TECHNICAL NOTE 1

DATE:	23 June 2023	**CONFIDENTIALITY:**	Confidential
SUBJECT:	FEC Red Bank Hydraulic Modelling		
PROJECT:	Red Bank	**AUTHOR:**	Julia Chambers
REVIEWER:	Lee Garratt	**APPROVER:**	Lee Garratt

INTRODUCTION

Overview

WSP have been commissioned by FEC to undertake flood modelling for the Red Bank development in Manchester. As part of Housing Infrastructure Fund (HIF) works, Arup developed a baseline model of the River Irk, which flows through the development site. Full details of the baseline model developed by Arup are provided in the technical note[1] that accompanies the baseline model, which is provided in Appendix A. The Arup baseline model was approved by the Environment Agency (EA) in November 2022. WSP have used the Arup baseline model as the basis for the flood modelling associated with the Red Bank development, which will support the two planning applications being submitted by FEC in April 2023. This technical note describes the hydraulic modelling undertaken to inform both planning applications.

The EA have done initial reviews of the models used to inform both planning applications between January and March 2023 and subsequently, where necessary, the models have been updated as well as this modelling technical note based on the EA review.

FEC Detailed Planning Application (Application 5)

FEC are seeking detailed planning permission from Manchester City Council (MCC) for plots NT02, NT03 and NT04 (hereafter referred to as 'application 5') within the Red Bank area as shown on Figure 1. The detailed plans for the proposed development within 'application 5' are provided in Appendix B, planning permission is being sought for the design as shown on these plans and therefore the development as shown on the plans has been tested within a hydraulic model to understand the impact on flood risk, inform emergency access and egress plans for the development and set Finished Floor Levels (FFLs) of buildings within the development. The Red Line Boundary (RLB) of the 'application 5' development has been provided in shapefile format within Appendix B. As well as the building plots and associated public realm, there are proposed changes to Dantzic Street in front of the NT02-04 plots including changes to the road levels and provision of a cycle route. Details of the proposed changes on Dantzic Street are show on drawing RDB-WSP-XX-XX-DR-TP-020 in Appendix B.

The flood design event for 'application 5' is the 1% Annual Exceedance Probability (AEP) + 35% climate change allowance in line with the latest guidance for flood risk assessment[2]. The proposed development is a residential lead mixed use development comprising of a mid to high rise buildings with a variety of uses at ground floor level and mainly residential uses at first floor level and above. Therefore, although the development mainly has 'less vulnerable' uses at ground floor level it is considered to be a 'more

[1] Victoria North Rivers. 2022 Hydraulic Modelling Update – Rev 5. Job No. 281943-28. File ref. 4-05-02. Date: 17th November 2022

[2] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#when-to-use-climate-change-allowances

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vulnerable' development due to its residential nature, therefore applying the central climate change allowance for the 2080s to the 1% AEP event is appropriate. The River Irk is within the Irwell Management Catchment, the central climate change allowance for the 2080s is 35%, the higher central allowance for the 2080s is 46% and the upper end allowance for the 2080s is 75%. The flood risk with the development in place has also been tested for the 1% AEP event plus 75% climate change allowance (upper end) in the hydraulic model as well as the following events; 20% AEP, 3.33% AEP, 1% AEP and 0.1% event to understand the full picture of risk with the development in place.

FEC Outline Planning Application (Application 4)

An outline planning application will also be submitted by FEC in March 2023 to Manchester City Council (MCC). The outline application (hereafter referred to as 'application 4') includes several plots labelled as 'RB' (Red Bank) where residential lead development is planned as well as public realm areas throughout the Red Bank area where landscaping is proposed. A number of the 'RB' plots sit on an area known as the plateau, which is approximately 10m higher than the floodplain of the River Irk and therefore not at flood risk. Five of the proposed 'RB' plots do sit within the floodplain; RB06, RB07, RB10, RB16 and RB17, these are shown on Figure 1. As 'application 4' is an outline application, there are not detailed design drawings for this development yet. Planning application is being sought based on the parameter plans for this development, the parameter plans are provided in Appendix C, the building footprints in Plan 1 have been used to assess the impact of the proposed building on flood risk within the area. The hydraulic model represents the maximum potential development footprint of the 'application 4' development.

An illustrative masterplan for 'application 4' has been developed but planning permission is not being sought for this within the outline application. However, it should be noted that potential flood mitigation options to offset the impact of the buildings within the floodplain are based on the illustrative masterplan and this has been used to inform ground levels of the proposed mitigation within the hydraulic model to enable the development public realm levels to tie in with building levels and existing surrounding ground levels. The illustrative masterplan is provided in Appendix C.

The flood design event for 'application 4' is the 1% Annual Exceedance Probability (AEP) + 35% climate change allowance in line with the latest guidance for flood risk assessment[2]. The proposed development is a residential lead mixed use development comprising of a mid to high rise buildings with a variety of uses at ground floor level and mainly residential uses at first floor level and above. Therefore, although the development mainly has 'less vulnerable' uses at ground floor level it is considered to be a 'more vulnerable' development due to its residential nature, therefore applying the central climate change allowance for the 2080s to the 1% AEP event is appropriate. The River Irk is within the Irwell Management Catchment, the central climate change allowance for the 2080s is 35%, the higher central allowance for the 2080s is 46% and the upper end allowance for the 2080s is 75%. The flood risk with the development in place has also been tested for the 1% AEP event plus 75% climate change allowance (upper end) in the

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hydraulic model as well as the following events; 20% AEP, 3.33% AEP, 1% AEP and 0.1% event to understand the full picture of risk with the development in place.



Figure 1 Development plot locations

DATA COLLECTION

Data Collected

Table 1 shows the data collected to inform the hydraulic modelling for both the 'application 4' and 'application 5' developments. No watercourse topographic data was collected as part of this assessment as topographic data of the River Irk was collected in January 2022 and used by Arup to update their Baseline model. The topographic survey in 2022 included a significant number of cross-sections on the River Irk through the reach of interest in this assessment. There were no recommendations made by the EA to undertake any additional topographic survey following their review and approval of the Arup Baseline model. WSP reviewed the Arup Baseline model and found that there was sufficient detail through the Red Bank area provided by the cross-sections included in the model.

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Table 1 Data Collected

Data	Source
Arup Baseline model of River Irk and Moston Brook, 2022	Environment Agency
Existing site topographic data (*PS-2158-TS-00.dwg*)	Schulze + Grassov (landscape architects for 'application 4' development)
Parameter plans for 'application 4' development	Maccreanor Lavington (masterplanners for 'application 4' development)
Design drawings for 'application 5' development	Maccreanor Lavington (designers for plot NT04) and Hawkins Brown (designers for plots NT02 and NT03)
Victoria Riverside design drawings	Arcadis
Illustrative masterplan for 'application 4' development	Maccreanor Lavington

Review of data

Topographic survey of the existing ground levels across the site supplied by Schulze + Grassov (provided in Appendix D) was checked against LiDAR levels. A good correlation was found between the topographic survey of ground levels and the levels in the LiDAR data; therefore, it was deemed suitable to use the LiDAR data to represent the floodplain within the model.

The Arup Baseline model was reviewed by WSP during its development prior to the sign off of the model by the EA. Therefore, once the Arup Baseline model had been approved by the EA, no further review was undertaken by WSP before using the model in this assessment. As part of the HIF works on behalf of Manchester City Council (MCC), Arup updated an existing 1D-2D coupled FMP-TUFLOW model of the River Irk through Manchester. Additional topographic survey was undertaken to add more detail into the model, particularly around the Red Bank area as it was the main focus for MCC. Arup updated the hydrology within the model and undertook a full calibration exercise for flows within the model using gauge data from Collyhurst Weir, which is approximately 166m upstream of the footbridge to St Catherine's Wood (shown on Figure 1). Arup also improved the stability of the model and ran the model for a range of flood design events, including climate change scenarios. The EA reviewed and approved the Arup model, which represents the existing flood risk from the River Irk, in November 2022.

The Arup Baseline model shows a small part of the NT04 plot to flood during the design flood event but no flooding is shown to plots NT02 or NT03. In terms of the RB plots, plots RB16, RB17, RB06, RB07 and RB10 are predicted to flood during the design flood event. The other RB plots that form part of the

'application 4' development are not predicted to flood and are on much higher ground, away from the floodplain.

It should be noted that there are issues with the dVol values in the Arup 2022 Baseline model, which propagate from Moston Brook. Moston Brook is upstream of the area of interest for this study and the instabilities at this location do not have a bearing on the results in the Red Bank area. Therefore, WSP has not sought to improve stability on the Moston Brook reach of the model as it is outside the scope of these works. As such, the issues with the dVol values are present within the FEC versions of the model that are discussed below but there is no impact of these on the results at Red Bank. There are five checks recorded by TUFLOW prior to the simulation for the Arup Baseline model, all are the same check, '2099 – Ignored repeat application of boundary to 2D cell. BC Type = HX'. These checks do not have an impact on model results. There are no warnings pre-simulation in the Arup Baseline model and no warnings or checks during the simulation. The Arup 2022 Baseline model is sufficiently stable through the Red Bank area to produce reasonable results and is appropriate to use in this assessment to inform both 'application 4' and application 5'.

METHODOLOGY

Model Updates

The Arup Baseline model has been used as the basis for the flood modelling undertaken by WSP to determine the impact on flood risk of both the 'application 4' and 'application 5' developments. It should be noted that for the model scenarios developed by WSP, changes were only made to the model within the Red Bank area between the footpath to St Catherine's Wood and Aspin Lane Bridge on the River Irk (both shown on Figure 1). No changes have been made to the model outside of this area in any of the scenarios developed by WSP.

In order to inform the FEC planning applications, WSP have developed three flood models, all based on the Arup Baseline model. Details of each of these models is provided in the sections below, the three scenarios are:

1. **FEC Baseline**
2. **'Application 5' Model (NT02-04 plots – detailed planning application)**
3. **'Application 4' Model (RB plots – outline planning application)**

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1. FEC Baseline

The FEC Baseline differs from the Arup Baseline model as it includes representation of the Victoria Riverside development which is currently in construction. It is assumed that by the time the NT02-04 and RB plots are developed that the Victoria Riverside development will be built. Therefore, it has been included in the baseline for this assessment. The layout and levels of the Victoria Riverside development were provided by Arcadis in September 2022 (see Appendix E) and have been incorporated into the model using z-shape layers to create the FEC Baseline. It should be noted that the level of the buildings associated with the Victoria Riverside development have been set to 90mAOD in the model rather than their FFLs, this is much higher than surrounding ground levels as the buildings have been designed not to flood using flood resistance measures and have therefore been raised above the flood level within the model.

The FEC Baseline model also includes a minor update to the inactive code layer (2d_code_inactive_FMT_NorthernGateway_2021_014_R) and the 2d_bc layer (2d_bc_links_FMT_NorthernGateway_2021_014_L) adjacent to the RB10 plot. The model has been updated with minor changes close to RB10 to more closely represent the 1D/2D interaction. A small adjustment has been made to the inactive code layer to include the full channel width to the culvert inlet, which was not included in the Arup 2022 Baseline model and the inactive code layer has also been extended to include the slipway from the RB10 plot into the river just upstream of the culvert. The 2d_bc layer has been adjusted to match with the updated inactive code layer to allow water to spill out of the 1D river channel into 2D at the correct location and at the correct elevation. The elevation for the bank levels has been set using the channel survey collected by Arup to build the Arup 2022 Baseline model and checked against site topographic drawings provided by Schulze + Grassov. The updated schematisation on the River Irk adjacent to RB10 is shown in Figure 2; The hatched area is the updated inactive code layer and the red line is the updated 2d_bc layer, the dashed black line represents the schematisation of the inactive code layer and 2d_bc layer in the Arup 2022 Baseline model.

