Appendix A

Architectural plans

Notes & Key:

HWS Ref: 2447

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Application Boundary Line

County Boundary

Denotes future Phase 3 (Boardwalk)

Site Plan - Tile 2 (10113)

Site Plan - Tile 1 (10112)

Block D (permitted under Phase 1. Application Reference: ABP-311181-21)

Block A (permitted under Phase 1. Application Reference: ABP-314686-22)

Housing (permitted under Phase 1. Application Reference: ABP-311181-21)

Permitted Phase 1 Coastal Quarter

DLR

WCC

Block B (permitted under Phase 1. Application Reference: ABP-314686-22) Not Commenced

Block C (permitted under Phase 1. Application Reference: ABP-311181-21) Currently under construction

Block I (hotel)

Block E

RIVER DARGLE

Bray River

Approved Sisters of charity access. Planning reference numbers: WCC Ref. 2460455 and DLRCC Ref. D24A/0563/WEB

Block H

Block G

Phase 3

See masterplan doc. BRA-HWS-02-XX-R-A-05002. For temporary use see Construction Management Plan 008913SD00029

For more landscape information see drawing 2301-PA-01_Landscape Masterplan Detail Area C by BSLA.

Wingfield

Corrin Bhré
Bray Commons

Bré Beag
Little Bray

N

0m 50m 100m 150m 200m @ 1:2000

Location:

Status:

S3 - ISSUED FOR PLANNING

Revision History:		Checked: SJ
P01	Planning Issue	31/01/2025 HWS

Project

Sea Gardens Phase 2

Client:

Shankill Property Investments Ltd

File Title: Scale: 1 : 1000 @A0

Proposed Overall Phase 2

File ID: Revision:

BRA-HWS-02-ZZ-D-A-10101 P01

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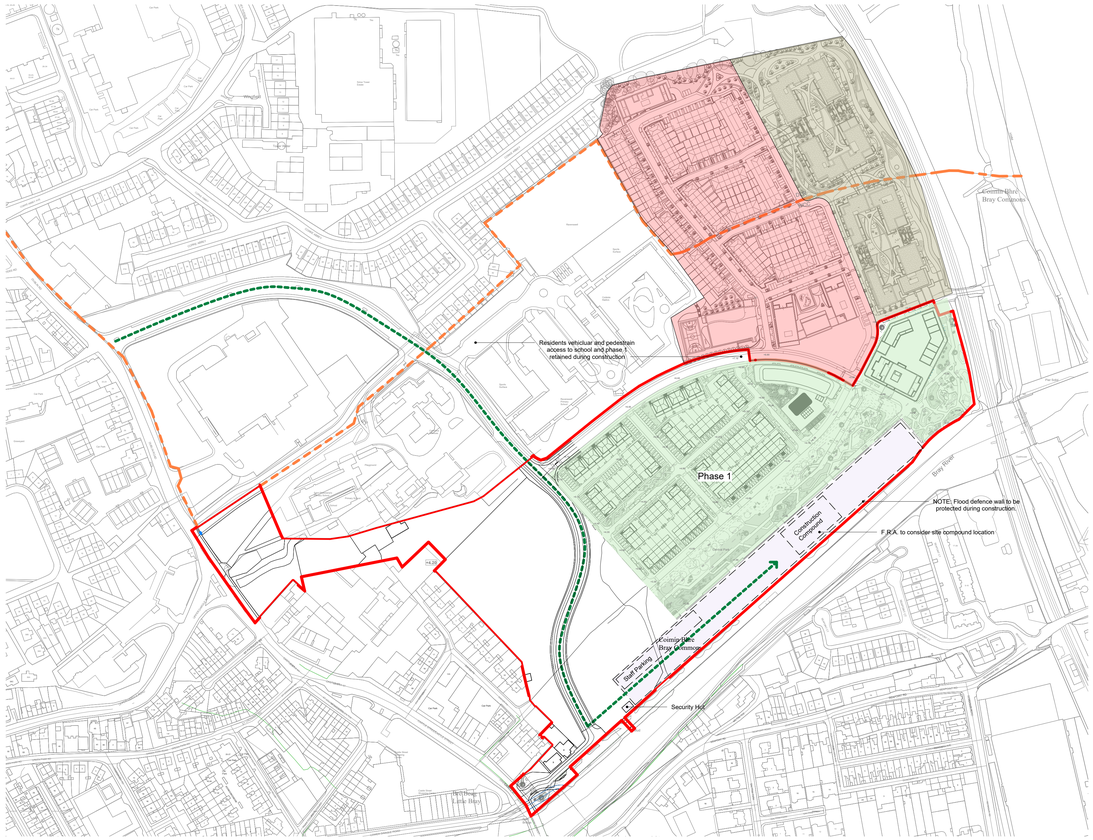
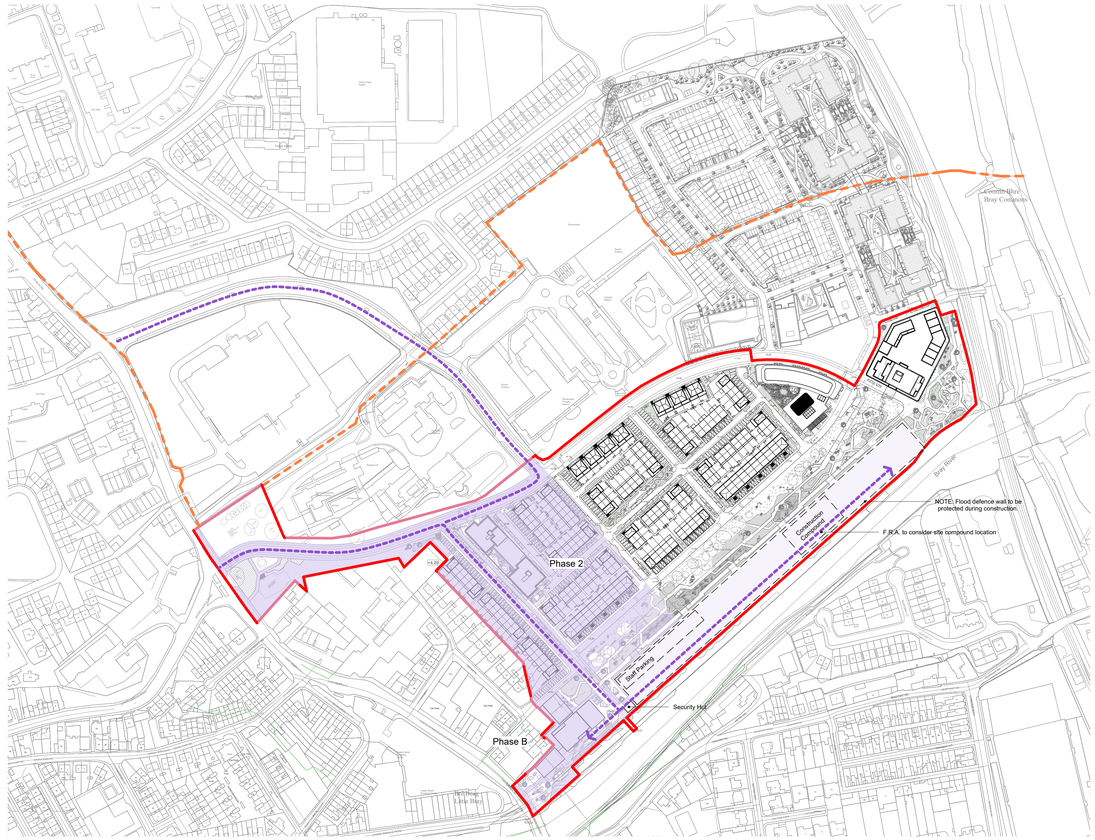


1 Phasing Plan - Phase 1
1 : 2000



2 Phasing Plan - Phase 2
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Application Boundary Line

County Boundary

Key

Phase 1

Phase 2

Construction Traffic Route Phase 1

Construction Traffic Route Phase 2

Phasing Works Compound / Site Office

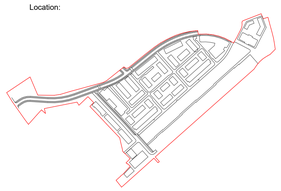
Permitted under planning reference ABP-311181-21. Due for completion Q3 2025.

Permitted under planning reference ABP-314686-22. Subject to Judicial review

N

0m 50m 100m 150m 200m @ 1:2000

Location:



Status:

S0 - INFORMATION

Revision History: Checked: SJ

P01	Issued for Information	28/10/2024	HWS
P02	Draft Planning Issue for Comment	04/12/2024	HWS
P03	Draft Issue with Updated Roads & Landscape	13/12/2024	HWS
P04	Final Draft Planning Issue	13/12/2024	HWS
P05	Phasing Drawing Update	16/12/2024	HWS
P06	Updated Phasing Plan	17/01/2024	SJ

Project

Sea Gardens Phase 2

Client:

Shankill Property Investments Ltd

File Title: Scale: 1 : 2000 @A0

Phasing + Construction Management Plan

File ID: Revision:

BRA-HWS-02-ZZ-D-A-10107 P06

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Appendix B

Meeting notes from Consultations with WCC

ARUP

Minutes

Project title	Bray River Quarter
Job number	293308-00
Meeting name & number	WCC meeting – flood risk
File ref	9-02-01
Time and date	9.00am 3rd August 2023
Location	Wicklow County Council & Videoconference
Purpose of meeting	Discussion on flood risk in vicinity of the subject site
Present	Marc Devereaux, Wicklow County Council Liam Bourke, Wicklow County Council Cathal Dalton, Ballymore Emer Kennedy, Ove Arup & Partners Ireland Ltd (Arup)
Apologies	Apologies
Circulation	Those present and apologies. Rachel Hoy, Ballymore Miquel Vinyals Paton, Arup Stephanie Merenbach, Arup

Topic		Action
1.	**Existing hydrology**	
1.1	Arup presented the results of their hydrological estimation for the River Dargle. The Q100 values determined, 98cumecs, is considerably lower than the Bray Flood Defence Scheme estimation of circa 300cumecs. Arup used the Flood Studies Update (FSU) method to determine this value; the FSU is considered to be the industry standard for catchments of this scale. This methodology was not in use at the time of the development of the Bray Flood Defence scheme.	Info
1.2	The Hurricane Charlie event of 1986 was understood to be a Q100 event during the development of the Bray Flood Defence Scheme. The method of estimation of this flow rate for this event is not available hence it is not possible to determine the source of this large discrepancy. WCC advised they will contact the original hydrologist, John Sullivan (UCD) to arrange a meeting to discuss further.	WCC

ARUP

Project title	Bray River Quarter
Job number	293307-00
Date of Meeting	03 August 2023

Topic		Action
	○ WCC noted that the 2011 flood event (in which Dublin airport and M11 flooded) came close to causing a flood event in Bray. The trash marks in Peoples Park were examined following in the event. John Sullivan advised at the time that this further calibrated the Q100 estimate for the Hurricane Charlie event.	Inf
	○ Arup advised that they had assessed the Hurricane Charlie event and found it to align with an extreme event rather than a Q100 event based on the FSU methodology.	Info
1.3	Arup to investigate other methods of estimating Q100. Due to the sensitivity of this area to flooding it is important that a conservative approach to flood risk management is adopted and, regardless of the FSU findings it is prudent to design the site with the Hurricane Charlie event as the design standard rather than a much lower FSU value.	Arup
1.4	Arup presented their findings of tidal boundary conditions. Of note was the tidal levels have risen. The Mean High-Water Spring (MHWS) tide is 100mm higher now than at the time of designing the flood defence scheme, the 200 year tidal return period is also high. This will be incorporated into the model.	Info
2.	**Hydraulics**	
2.1	The results of Arup's model show out of bank flooding in the Hurricane Charlie event. All agreed that the model must align with the HR Wallingford Physical Model study. The physical (HR Wallingford) and computer (Arup) agree with regard to the source of out of bank flooding in an exceedance event which would overtop the wall, namely it would propagate at the Peoples Park. However, the trigger level appears to be lower in the Arup model. Arup to investigate the source of this discrepancy (roughness, channel alignment, bed conditions, tidal boundary) and revert.	Arup
2.2	WCC to send the HR Wallingford Physical Model study videos Arup/Ballymore	WCC
2.3	A discussion was had on the existing flood relief channel and outlets into the river at the golf club. This is in place to act as a safety valve should the river break its banks at the Peoples Park. In such an event, flood waters would flow through O'Dwyer Park into the golf club and re-enter the river via the channel and associated culverts. This channel and culvert are to be maintained in the proposed development and should be included in the model.	Arup
2.4	WCC suggested that the existing model should be modelled as this might indicate source of discrepancy between the two models. Existing cross sections	Arup

ARUP

Project title	Bray River Quarter
Job number	293307-00
Date of Meeting	03 August 2023

Topic		Action
	are included in the appendices of the HR Wallingford report. Arup to consider this further.	
2.5	WCC requested that the model run include a sensitivity test with 0.04 roughness of the riverbed.	Arup

