEP) plus CC	4.785	4.785		0.225
1:1000 (0.1% AEP) plus CC	4.976	4.976		0.034

Figure 5-10 –1:200 (0.5% AEP) plus CC Flood Depths (Proposed)

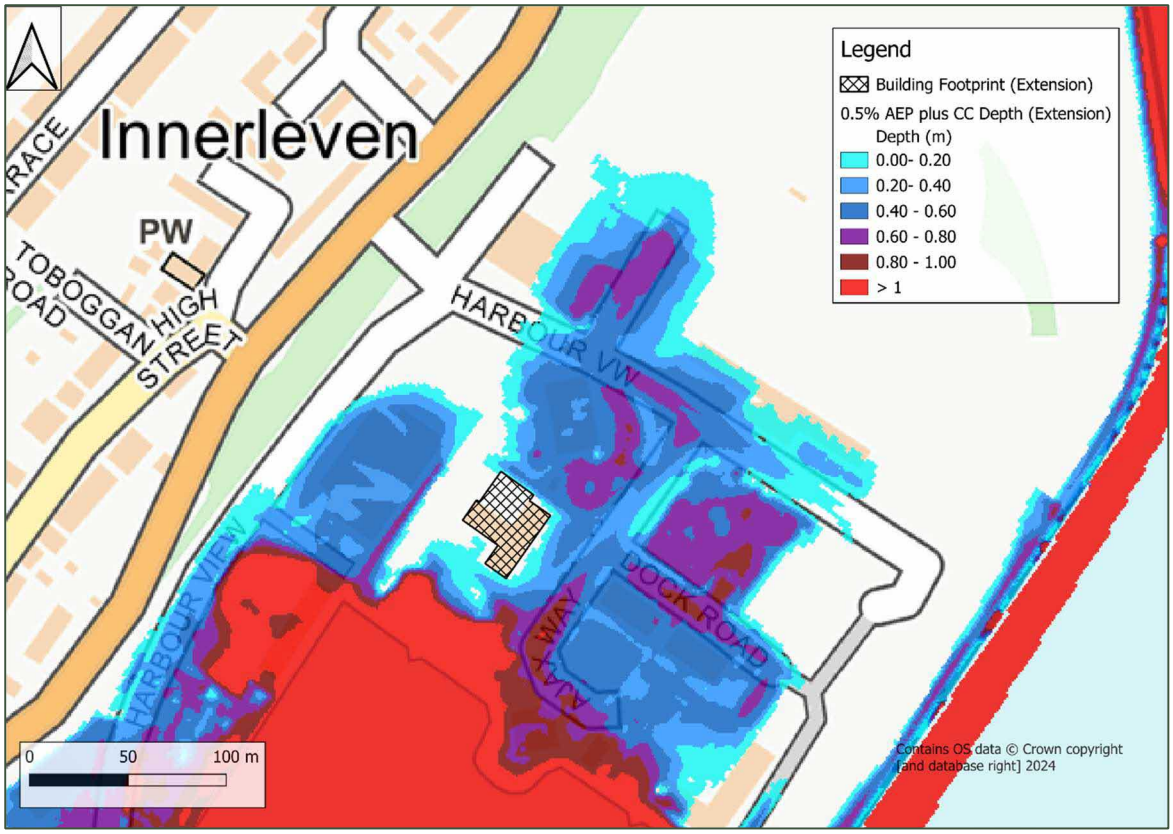
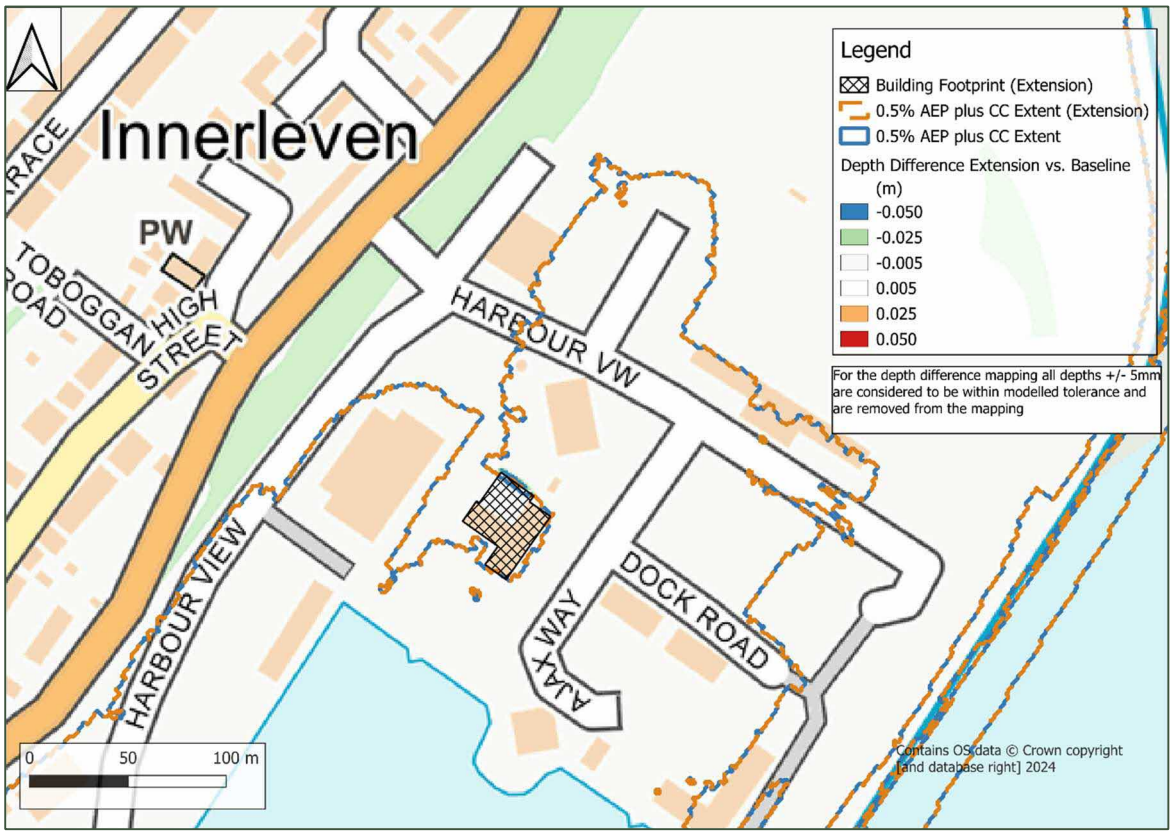


Figure 5-11 –1:200 (0.5% AEP) plus CC Flood comparison (Proposed vs Baseline)



5.2.2.1 Access and Egress

For the building extension, the access and egress arrangements were reviewed in the context of the full facility and as the building threshold is above the 1:200 year plus CC flood level the building itself remains free from flooding.

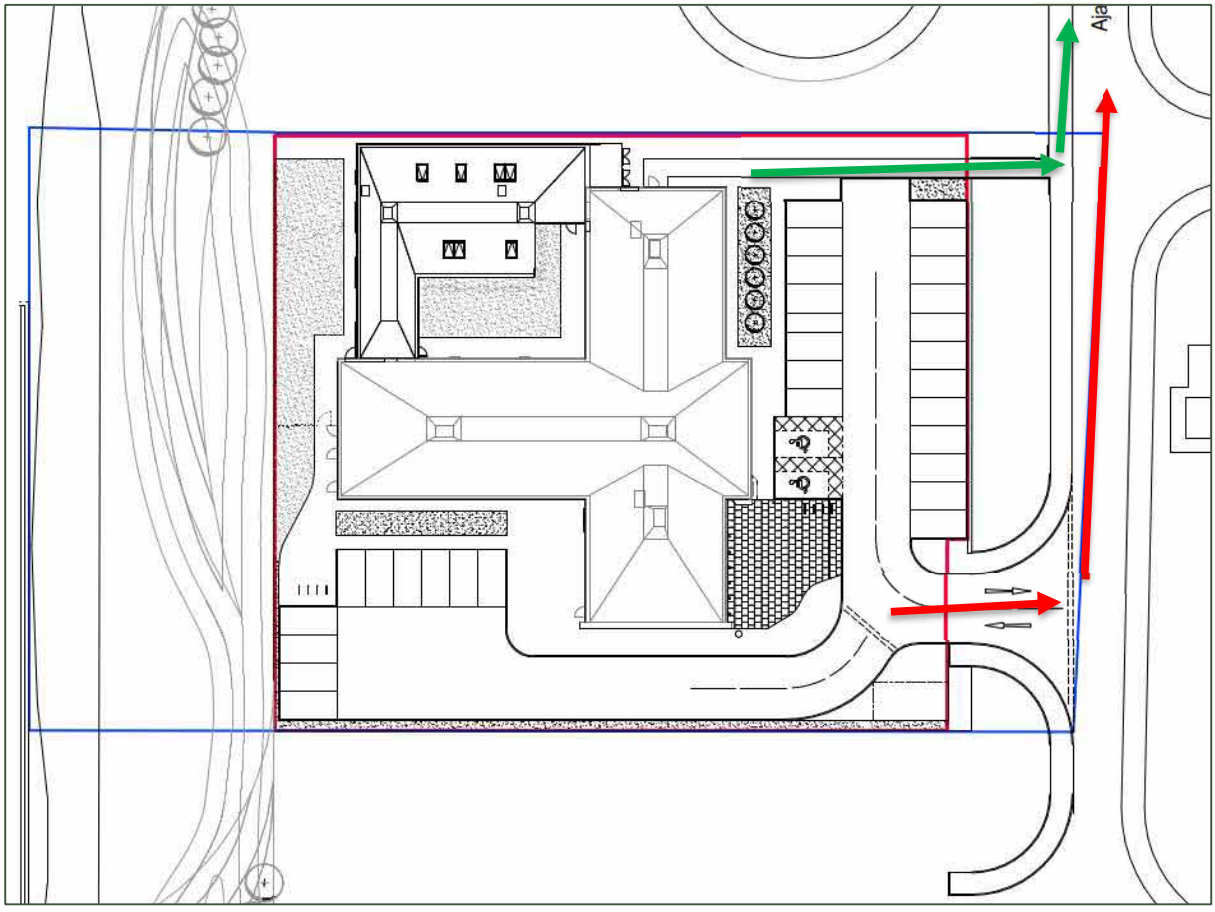
With the extension, the access road is still the first point to flood and the flood free access is maintained up to the 1:1000 year event. There is unlikely to be flood free access during the 1:200 year plus CC event.