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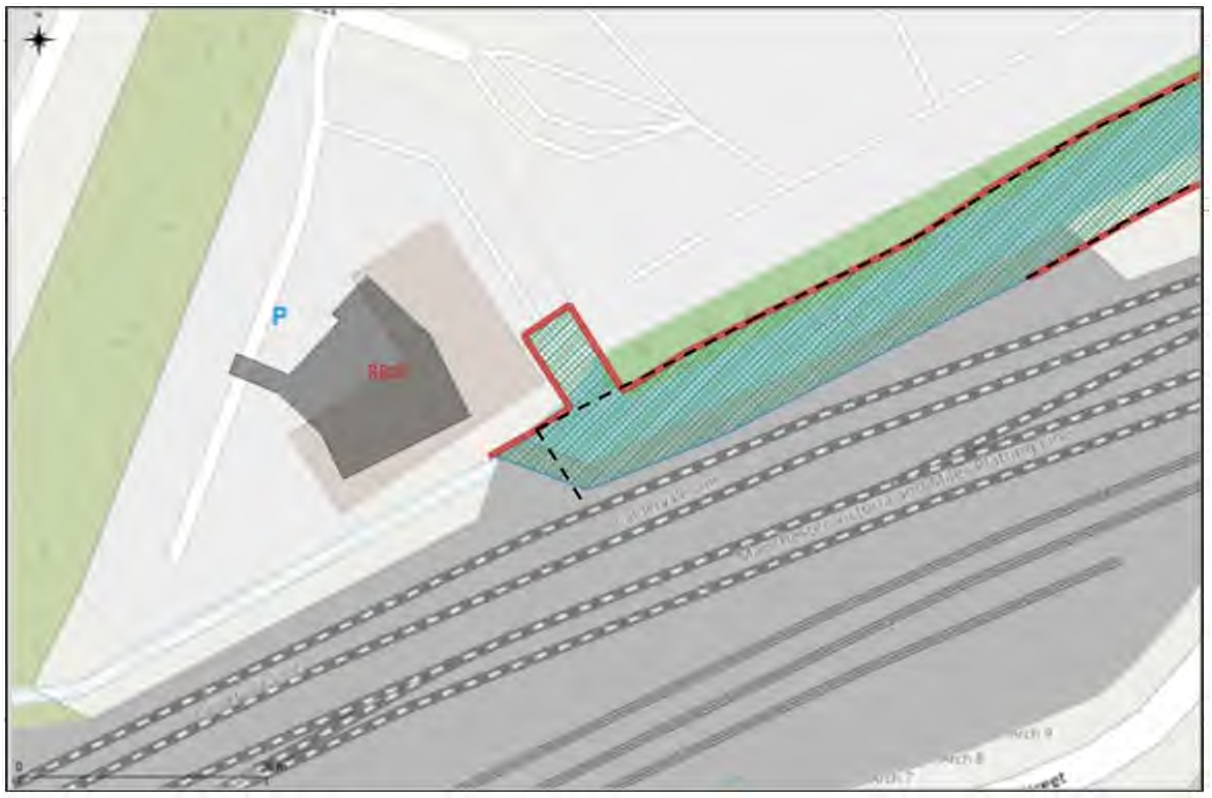


Figure 2 River Irk schematisation update at RB10

A comparison was undertaken between the Arup Baseline model and the FEC Baseline model for reference purposes only. The comparison showed only negligible differences in flood levels across the 2D domain between the two baseline models. The car park at the Victoria Riverside development has been designed as flood compensatory storage, therefore the area is shown as flooded in the FEC Baseline where it wasn't in the Arup Baseline model as shown in Drawing 79268-MR1-001-A in Appendix F.

2. 'Application 5' Model (NT02-04 plots – detailed planning application)

In order to inform the detailed planning application for the 'application 5' development, the FEC baseline model was updated to include representation of the development planned on plots NT02-04 as per the design (see Appendix B for drawings). This includes buildings plus changes to the public realm including on Dantzic Street including road, pavement and cycleway levels. The proposed changes to Dantzic Street are shown on drawing RDB-WSP-XX-XX-DR-TP-020 in Appendix B, an ascii file which interpolates between the proposed levels on Dantzic Street and the surrounding existing ground levels has been used to represent the proposed changes to Dantzic Street within the model The proposed buildings on plots NT02 and NT03 were set to their FFLs as

these are above the design flood level (1% AEP + 35% climate change). The FFL of the building on plot NT04 that fronts onto Dantzic Street is lower than the design flood level. Flood resistance and resilience measures are proposed at this building to prevent it flooding during the design flood event, the building level within the model has been set to the top level of flood resistance measures (a concrete upstand built into the front of the building plus provision for flood gates across openings) as shown on the drawings in Appendix B, Table 2 shows the levels of each building as set in the model and the drawings that the levels have been taken from. No other changes were made to the model to represent the 'application 5' development.

Table 2 Levels set for each building within the model for the 'application 5' development

Plot	Building*	Level of Z shape in model (mAOD)	Drawing level taken from	Comments
NT02	Clubhouse	31.55	RDB-HBA-2B-ZZ-DR-AR-080310	Please note that the FFL for the clubhouse on the final design drawings is 31.61mAOD. This has not been updated in the model as the previous FFL (31.55mAOD) is above the flood level (30.88mAOD) in this location.
NT03	Tower 2	32.00	RDB-HBA-2C-ZZ-DR-AR-080311	
	Tower 2 – west commercial unit	31.84	Page 147 in RDB-HBA-2X-XX-RP-AR-080025_DAS_P5	Detail of level for commercial unit not shown on design drawings but included in Design and Access Statement submitted as part of planning application.
	Tower 2 – east commercial unit	31.72	Page 147 in RDB-HBA-2X-XX-RP-AR-080025_DAS_P5	Detail of level for commercial unit not shown on design drawings but included in Design and Access Statement submitted as part of planning application.
	Tail 3	32.00	RDB-HBA-2X-ZZ-DR-AR-080312	
NT04	Tower 4	31.555	FFL: RDB-MLA-2D-00-DR-AR-01310000 Flood resistance details: RDB-MLA-2D-XX-DR-AR-	FFL is 30.955 – flood resistance measures 610mm above this

			01321101; RDB-MLA-2D-XX-DR-AR-21720001	
	Midrise 4	31.555	FFL: RDB-MLA-2D-00-DR-AR-01310000 Flood resistance details: RDB-MLA-2D-XX-DR-AR-01321101; RDB-MLA-2D-XX-DR-AR-21720001	FFL is 30.955 – flood resistance measures 610mm above this

*see drawing RDB-MLA-01110000-PROPOSED SITE PLAN for building names

3. ‘Application 4’ Model (RB plots – outline planning application)

Outline planning permission is being sought for the RB plots, this includes all ‘RB’ plots that are part of the proposed development including five plots that shown as at flood risk in the FEC Baseline model (RB06, RB07, RB10, RB16 and RB17). It should be noted that the ‘application 5’ development is not included in the outline planning application. The results of the ‘application 4’ model have been compared to the FEC Baseline model; therefore, it has not been assumed that the ‘application 5’ development will be built before the ‘application 4’ development. As planning permission has not been granted for ‘application 5’ yet, this development cannot be included in the baseline used to test the impact of the ‘application 4’ development.

The ‘application 4’ model includes representation of the plots shown on the parameter plan (Appendix C) that lie within the floodplain, this is split into three main areas as follows (see Figure 1 for plot locations):

- Plots RB16-17 (on an area known as Travis Island)
- Plots RB06-07
- Plot RB10

The FEC Baseline model was updated to represent the maximum possible building footprints as shown on the parameter plan in each of these areas. Initial modelling showed that as the buildings on the plots listed above displaced flood water, mitigation was required to ensure that flood risk was not increased elsewhere as a result of the ‘application 4’ development. The representation of the ‘application 4’ development (including flood mitigation) within the model in the three areas listed above is described in the sections below.

Plots RB16-17 (Travis Island)

The masterplan ambition for Travis Island is to create terraced wetlands along the river, the terracing has been designed to provide compensatory flood storage and offset the impact of the

buildings within the floodplain at this location. The FEC Baseline model shows flooding mainly to the eastern side of Travis Island, the buildings on plots RB16 and RB17 will displace floodplain volume. The illustrative masterplan that has been used to inform the flood mitigation modelled includes terracing all the way around the river meander at Travis Island as shown on the illustrative masterplan drawing in Appendix C.

The buildings on plots RB16 and RB17 were represented as a z shape with an elevation specified. The buildings will be designed to not flood during the design event (1% AEP +35% climate change) and have been set at a level of 31.67mAOD in the model, which is the maximum flood level around the RB16 and RB17 plots plus 300mm freeboard. The terracing on plots RB16 and RB17 has been represented using a number of z shapes, each set to a different level representing the steps up from the River Irk to the plot buildings. Figure 3 shows the z shapes that have been used to represent the terracing and the levels they are set to. As part of the proposed works, the riverbank along Travis Island is to be lowered to allow water onto the floodplain earlier on during a flood event, the lower bank has been represented in both 1D and 2D within the model.

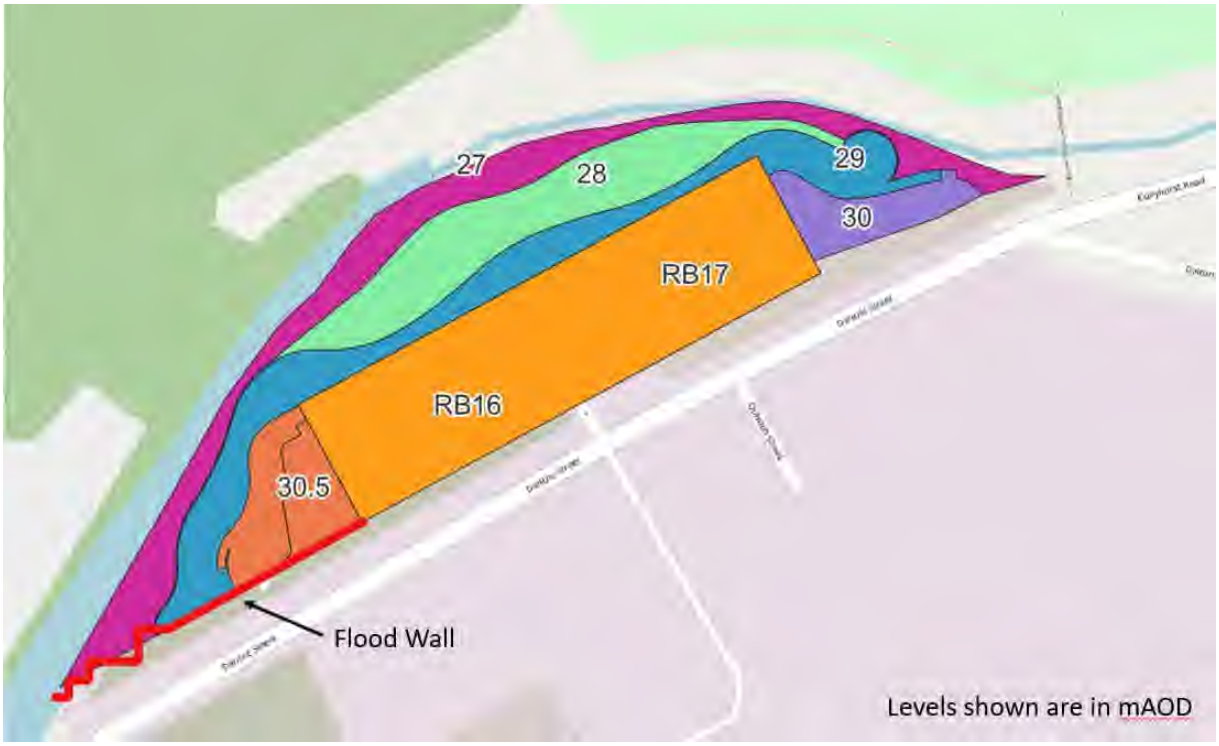


Figure 3 Proposed changes at RB16 and RB17

It was found that allowing more water out of the river at this location led to an increase in flooding on the western side of Dantzic Street as water flowed around the western side of RB16 off Travis Island and onto Dantzic Street. In order to prevent this happening and to maximise the storage provided on Travis Island during a flood event, a wall is proposed along the edge of plot RB16 parallel to Dantzic

Street to contain water within Travis Island during a flood event. The wall has been represented with a z line in the model set to 90mAOD to ensure water cannot transfer between Travis Island and Dantzic Street at this location, this is above the water level predicted at this location for the design flood event. The location of the wall is shown in Figure 3.

It should be noted that a wall at this location with the terracing in place could be subject to significant hydraulic loading during a flood event. At the detailed design stage, the height of the proposed wall should be derived based on the maximum flood level plus freeboard (calculated using the residual uncertainty guidance[3]) and breach analysis should be undertaken to understand the risk should a failure of the flood wall occur.

Plots RB06-07

Plots RB06 and RB07 lie on the northern bank of the River Irk downstream of Travis Island. The buildings on plots RB06 and RB07 were represented as a z shape with an elevation specified. The buildings will be designed to not flood during the design event (1% AEP +35% climate change) and have been set at a level of 31.5mAOD in the model, which is the maximum flood level around the RB06 and RB07 plots plus 300mm freeboard. Both plots are within the floodplain as shown by the results of the FEC Baseline modelling. Terracing in front of the buildings on these plots is proposed within the illustrative masterplan (Appendix C) to connect the river to the public realm areas of these plots. The riverbank has been lowered and terraced and is designed to flood in front of the buildings. The 1D model has been widened in this area to represent the detail of the terracing as it steps up from the river as this could not be represented accurately in 2D due to the 4m cell size. The area immediately in front of the buildings has been set to 30mAOD within the 2D model. Figure 4 shows a typical 1D section within the reach of the River Irk in front of the RB06/07 plots and Figure 5 shows the changes that have been applied within the 2D model on these plots.