3. Next Meeting

3.1	A follow up meeting will be held once the hydrology and hydraulics are further progressed.	Info

ARUP

Memo – Summary of meeting

Project title	Sea Gardens, Phase 2: Flood Risk Modelling Progress
Job number	293308-00
Meeting name & number	Flood Risk update, 02
File ref	9-04
Time and date	15:00 6 December 2023
Location	Teams
Purpose of meeting	Provide an update on the hydraulic modelling work and flood risk management
Present	Liam Bourke (Wicklow County Council - WCC) Marc Devereux (WCC) Cathal Dalton (Ballymore) Rachel Hoy (Ballymore) Ken Leahy (Arup) Rodoula Gregoriou (Arup) Emma Krampe (Arup)
Apologies	
Circulation	Those present Names for circulation

Topic **Action**

1. Summary

- Reviewed action items from previous meeting with WCC
  - Showed comparison of values between FSU, FSR, and IH124 1 in 100-year events in comparison to Hurricane Charlie event
  - Sensitivity of riverbed Manning's n values: Arup has modelled the Hurricane Charlie event with both 0.03 and 0.04. Results show the Arup model produces results closer to the HR Wallingford model when Manning's N values are more conservatively set at 0.04. WCC has indicated this is acceptable.
- Discussion regarding exceedance event during which flood defences are overtopped.
  - The Arup model does not include areas farther upstream including La Vallee and the Slang where water is thought to have left the riverbanks and flowed overland into Little Bray. This is acceptable as farther upstream is not of interest to the site boundary.
  - The Arup model does indicate the overland flow path once water has entered Little Bray including its route to the north of the SuperValu

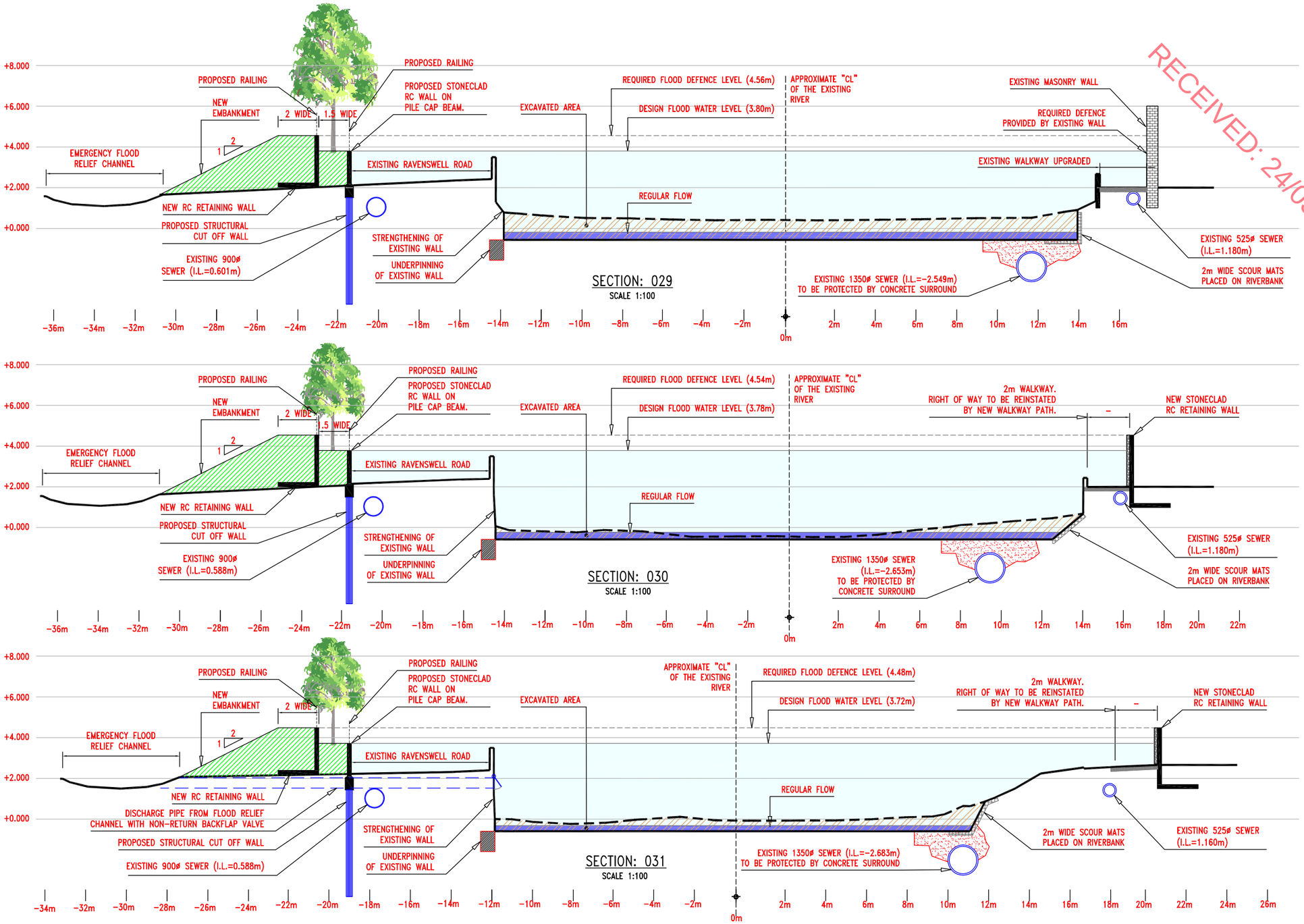
ARUP

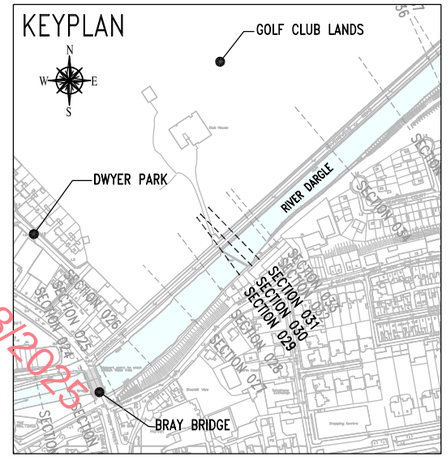
Project title	Sea Gardens, Phase 2
Job number	293308
Date of Meeting	6 December 2023

Topic	Action
complex, down Castle Street and through Dwyer Park into the lowlands within the site boundary. o Necessary to ensure floodwaters entering Little Bray have the opportunity to leave Little Bray and re-enter the riverbed to go out with the tide as occurred during the wall failure along Ravenswell Road during the Hurricane Charlie event. Arup to document appropriately in the report. o Necessary to ensure any proposed roads which run north from the Ravenswell car park and replacing the access road to the Ravenswell Primary School will maintain lower levels established during the construction of the access road so as to prevent interference of flows from Dwyer Park.	Arup Arup
- Present draft emergency access and egress information via text/diagrams once prepared to WCC including indications for pedestrian emergency exit to higher ground from apartment blocks.	Arup
- Arup to review Inspector's Report issued by An Bord Pleanála regarding culvert designed for water removal near Ballymore proposed apartment blocks.	Arup

Appendix C

River Dargle Flood Defence Scheme drawings





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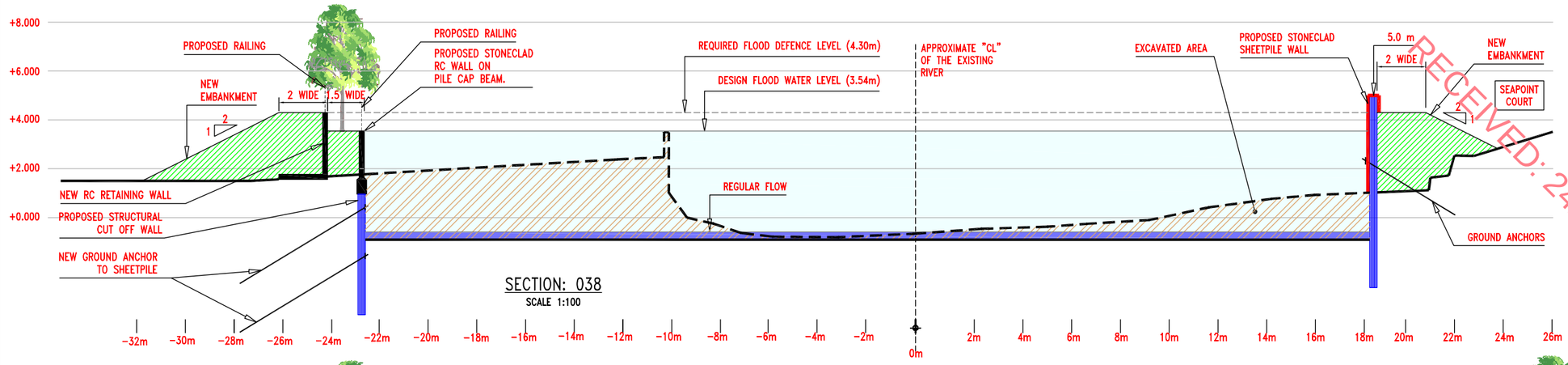

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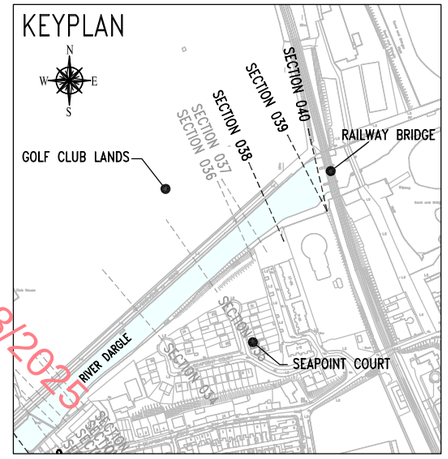

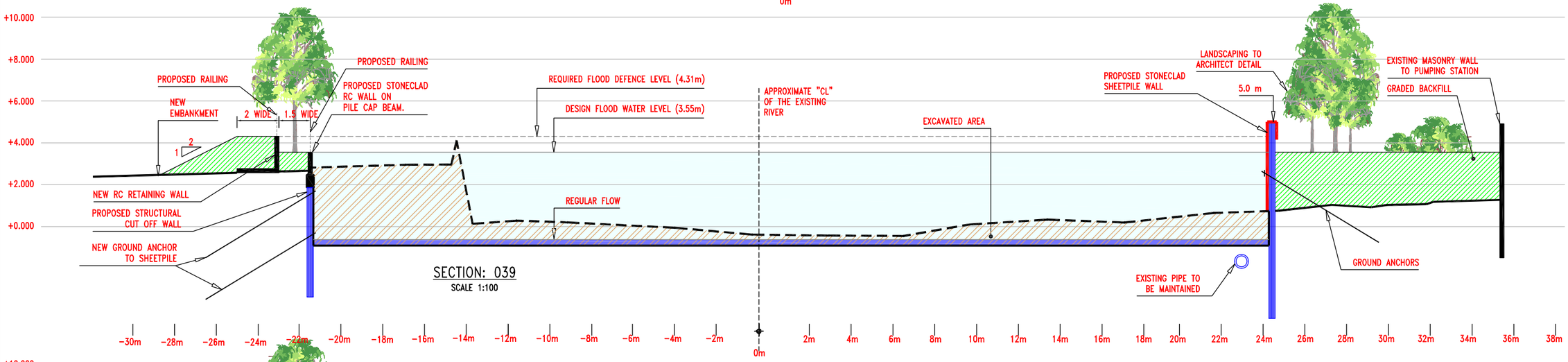

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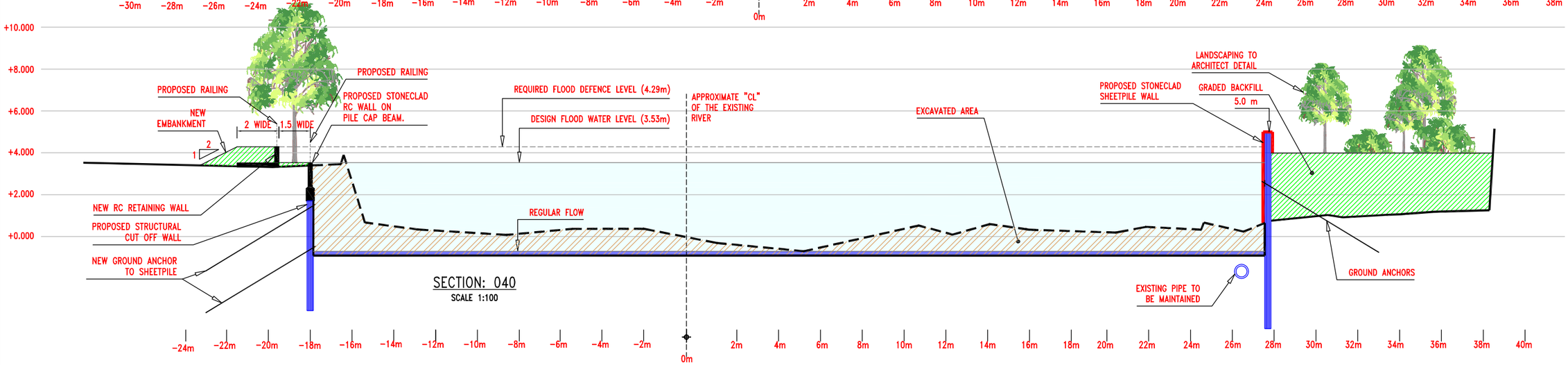