Section 5.3 details the proposed mitigation to provide flood free access and egress for events with the inclusion of climate change for sea level rise.

5.3 Mitigation for flood free access and egress

It is recommended that an evacuation procedure is developed to ensure that the building can be safely evacuated in advance of a flood event. There are two evacuation routes available as noted on Figure 5-12 –Red denotes the vehicular route and Green denotes the pedestrian route.

Figure 5-12 –Access and egress route local to the medical Practice



There are various publicly available information sources which can be used to inform the risk of flooding to the site:

- Met Office UK weather warnings; and
- SEPA 3-day flood forecasts[16]

SEPA also operate flood forecasting services that is operational 24 hours a day and seven days a week. They provide specific coastal flood warnings for the Leven area[17]. The threshold level for this flood warning is not likely to be specifically for the medical practice location. Nevertheless, it is recommended that key staff and the facility are signed up to the coastal flood alerts and warnings provided by SEPA.

The medical practice opening hours are 8.30am to 5.30pm and therefore, onsite observations of the tidal levels can also be used to facilitate the evacuation of the building.

Tidal information for Leith can be found at the National Tidal and Sea Level Facility[18]. It should be noted that the tide is measured in chart datum. The datum for Leith is -2.9mAOD in relation to Ordnance Datum.

The hydraulic modelling demonstrates that the Green pedestrian route is located furthest from the onset of flooding. The modelling has been used to determine a monitoring and evacuation plan during the operational hours of the facility. The evacuation process has been outlined in Table 5-5, which provides a timeline of actions to identify the risk and enact an evacuation that provides 65min to evacuate the building. The flood free access route up to the B932 (South Street) is shown in Figure 5-13.

[16] Scottish Flood Forecast | Monday 22 January 2024 (sepa.org.uk)

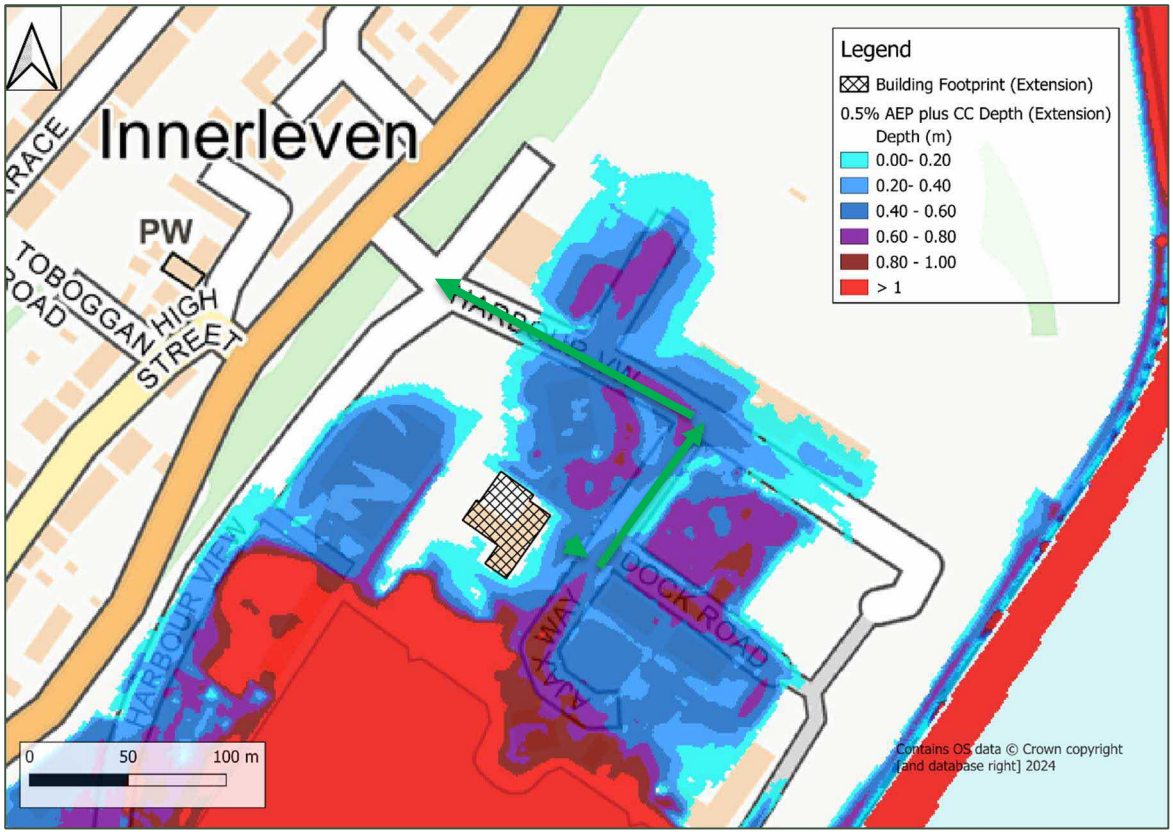
[17] Flood Updates –SEPA Floodline

[18] Real-time/near real-time data display for Leith | National Tidal and Sea Level Facility (ntslf.org)

Table 5-5: Flooding Timeline and evacuation actions

Elevation (m AOD)	Elevation (ACD)	Description	Action	Number of times exceed at Leith
n/a	n/a	Daily review of the 3-day SEPA flood forecast and review of the Met Office information		n/a
2.8	5.70	Daily review of tidal forecast each morning and / or preceding evening	If levels are forecast to exceed 2.8 m AOD then activate an observation and review of tidal information	329 (approx. 10 times a year)
3.20	6.10	0.4 m below top of Dock no.3	Enhanced monitoring of tidal levels, forecasts and on-site observations. Review numbers on site and time required for evacuation	104 (approx. 3.5 times a year)
3.40	6.30	75 mins before Pedestrian access starts to flood	Consider closing of building and evacuation if tide has not peaked and levels are forecast to exceed 3.6 m AOD	25 (<1 a year)
3.60	6.50	Dock no.3 close to overtopping	30mins before vehicle access starts to flood and 65mins before Pedestrian access starts to flood – evacuation should be underway	3
4.02	6.92	Ajax Way begins to flood	For information only	0
4.09	6.99	Vehicle access starts to flood	For information only	0
4.40	7.30	Pedestrian access starts to flood	Evacuation to be fully complete	0

Figure 5-13 –Access and egress route in a wider context (denoted in Green)



5.4 Model Quality Assurance

This section outlines the Quality Assurance (QA) measures undertaken in developing the hydraulic model.

Part of the general model QA process involves reviewing the TUFLOW messages generated during the model compilation stage and resolving any issues. Warnings produced by TUFLOW during the run are also investigated. Locations causing recurring warnings were identified and a solution implemented to reduce or remove the source of the issue. Model logs have also been utilised to record the key decisions made when developing the model, allowing for traceability and aid in the transfer of the models between different users. The main components of the model build, configuration and application were recorded and have been reviewed and signed-off by a senior hydraulic modeller.