It should be noted that no changes to Union Bridge (shown on Figure 5) have been made as part of the ‘application 4’ model but the river section at the upstream face of the bridge has been widened to include the terracing on the right bank within the 1D. The spill over the structure is represented in 2D using a HX line across the face of the bridge, in the ‘application 4’ model the HX line has been widened compared to that in the Arup Baseline model to match the increased width of the 1D river section at the upstream face of the bridge. An additional 1D cross-section has been added to the ‘application 4’ model upstream of Union Bridge – IRK01_0957. It was noted that there was a slight increase in flow fluctuations through the reach of the River Irk in front of plots RB06 and RB07 in the ‘application 4’ model compared to the Arup Baseline model. The additional section (IRK01_0957) was added to smooth flows through the reach as they approached Union Bridge.

[3] Accounting for residual uncertainty: an update to the fluvial freeboard guide. Report – SC120014. Environment Agency, 2017.

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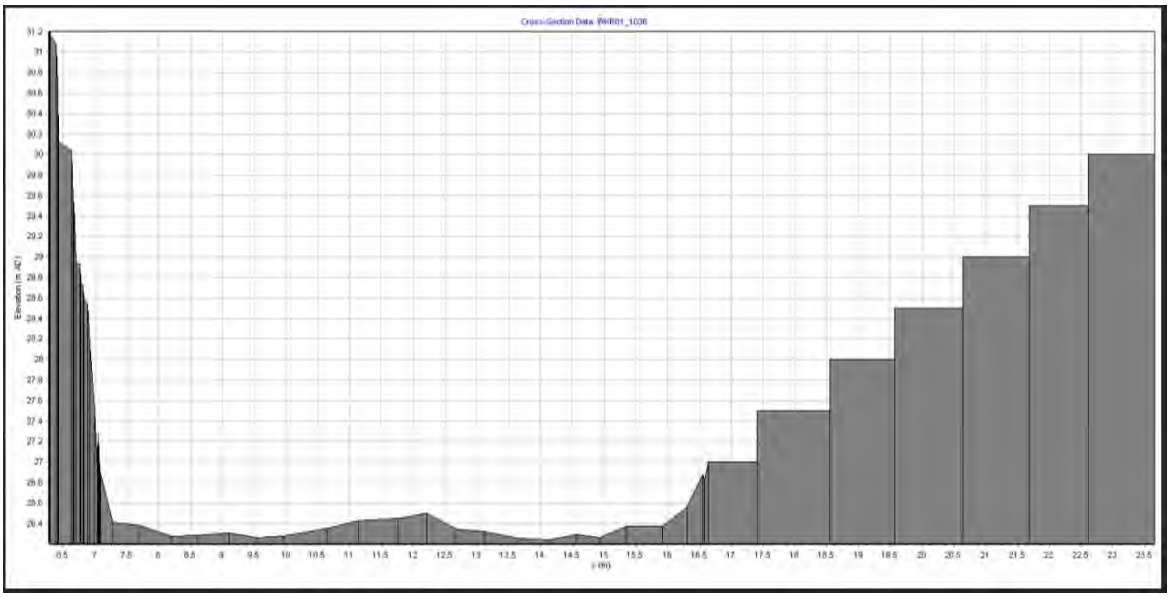


Figure 4 Typical section through 1D model alongside RB06 and RB07 plots



Figure 5 Proposed changes at RB06 and RB07

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Plot RB10

Plot RB10 is further downstream than RB06 and RB07 where the disused railway viaduct meets the live railway viaduct. The building on plot RB10 (shown on Figure 6) was represented as a z shape with an elevation specified. The building will be designed to not flood during the design event (1% AEP +35% climate change) and has been set at a level of 30.74mAOD in the model, which is the maximum flood level around the RB10 plot plus 300mm freeboard. No other changes were made at plot RB10 within the 'application 4' model.



Figure 6 Proposed changes at RB10

Hydrology

The hydrology has not been changed from that used in the Arup Baseline Model as Arup completed their hydrological assessment, which included calibration of flows on the River Irk using data at Collyhurst Weir approximately 166m upstream of the Red Bank area in 2022. Therefore, the hydrology within the model is up to date and uses the latest methods and data available. No further calibration of the hydraulic model was undertaken as part of this assessment. Future users of the model should consider how long ago the

hydrological assessment was undertaken when they come to use the model and whether newer methods and data are available and therefore whether an updated assessment is necessary.

Inflow files (ieds) for the following return periods were supplied with the Arup Baseline Model; 20% AEP, 10% AEP, 5% AEP, 3.33% AEP, 1% AEP, 1% AEP + 35% climate change allowance and 0.1% AEP. There are seven inflows to the model, on the Irk there is an upstream inflow and three intervening inflows along the modelled length of the watercourse. There is an upstream inflow on Moston Brook and two intervening inflows along the rest of the brook. The location of each inflow and the peak flow at each inflow for the design event is shown in Table 3.

The downstream boundary of the model is at the confluence of the River Irk with the River Irwell and a Head-Time Boundary (HTBDY) has been used to represent levels on the River Irwell at the downstream extent of the River Irk within the model. The following comment is provided within the downstream boundary node of the model as provided by Arup:

D/S HT boundary shape taken at Irk/Irwell confluence from "LowerIrwell_SALF_2ndBasin_PostScheme_v310817.DAT" obtained from the EA on 07/05/2019. HT taken from node "IRW1_3072Ju" from "POST3_Def_Q100" results. Peak 10 hrs taken to match 10hr simulation of the Irk. 13/12/2021 - Shape of previous boundary retained. Duration changed to ~16 hours to match updated hydrology for HIF. Peak shifted to 10hrs to match peak at the downstream boundary on the Irk. Peak taken as the Defended level at node IRWZ1_2170 for 100yr - 26.03mAOD on the 2018 Ship Canal model.

The downstream boundary has not been altered for the modelling undertaken on behalf of FEC.

The ‘application 4’ and ‘application 5’ models have been run for the following events: 20% AEP, 3.33% AEP, 1% AEP, 1% AEP + 35% climate change allowance, 1% AEP + 75% climate change allowance and 0.1% AEP.

Table 4 shows the inflows and downstream boundary conditions used within the models (same for both) and their sources.

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Table 3 Inflow locations and peak flows for 100 year + 35% climate change allowance design event (inflow location descriptions and Easting/Northing values are taken from Arup Flood Estimation Report[4])

Inflow name (model node)	Inflow Location	Easting, Northing	20% AEP Peak Flow (m3/s)	3.33% AEP Peak Flow (m3/s)	1% AEP Peak Flow (m3/s)	1% AEP + 35% CC Peak Flow (m3/s)	1% AEP + 75% CC Peak Flow (m3/s)	0.1% AEP Peak Flow (m3/s)
Irk_005	Upstream extent of River Irk	383400, 401800	24.50	34.60	40.51	55.83	70.88	69.53
Irk_001_int	Intervening catchment between downstream extent and Collyhurst weir	383850, 398900	1.85	2.62	3.06	4.22	5.36	5.19
Irk_003_int	Intervening catchment between Collyhurst weir and Moston confluence	383850, 399700	1.48	2.10	2.45	3.37	4.28	4.10
Irk_004_int	Intervening catchment between confluence and upstream model extent	385300, 400500	3.88	5.48	6.38	8.79	11.16	10.79
Most_002	Upstream extent of Moston Brook	388000, 401150	6.49	9.28	10.88	14.99	19.03	18.33
Most_003	Additional area	385000, 399900	1.32	1.89	2.24	3.08	3.91	3.82
Most_001_int	Intervening catchment between upper Moston Brook and confluence	383350, 400450	4.87	6.97	8.21	11.31	14.36	13.93

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Table 4 Event configuration for FEC modelling

Event	Inflows	Downstream Boundary
20% AEP	VICTORIA_NORTH_5YR_Arup_9pt5_v5.ied (as supplied with Arup Baseline model)	Irwell_DSBDY_20yr_v3.IED (as supplied with Arup Baseline model, no lower return period downstream boundary files provided)
3.33% AEP	VICTORIA_NORTH_30YR_Arup_9pt5_v5.ied (as supplied with Arup Baseline model)	Irwell_DSBDY_20yr_v3.IED* (as supplied with Arup Baseline model, closest return period downstream boundary file provided, no 30yr downstream boundary file supplied)
1% AEP	VICTORIA_NORTH_100YR_Arup_9pt5_v5.ied (as supplied with Arup Baseline model)	Irwell_DSBDY_100yr_v3.IED (as supplied with Arup Baseline model)
1% AEP + 35% climate change allowance	VICTORIA_NORTH_100YR_CC2080_Arup_9pt5_v5.ied (as supplied with Arup Baseline model)	Irwell_DSBDY_100yr_CC2080_v3.IED (as supplied with Arup Baseline model)
1% AEP + 75% climate change allowance	VICTORIA_NORTH_100YR_CC2080_upper_end_Arup_9pt5_v5.ied (created by WSP by scaling up flows in VICTORIA_NORTH_100YR_Arup_9pt5_v5.ied by 1.75)	Irwell_DSBDY_1000yr_v3.IED** (as supplied with Arup Baseline model, 1% AEP + 75% climate change allowance inflows close to 0.1% AEP inflows)
0.1% AEP	VICTORIA_NORTH_1000YR_Arup_9pt5_v5.ied (as supplied with Arup Baseline model)	Irwell_DSBDY_1000yr_v3.IED (as supplied with Arup Baseline model)

*The Irwell_DSBDY_20yr_v3.IED was used as the downstream boundary for the 3.33% AEP model runs as a 30 year (or 3.33%) downstream boundary IED was not supplied with the Arup Baseline model.

**Table 3 shows that the 1% AEP event plus 75% climate change allowance inflows are very similar to the 0.1% AEP inflows, therefore it was deemed appropriate to use the Irwell_DSBDY_1000yr_v3.IED as the downstream boundary condition for the 1% AEP event plus 75% climate change allowance runs.

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MODEL PERFORMANCE

Warning and Checks

There are various 1D warnings during the model simulation setup phase reported in the Flood Modeller zzd files for each model iteration. The following warnings occur in all versions of the model during the setup phase and are inherited from the Arup Baseline model:

- Warning W2010 - Poor interpolation u/s of IRKR01_3876 max u/s area of 208.5932 -> 76.7929

  This is outside of the reach of interest for this study and has not been investigated further.

- Warning W2044 - different values (+/- 20 %) for Mannings n encountered within one panel. Make sure L/R panel markers do not appear within an arch.

  This occurs for various nodes within the 1D model – Manning's values have not been changed from Arup Baseline model.

- Warning W2238 - panel at offset *xxxxx* has very small width

  This occurs for various model nodes within the model – no updates that would affect this have been made, retained from Arup Baseline model.

- Warning W2229 - Value of trash screen height is set to 0; areas will be calculated using piezometric head.

  This occurs at three nodes within the model and is retained from the Arup Baseline model, therefore it has not been investigated further.

During each simulation for each version of the model, Warning W2262 occurs numerous times highlighting backflow at culvert units. This is a very common warning within flood models as water levels are rising.

The five 2D checks (all '2099 – Ignored repeat application of boundary to 2D cell. BC Type = HX') prior to simulation present in the Arup Baseline model also occur in the three models developed for this assessment.

For the FEC Baseline model, there are an additional two checks pre-simulation (2x CHECK 2370 – Ignoring coincident point found in Z Shape Layer) and three warnings pre-simulation (3x WARNING 2073 – Null Shape object ignored. Only Regions, Lines, Polylines & Multiple Polylines used). CHECK 2370 occurs where there are two points within a model cell and the value of only one of them is used to assign an elevation to the cell as part of a z shape layer, these relate to where design information for the Victoria Riverside development has been read into the model and the resolution of elevation points within the z shapes is higher than that of the model grid. The representation of Victoria Riverside has been checked within the model and is appropriate, therefore the coincident points flagged by TUFLOW are not impacting on the representation of the Victoria Riverside development. WARNING 2073 relates to "None" or "Null"

objects, which GIS software may add to the layer to indicate deleted objects (particularly if using the shapefile format) – these objects are ignored by TUFLOW and do not influence the model set up or results. There are no checks or warnings during the FEC Baseline simulation.

For the ‘application 5’ model, the checks prior to simulation in the FEC Baseline model also occur plus 7x WARNING 0305 - Projection of .shp file is different to that specified by the SHP Projection == command. The layers for which this projection warning occurs have been checked and all are in British National Grid, which is the same as the grid specified in the SHP Projection == command. It is unclear why this warning occurs but it is not affecting model results and all files are in the correct projection. There are no checks or warnings during the ‘application 5’ simulation.

For the ‘application 4’ model, the checks prior to simulation in the FEC Baseline model also occur plus there are 245 warnings pre-simulation (245x WARNING 2073 – Null Shape object ignored. Only Regions, Lines, Polylines & Multiple Polylines used) relating to objects that have been deleted from shapefiles within the model, this has no impact on the model. There are no checks and warnings during the ‘application 4’ simulation.

Model Stability

A number of model outputs were checked to understand the model stability and ultimately the reliability of the model results, particularly through the Red Bank area. The 1D runtime plots for the FEC Baseline model, ‘application 5’ model and ‘application 4’ model are shown on Figure 7, Figure 8 and Figure 9 respectively. Each runtime plot shows only minor poor convergence throughout the model run showing that the 1D model is generally stable. It should be noted that the default 1D parameters have been used within Flood Modeller for each of the models.