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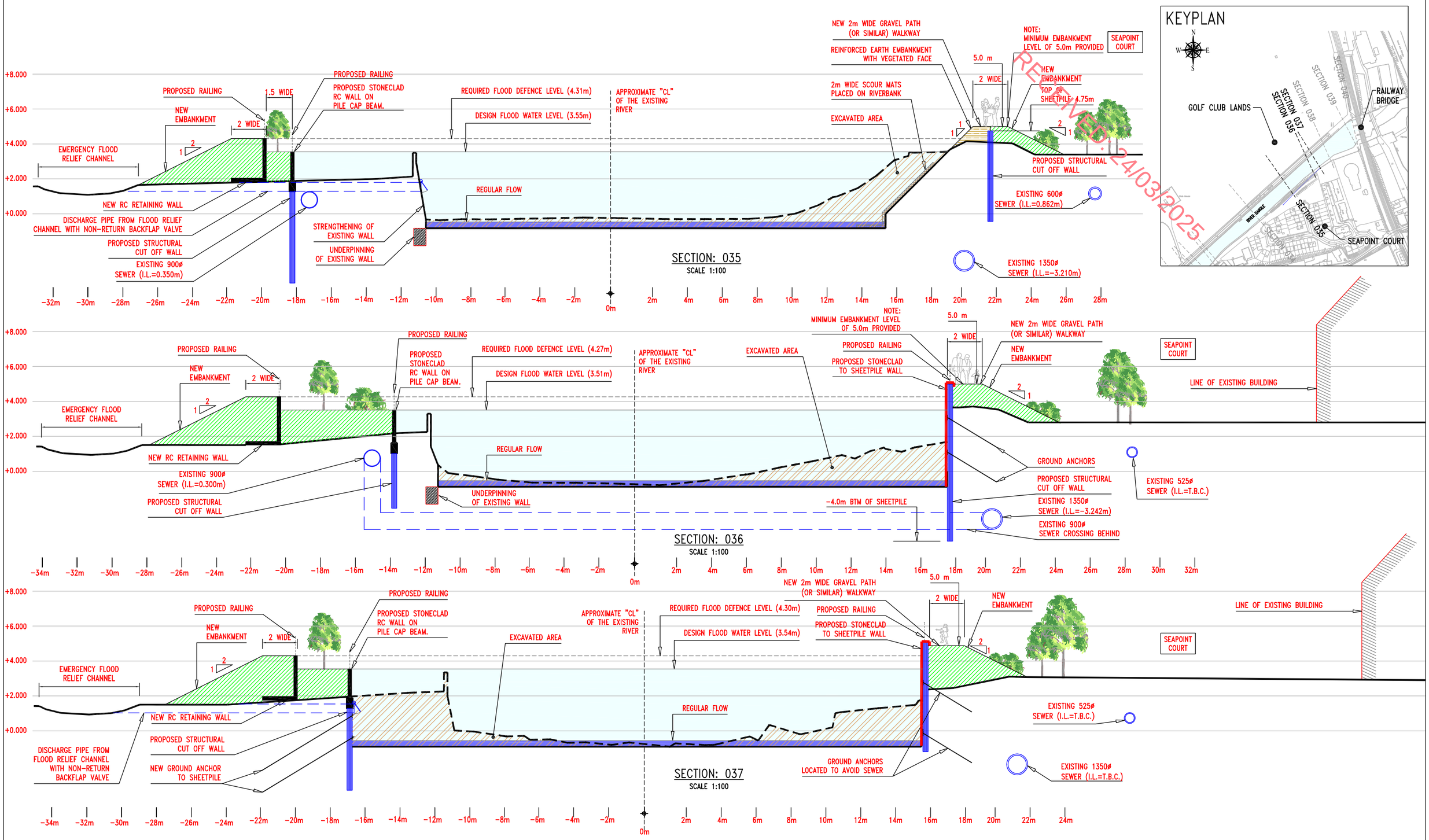

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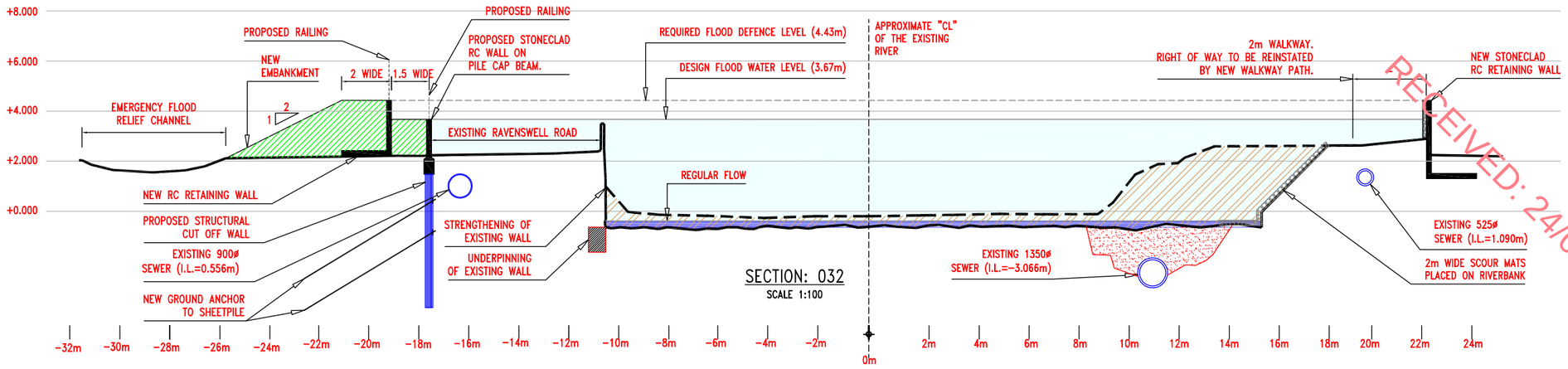

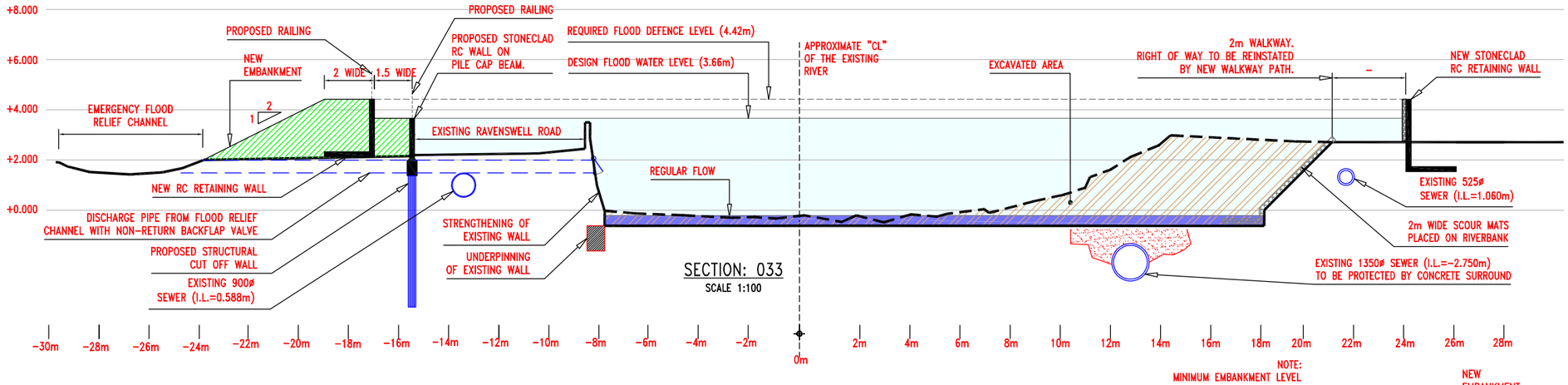

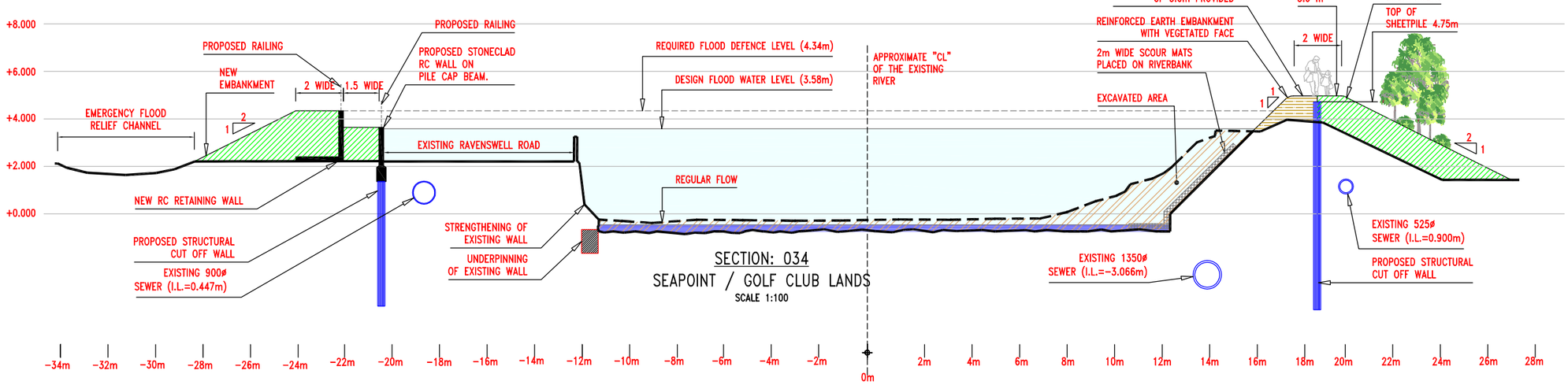

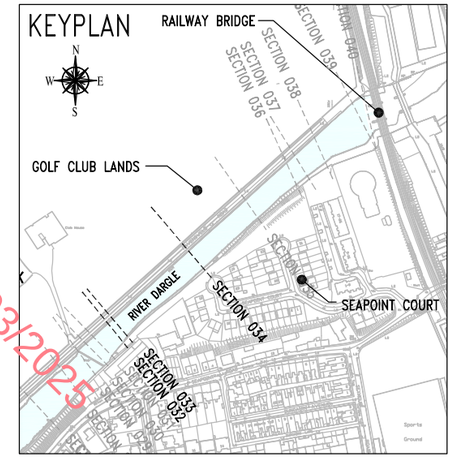

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Appendix D

Hydrology and Hydraulic Modelling set up

D.1 Hydrology Methodology

D.1.1 Hydrological Analysis of the River Dargle – Flood Studies Update

The OPW Flood Studies Update (FSU) portal software was used to estimate fluvial peak flows and hydrographs. In the case of the River Dargle, the catchment was ungauged; as such Q_{med} was calculated based on catchment characteristics and adjusted using flow data from a pivotal site. The pivotal site is selected based on the distance and characteristics of the selected site (hydrological similarity).

D.1.1.1 Subject Site Selection

First, the principal subject site 10_1327_1 was selected as shown in Figure D.1 - 7-1. The subject site selected is upstream of the proposed development site as well as the Swan River, a tributary of the River Dargle flowing under Herbert Road and joining the River Dargle 1.3km upstream from Bray Harbour. The Swan River was included as a separate catchment input in the model, represented by the ungauged site 10_534_4 (shown in Figure D.1 - 7-2). Subject site 10_534_4 is approximately 7.436 km^2, or less than 25km^2, thus the FSU 5-variable small catchment method was used for the estimation of Q_{med}.