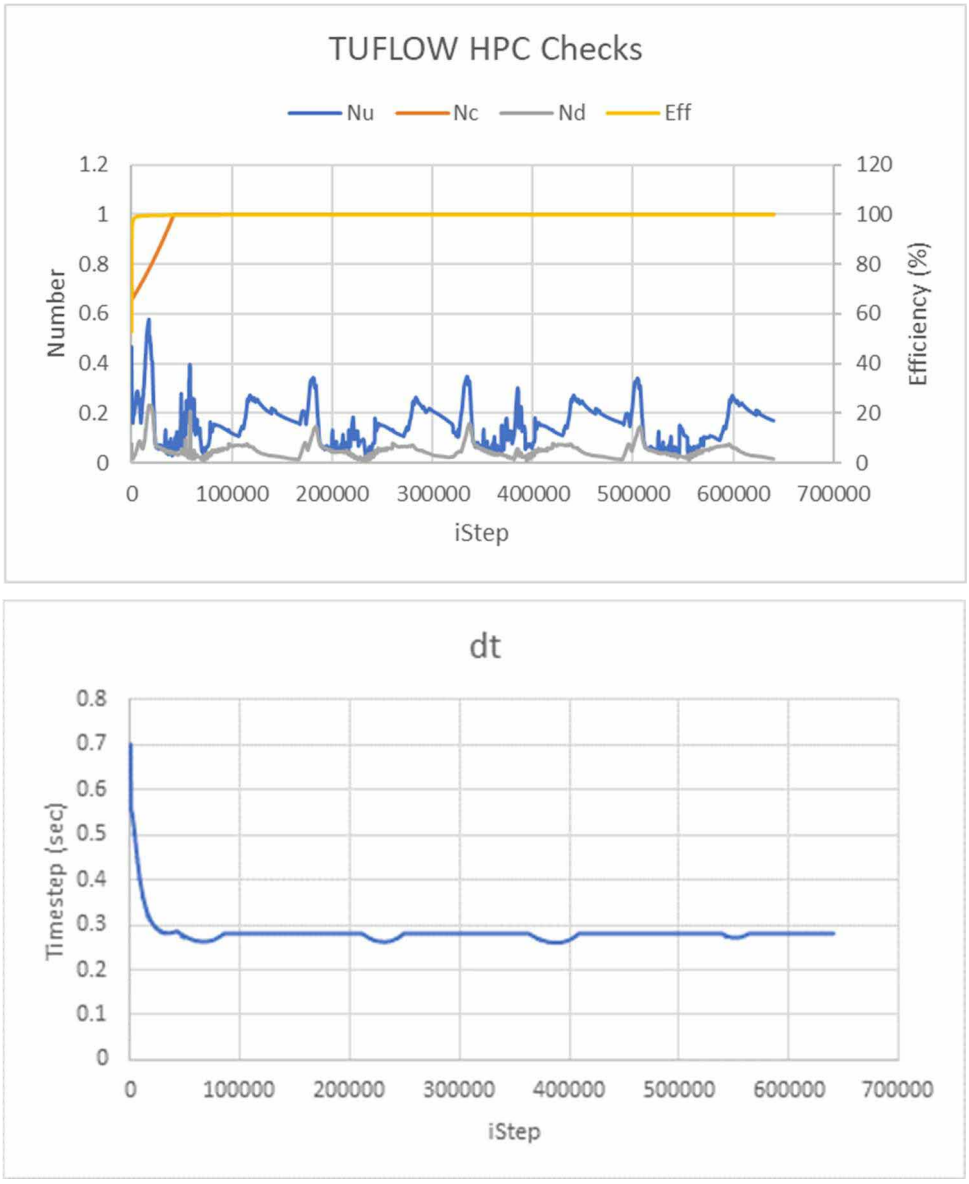
Further QA over the course of the model build was undertaken, including:

- Material roughness was checked by importing and thematically mapping the grd_check file to ensure surface resistance was applied correctly with respect to aerial images;
- The extent of the 2D domain was reviewed to ensure it was not limiting flood extents in the larger flood events within the area of interest; and,
- Minimum dT values across the 2D domain were reviewed to highlight any troublesome areas that were slowing down overall run time.

5.5 Model Stability

The model has been reviewed and found to be stable and suitable for its intended use. TUFLOW HPC is inherently stable by nature of the adaptive time-stepping, the time-steps (dT) are consistent, and the Nu, Nc and Nd are within acceptable limits as identified by the software developers.

Figure 5-14 –TUFLOW HPC Checks



5.6 Model sensitivity testing

Sensitivity analysis is the study of how the variation in the output of the model (depth) can be apportioned, qualitatively or quantitatively, to difference changes in the model inputs (model variables, boundary conditions and parameters).

Sensitivity analysis is used to identify:

- The factors that potentially have the most influence on the model outputs;
- The factors that need further investigation to improve confidence in the model; and,
- Regions in space where the variation in the model output is greatest.

In line with good practice, the following parameters, and variables for the hydraulic model have been varied in accordance with the % uplift / parameter change specified in Table 5-6:

Table 5-6: Sensitivity Analysis Variables

Parameter	Value change
Model cell size	10 m and 5 m
Channel and floodplain roughness	± 40 %

A universal separate increase and decrease of 40% to the Manning's n roughness values was applied across the entirety of the model domain. The model results demonstrated a change in water levels with +/- 5 mm. Based in this analysis, it can be concluded that the adopted roughness parameters have a negligible impact on the modelling results.

Sensitivity tests were carried out with 10 m and 5 m cell sizes for both the 1:200 and 1:1000 year plus CC events. The results demonstrate that the change in water levels for differing grid sizes is no more than 2 mm. The flood extents present a minor difference, with the courser resolution model producing a slightly larger extent. This is expected and is due to the loss of detail in the model and the averaging of ground elevations. Therefore, it can be concluded that the cell size parameterisation has a negligible impact on the modelling results.