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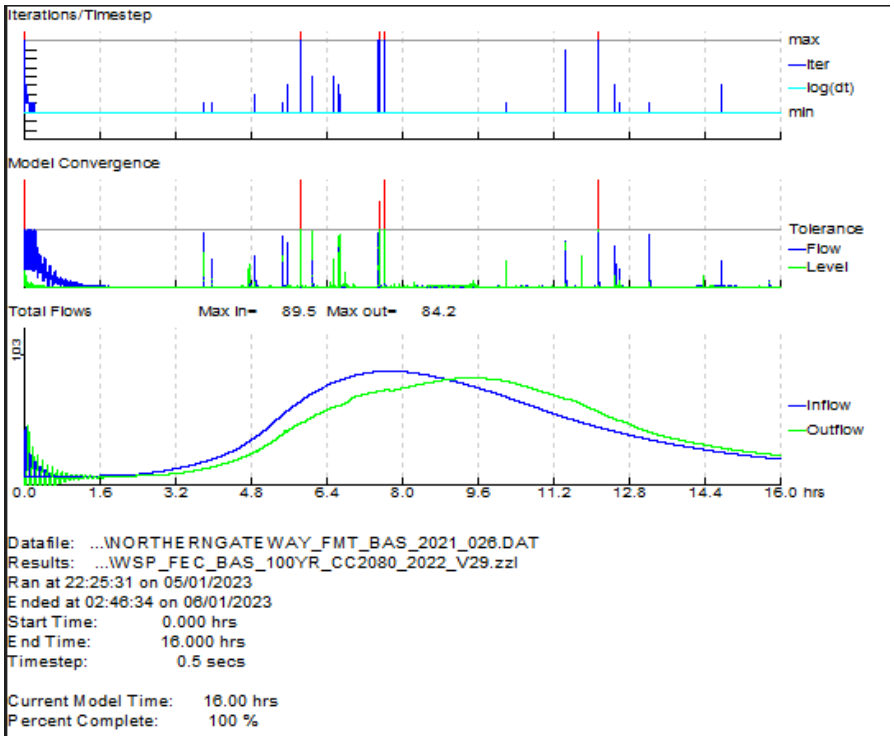


Figure 7 1D runtime plot FEC Baseline model

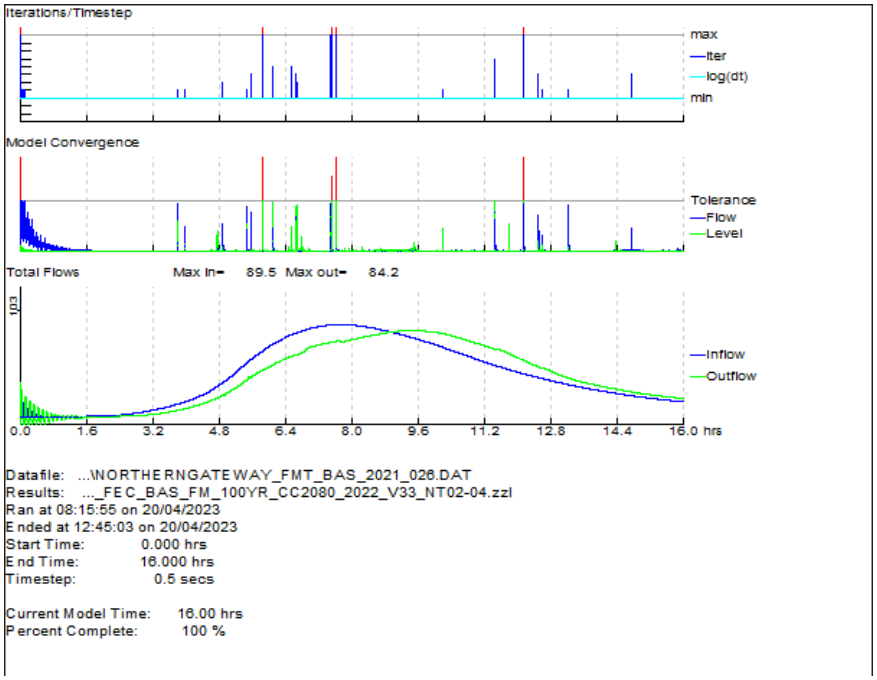


Figure 8 1D runtime plot 'application 5' model

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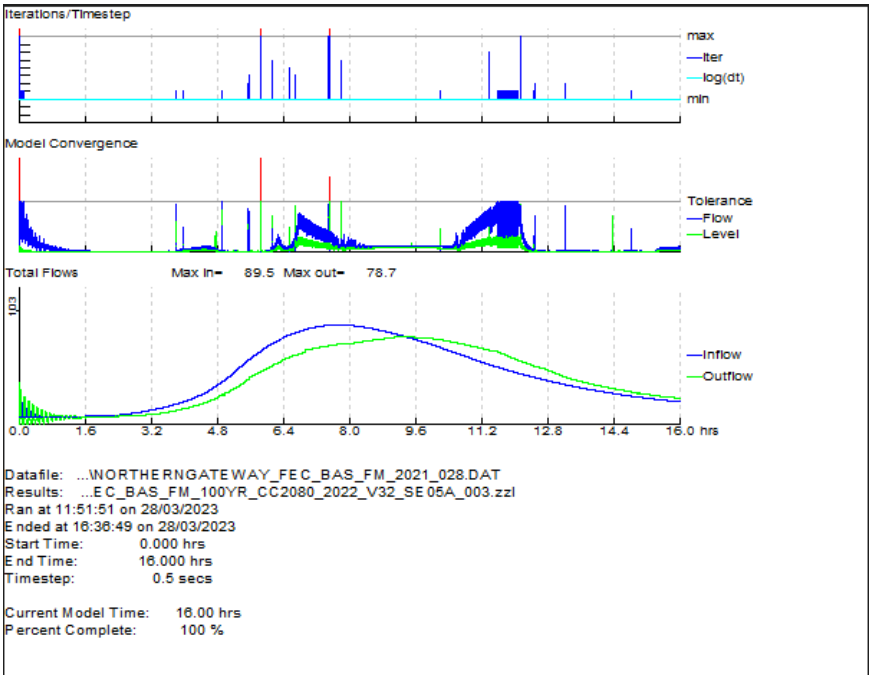


Figure 9 1D runtime plot 'application 4' model

In the initial EA review of the ‘application 4’ model, it was noted that the model was more unstable in the 1D throughout the reach of the ‘application 4’ development than the FEC Baseline model. The 1D ‘application 4’ model has been updated following the EA review to reconcile the 1D bank heights on the right bank adjacent to plots RB06 and RB07 with the 2D bank heights (both are now set to 30mAOD). Unfortunately, there is some instability in the flows approaching the peak and after the peak through this reach for the 'application 4' model. WSP did look to improve this but couldn’t find a solution to smooth the flows, the instability is related to the large exchange of water between 1D and 2D as the revised banks are overtopped in the 'application 4' model. Tweaking of the top terrace level was tried to improve stability but it was found that the top level had to be 30mAOD to provide effective flood storage and prevent an adverse impact on flooding elsewhere. The additional node added upstream of Union bridge (IRK01_0957) in the ‘application 4’ model was an attempt to smooth flows as they move from the terraced river section to Union Bridge but this did not remove all of the instability seen through this reach. This phenomenon does not affect the peak water levels predicted in the 1D and does not cause 2D instabilities. Therefore, the impact on model results is negligible. The difference in flows at node IRKR01_1081 between the FEC Baseline model and the ‘application 4’ model is shown on Figure 10. The difference in stage between the two models is shown in Figure 11.

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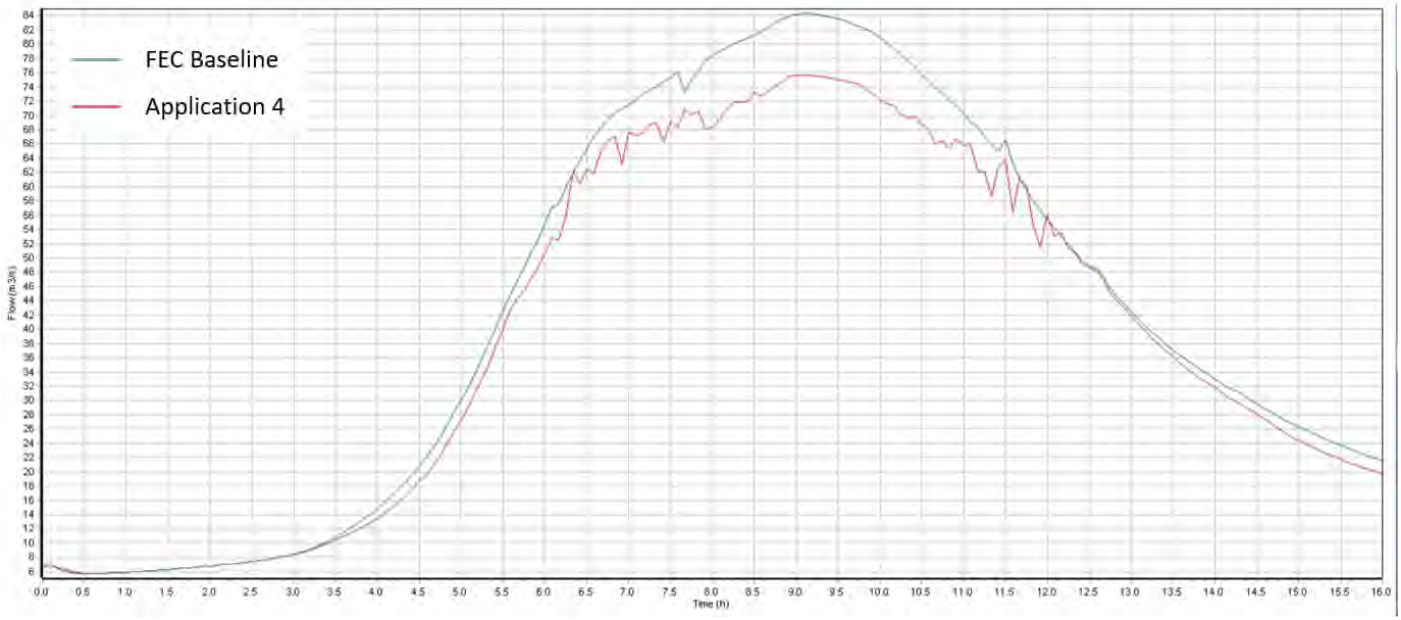


Figure 10 Comparison of flow variability at model node IRKR01_1081 adjacent to plot RB07 and the western end of Travis Island

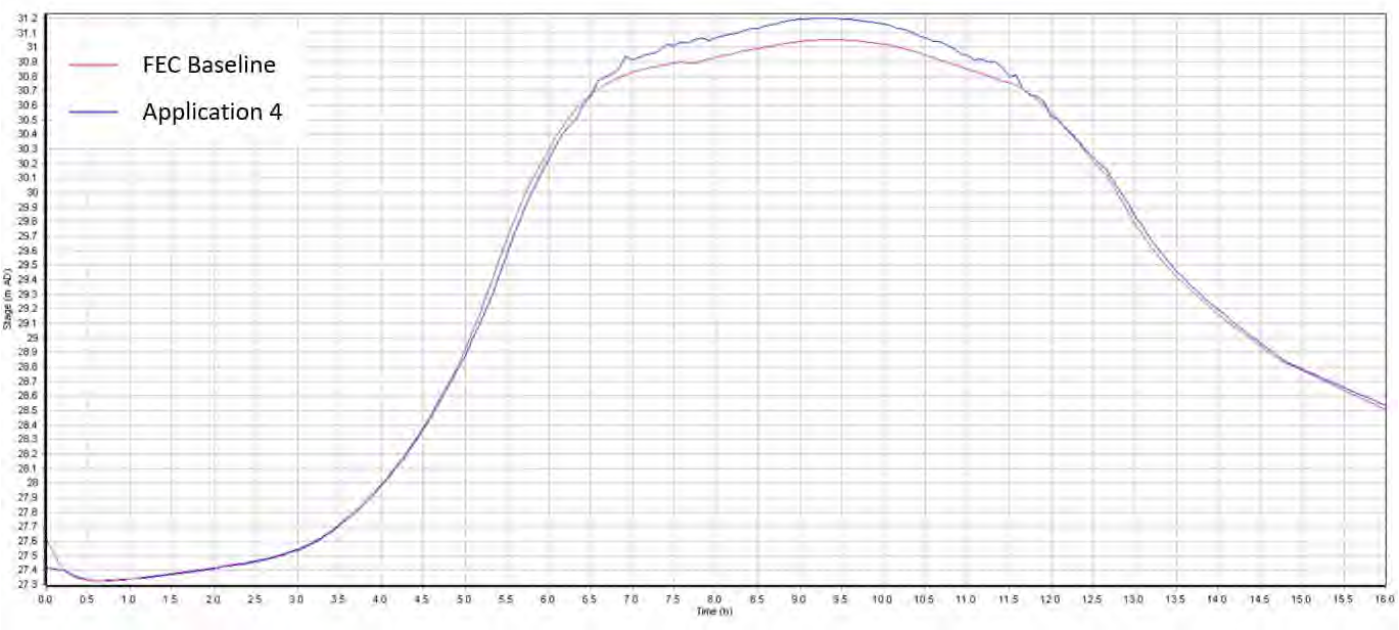


Figure 11 Comparison of stage at model node IRK01_1081

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The change in volume between 1D and 2D (dVol) for each model for the design event (1% AEP + 35% climate change) has been plotted and is shown in Figure 12 for the FEC Baseline, Figure 13 for 'application 5' and Figure 14 for 'application 4'. As stated in the Data Collection section, it should be noted that there are issues with the dVol values in the Arup 2022 Baseline model, which propagate from Moston Brook. Moston Brook is upstream of the area of interest for this study and the instabilities at this location do not have a bearing on the results in the Red Bank area. Therefore, WSP has not sought to improve stability on the Moston Brook reach of the model as it is outside the scope of these works. As such, the issues with the dVol values are present within the FEC versions of the model presented in this report but there is no impact of these on the results at Red Bank. In Figure 12, the FEC Baseline dVol plot has been compared to the Arup 2022 Baseline dVol plot (for the 1% AEP event +35% climate change) to show the negligible difference between the two models.