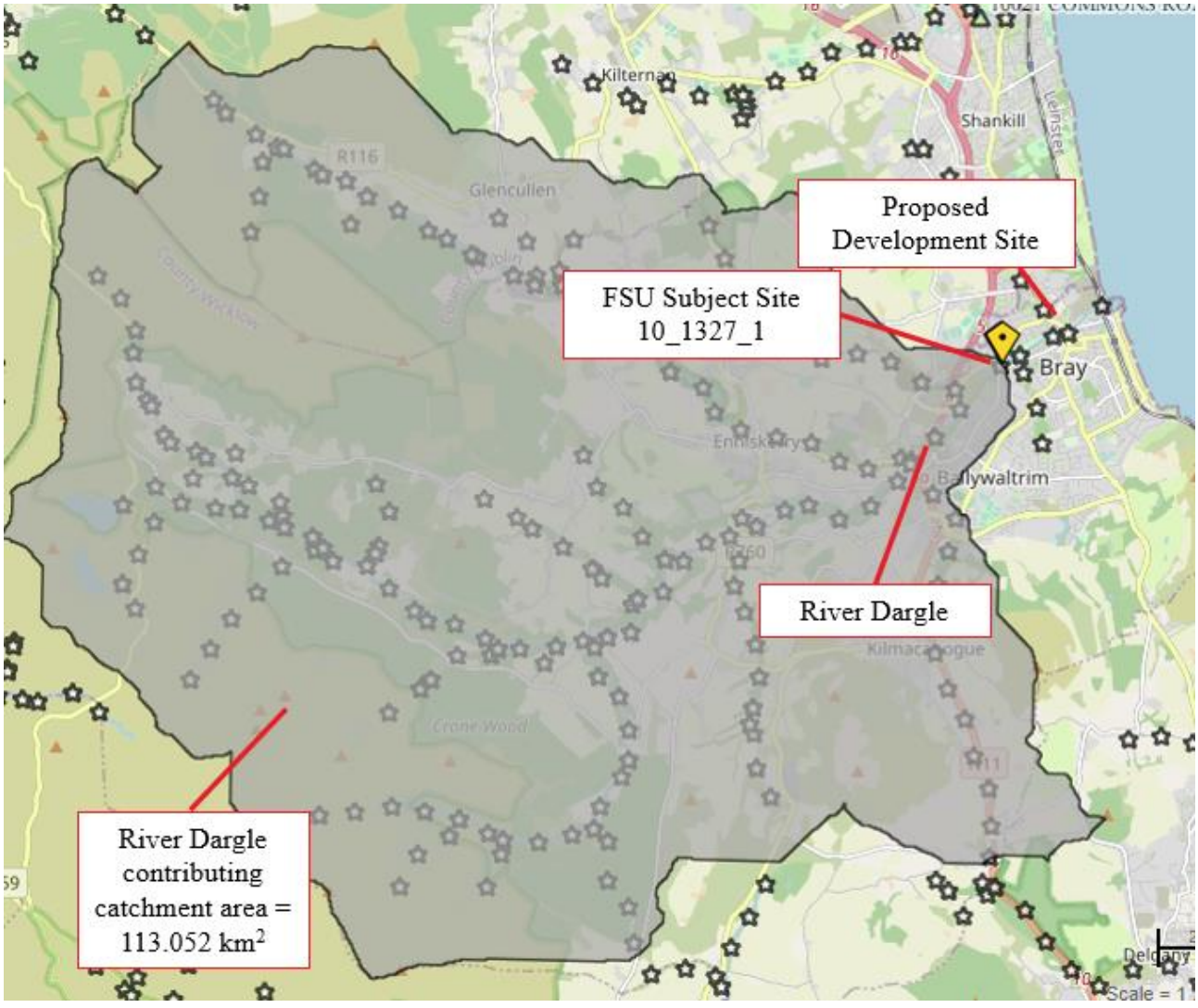

Figure D.1 - 7-1. River Dargle Subject Site (10_1327_1) Location and Catchment

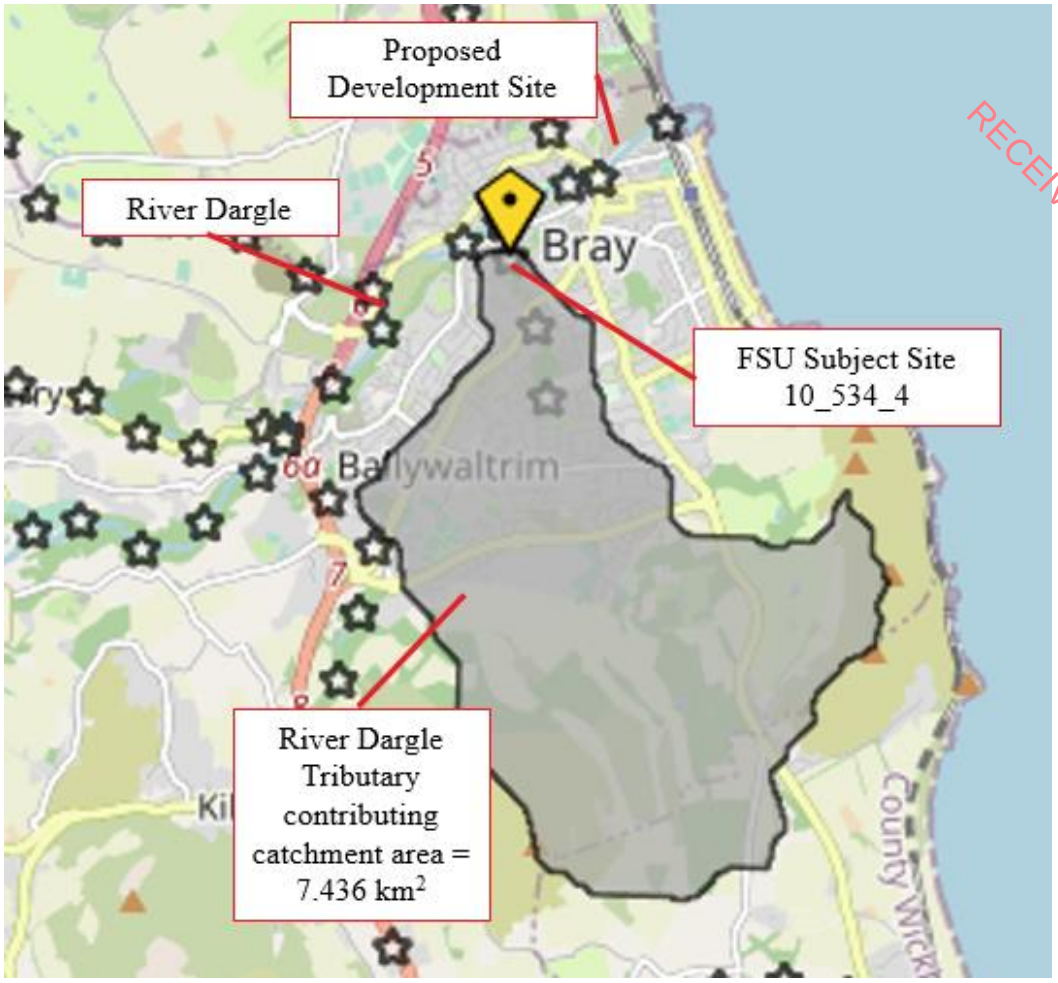

Figure D.1 - 7-2. River Dargle Tributary (Swan River) Subject Site (10_534_4) and contributing catchment

D.1.1.2 Pivotal Site Selection

The subject site location does not have any pivotal sites located upstream or downstream of the subject site on the same river; therefore, it was necessary to evaluate between candidate pivotal sites from other catchments to determine the pivotal site which provided the most hydrological similarity as calculated by the FSU hydronet portal.

Syngefield Station (St. No. 25022) was selected as the pivotal site because the site was the second-closest in hydrological similarity, had the smallest centroid distance, and had physical catchment parameters that remained the most in bounds with respect to the other candidate sites.

D.1.1.3 Q_{med} Estimation

The Q_{med} value or index flood value was calculated based on catchment characteristics and the annual maximum flow series data from the pivotal site. An adjustment factor was applied to the calculated Q_{med} value derived from the ratio between the subject site Q_{med} and the pivotal site Q_{med}. An additional Factorial Standard Error (FSE) was applied to the Q_{med} depending on the calculation method used for each catchment (1.37 for the FSU 7-variable equation and 1.686 for the FSU 5-variable equation). These values are recorded in Table A.1.1.

Table A.1.1. Q_{med} Calculations

Subject Site	10_1327_1 (River Dargle)	10_534_4 (Swan River)
River Dargle QMED (m^3/s)	29.679	0.672
Pivotal Site Qmed (m^3/s)	31.2	31.2
Pivotal Adjustment Factor	1.213	2.489
Factorial Standard Error	1.37	1.686
Adjusted Qmed (m^3/s)	49.31	2.82

D.1.1.4 Pooled Flood Frequency Analysis

The flood frequency curve was calculated by the FSU software and the GEV distribution was applied. Table A.1.2 and Table A.1.3 report the growth factors and associated flows for the two subject sites.

Table A.1.2 Growth Factors and Design Flood Values for Subject Site 10_1327_1 (River Dargle)

Return Period	Growth Factor (pooling)	Design Flood
Q1	0.83	40.93
Q2	1	49.31
Q5	1.24	61.14
Q10	1.38	68.05
Q20	1.51	74.46
Q50	1.66	81.85
Q100	**1.76**	**86.78**

For the River Dargle flows, it was necessary to account for the downstream area of the catchment (between the estimation point and Bray Harbour) not included in the subject catchment area. The Q100 peak value was therefore adjusted to match the peaks found at the ungauged estimation location 10_1275_2 (Bray Harbour) and therefore increased from 86.8m^3/s to **89.8m^3/s**.

Table A.1.3 Growth Factors and Design Flood Values for Subject Site 10_534_4 (River Swan)

Return Period	Growth Factor (pooling)	Design Flood
Q1	0.7	1.97
Q2	1	2.82
Q5	1.43	4.03
Q10	1.72	4.85
Q20	1.99	5.61
Q50	2.35	6.63
Q100	2.61	7.36

D.1.1.5 Calculation of Hydrographs

The FSU software calculates peak flow hydrographs using comparison of typical hydrograph shapes under a certain peak for a pivotal site.

The subject site selected is the same as the subject sites above, 10_1327_1 and 10_534_4. The pivotal site selected was White Bridge – 22009 which had a hydrological similarity of 0.6832. A deformation factor of 1 and a shape parameter *n* was set to 20.

Following production of the characteristic hydrographs, and in order to account for the downstream area of the catchment not included in the subject site catchment area, the hydrograph shapes were adjusted using triangulation of the rising and falling limbs to match the peaks found at ungauged estimation location 10_1275_2. Using triangulation, the volume of water underneath the curve was not altered significantly.

For the Hurricane Charlie event, the recorded peak flow at Bray Harbour was reported as 300 m^3/s. The hydrograph produced for station 10_1327_1 was scaled up and adjusted to produce this peak at Bray Harbour.

D.1.2 Production of Tidal Curves

Tidal peaks were obtained from the ICWWS Phase 1 Study as detailed in Section 4.1.2. The predicted tidal curve was obtained from the NE Atlantic Operational Model at Bray Harbour, which is a modelled, not observed point. The tidal curve was taken from 13/8/23 through 20/8/23, a period which covered the spring tide for August and represented the approximate time of year the Hurricane Charlie event took place. The mean high water spring tide (MHWS) was obtained from the Irish Marine Institute Dublin Port gauge. The difference between the ICWWS peak and the maximum level from the curve was taken for each tidal scenario: 200-year (0.5%AEP) , 2-year (50%AEP), and MHWS. This difference was then added or subtracted to the curve to generate the three tidal curves.

D.1.3 Joint Probability Scenarios

To account for the worst-case scenario, the hydrograph and tidal curves were adjusted so that the peaks coincide at the same time, generating the highest overall levels during any joint probability scenario. The combinations of tidal and fluvial events are described in Section 4.1.3.

D.2 HEC-RAS Modelling

The HEC-RAS model is a 2D mesh hydraulic model comprising 45,946 computation points. Development of the model involved the collation of multiple data sources including LiDAR terrain, topographical survey, cross-sectional data, land-use survey and calculated hydrological inputs.

D.2.1 Terrain and Topography

LiDAR DTM data from Murphys Survey was obtained in 2023 for the site and upstream area of the catchment as shown in Figure A.2.1. Inaccuracies within the LiDAR data due to sediment buildup required modification of the terrain according to levels specified in the cross-sectional surveys. This mainly affected the riverbed, which was reconstructed with a gradient, decreasing from 1.69m AOD to -0.5m AOD. The values reflect approximations of the cross-sectional survey while maintaining decreasing elevations towards Bray Harbour.

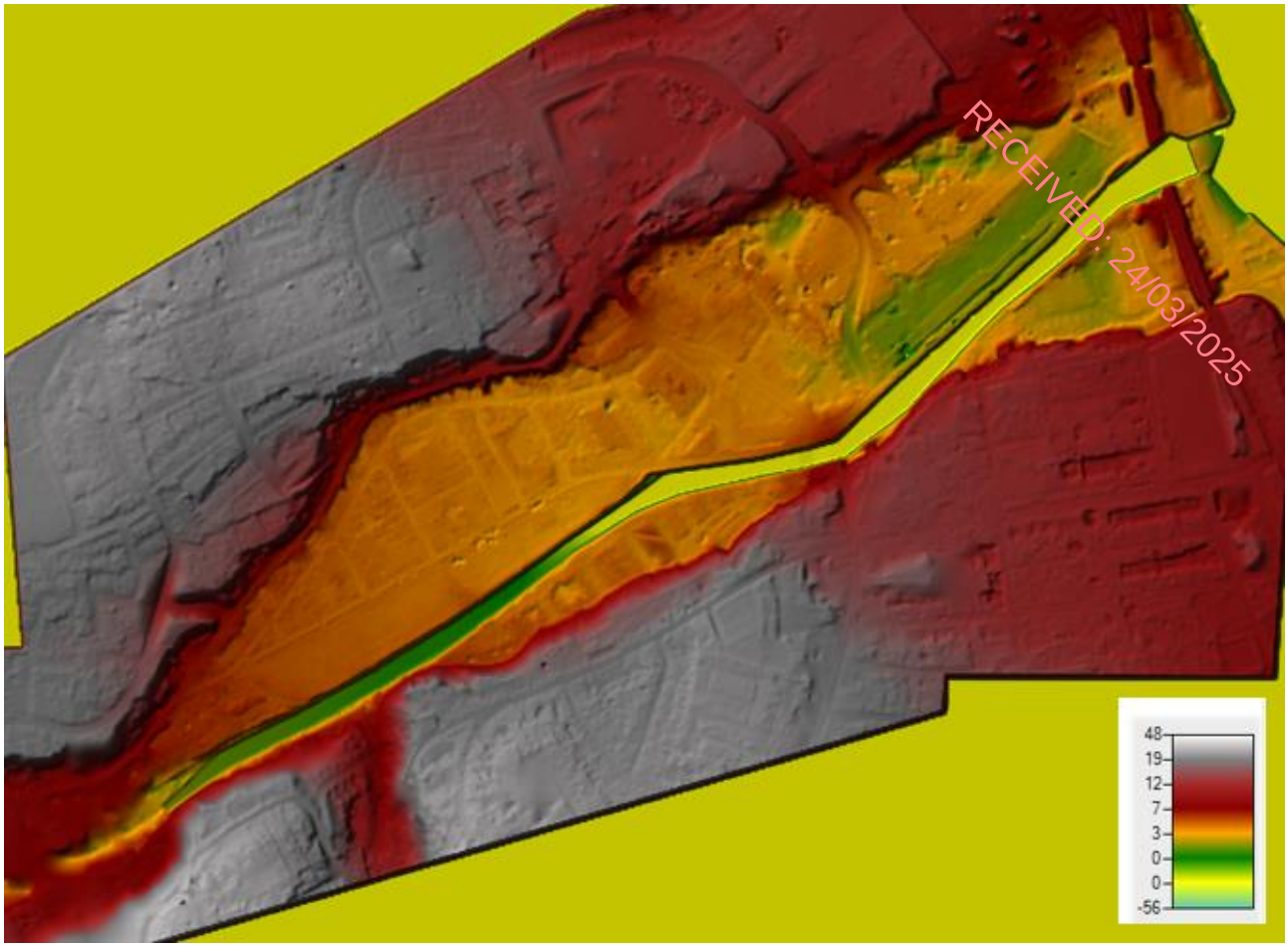

Figure A.2.1 Terrain modifications to bed level.