Figure 5-15 –1:200 (0.5% AEP) Sensitivity testing of Mannings n roughness

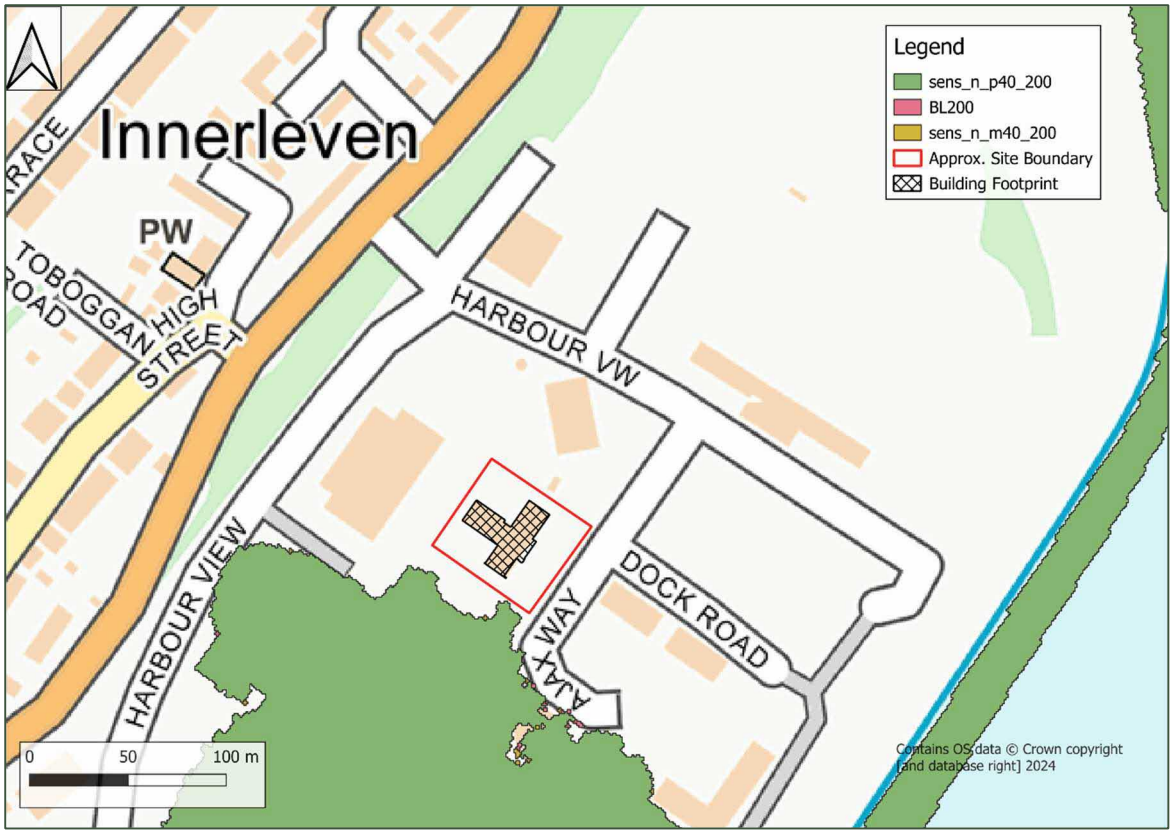


Figure 5-16 –1:200 (0.5% AEP) Sensitivity testing of cell resolution

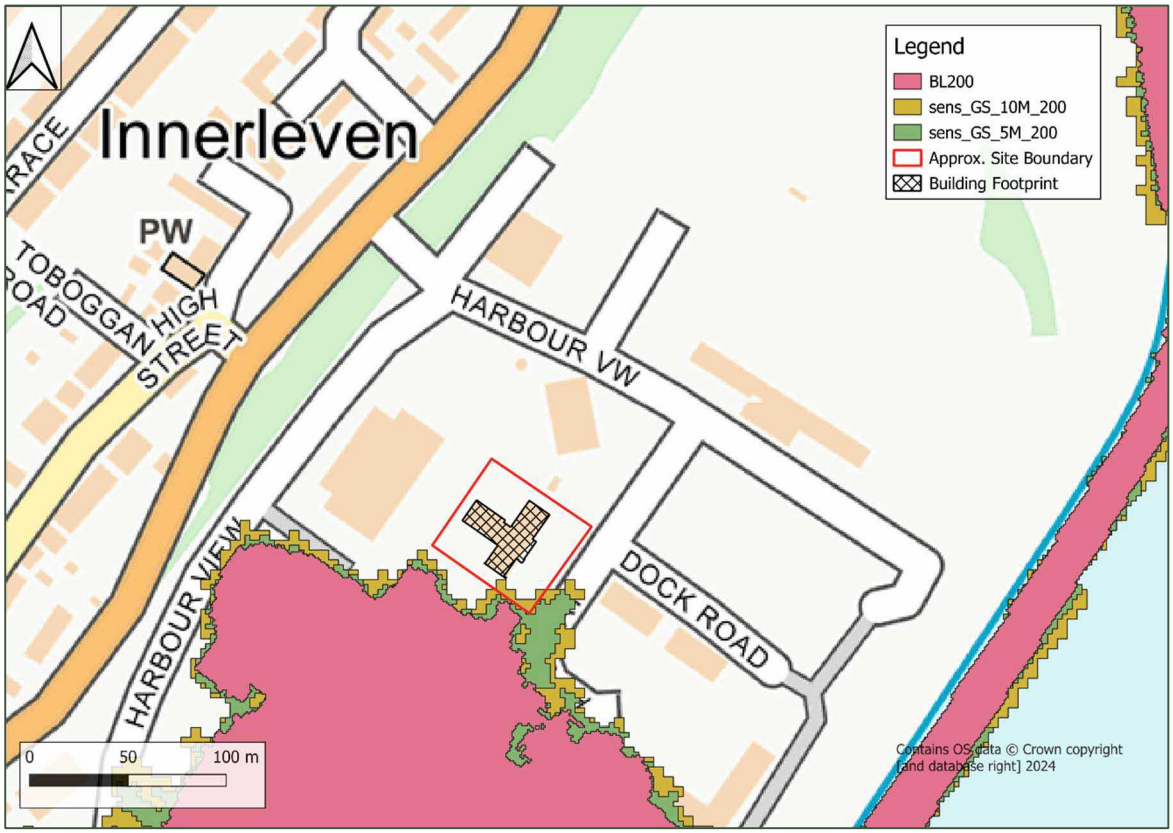


Figure 5-17 –1:1000 (0.1% AEP) plus CC Sensitivity testing of Mannings n roughness

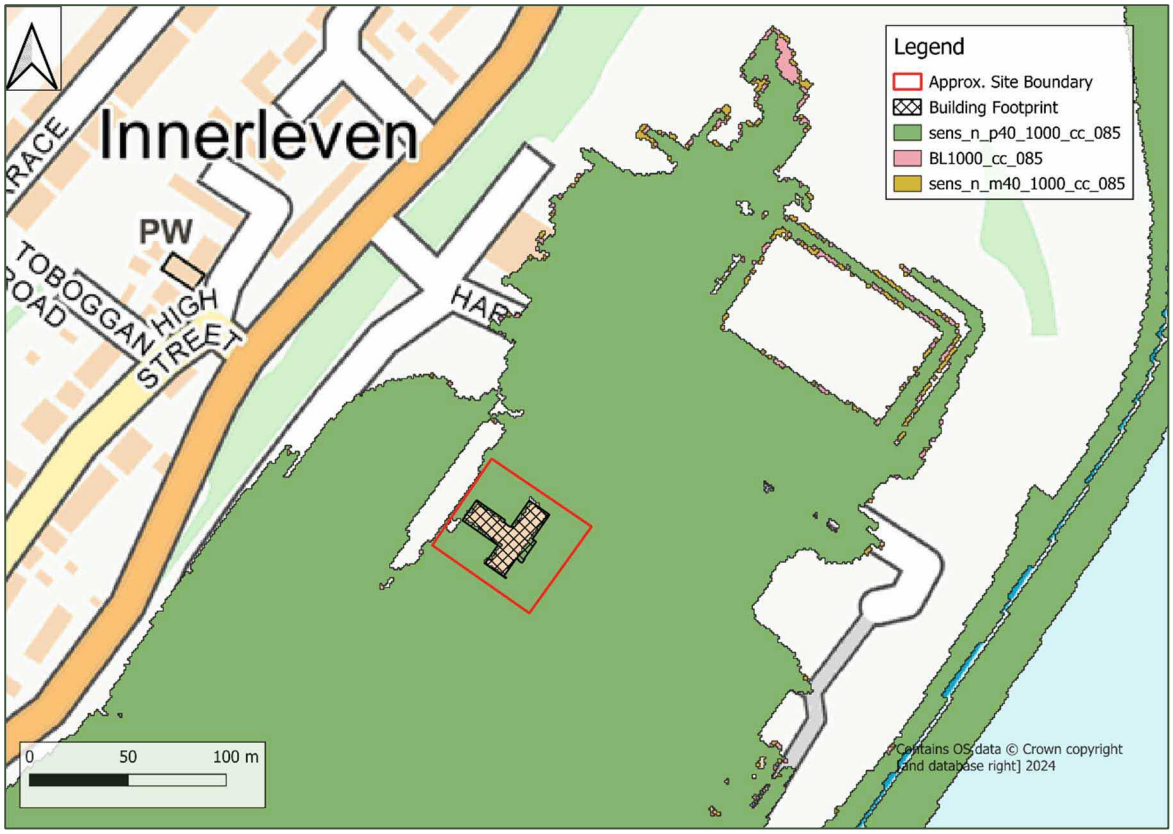
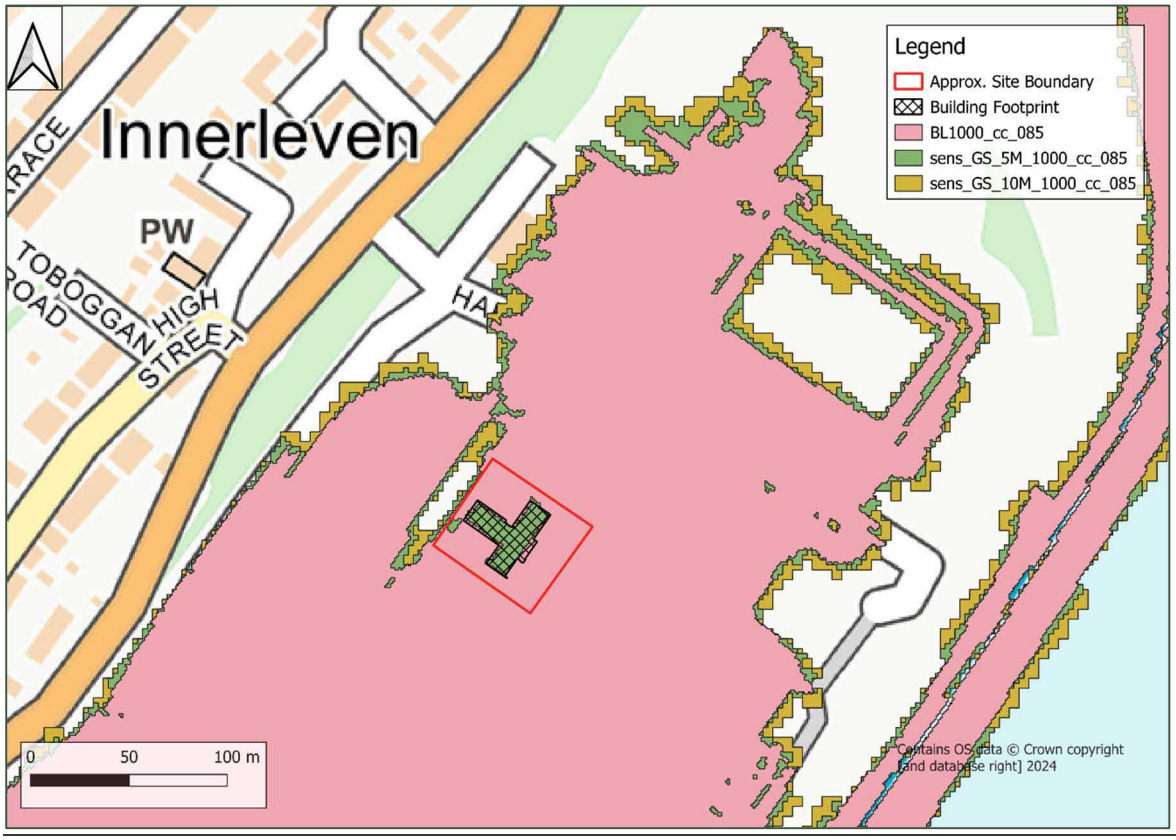