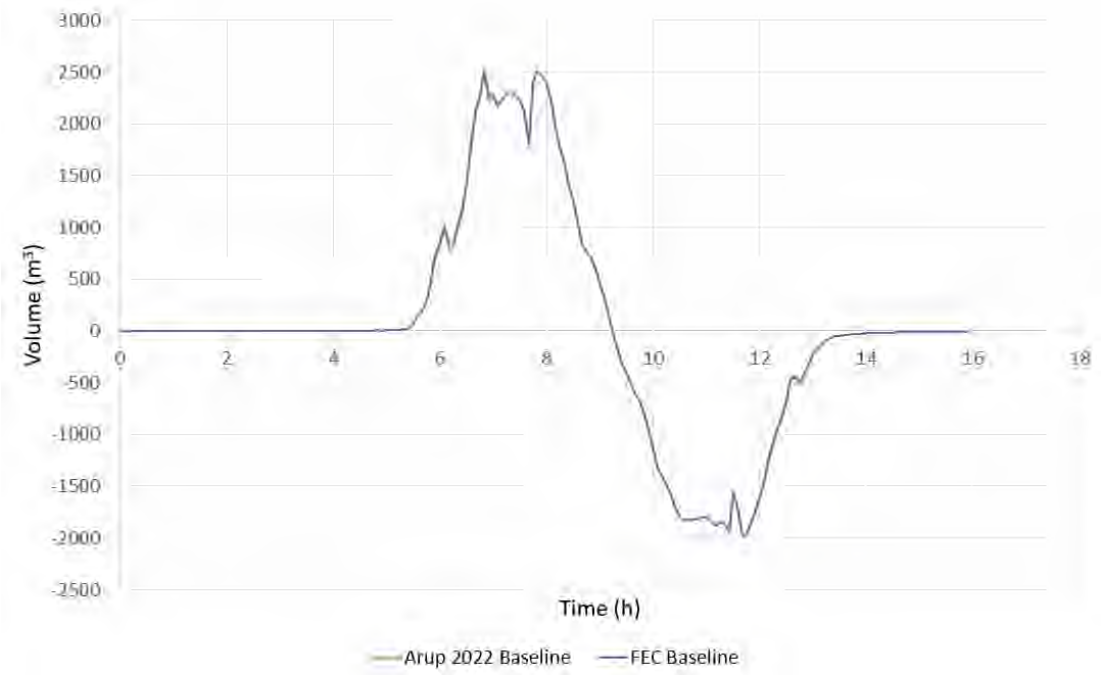


Figure 12 FEC Baseline dVol plot and comparison with Arup 2022 Baseline dVol plot

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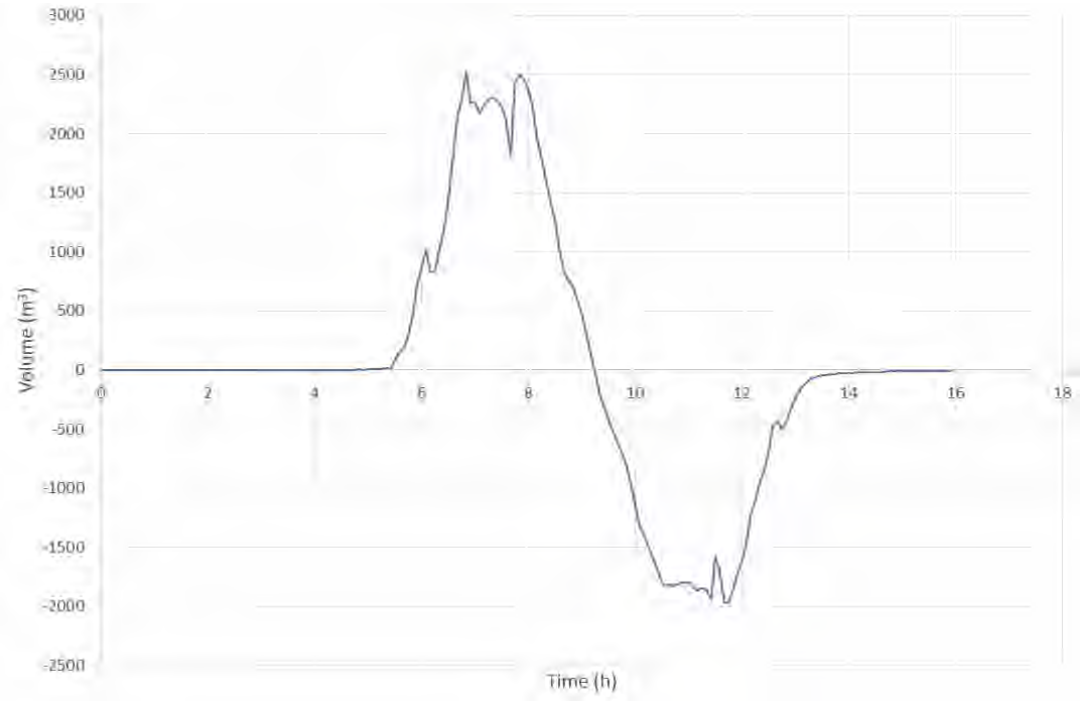


Figure 13 'Application 5' dVol plot

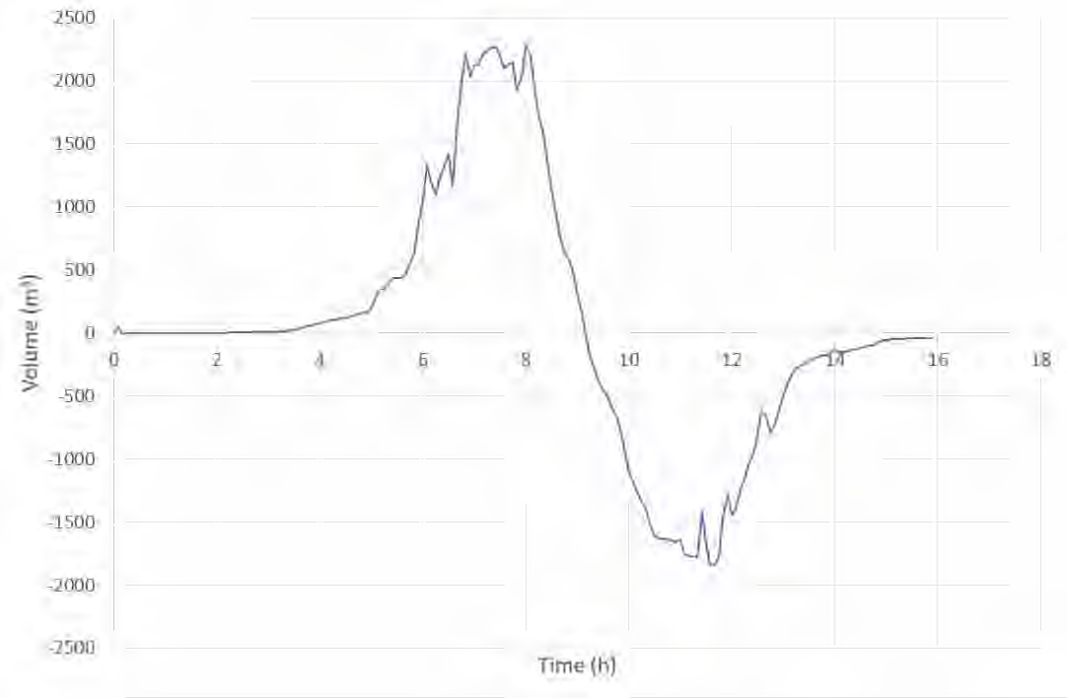


Figure 14 'Application 4' dVol plot

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TUFLOW advise that the mass balance error within models should not exceed +/- 1% for significant periods. The cumulative mass balance error for each model was plotted for the design event as an additional model stability check and is shown in Figure 15, Figure 16 and Figure 17. There are spikes of mass error beyond -1% around 5 hours into both the FEC Baseline and 'application 5' model runs; however the mass error is not outside of the optimum range for a significant period of time. The mass error during the 'application 4' model run is within +/- 1%. This suggests that the 2D model is generally stable.

The 1D mass balance error reported by FMP is also acceptable, for the FEC Baseline model the mass balance error of peak system volume is -0.37% and the mass balance error of boundary inflow volume is -0.02%. The figures are similar for the 'application 4' model with a mass balance error of peak system volume of -0.042 and a mass balance error of boundary inflow volume of -0.02%. For the 'application 5' model, the mass balance error of peak system volume is -0.38% and the mass balance error of boundary inflow volume is -0.02%. This suggests that the 1D model is stable.