Topographical data was supplied for the regions shown in Figure A.2.2. Topographical levels were provided at lower resolution than LiDAR data, thus the topographical survey was used primarily to delineate the defences and levels for the defended scenario. Flood defences further upstream where topographical survey was not supplied were constructed using cross-sectional surveys.

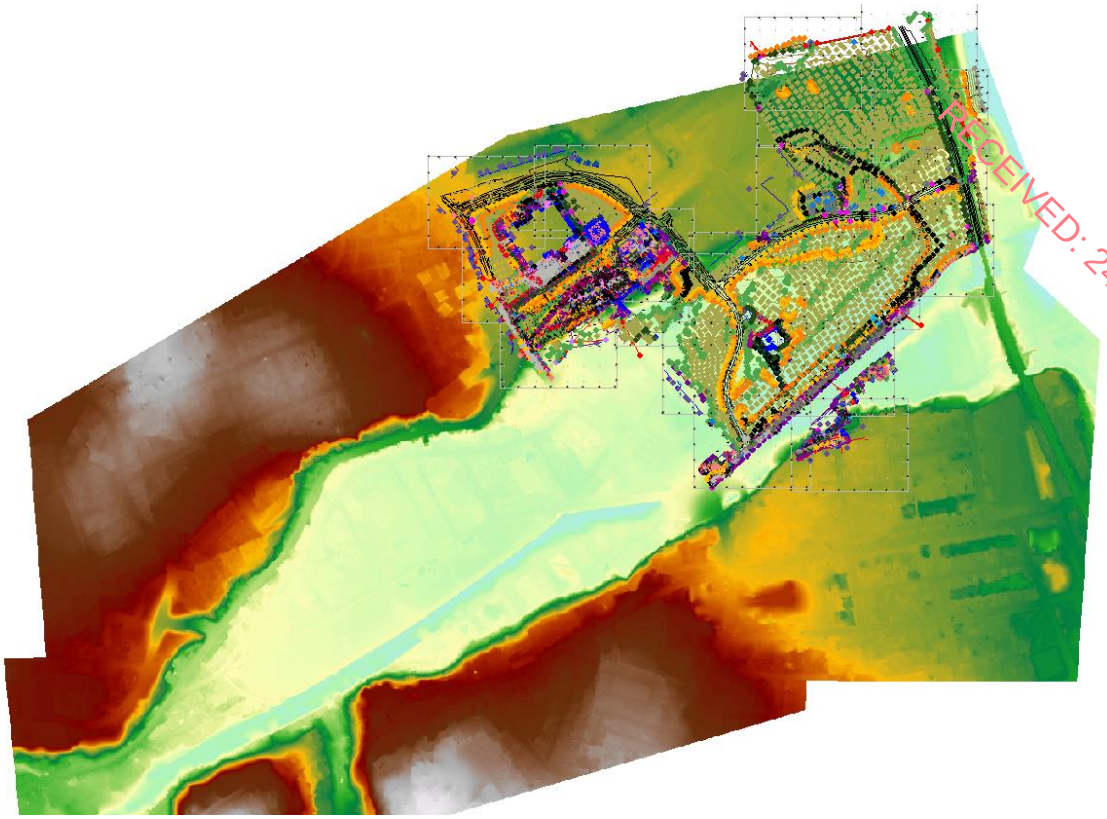

Figure A.2.2 Topographical survey overlaying LiDAR data.

D.2.2 Land Use

The River Dargle site on the southern border of the proposed development site and flows generally southwest to northeast at this location. The River Dargle catchment is approximately 121.85 km^2 when delineated at Bray Harbor. The catchment area above the site is predominantly rural, with most urban development occurring adjacent to the proposed site. The various land uses were modelled as 7 Manning's n categories shown in Table A.2.1, maps of which are shown in Figure for the existing scenario.

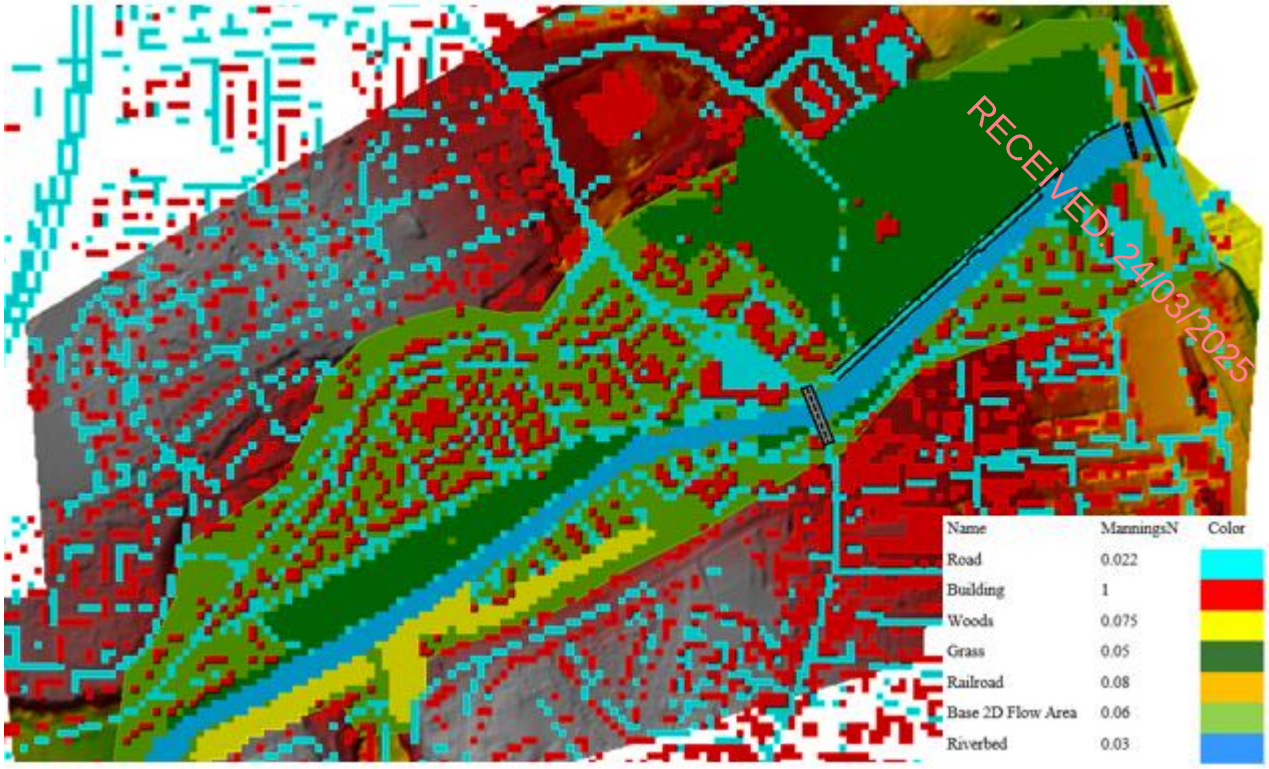

Figure A.2.3 Model Land Use Layer

Table A.2.1 Manning's N Values

Name	Mannings N	Colour
Road	0.022	
Building	1	
Woods	0.075	
Grass	0.05	
Railroad	0.08	
Base 2D Flow Area	0.06	
Riverbed	0.03	

D.2.3 Hydrological inputs

Hydrological conditions were applied through 5 boundaries as shown in Figure A.2.4. Upstream, hydrology was applied via hydrograph inputs through the upstream River Dargle boundary and the Swan River boundary.

At the downstream, the tidal stages were input on a boundary along the downstream riverbed. Two additional boundaries were located on the left and right banks to prevent glass walling. The normal depth boundary condition was applied at 0.004.

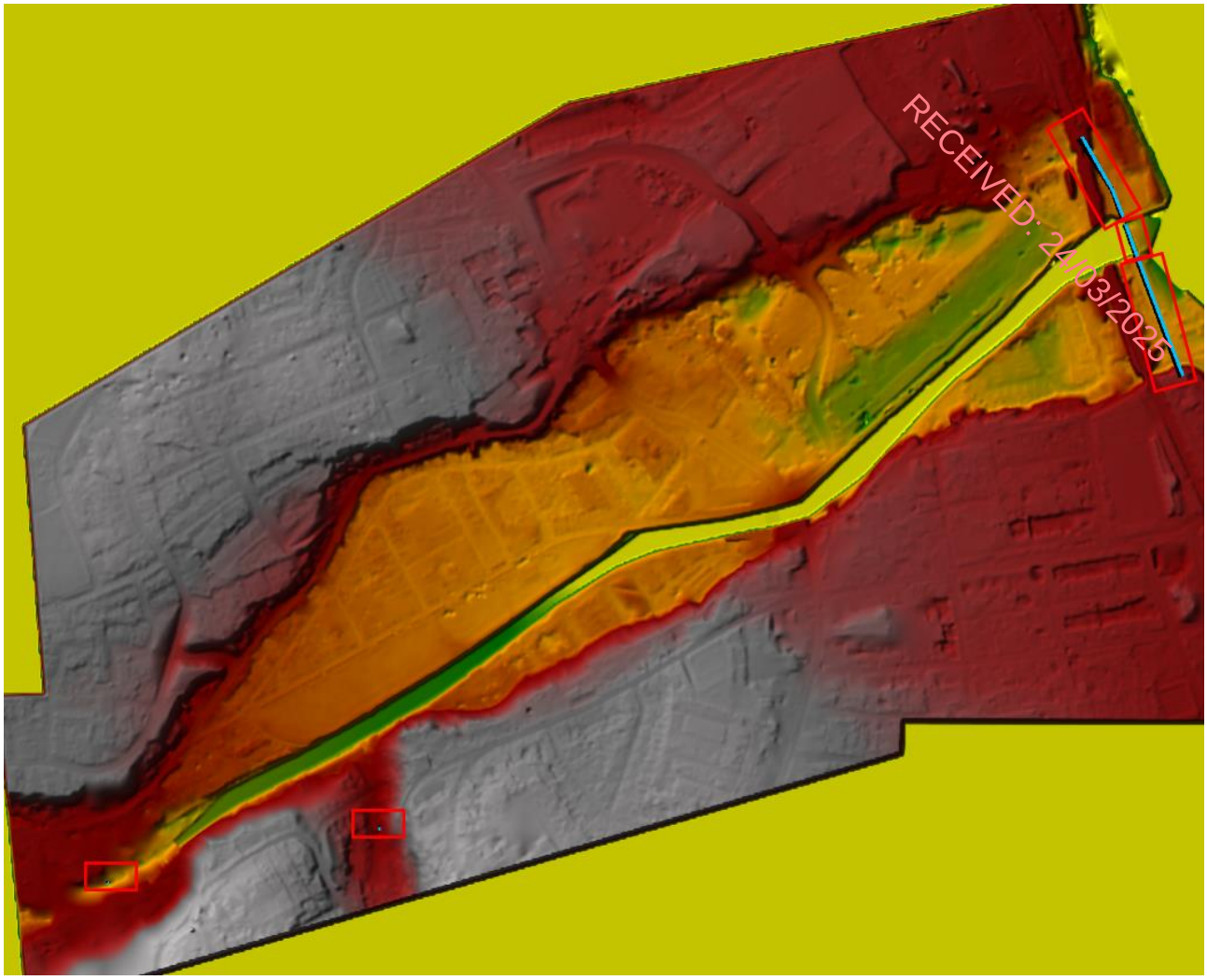

Figure A.2.4 Model Boundary Condition

ARUP

Shankill Property Investments Limited

Sea Gardens Phase 2

Flood Emergency Management Plan

Reference: 293308-ARUP-ZZ-XX-RP-C-0002

Final | 12 March 2025

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1. Introduction

1.1 Background

Shankill Property Investments Limited is seeking permission from Wicklow County Council (WCC) for the development of a proposed mixed-use development, including residential, retail/retail services, and commercial uses on the former Bray Golf Course lands in Bray, County Wicklow. The proposed development is part of the Harbour Point Masterplan, now Sea Gardens. Phase 1a of the masterplan is nearing completion, and planning permission for Phase 1b has recently been granted. The proposed development relates to the next phase of the masterplan, which is called Sea Gardens Phase 2.