Figure 5-18 –1:1000 (0.1% AEP) plus CC Sensitivity testing of cell resolution



5.7 Shoreline

The Fife Shoreline Management Plan was published on the 15th of December 2011. A review of the management plan identifies that the proposed extension is within Policy Unit 34. The plan identifies that the preferred policy option is to hold the line for years 0-20, , 20 to 50 and years 50-100. On the assumption that the policy continues to be hold the line for the next c.90 years, this exceeds the lifespan of the current and proposed extension.

Reviewing the dynamic coast webmapping[19] there is no evidence of future coastal erosion due to the present of artificial sea defences.

6.0 BREEAM

The technical manual for BREEAM In-Use International Commercial V6.0.0 was used to assess the site against Asset Performance: Rsl 01 Flood Risk Assessment, which describes an environmental performance standard against which existing, non-domestic buildings can be assessed and achieve a BREEAM In-Use rating.

Table 6-1 highlights the relevant Sections of the Flood Risk Assessment in relation to the BREEAM criteria.

Table 6-1: BREEAM Criteria

Criterion	Description	Section
1	Flooding from the following sources must be taken into account: a) Fluvial (rivers) b) Tidal (sea) c) Surface water: sheet run-off from adjacent land (urban or rural) d) Groundwater: most common in low-lying areas undlain by permeable rock (aquifers) e) Sewers: combined, foul or surface water sewers f) Reservoirs, canals and other artificial sources g) A nearby functional flood plain	Section 4.0 and 5.0
2	Flood risk maps produced by a Local or National Authority can form the basis of a Flood Risk Assessment but will not be sufficient on its own to demonstrate compliance	Section 2.1
3	Flood Risk Assessments need to be undertaken by a relevant organisation/authority or a competent individual	Section 2.1, 4.0, 5.0, 5.3, Appendix D
4	It must be demonstrated that recommendations have been implemented	Section 5.2.2.1, Section 5.3
5	An allowance for climate change should be based on a Medium or High Emissions Scenario from a robust Climate Model	Section 3.4, 5.2.1 and 5.2.2

[19] DC2 Advanced WebMap (arcgis.com)

7.0 Conclusions and Recommendations

SLR Consulting Limited was appointed by PHB Group to prepare a Flood Risk Assessment to quantify the flood risk to the proposed extension of the Airlie Medical Practice.

A 2D TUFLOW model has been developed to quantify the risks of flooding to the site.

The extension of the medical practice does not change the land use vulnerability of the existing building.

The hydraulic modelling results show that the current medical Practice and proposed extension remains free from flooding up to and including the 0.1% AEP event with a freeboard of 859 mm. For the 0.5% AEP event, there is a freeboard of 1.048 m, which is greater than 600 mm in line with Fife Council guidance.

The building and extension are also free from flooding for the 0.5% AEP plus CC event with a freeboard of 225 mm to the surveyed building threshold. Although, this is typically a lower freeboard than recommended in the SEPA guidance. The hydraulic modelling sensitivity testing has demonstrated that the model results are not sensitive to the model grid or roughness values adopted. The dominate influence on water level are the extreme water levels. This provides greater confidence in the modelling parameters used and therefore a lower freeboard can be considered acceptable.

There is a small loss of floodplain of 3.9 m^3 –as this is in a tidal context and the hydraulic modelling has demonstrates no impacts to flood extents or water levels compensatory storage is not required.

The modelling results demonstrate that there is dry access and egress for pedestrians up to and including the 0.1% AEP. When climate change is simulated, there is a requirement to evacuate the building to provide flood free access and egress. The location of the pedestrian access route is located furthest away from the onset of flooding allowing the medical practice greater time to evacuate.

An evacuation process is documented to provide 65 minutes to evacuate the medical practice.

The shoreline management preferred policy option is to hold the line for the next 100 year from the published date of 2011.

Appendix A Extension Plan

Airlie Medical Practice

Flood Risk Assessment

PHB Group

SLR Project No.: 428.013182.00001

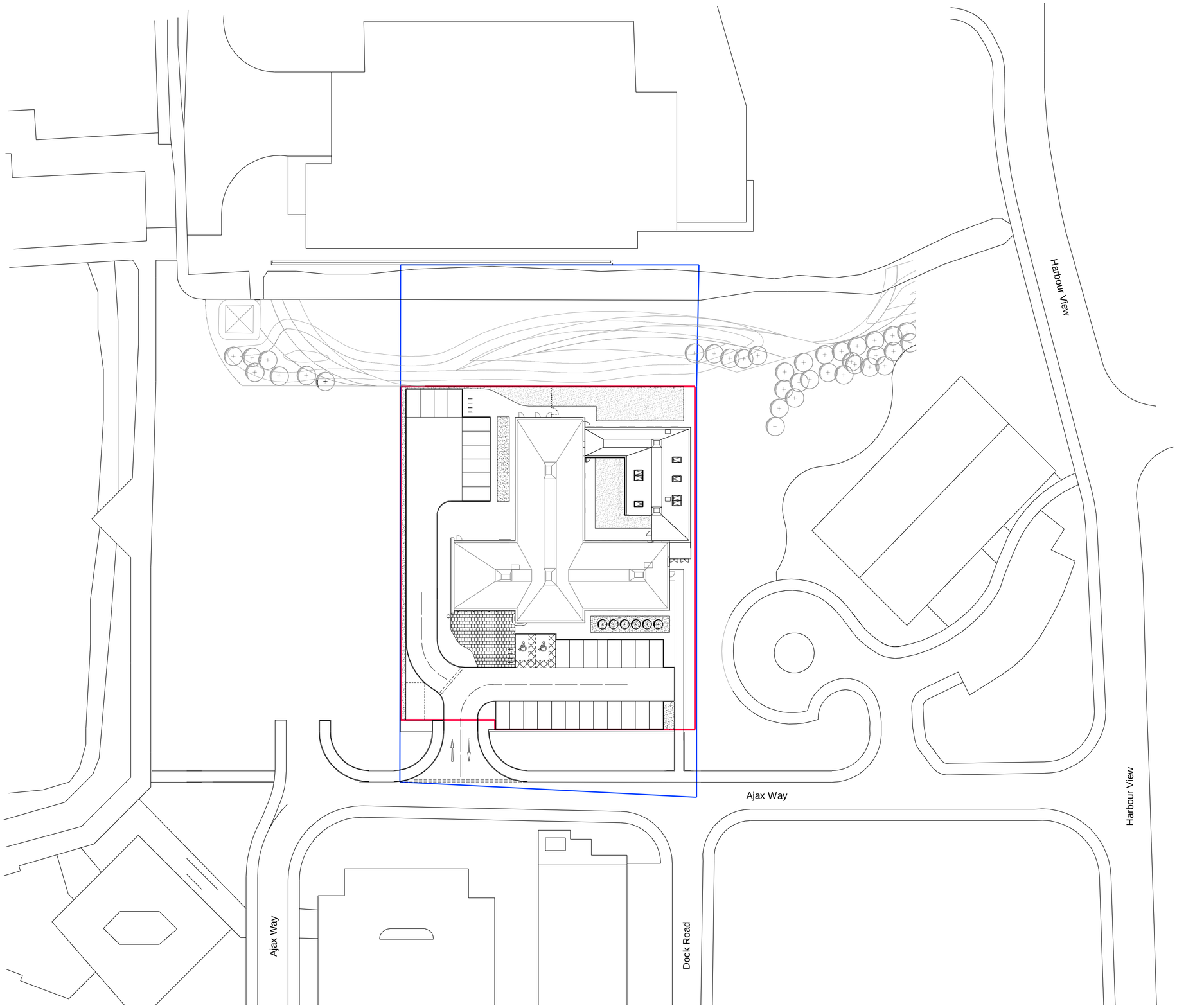
24 January 2024

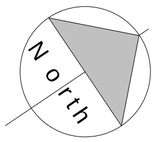
NOTES

1. Drawing prepared from archive drawing received from PHP and partial measured building survey by MHLS. All critical dimensions to be checked prior to ordering of materials.