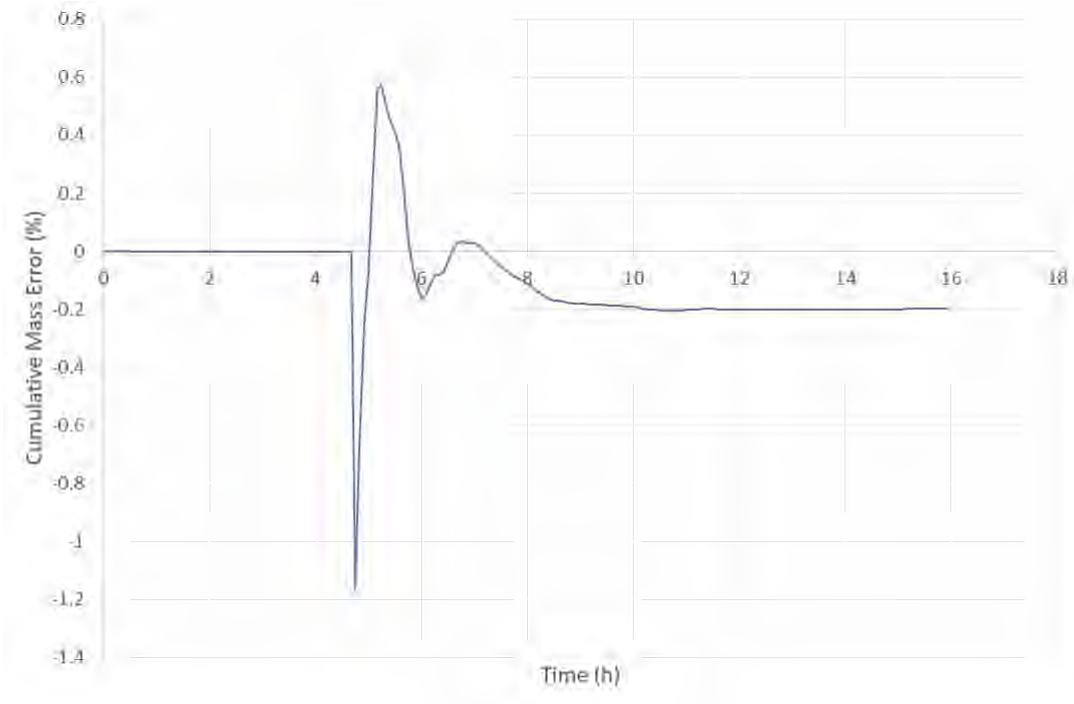


Figure 15 FEC Baseline cumulative mass error 1% AEP event + 35% climate change

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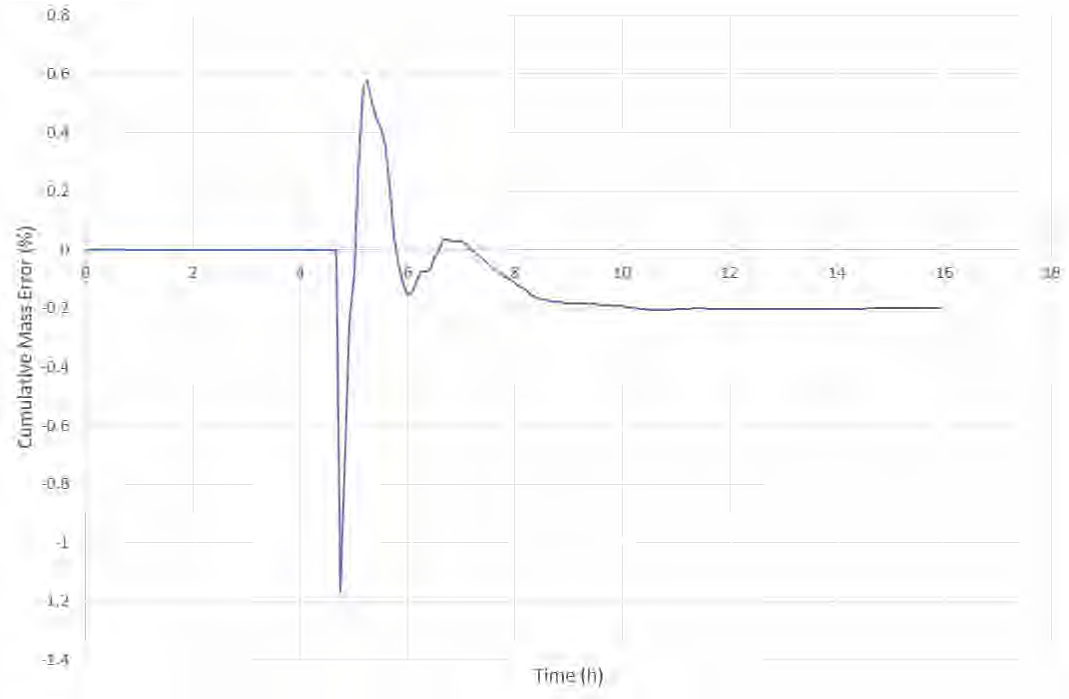


Figure 16 'Application 5' cumulative mass error 1% AEP event + 35% climate change



Figure 17 'Application 4' cumulative mass error 1% AEP event + 35% climate change

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MODEL RESULTS

Overview

Both the 'application 4' and 'application 5' models have been run for six events, the flood depth and extent predicted by each model for each event is shown on the maps provided in Appendix G. The FEC Baseline model has been run for the 1% AEP event plus 35% climate change allowance to determine the impact of each of the developments on flood risk for the design event. The flood depth and extent predicted by the FEC Baseline model for the 1% AEP event plus 35% climate change allowance are presented in Appendix G. The FEC Baseline model shows that the 'application 5' development is at low flood risk with only a small area of plot NT04 predicted to flood. The RB plots that form part of the 'application 4' development are at much greater flood risk and therefore displace a greater volume of flood water. The following section discusses the impact of both 'application 4' and 'application 5' on flood extent, water levels and flood mechanisms. The models have been used to determine the FFLs for each development as discussed in the Flood Risk Assessment.

Assessment of Development Impact

The FEC Baseline model has been used to test the impact of the 'application 5' and 'application 4' developments. The flood extent and water level results of the model scenarios representing the two developments have been compared to that of the FEC Baseline model for the 1% AEP event plus 35% climate change (the design event) to determine the impact of the developments in terms of flood risk. The model results have also been interrogated to determine the impact of each development on flood mechanisms and flow routes.

The difference in maximum water level between the FEC Baseline and the 'application 5' and 'application 4' model scenarios has been assessed and is presented as "impact" on the drawings in Appendix F comparing the results using thematic mapping. The thematic maps have been banded using the Flood Risk Magnitude Criteria outlined in Table 3.71 "Estimating the magnitude of an impact on an attribute" of LA 113 Road Drainage and the Water Environment (formerly HD 45/09) Revision 1[5] and is summarised in Table 5 below.

An additional two categories have been used for the thematic maps to show the areas benefiting from measures (i.e. no longer flooding) and areas that are newly flooded (adversely impacted), refer to Table 6.

[5] Design Manual for Roads and Bridges, LA 113 Road Drainage and the Water Environment (formerly HD 45/09) Revision 1

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Table 5 Flood Risk Magnitude Criteria

Magnitude	Change in peak flood level
Major Adverse	>100mm
Moderate Adverse	>50mm
Minor adverse	>10mm
Negligible	±10mm
Minor beneficial	>-10mm
Moderate beneficial	>-50mm
Major beneficial	>-100mm

Table 6 Areas Benefiting or Newly Affected

Description	Legend
Area benefitting	Was wet now dry
Area adversely impacted	Was dry now wet

FLOOD EXTENT

The difference in flood extent between the ‘application 5’ model results and FEC Baseline model results is minimal as only a small amount of flood water (<2m^3) is displaced by the ‘application 5’ development (as one of the buildings on plot NT04 just encroaches onto the floodplain). This is shown by the minimal black area on drawing 79268-MR1-002 in Appendix F showing the area that ‘was wet now dry’. There are very small areas of pink shown on drawing 79268-MR1-002, which indicate areas classified as ‘was wet now dry’ on the eastern side of Travis Island. The slight reduction in flood extents is due to the change in levels on Dantzic Street proposed as part of the ‘application 5’ development.

There is more of a difference in flood extent between the ‘application 4’ model results and FEC Baseline model results as the RB plots displace more water on the floodplain. The areas where water is displaced by the buildings on plots RB10, RB06, RB07 and RB16 show in pink (was wet now dry) on drawing 79268-MR1-003 in Appendix F. There are additional areas of pink on drawing 79268-MR1-003 too, most notably on the south side of the live railway viaduct where a significant area of flood risk is shown to be removed in the ‘application 4’ model. There are also areas shown in black (was wet now dry) on drawing 79268-MR1-

003 associated with the proposed terracing on Travis Island and in front of plots RB06 and RB07 where water is being stored during flood events.

WATER LEVELS

The impact of the 'application 4' and 'application 5' models on water levels during the 1% AEP plus 35% climate change allowance event compared to the FEC Baseline model is also shown on the drawings in Appendix F.

Drawing 79268-MR1-002 shows that in general the impact of the 'application 5' model on water levels compared to the FEC Baseline model is negligible. There is a reduction in water levels with the 'application 5' development in place compared to the FEC Baseline model on the eastern side of Travis Island. The reduction in water levels is due to the changes in road levels along Dantzic Street in front of the NT02-04 plots that are part of the 'application 5' development.

In terms of water level changes as a result of the 'application 4' development, there are generally decreases in water level through the development area as well as upstream and downstream as shown by the green areas on drawing 79268-MR1-003 in Appendix F. On Collyhurst Road and Dantzic Street, peak flood levels for the 1% AEP event plus 35% climate change allowance are reduced by more than 0.1m (major beneficial). Water levels upstream of the footbridge to St Catherine's Wood on Collyhurst Road up to Collyhurst Weir are reduced by more than 0.1m. On the eastern side of Dantzic Street, water levels are reduced by up to 0.15m. On the western side of Dantzic Street, water levels are reduced by up to 0.24m. There is also a significant reduction in water levels on the RB10 plot and to the north of this with water levels reducing by up to 0.12m (major beneficial). Between the RB10 and RB06/07 development plots, in the area including and surrounding RB09 (owned by a different developer) there is also a reduction in flood levels of up to 0.029m (minor beneficial). Further away from the 'application 4' development, there is a negligible impact on water levels as shown on drawing 79268-MR1-003.

A significant increase in water levels through the 'application 4' development reach alongside Travis Island and in front of RB06/07 is shown in channel as a result of the 'application 4' development. This is where the buildings in the 'application 4' development are displacing water and causing levels to increase in the channel. There are also significant increases in water level where the terracing is proposed in front of plots RB06/07 as this area is being used for flood storage during the design event.

The maximum depth of water predicted against the flood wall on Travis Island is approximately 3m as shown on Figure 18, this depth of water is predicted along the most western 21m of the proposed flood wall. It may be that the terracing levels could be raised for the most western end of Travis Island as part of the detailed design for this area to prevent such high flood depths against the wall. It is unlikely that raising the terrace levels on the western end of Travis Island where the high depths occur will significantly reduce the flood storage provided at Travis Island to mitigate for the 'application 4' development. It should also be noted that high flood depths (~3m) are predicted on the terracing at the back of the buildings on plots RB16 and RB17 (between the buildings and the River Irk) as shown on Figure 18. Careful consideration of flood

hazard and public safety during flood events will be required at detailed design stage for this area. Flood hazard associated with both the 'application 4' and 'application 5' developments is discussed within the FRA.

The existing wall along the left bank of the River Irk upstream of Union Bridge, which runs along Dantzic Street is assumed not to fail during flood events in the modelling undertaken for this assessment. It should be noted that the structural integrity of the wall and its ability to withstand significant water pressure during a large flood event has not been confirmed as part of this assessment. There is overtopping of the wall immediately upstream of Union Bridge predicted by the model with the 'application 4' development in place for the 1% AEP plus 35% climate change event but further upstream the wall is not overtopped but the peak water level is only approximately 0.01m lower than the top of wall level opposite the RB06/07 plots. Therefore, at detailed design, there is a need to undertake a residual uncertainty analysis for the wall and consideration should be given to potentially upgrading this wall and/or providing adequate freeboard above the peak water level for the design flood event. Breach analysis will also need to be undertake for the wall at detailed design stage (parameters for testing to be agreed with EA) to determine the risk if the wall were breached during a flood event with the 'application 4' development in place. The breach analysis would inform the overall residual uncertainty analysis.

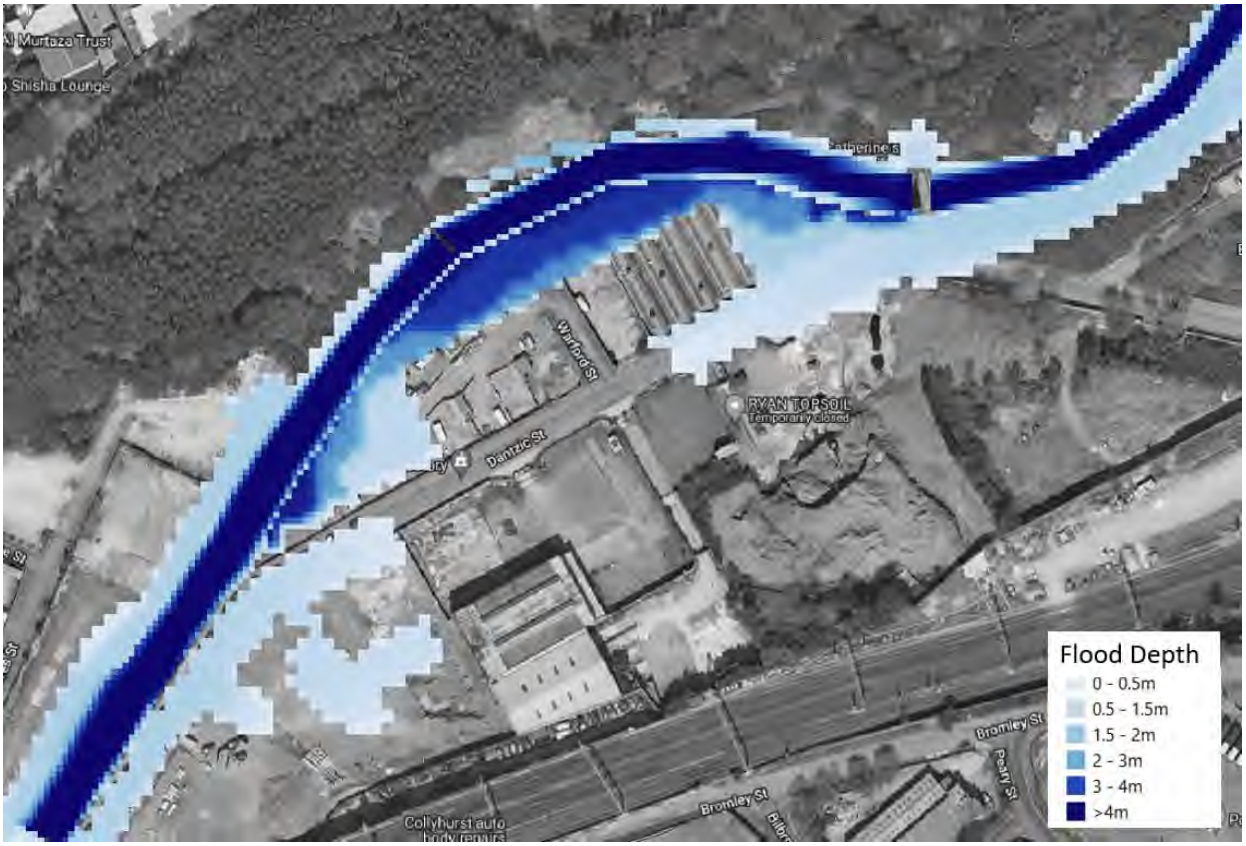


Figure 18 Predicted flood depths on Travis Island for 1% AEP event plus 35% climate change allowance

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FLOOD MECHANISMS

The FEC Baseline model shows that the main existing flood mechanisms into the Red Bank area are:

1) *Water overtopping the left bank of the River Irk upstream of Collyhurst Weir and flowing along Collyhurst Road onto Dantzic Street*
2) *Water overtopping the left bank of the River Irk onto Travis Island directly*
3) *Water overtopping the right bank of the River Irk upstream of Union Bridge (flooding the area proposed for plots RB06 and RB07)*
4) *Water overtopping the right bank of the River Irk downstream of Union Bridge (flooding plot RB10 and surrounding areas)*
5) *Water flowing from the right bank of the River Irk over Union Bridge and onto Dantzic Street plus through gaps in the live railway viaduct on the south side of the River Irk*

Due to the minimal impact of the 'application 5' development on the floodplain, there is a negligible impact on flood mechanisms as a result of this development.