Arup was requested to prepare a Flood Emergency Management Plan (FEMP) for the Sea Gardens Phase 2 development. The FEMP was requested following consultations with WCC and is intended to form part of the planning application for the development of the site.

The Sea Gardens Phase 2 site is located on a largely undeveloped plot within an urbanised area with several residential, industrial and commercial developments within a 1km radius. The site is bordered by the Ravenswell Primary School and Sea Gardens Phase 1 development to the north, the DART railway line to the east, Ravenswell Road to the south, and the Little Bray neighbourhood to the west. River Dargle flows from southwest to northeast at the south of the site.

Figure 1-1 Site location (Background aerial image: ©Google Earth)

The area is at a high risk of flooding due to its proximity to the sea and the River Dargle. An unprecedented historical flood in 1986, colloquially known as “Hurricane Charlie” is remembered in the public conscious due to extensive flooding in Little Bray and an estimated peak flow of 300 m^3/s at Bray Harbour. The River Dargle Flood Defence Scheme was completed in October 2017 in response to the risk of future flooding and consists of flood walls, embankments, a by-pass channel at the Fran O’Toole bridge, an upstream storage reservoir, and channel reconstruction to increase channel capacity and efficiency. The site is protected from flooding against the Hurricane Charlie fluvial event and the 0.5% Annual Exceedance Probability (AEP) tidal event. There has been no recorded flooding since the completion of the flood scheme.

1.2 Scope and Objectives

The main objective of the FEMP is to assist the facilities management in the implementation of an effective flood emergency response plan that will provide maximum safety to residents, visitors and other users and minimise damages to property as a part of discharging its regulatory duties as required in the Occupiers' Liability Act (1995). The FEMP outlines the responsibilities of all parties involved, actions to be taken, coordination arrangements and communication channels to be used prior to, during and after a flood event.

The contents of this FEMP must be disseminated by the Facilities Management section to staff and relevant parties and a copy must, as a minimum, be kept at the offices of the Facilities Management.

This FEMP should be reviewed at least once every three years or after a flooding event, whichever is earlier, to capture if conditions have changed since the last review. This plan should also be updated following development of the National Flood Forecasting and Warning Service by Met Éireann.

2. Flood Risk Assessment Summary

A Flood Risk Assessment (FRA) was prepared for the site by Arup for this planning application. A summary of the findings of the FRA is included below.

2.1 Source of Flood Risk

The site is at risk of tidal and fluvial flooding from the River Dargle. The site is benefitting from the River Dargle Flood Defence Scheme.

The Bray Municipal District LAP Strategic Flood Risk Assessment (SFRA) identifies areas at risk of flooding to the district using a number of data sources, and designates them in Flood Zones A, B and C, at high, moderate or low risk of flooding, as shown in Table 2-1. The Planning System and Flood Risk Management Guidelines (2009) state that flood defences should be ignored when determining flood zones. As such, whilst the site is protected by defences, it is located partially within Flood Zones A, B and C.

Table 2-1 Flood Zone Categories

Zone	Description
Flood Zone A	Probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding)
Flood Zone B	Probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 year and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 for coastal flooding)
Flood Zone C	Probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

Hydraulic modelling was undertaken as part of the Flood Risk Assessment (FRA) submitted for planning for the development. The modelling has confirmed the findings of the SFRA, showing the site is partially at risk of inundation during the 1% AEP fluvial event and the 0.5% AEP tidal event, when defences are not considered, the extents of these events are shown in Figure 2-1.

Figure 2-1 Flood extents for the 1% AEP fluvial flood event and the 0.5% tidal flood event (undefended scenario)

2.2 Protection Level

Under the River Dargle Flood Defence Works, the site is within the defended area designed to withstand the 1% AEP fluvial flood and the 0.5% AEP tidal flood events, plus allowances for climate change and freeboard. The defences were also designed to withstand Hurricane Charlie, which exceeds the 1% AEP fluvial event and therefore protects the site beyond the Planning Guidelines standards, with an extreme flood flow of 300m^3/s.

The Sea Gardens Phase 2 development is primarily defended by two parallel flood walls—a front wall set at 2.3m AOD and a back wall set at 4.54m AOD. Additionally, 6 circular culverts of diameter 1.35m were built under Ravenswell Road, just upstream of the rail bridge and fitted with non-return flap valves. These are located at the eastern part of the site and penetrate through both defence walls, and serve as a means to return water to the River Dargle should an exceedance event or breach of defences occur, as shown in Figure 2-2. A flood relief culvert was also constructed alongside the Fran O'Toole Bridge on Main Street to allow for increased flow capacity beneath the bridge during high flows.

The function of the site and culverts as means of conveying the flood water during an exceedance/breach event are important for the River Dargle Flood Defence Scheme. As such, the masterplan has been developed to respect this function.

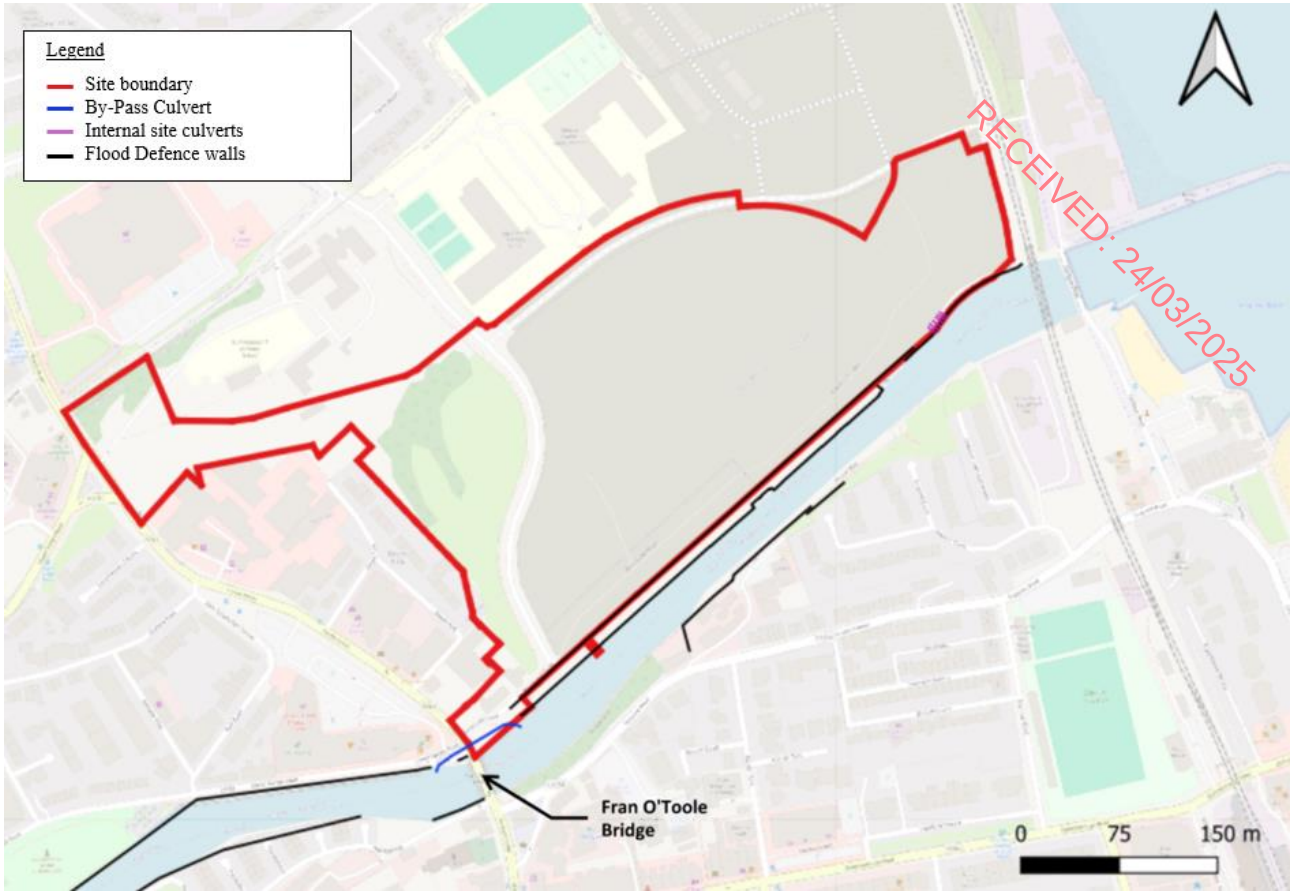

Figure 2-2 Flood defence measures and culverts along the River Dargle

2.3 Exceedance event

There is residual risk of flooding to Bray and the site from an exceedance event (event of higher magnitude that could overtop the defences) or breach of the defences.

The FRA completed along with this FEMP modelled an exceedance event, set at a fluvial flood peak of 380m^3/s, in order to understand the flow paths of floodwaters during such an event, design the masterplan in order to maintain these flow paths in and out of the site, and manage residual risk within the site.

During an exceedance event of the defended scenario, flooding of the site occurs largely due to overland flows from overtopping of the riverbanks upstream of the Fran O'Toole Bridge at People's Park (Little Bray). The flow path from Little Bray follows down through the SuperValu parking lot along R761 and through the gate at Dwyer Park where it first enters the site. This flow path is very similar to the flood path occurring during Hurricane Charlie.

From there, water is stored at the lower part of the site and returns to the river via a series of 6 culverts at the north-eastern part of the site, as demonstrated in Figure 2-3.

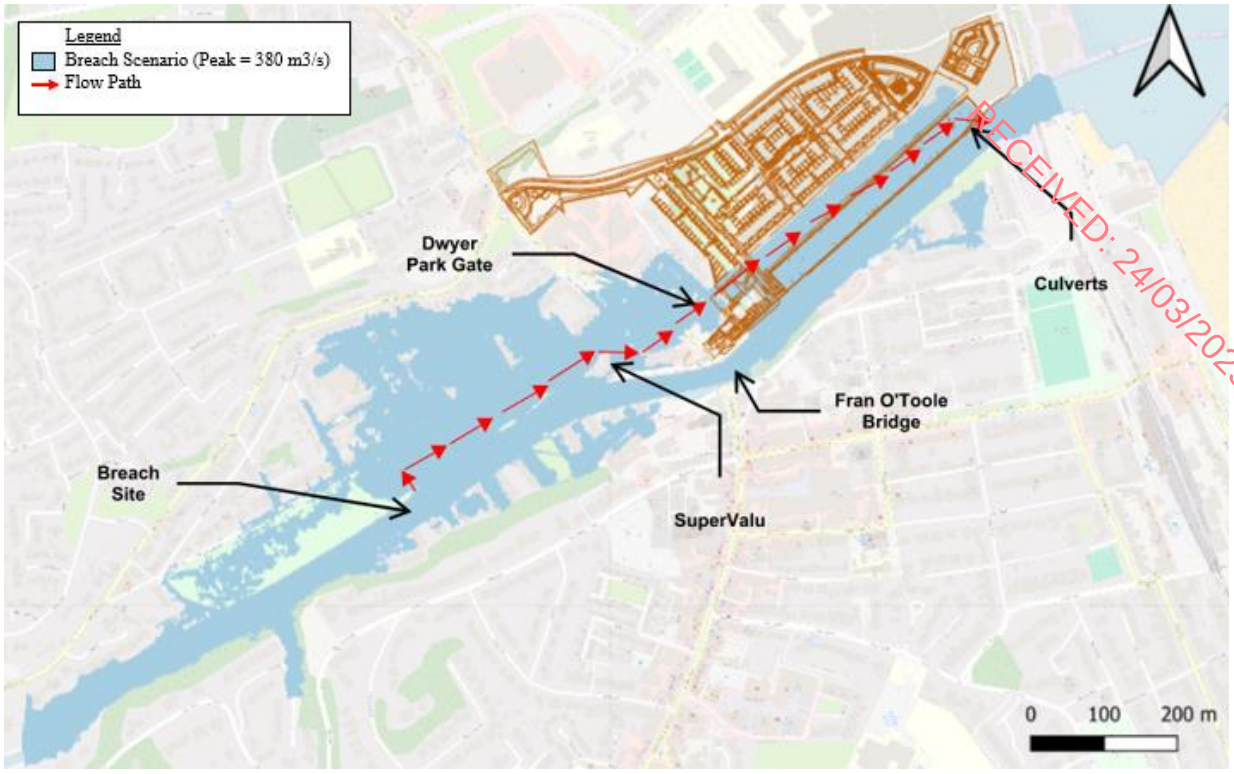

Figure 2-3 Fluvial flood extents for the exceedance event (380 m^3/s)

The proposed development has been set back from this flow path. Landscaping and the setting of the building levels have been undertaken in such a manner to ensure no impact on conveyance or storage of the natural floodplain between the undeveloped and developed scenarios, under the above exceedance event. A linear community park is proposed along the southern boundary of the masterplan development to provide space for the flood water to move through the site. The levels of the linear community park are designed to slope towards the 6 culverts that allow floodwater to drain back to the River Dargle when the tide is out, ensuring quick drying of the site following an exceedance event.