Denotes Application Boundary

Denotes Land Ownership Boundary





1 Site Plan -Proposed
1 : 500

Rev	Description	Drawn	Checked	Date Issued

0m 10m 20m 30m 40m 50m

VISUAL SCALE 1:500 @ A2

Drawn	DC
Date	14/09/2023
Scale @ A2	As indicated
Status	S2

Austin-Smith:Lord Ltd
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Landscape Architects
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CF11 0SN
t +44 (0)2920 225 208
e cardiff@austinsmithlord.com

Drawings and models powered by Austin-Smith:Lord Ltd BIM using AutoDesk Revit

Austin-Smith:Lord

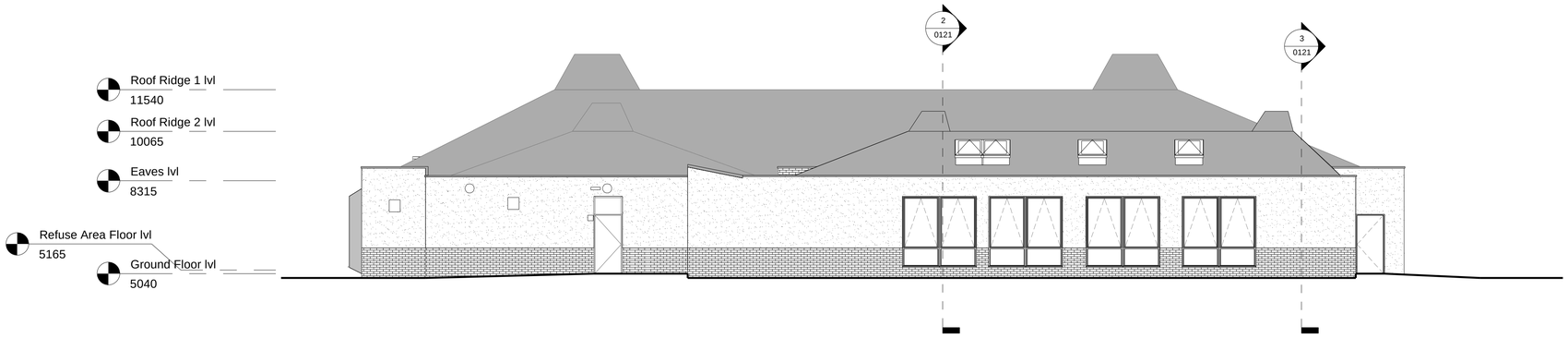
Project Airlie Medical Centre Methil

Description Site Plan - Proposed

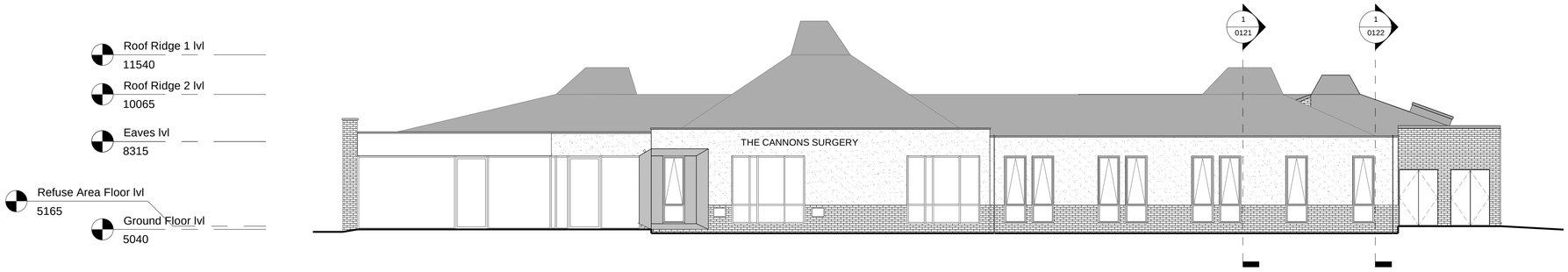
Job No.	Drawing No.	Revision
222069	222069- ASL- XX- XX- DR- A- 0013	

NOTES

1. Drawing prepared from archive drawing received from PHP and partial measured building survey by MHLS. All critical dimensions to be checked prior to ordering of materials.



1 North -Proposed
1 : 100



2 East -Proposed
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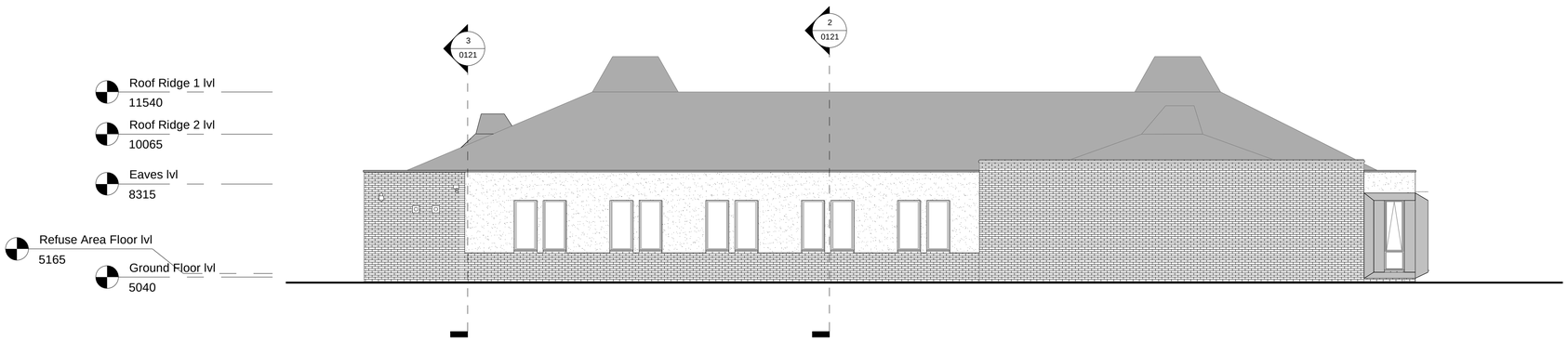

3 South -Proposed
1 : 100

Rev	Description	Drawn	Checked	Date Issued

0m 2m 4m 6m 8m 10m

VISUAL SCALE 1:100 @ A1

Drawn	DC
Date	14/09/2023
Scale @ A1	1 : 100
Status	S2

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Project Airlie Medical Centre Methil