The 'application 4' model has the following impacts on each flood mechanism:

1) *Water overtopping the left bank of the River Irk upstream of Collyhurst Weir and flowing along Collyhurst Road onto Dantzic Street* – no impact on this flood mechanism
2) *Water overtopping the left bank of the River Irk onto Travis Island directly* – the presence of the buildings on Travis Island means that a large area on the eastern side of Travis Island is no longer flooded. However, due to the terracing proposed and lowering of the riverbanks, additional water overtops onto the western side of Travis Island and without inclusion of the flood wall, this would cause an increase in water levels on the western side of Dantzic Street.
3) *Water overtopping the right bank of the River Irk upstream of Union Bridge (flooding the area proposed for plots RB06 and RB07)* – Instead of flooding the area proposed for buildings on RB06 and RB07 (which are raised above the flood level), flooding at this location is concentrated on the terracing proposed as part of 'application 4'.
4) *Water overtopping the right bank of the River Irk downstream of Union Bridge (flooding plot RB10 and surrounding areas)* – There is little impact on this flood mechanism, however the proposed building on plot RB10 does displace water.
5) *Water flowing from the right bank of the River Irk over Union Bridge and onto Dantzic Street plus through gaps in the live railway viaduct on the south side of the River Irk* – This flood mechanism still occurs with the 'application 4' development in place but the volumes of flood water flowing across Union Bridge and onto Dantzic Street are less. A significant area to the south of the live

railway viaduct is removed from the floodplain with the 'application 4' development in place as shown on drawing 79268-MR1-003 in Appendix F.

RECOMMENDATIONS

'Application 4' is an outline planning application; additional flood modelling and assessment is likely to be required at the detailed design stage to support the detailed application(s) for the development plots included in 'application 4'. The following recommendations for the detailed design stage are made:

- Additional flood events to those modelled for 'application 4' may be required at detailed design stage to finalise design of scheme elements including the proposed terracing and the flood wall on Travis Island.
- Further consideration of the flood wall on Travis Island will be required at detailed design stage, there is potential for considerable hydraulic loading on the western end of the wall as it is currently proposed. It is likely that breach modelling will be required at detailed design stage to understand the risk associated with a failure of this flood defence. At detailed design stage, the flood wall should be designated a realistic height within the model including freeboard (using the residual uncertainty allowance guidance[3]) above the 1% AEP event plus 35% climate change allowance peak water level.
- Terracing levels on Travis Island should ideally be revised to reduce the depth of water against the western end of the flood wall.
- Consideration should be given to flood hazard and public safety during a flood event given the predicted high flood depths on Travis Island.
- Residual uncertainty analysis and an understanding of the residual risk associated with the existing left bank wall upstream of Union Bridge is required at detailed design stage. As part of this, breach analysis for the wall should be undertaken to understand the flood risk if a breach were to occur when the 'application 4' development is in place.
- At detailed design stage, a sensitivity test using a 2m cell size within the model may be required to model smaller flow routes in detail.

General recommendations:

- It was not deemed necessary for this assessment as it is out of the area of interest, but future users of the model may wish to improve stability on Moston Brook as this is the source of the dVol instability within the model. This will be particularly important if future studies require accurate results on Moston Brook.

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DATE:	23 June 2023	**CONFIDENTIALITY:**	Confidential
SUBJECT:	FEC Red Bank Hydraulic Modelling		
PROJECT:	Red Bank	**AUTHOR:**	Julia Chambers
REVIEWER:	Lee Garratt	**APPROVER:**	Lee Garratt

SUMMARY

WSP were commissioned by FEC to understand the impacts of the 'application 5' development and 'application 4' development on flood risk within the Red Bank area. Detailed planning permission is being sought for 'Application 5' and outline planning permission is being sought for 'Application 4'. The Arup 2022 Baseline model (approved by the EA in October 2022) was used as the basis for the flood modelling. A FEC Baseline version of the model has been created to include representation of the Victoria Riverside development, which is currently being constructed and therefore has consent. It is assumed that the Victoria Riverside development will be built by the time either the 'application 5' or 'application 4' developments are built. A small update to the 1D-2D linking adjacent to development plot RB10 was also made within the FEC Baseline model to represent the spillway into the river on plot RB10 and the full width of the river upstream of the culvert under the railway viaduct at this location.

A version of the model to represent the 'application 5' development was then created and the results of this model compared to the FEC Baseline model, the impact mapping shows a negligible impact on flood risk elsewhere as a result of the NT02-04 development and a slight reduction in water levels and extent on the eastern side of Travis Island due to the changes in road levels along Dantzic Street as part of the 'application 5' development.

A version of the model was also created to represent the 'application 4' development, which includes the buildings on the RB plots that are within the floodplain (and therefore displace flood waters) and the mitigation measures included as part of the development to offset its impact of flood risk. Terracing of the riverbanks and floodplain is proposed in front of plots RB16/17 and plots RB06/07 to provide storage during flood events. The impact mapping shows that the 'application 4' development including the mitigation measures does not have an adverse impact on flood risk elsewhere and in fact a betterment is seen over a large area including a reduction in flood extent on the south bank of the River Irk near to the live railway viaduct.

As discussed, there are known stability issues within the Arup 2022 Baseline model on Moston Brook, these have not been addressed as part of this work as Moston Brook is outside of the area of interest for this study and the instabilities do not have an impact on results in the Red Bank area and WSP are confident in the results of the modelling explained in this note.

Recommendations have been made for further modelling work and considerations required at the detailed design stage of the 'application 4' development.

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RB02

RB03

RB04

RB05A

RB05B

RB05C

RB06
RB06
MIN. FFL 31.20
(100 YR +35%)
MIN. FFL 31.43
(1000 YR)

RB07
RB07
MIN. FFL 31.20
(100 YR +35%)
MIN. FFL 31.43
(1000 YR)

RB10
RB10
MIN. FFL 30.34
(100 YR +35%)
MIN. FFL 30.87
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RB12B

RB16
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RB17
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DRAWING STATUS:

S2 - FOR INFORMATION

8 First Street, Manchester, M15 4GU, UK
T+ 44 (0) 161 200 5000
wsp.com

CLIENT:

FEC

ARCHITECT:

MLM

SITE/PROJECT:

RED BANK AND DANTZIC STREET

TITLE:

APPLICATION 4 - MINIMUM FINISHED FLOOR LEVELS AND DESIGN FLOOD EXTENTS

SCALE @ A1:	CHECKED:	APPROVED:
1:1250	SM	SM

PROJECT NO:	DESIGNED:	DRAWN:	DATE:
70079268	UB	UB	March 23

DRAWING No: REV:

RDB-WSP-XX-XX-DR-C-0016 P01

c WSP UK Ltd

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APPLICATION 5 – FFL STRATEGY:

THE STANDARD EA GUIDANCE FOR SETTING OF PROPOSED FINISHED FLOOR LEVEL'S (FFL'S) FOR BUILDINGS WHICH ARE AT RISK OF FLUVIAL FLOODING IS THAT THEY SHOULD BE SET AT OR ABOVE THE DESIGN FLOOD LEVEL (100 YEAR PLUS 35% CLIMATE CHANGE EVENT). IT HAS NOT BEEN POSSIBLE TO ACHIEVE THIS WHILST MAINTAINING THE ACTIVE FRONTAGES TO THE PROPOSED BUILDINGS WHICH ARE AN IMPORTANT FEATURE OF THE DESIGN. WHERE THE EA REQUIREMENTS HAVE NOT BEEN ABLE TO BE ACHIEVED THE EA HAVE BEEN CONSULTED AT THE PRE–APPLICATION STAGE. FOR PLANNING APPLICATION 5 (DETAILED).
PLOTS NT02 & NT03 ARE SET ABOVE THE DESIGN FLOOD LEVEL PLUS 300mm.
THE APPROACH FOR NT04 IS TO HAVE THE FFL SET BELOW THE DESIGN FLOOD LEVEL. THE DESIGN FLOOD LEVEL IS 31.55m AOD. THE PROPOSED FFL IS 30.955m AOD. FLOOD RESISTANT CONSTRUCTION WILL BE PROVIDE TO 600mm ABOVE FFL WHICH IS 31.555m AOD. FLOOD RESILIENCE WILL BE PROVIDED TO THE 100YR FLOOD LEVEL WHICH IS 31.84m AOD.

RB05A
RB05B
RB05C
RB04
RB03
RB02
RB01
RB12B
RB17
RB16
RB06
RB07
RB10

PLOT NT04
DESIGN FLOOD LEVEL – 31.56m AOD
PROPOSED FFL – 30.955m AOD
FLOOD RESISTANCE UPTO 610mm
ABOVE FFL – 31.56mm AOD
FLOOD RESILIENCE MEASURES UP TO
1000 YR FLOOD LEVEL – 31.93m AOD

PLOT NT03
FFL = 32.00m AOD
(THIS PLOT IS SET ABOVE THE DESIGN FLOOD LEVEL PLUS 300mm FREEBOARD)

PLOT NT02
FFL = 31.55m AOD
(THIS PLOT IS SET ABOVE THE DESIGN FLOOD LEVEL PLUS 300mm FREEBOARD)

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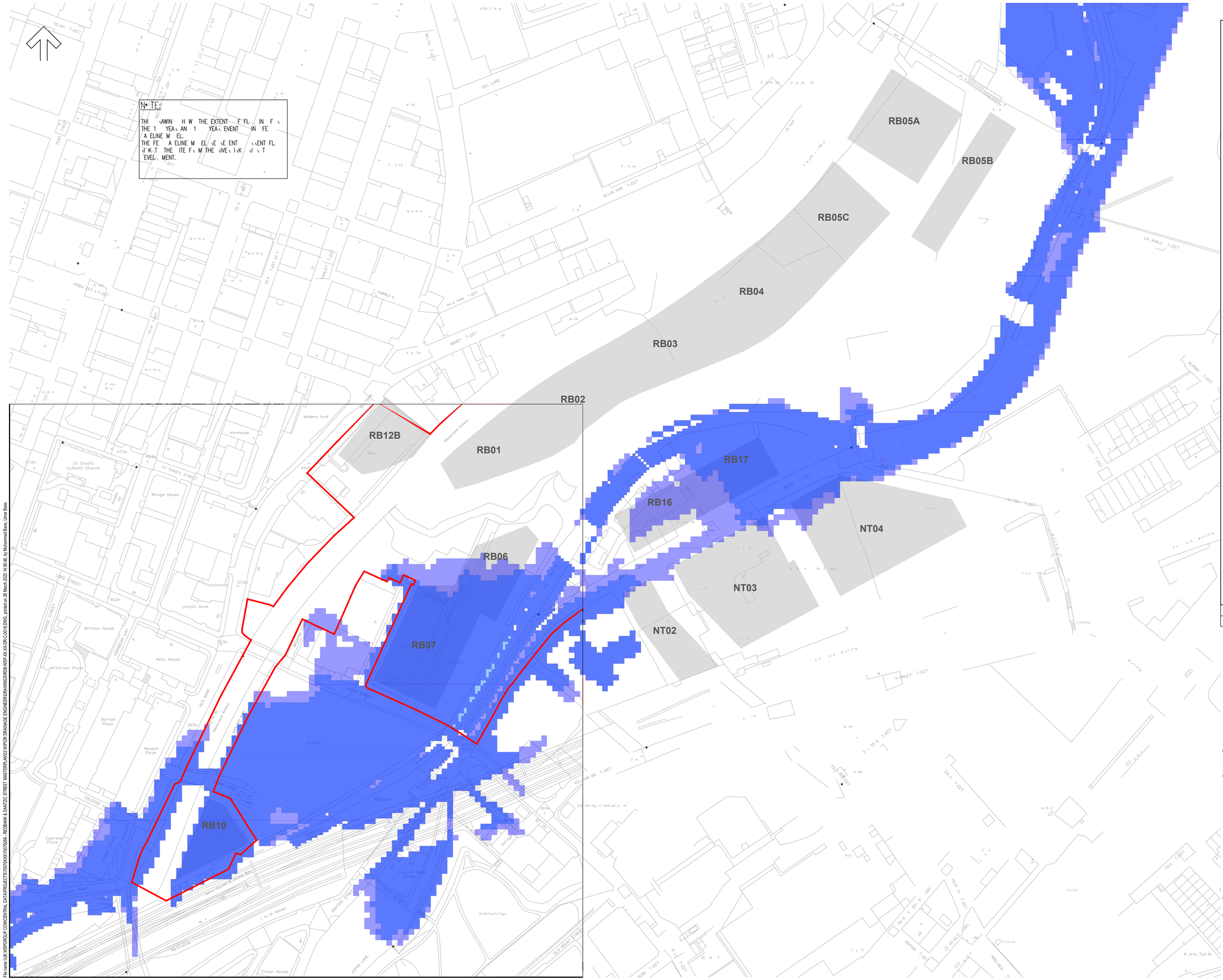
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70079268	UB	UB	March 23