2.4 Potential Impact of Flooding

The proposed development will include 341 no. residential units, consisting of a mix of houses, duplexes, and apartments (Blocks E and H) and c. 18,300 sq.m of mixed uses consisting of a hotel (Block I), a childcare facility, a medical centre, and retail/retail services and commercial units distributed in Blocks E, G, H and I. In addition, it will provide for all associated and ancillary development and infrastructural works, including the provision of hard and soft landscaping, open spaces, and boundary treatments. Ancillary car and bicycle parking will be provided at surface and undercroft levels, and a new internal pedestrian, cycle and vehicular network will connect the development with adjoining developments and roads. The sitewide masterplan is shown in Figure 2-4.

The housing development located north of the community park is set back from areas at risk of flooding during the exceedance event, and above the flood protection level. This is shown in purple and marked with Number 1. No further mitigation measures will be required at these areas.

The linear community park is a conveyance route for floodwater during an exceedance event. Flooding may impact the landscaping and wash in debris, which will settle in the park when water levels recede. Cleanup procedures will be necessary.

Block G (retail unit) is proposed within an area at risk of inundation during the exceedance flood event. The retail unit spaces located within Block G have finished floor levels set between 2.5m AOD to 4m AOD. Two of the units are above the flood protection level of 3.5m AOD (marked in orange and numbered with 2 in Figure 2-4) and do not require any further protection. Three of the retail units are set at 2.5m AOD, 3.0m AOD and 3.25m AOD (marked in pink and numbered with 3 in Figure 2-4). These ground floor levels are set below the flood protection level and as such flood waters could enter the retail units, if no demountable barriers were deployed, causing damage to the retail spaces and stock.

The block has been placed within the masterplan in such a way so as to avoid obstruction of the flow path from Dwyer Park. To prevent flood risk inundation to the three units with lower ground floor levels, demountable barriers are proposed at their entrances. The location of these are shown in Figure 2-5.

Site-specific flood protection measures to reduce the impact of exceedance flooding to the development are described in Section 3.2.

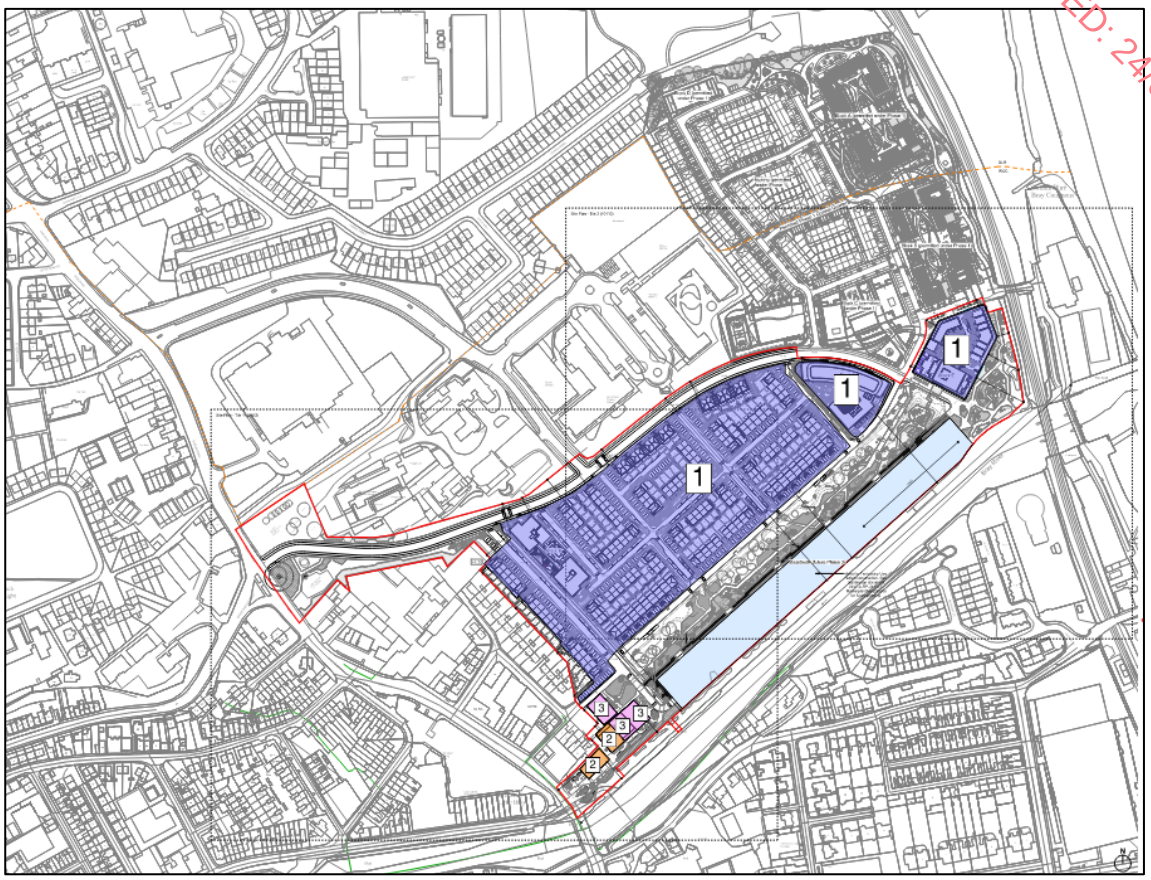

Figure 2-4 Masterplan indicating areas with raised development levels or other flood protection measures

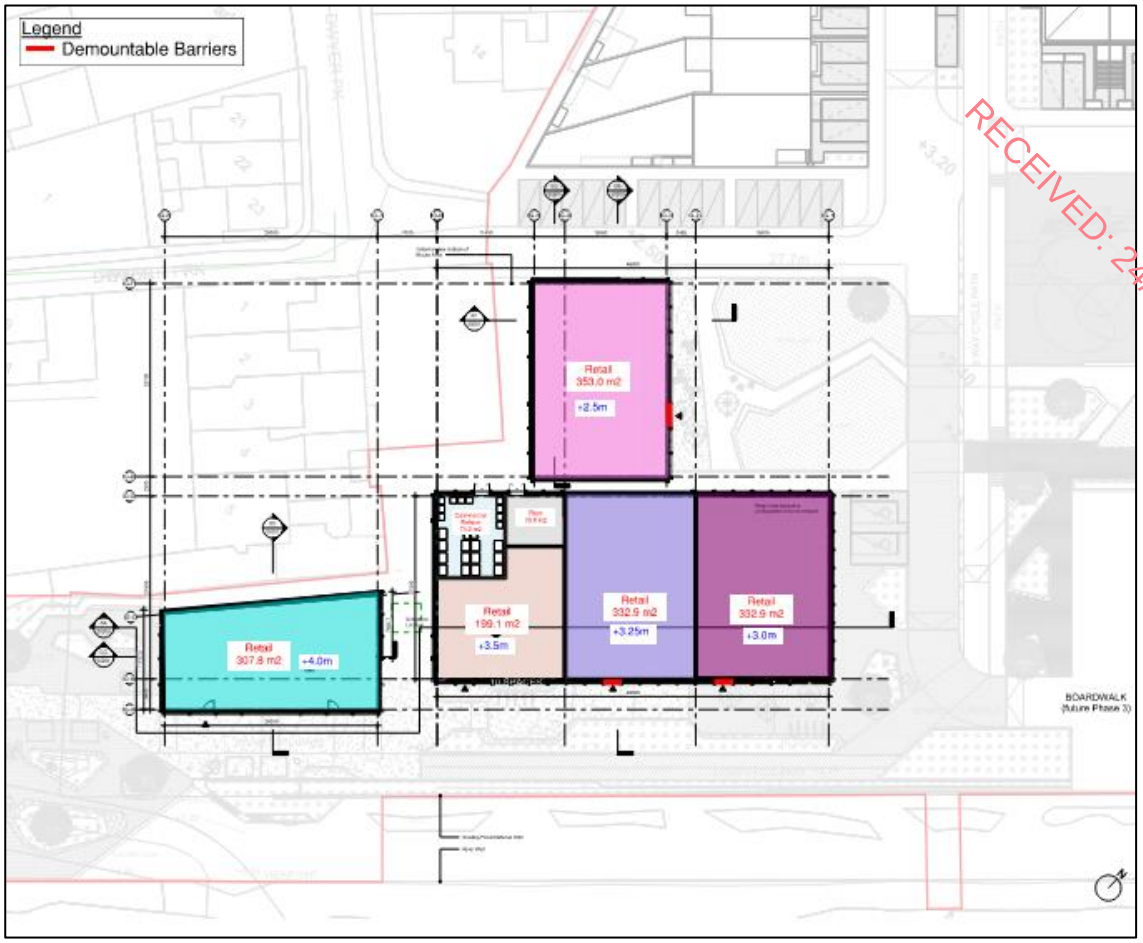

Figure 2-5 Detailed architectural drawing of Block G levels and location of demountable barriers

3. Mitigation Measures

3.1 Bray Mitigation Measures

Bray Municipal District has published the Bray Flood Emergency Plan in 2008 detailing the four stages of flood warning, the agencies mobilised during the event, communication channels, traffic management, and evacuation routes. The emergency plan was prepared before the River Dargle Flood Relief Scheme was put in place and is currently being updated. Information on the updated plan is currently being sought through the council.

According to the plan (2008), there is no automatic flood warning system for Bray. The Flood Assessment Manager and Local Authority are the primary agencies responsible for initiating the flood action plan through changes to the River Flood response stage. Met Éireann is the primary source of information regarding weather warnings and forecasts used to make decisions regarding flood response.

3.2 Site-Specific Measures

The site has been designed to mitigate and reduce potential damage and risk during an exceedance event. This has been accomplished through the maintenance of existing flow paths. Floodwaters enter the western end of the site through the gate at Dwyer Park and enter the linear park horizontally spanning the development.

The linear park has been designed at such levels to channel water away from the northern housing developments and towards the existing six 1.35m diameter culverts fitted with non-return flap valves in the southeastern corner of the site which will allow water to re-enter the River Dargle during low tide and prevent water from ponding within the development.

The majority of the development is located outside the flood extents and raised above the flood protection level. The flood protection level is set as the 0.5%AEP tidal event, with 300mm freeboard, in line with the Wicklow County Council Strategic Flood Risk Assessment (WCC SFRA). This level is at 3.5m AOD. Climate change allowances are not made, as the site is protected by direct defences that allow for climate change.

The ground floor levels of the retail units located in the southwest of the site increase from 2.5m AOD to 4m AOD, with higher levels towards the west and levels decreasing to meet the linear park to the east. The three units set at 2.5m AOD, 3.0m AOD and 3.25m AOD are at risk from flooding during an exceedance event. A water exclusion strategy will be followed, were demountable barriers will be erected during potential flooding events and construction strategies shall be employed in the design to prevent water seepage, maintain structural integrity, and reduce residual risk if water were to enter by facilitating draining and drying.

Maintenance of the development is essential in order to retain site mitigation measures during an exceedance event. The linear park should be maintained in accordance with the landscape plan and site levels should not be increased to maintain the conveyance capacity of the park. The culverts and culvert flaps should be inspected and maintained annually to remove debris and ensure the function of the structure. Finally, the flow route north of the retail space from Dwyer Park in the southwestern corner of the site must be maintained. No additional structures shall be placed within the flow path, such that exceedance flows are not impeded.

Maintenance for the demountable barriers must also be organised to ensure an effective strategy. Spare components for flood barriers such as bolts or screws should be available on site at all times in an accessible location to those designated to erect the flood barriers. Annual test runs of barrier erection should be organised by development management and maintenance plans should be carried out in accordance with the barrier manufacturer's specifications. Barriers should be stored onsite, in easy-to-access locations, preferably within the interior locations where they are needed.

4. Flood Risk Warnings

Bray relies primarily on the national extreme weather warnings issued by Met Éireann (Irish Meteorological Service). The Met Éireann system includes operational river flood and coastal forecast integrated models at the national and catchment level, as well as a communication strategy for releasing flood advisories and alerts. Advisories are available 3 days in advance on the Met Éireann website. The service is available 24 hours a day, 7 days a week, 365 days a year.

The Sea Gardens Phase II site is within the jurisdiction of the Wicklow County Council (WCC) and the Bray Municipal District. The WCC Major Emergency Plan and the Bray Flood Emergency Plans should serve as the basis for actions taken in the event of a flood emergency. It should be noted that the plan was prepared before the River Dargle Flood Defence Scheme was constructed and the updated plan is not publically available yet.

The River Dargle real-time water level is regularly monitored and reported at Ravenswell Road (Station 00000010062) on waterlevel.ie. Data is reported for the previous 5 weeks at a 15-minute timestep, with updates to the website every hour. The station is operated by the Office of Public Works (OPW).