Description Elevations - As Proposed Pg1

Job No.	Drawing No.	Revision
222069	222069- ASL- XX- ZZ- DR- A- 0119	

Appendix B Topographic Survey

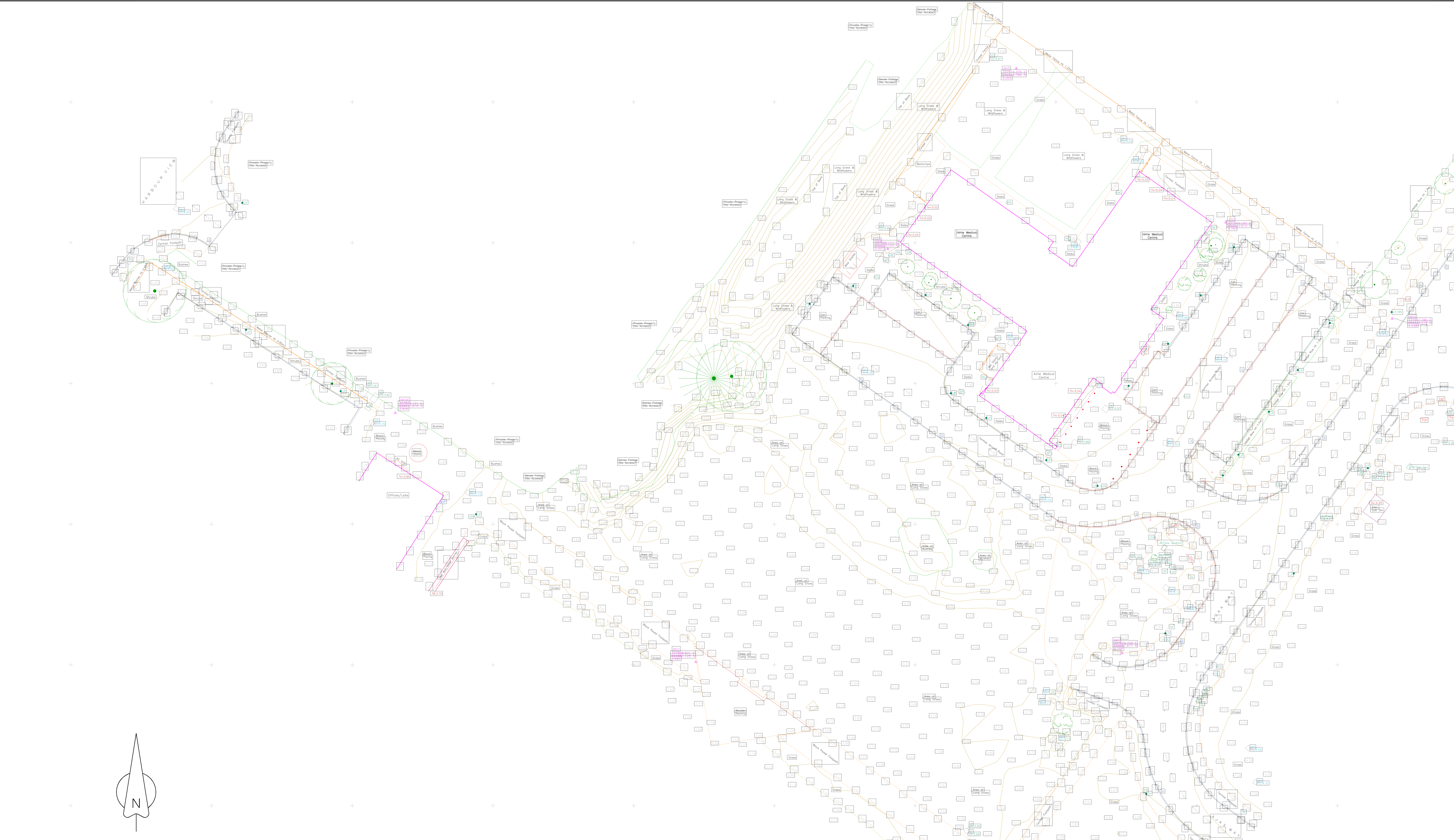
Airlie Medical Practice

Flood Risk Assessment

PHB Group

SLR Project No.: 428.013182.00001

24 January 2024



	Easting	Northing	Elevation	Marker
MH1	337929.409	699881.671	4.156	NAIL
MH2	337911.191	699816.196	3.441	NAIL
MH3	337868.831	699880.428	3.660	NAIL
MH3A	337826.121	699915.818	3.846	NAIL
MH4	337967.785	699929.219	4.438	NAIL
MH5	337914.375	699964.786	5.004	PEG
CS1	337944.147	699942.913	4.791	NAIL
CS3	337896.111	699939.120	5.007	NAIL

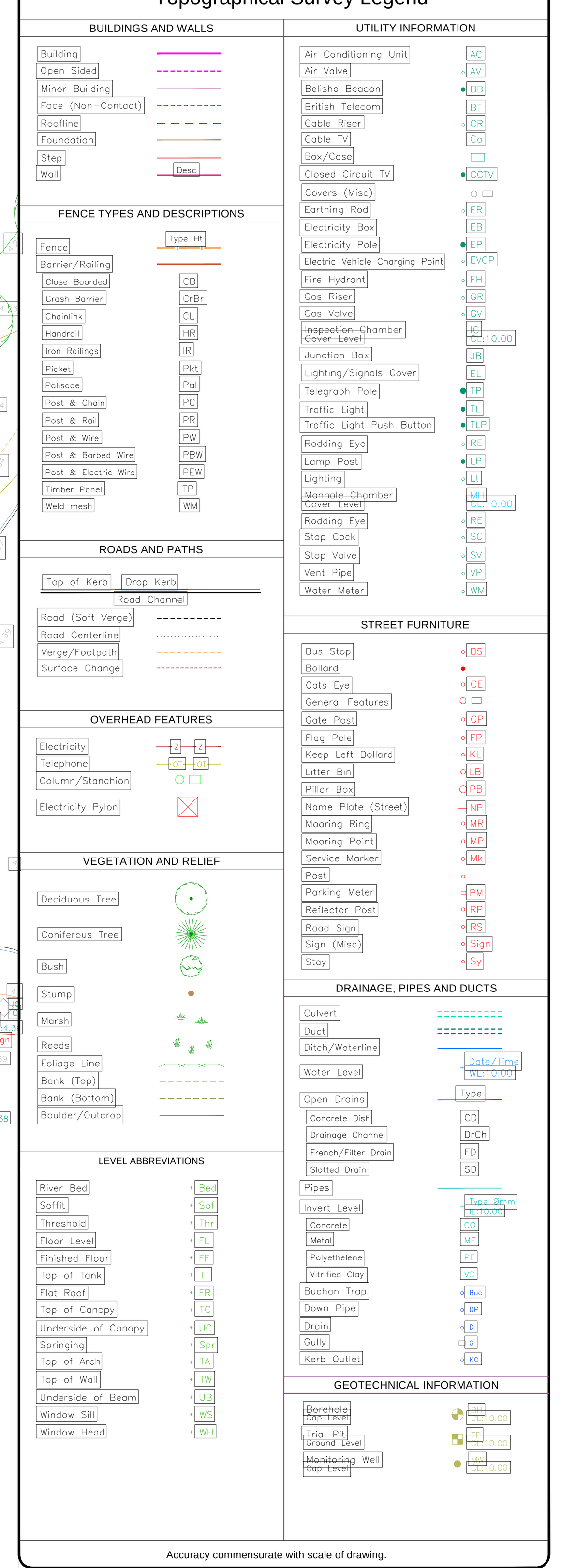
Survey Notes

Control Station

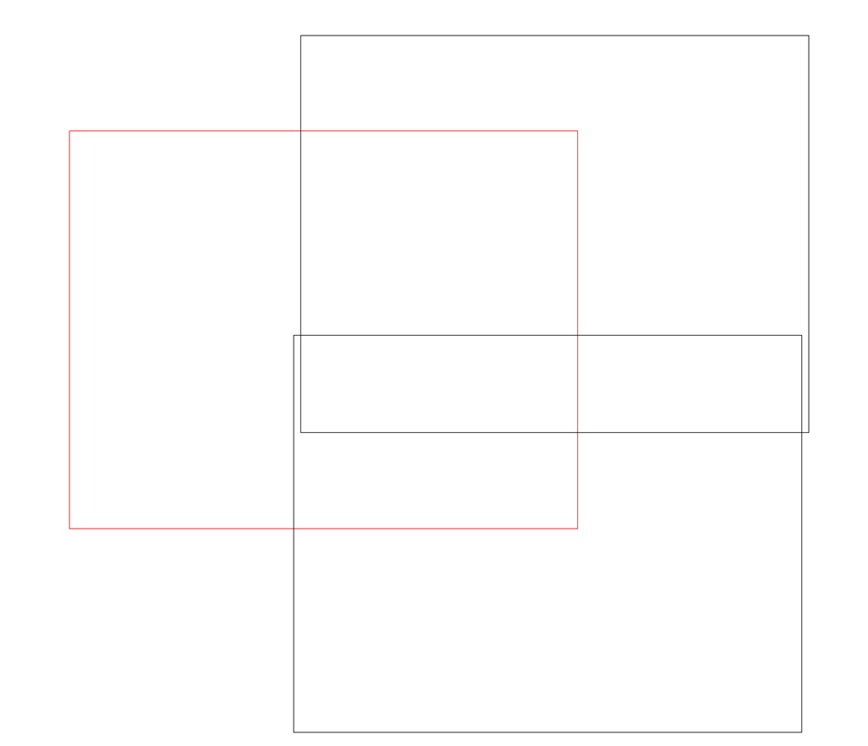
Grid based on OSGB36 (OSTN15)

Levels related to ODN (OSGM15)

Notes



Sheet Index



Rev.	Date	Description
02		
03		
04		
05		
06		

MALCOLM HUGHES
CHARTERED LAND SURVEYORS
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Accreditations

FS 14126

Client

Austin-Smith:Lord Ltd

25 Bothwell Street

Glasgow, G2 6NL

Project

Airlie Medical Centre

Ajax Way

Methill

Drawing Title

Topographical Survey

Sheet 1 of 3

Drawn By	C.D.	21/12/2023	Survey Date	Dec 2023
Checked by	V.OK	22/12/2023	Scale	A0 @ 1:200

Drawing No - Rev: 61125_TO_01 00

Appendix C SEPA Checklist

Airlie Medical Practice

Flood Risk Assessment

PHB Group

SLR Project No.: 428.013182.00001

24 January 2024

Flood Risk Assessment (FRA) Checklist

(SS-NFR-F-001 - Version 13 - Last updated 15/04/2015

This document should be attached within the front cover of any flood risk assessments issued to Local Planning Authorities (LPA) in support of a development proposal which may be at risk of flooding. The document will take only a few minutes to complete and will assist SEPA in reviewing FRAs, when consulted by LPAs. This document should not be a substitute for a FRA.