Bray Municipal District has established a set of 4 alert stages and identified the response agencies mobilised under each stage as described in Table 4-1.

Table 4-1 Bray Municipal District Flood Action Response Stages

Stage	Level	Action	Personnel	Description
All Clear	1			No imminent likelihood of flooding. Time, training and testing of the plan should be carried out. Awareness of flooding issues should be understood by community.
Flood Watch	2	Informed	Civil Defence Gardaí Fire Service	Severe weather warning with high water levels expected is issued by Met Éireann. No imminent risk to property is identified. Bray Municipal District Flood Operations Manager and Flood Warning Manager are activated.
Flood Imminent	3	Begin Mobilisation	Civil Defence Gardaí Fire Service Wicklow County Council Health Services Executive (HSE)	Possible flooding and damage to properties and roads is expected. The Bray Flood Operations Manager and Flood Warning Manager are activated.
Severe Flood Warning	4	Mobilised	Bray Municipal District Civil Defence Fire Service Gardaí Wicklow County Council HSE Defence Forces (Army)	Extensive flooding of properties and major threat to life is expected. Evacuations may be required and assistance from organisations outside of the imminent area may need to be called upon.

4.1 Warning Lead-time

The estimated lead-time provided by Met Éireann is approximately 3 days when issuing official advisories. However, flood forecasts are provided at 5-day lead times for fluvial and coastal flood risk. Wicklow County Council has developed ‘eAlerts’ in conjunction with Met Éireann to issue warnings within the county which should be monitored by the Flood Manager. The catchment has a relatively short and ‘flashy’ response time during heavy rainfall periods and the Flood Manager must be kept up to date on weather forecasts in order to trigger flood alert actions when needed.

In addition to quantitative measures, a physical indicator has been identified to aid the Flood Manager in triggering the flood alert actions. The River Dargle Flood Defence Scheme has been designed to withstand the Hurricane Charlie event flows. In the case of an exceedance event, the river water level will rise and begin flooding the pedestrian path between the two flood defence walls at the southern border of the site. The Flood Manager should monitor flooding occurring on this path as well as the water levels updated on Ravenswell Road (Station 00000010062). Once water levels have reached 2.8m AOD and the pedestrian path is flooded by approximately 0.5m, the Flood Manager should trigger additional flood alert actions as detailed in the following section. The water level of 2.8m AOD represents the point when a significant amount of flow has occurred (250m^3/s) and allows a lead time of approximately 5 hours before overland flows could potentially reach Block G. Additionally, it is an event which is clearly visible on the pedestrian path between the defence walls at the southern border of the site, with approximately 0.5m of flooding.

4.2 Flood Alert Actions

In the event of a severe weather warning issued by Met Éireann for the site area and its surrounding catchment, the following steps shall be taken:

1. Monitor Met Éireann warnings to understand severity and potential worsening of conditions.
2. Monitor real-time water levels of OPW Hydro-Data gauge at Ravenswell Road (Station 00000010062). If the water level reaches 2.8mOD, the emergency management actions for Block G are triggered. If severe weather alerts are received prior to the end of the working day, such that flooding may occur overnight, a cautionary approach should be taken and the demountable barriers should be erected before closing the units for the evening.
3. Owners, staff, and patrons of Block G should be notified their business/retail sites must be closed and all persons should evacuate following the safe egress route.
4. The Flood Warder of each retail unit is responsible for erecting demountable barriers at the Block G locations which fall beneath the flood protection level of 3.5m AOD.
5. The Flood Manager monitors the information and warnings issued by Bray Municipal District, Wicklow County Council, and Met Éireann. Once the severe weather warnings have been lifted, floodwaters have receded from behind the flood defence walls, and the site is determined safe for access, the Flood Manager may issue the 'all clear', triggering the removal and storage of the demountable barriers, and allow access for persons into Block G.

4.3 Flood Alert Responsibilities

The overall responsibility of managing flood event notices, the coordination of flood warnings, and evacuation procedures lies with the Facilities Manager who will be assigning his/her deputies: Flood Manager, Assistant Flood Manager and Flood Wardens, as appropriate.

The **Facilities Manager** is responsible for:

- Maintaining flood demountable barriers and keeping them in working order;
- Undertaking trials of flood defence deployment at least once a year;
- Ensuring there are enough staff trained to deploy flood defences in case back up is required;
- Notifying all residents and commercial personnel of flood warnings;
- Notifying retail units personnel of the times the flood defences are expected to remain erected, or as soon as possible in an emergency;
- Keep this FEMP up to date.

The **Flood Manager** is responsible for:

- Receiving Wicklow County Council and/or Bray Municipal District warnings;
- Regularly monitoring WCC website for any alerts;
- Regularly monitoring water levels of the River Dargle on www.waterlevels.ie and notifying patrons and staff of Block G retail units when an evacuation alert is issued;
- Keeping the Flood Register up to date;
- Keeping a record of vulnerable occupiers in the residential properties or vulnerable staff in retail units;
- Collecting information from the flood wardens during an emergency and for communicating with the emergency services upon arrival, if required.

Flood Wardens are responsible for:

- Deploying the demountable flood barriers;

- Assisting on evacuation, if required, by supporting users of the retail spaces, to evacuate before a flood event, and follow egress evacuation routes.
- Assessing any damage from flood events and putting in place a cleaning/drying plan.

4.3.1 Contact Details of Responsible Personnel

Table 4-2 lists the contact details of personnel responsible for the purpose of the Flood Emergency Management Plan.

Table 4-2 Emergency Response Team Contact List

Role	Name	Address	Tel/Mobile	Emergency Contact No.
Facilities manager				
Flood Manager				
Flood Warden				
Flood Warden				
Flood Warden				

4.3.2 Vulnerable People

The Flood Manager will be responsible for keeping a record of vulnerable occupiers and persons with disabilities to facilitate assistance during the flood if required. If on the day of evacuation, a person with a health condition or impairment needs assistance in evacuation, they must make themselves known to the Flood Management team who will organise the preparation of a Personal Emergency Evacuation Plan (PEEP). The Flood Manager will ensure that appropriate arrangements are put in place to make the required assistance available in an evacuation.

4.3.3 Key Services Control Locations

If possible, confirm controls for these services are located above flood level or sealed (with expanding foam or similar) for the three retail units at risk of inundation.

Table 4-3 Key Services Control Locations

Description	Current Location	Remark	Emergency Contact No.
Electricity		Above flood level	
Gas/Heating system		Above flood level	
Water		Closed cell insulation	
Sewer/drainage system		Non-return valves + maintenance to ensure effectiveness	
Communication lines (tele, TV, Internet)		Insulation in the ducts	

Table 4-4 Valuable Materials and Equipment Locations

Description	Location	How to protect them from flood
First Aid Kit		
Defibrillator		

Description	Location	How to protect them from flood
Chemicals (including cleaning products)		Should be stored above flood protection level of 3.5m AOD.
Vehicles	East of entrance from Dwyer Park	Alert residents that vehicles must be moved to higher ground when issuing warnings

5. Safe Egress and Evacuation Routes

5.1 Evacuation Procedure

The Masterplan has been designed to ensure evacuation is a last resort for residents, as the finished floor levels have been set above the flood protection level. If an evacuation alert is issued for the Block G three exposed retail units, staff and patrons should follow roadways towards higher ground to the north. In case of a medical or other emergency coinciding with an extreme flood, residents of duplexes/houses to the north of the linear park may follow routes to safety towards the north as marked in Figure 5-1.

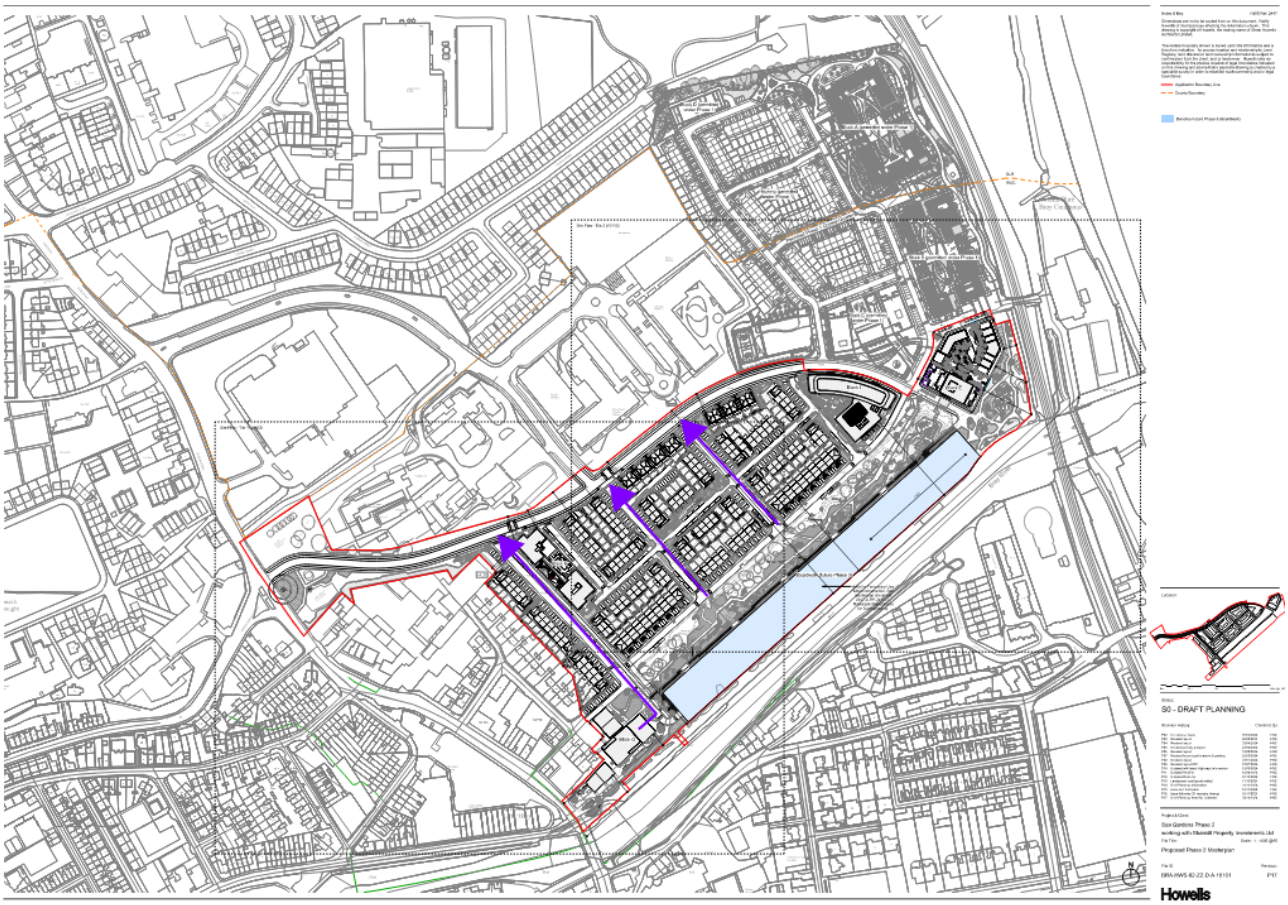

Figure 5-1 Emergency Egress Route (egress directions shown via purple arrows)

5.2 Action Post Evacuation

5.2.1 Emergency Services

When evacuation is over, there may be a need to contact the Bray Municipal District or Wicklow County Council Emergency help lines with the below numbers if further assistance is required.

- Wicklow County Council out-of-hours emergency service: (01) 291 6117
- Bray Municipal District out-of-hours service: (01) 291 0911

The Council will have a response plan which may include a temporary Rest Centre where evacuees can rest and receive assistance as required. It may not be possible to return to the affected areas even after the flood subsides. Adequate time must be allowed for clean-up and re-establishment of services.

It must be remembered that flood water can be dangerous to health as it may be contaminated with sewage, oil, chemicals, or other hazardous substances and residents must be encouraged not to come in contact with the flood water.

6. Action Post Flood

6.1 Flood Register

A Flood Register is to be prepared and kept up to date by the Flood Manager after a flood event. Issues encountered during evacuation, i.e., related to warnings issued, evacuation procedure, coordination, duration of the flooding, any injuries, or damages to property, etc. must be recorded. Also important is to record the time taken to return to normal use. This information will help modify procedures or update the plan as required.

It is also useful to keep a register of people who have assisted in the:

- Installation of flood barriers
- Transportation of equipment materials to a safe place
- Provision of emergency or medical support, etc.

6.2 Training

Flood Wardens shall attend internal training on how to deploy and maintain existing flood defences in case of an emergency before taking the role.

Trials of flood defence deployment shall be undertaken at least once a year.

7. Document Control

A paper copy of this FEMP must be available at the facilities office and kept up to date to maintain safety at its highest. It should be shared with the owners and staff of the three retail units at risk of inundation. It should be reviewed at least once every three years or after a flooding event, whichever is earlier. If any of the site conditions changes in a way that is relevant to the Plan, an update must be completed. This plan should be updated following development by Met Éireann of the National Flood Forecasting and Warning Service as the service matures. Responsibility for this lies with the Facilities Manager.