Development Proposal						
Site Name		Airlie Medical Practice				
Grid Reference	Easting:	337922	Northing:	699929		
Local Authority		Fife Council				
Planning Reference number (if known)						
Nature of the development		Other	If residential, state type:		Medical Practice	
Size of the development site		0.04	Ha			
Identified Flood Risk	Source:	Tidal	Source name:			
Supporting Informatio						
Have clear maps / plans been provided within the FRA (including topographic and flood inundation plans)		Yes				
Has a historic flood search been undertaken?		Yes				
Is a formal flood prevention scheme present?		No	If known, state the standard of protection offered			
Current / historical site use		Medical Pracice				
Hydrology						
Area of catchment		n/a	km^2			
Qmed estimate		n/a	m^3/s	Method:	Select from List	
Estimate of 200 year design flood flow		n/a	m^3/s			
Estimation method(s) used *		Select from List	If other (please specify methodology used):			
			If Pooled analysis have group details been included		Select from List	
Hydraulics						
Hydraulic modelling method		2D	Software used:		TuFlow	
If other please specify						
Modelled reach length			m			
Any structures within the modelled length?		Select from List	Specify, if combination			
Brief summary of sensitivity tests, and range:						
variation on flow (%)		n/a	%			
variation on channel roughness		+/-40%				
blockage of structure (range of % blocked)			%	Reference CIRIA culvert design guide R168, section 8.4		
boundary conditions:		**Upstream**			**Downstream**	
(1) type		Flow			Tidal	
	Specify if other			Specify if other	CFB	
(2) does it influence water levels at the site?		Yes			Yes	
Has model been calibrated (gauge data / flood records)?		No				
Is the hydraulic model available to SEPA?		Yes				
Design flood levels	200 year	3.962	m AOD	200 year plus climate change	4.785	m AOD

Flood Risk Assessment (FRA) Checklist

(SS-NFR-F-001 - Version 13 - Last updated 15/04/2015

Coastal						
Estimate of 200 year design flood level		3.962	m AOD			
Estimation method(s) used		Existing report	If other (please specify methodology used):	EA CFB boundary adjusted for sea level rise		
Allowance for climate change (m)			m			
Allowance for wave action etc (m)			m			
Overall design flood level			m AOD			
Development						
Is any of the site within the functional floodplain? (refer to SPP para 255)		Yes	If yes, what is the net loss of storage	3.9	m^3	
Is the site brownfield or greenfield		Brownfield				
Freeboard on design water level (m)			m			
Is the development for essential civil infrastructure or vulnerable groups?		Yes	If yes, has consideration been given to 1000 year design flood?	Yes		
Is safe / dry access and egress available?		Neither	Min access/egress level		m AOD	
If there is no dry access, what return period is dry access available?		1000	years			
If there is no dry access, what is the impact on the access routes?	Max Flood Depth @ 200 year event:	0	m	Max Flood Velocity:	0	m/s
Design levels	Ground level	5.01	m AOD	Min FFL:	5.01	mAOD
Mitigation						
Can development be designed to avoid all areas at risk of flooding?		No				
Is mitigation proposed?		No				
If yes, is compenstory storage necessary?		No				
Demonstration of compensatory storage on a "like for like" basis?		No				
Should water resistant materials and forms of construction be used?		No				
Comments						
Any additional comments:		Dry pedestrian access is available for the present day 0.1% AEP. Accounting for climate change there is no dry access, for the 0.5% AEP plus CC event, and an evacuation plan has been proposed to allow for dry access/egress.				

Approved by: R. Walker
Organisation: SLR Consulting
Date: 24.01.2024

Note: Further details and guidance is provided in 'Technical Flood Risk Guidance for Stakeholders' which can be accesssed here:- **CLICK HERE**

**** ReFH2 is now accepted by SEPA for flow estimates in Scotland. Any use of this method should be compared with other accepted methods.***

Appendix D Self-Certificate

Airlie Medical Practice

Flood Risk Assessment

PHB Group

SLR Project No.: 428.013182.00001

24 January 2024

Appendix 3 - Flood Risk Assessment - Compliance Certificate

I certify that all the reasonable skill, care and attention to be expected of a qualified and competent professional in this field has been exercised in carrying out the Flood Risk Assessments and preparing the Flood Risk Assessment Report for the below named development in accordance with the Reporting Requirements for Flood Risk Assessments issued by SEPA.

ePlanning Reference No.....

Planning Application No. (completed by Fife Council Planning Service) .....

Roads Construction Consent No. (completed by Fife Council Planning Service) ..... N/A

Name of Development..... Airlie Medical Practice, Ajax Way, Methil, Fife

Name of Developer..... PHP Group, Burdett House, 15-16 Buckingham Street, London WC2N 6DU

Name and Address of Designers Organisation .....

.....SLR Consulting.....

.....1 Bartholomew Lane, London, United Kingdom, EC2N 2AX.....

.....

Name of Designer.....SLR Consulting.....

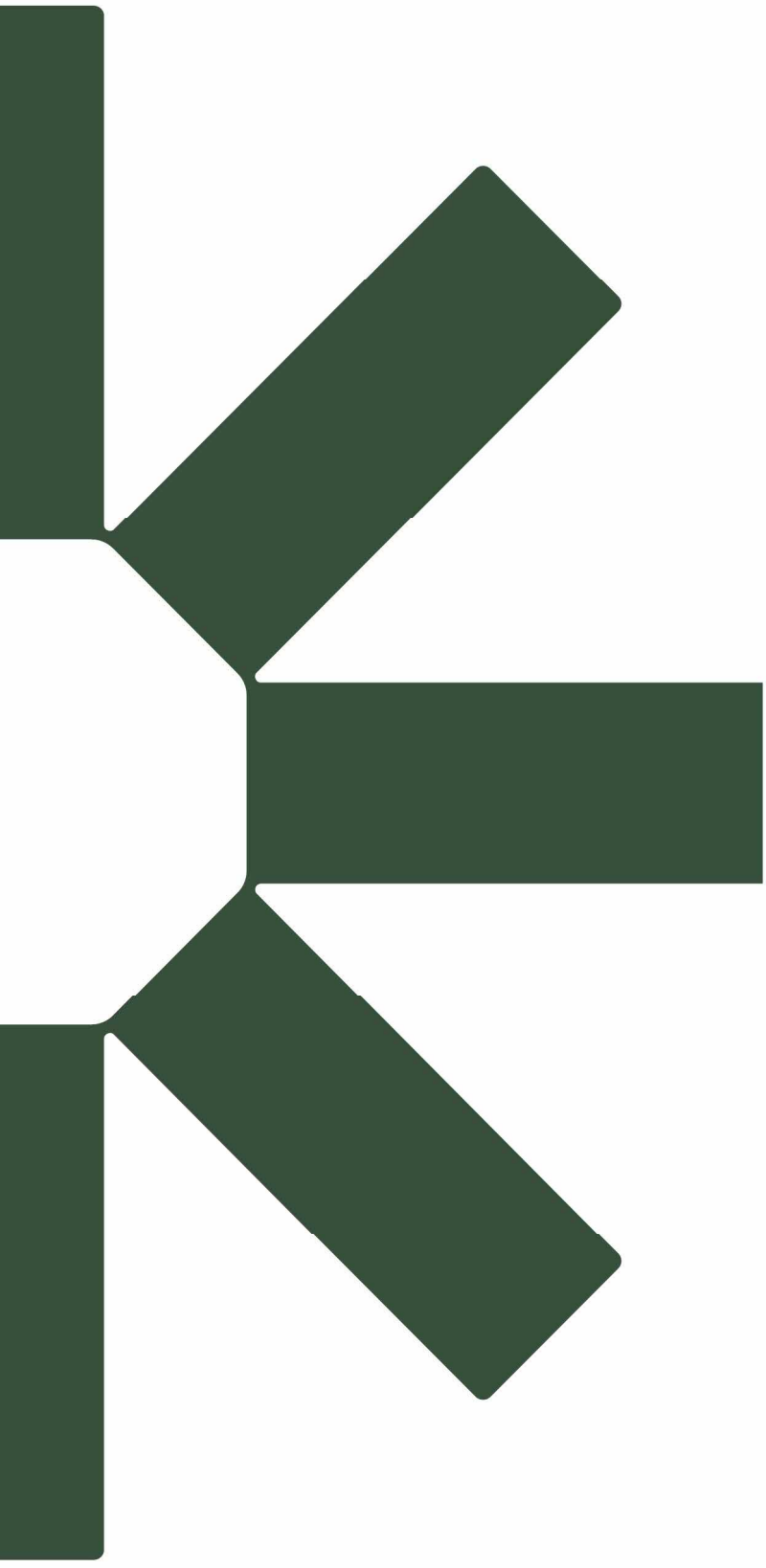
Position Held.....Principal Flood Risk Consultant.....

Engineering Qualifications[4] C.WE0 .....

Signed .....[redacted].....

Date.....2/12/22.....

[4] Minimum Qualification - Incorporated Engineer or equivalent from an appropriate Engineering Institution.



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