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DRAWING STATUS:

S0 - WORK IN PROGRESS

8 First Street, Manchester, M15 4GU, UK
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CLIENT:

FEC

ARCHITECT:

MLM

SITE/PROJECT:

RED BANK AND DANTZIC STREET

TITLE:

FEC BASELINE MODEL 100 YEAR AND 1000 YEAR FLOOD EXTENTS

SCALE @ A1:	CHECKED:		APPROVED:	
1:1250	SM		SM	
PROJECT NO:	DESIGNED:	DRAWN:	DATE:	
70079268	UB	UB	March 23	
DRAWING No:				REV:
RDB-WSP-XX-XX-DR-C-0018				P01

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ARUP

Technical Note

Project title	Victoria North Rivers
Job number	281943-28
File reference	4-05-02
cc	
Prepared by	Louise O'Regan
Date	17 November 2022
Subject	2022 Hydraulic Modelling Update – Rev 5

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1. Introduction

This note describes updates made to the Baseline (Existing Condition) Victoria North hydraulic model in April – June 2022, with additional updated made during November 2022 following a review by the Environment Agency (EA).

The model is a 1D-2D, Flood Modeller Pro – TUFLOW hydraulic model of the River Irk, from Harpurhey to the River Irwell confluence; the Moston Brook, from Failsworth to the River Irk confluence is also represented. The model was created in 2019 through combining of several historic models, as shown in Figure 1:

- 2009 EA Irk model (by JBA) which extended from the A6010 Queens Road Bridge to the Irwell confluence, immediately downstream of Victoria Station culvert (blue);
- 2004 EA Irk model (by Atkins) for approx. 1.5km extent upstream of Queens Road Bridge (red);
- 2007 1D EA model of Moston Brook (purple);
- 2015 EA model of River Irwell.

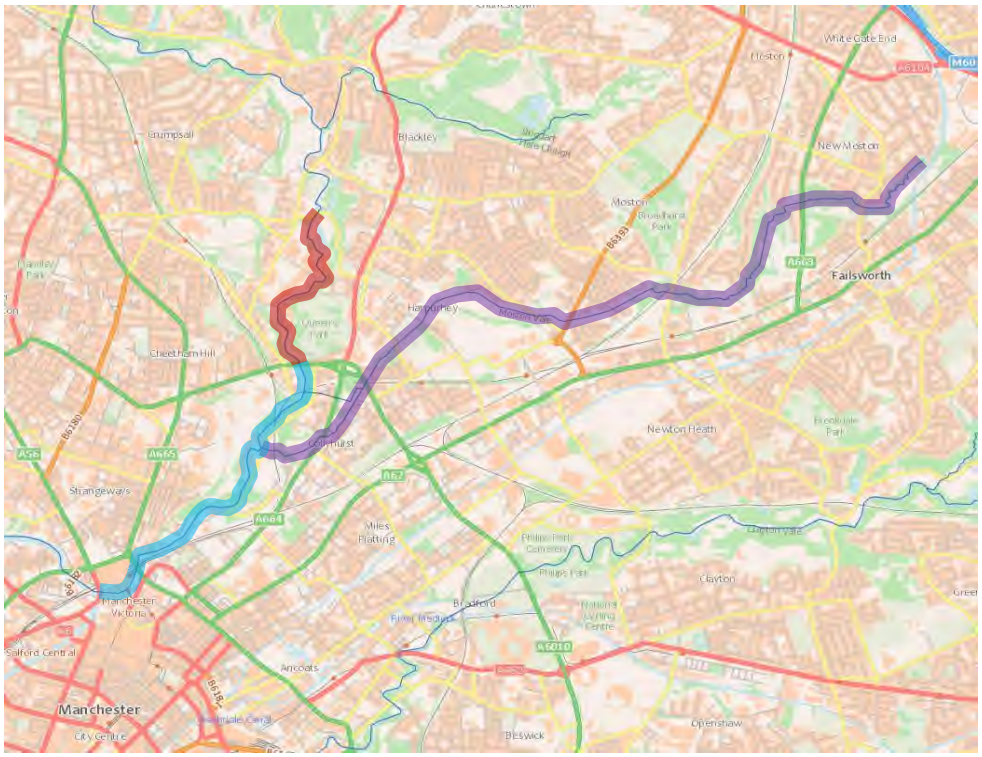


Figure 1: Extents of existing Environment Agency models used

The model was subsequently edited in 2021 to support the Victoria North HIF Infrastructure Works planning application, with the changes made detailed in *'VNIF-ARP-ZZ-RIV-RP-DF-0002_HydrModellingofInfraProposals_Issue4'*. The resulting *'2021 Interim Model'* forms the basis of the work completed here.

The 2021 Interim Model was updated with edits primarily based around the inclusion of additional topographical survey along the River Irk captured as part of the project. Additional survey was considered necessary to improve the performance of the hydraulic model, and improve the model resolution and hydrology calibration to a gauging station situated immediately upstream of Collyhurst Weir. The updates also include actions which remained outstanding from the 2021 Interim Model Environment Agency review; one remaining comment surrounded the incorporation of the 2022 hydrology update, which is described in Section 3.3.

The Baseline model represents the existing condition, as of Quarter 1 2022 (January – March 2022) when additional survey was completed. It is proposed that all future FRAs and 'with scheme' comparisons across the entire Victoria North scheme (including the River and Flood Alleviation Works, phasing checks and any future planning applications that are part of the wider project) will be compared back to this Q1 2022 'Baseline' situation and used as a benchmark for comparisons to assess changes to flood risk.

Following the Environment Agency review in November 2022 and discussions with the project team, the Baseline model which represents the existing condition no longer includes approximately 85m of wall on the right bank (north) of the watercourse immediately upstream of Union Bridge. This wall will be referred to as Union Plaza Wall and is discussed further in Section 3.4.1.

2. Additional survey data

Additional survey of the watercourse was undertaken by Volker Stevin in February 2022 and a topographic survey of Scotland Weir was completed in April 2022. The key components of these surveys included:-

- Scotland Weir Topo / Bathmetry Survey *ref 'SSS-IFA-SW-DR-001-A' by Site Surveying Services Ltd dated 19th April 2022.*
- River Irk Topographical including a 3D Laser Scanning Survey ref *'2381331_XS_River Irk' Rev B by Central Alliance Survey dated January 2022.*
- Collyhurst Weir Topographical including a 3D Laser Scanning Survey ref. *'2381331_XS_Collyhurst Weir' Rev B by Central Alliance Survey dated January 2022.*

In addition, BAM Nuttall have also conducted a topographical survey of the wider Victoria North Site which has been used to supplement any gaps or verify levels (*Ref PS-2158-TS-00.dwg by Paragon Surveys Sept 2021*).

2.1 Collyhurst Weir

Additional topographic survey data at Collyhurst Weir was collected to improve confidence in a rating at Collyhurst gauge upstream and downstream of the weir. Whilst the 2019 survey adequately captured a cross section along the crest of the weir, previous survey was not sufficient to allow a good match between the modelled rating and empirical data. Peter Spencer (EA) provided the following recommendations regarding additional survey data, suggesting that for any more modelling a more detailed station-selective survey would be required:

- The channel upstream of the weir should be represented by several surveyed cross sections
- There should also be several cross sections between the end of the simple river section upstream and the expansion to the weir
- A cross section should also represent the exact location of the inlet pipe to the gauging station
- The sections downstream of the weir are required to be detailed, including bridges representation of overtopping of the river channel

11 cross-sections were surveyed along the reach of the River Irk around Collyhurst Weir, extending 50m upstream and 40m downstream of the weir. This captured the widening and narrowing of the channel around the weir and also captured a cross section at the location of the gauge inlet. The location of the surveyed sections compared to the Existing model sections are shown Figure 2.



Figure 2: Comparison of the location of Existing model nodes, and surveyed sections at Collyhurst Weir.

2.2 Union Bridge

22 cross-sections were surveyed in the reach around Union Bridge, extending approximately 160m upstream and 130m downstream of the bridge; a comparison between the surveyed sections and Existing model sections is shown in Figure 3.



Figure 3: Comparison of the location of Existing model sections and survey sections, along the River Irk around Union Bridge

2.3 Aspin Lane culvert

19 cross-sections around, and through, the Aspin Lane culvert were surveyed, extending 20m upstream, 130m through, and approximately 85m downstream of the culvert (Figure 4).

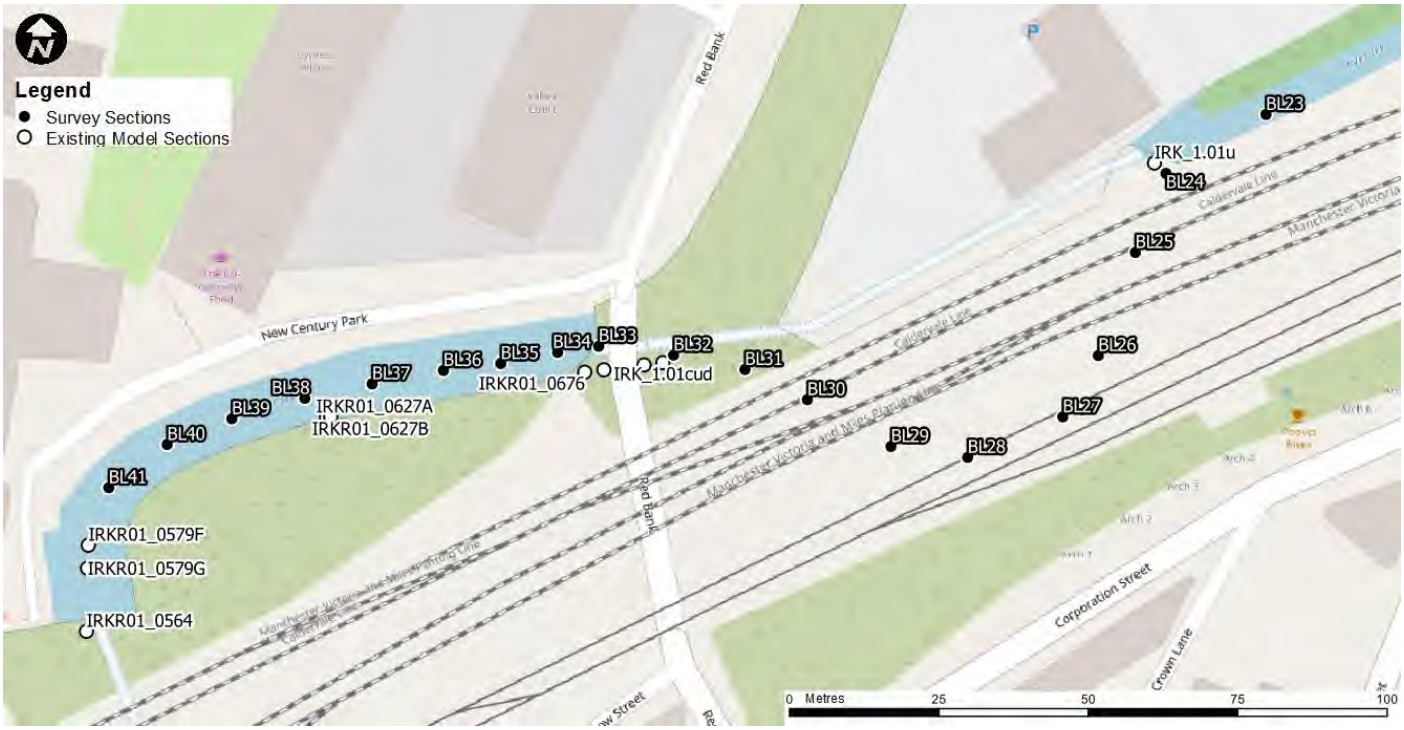


Figure 4: Comparison of the location of Existing model sections and survey sections, along the River Irk around the Aspin Lane culvert

2.4 Survey review

The received surveyed cross-sections were cleaned to remove points representing non-solid structures, such as fences, which are considered to have no effect on out of bank flows. Hard bed levels from the survey have been used as it is assumed that a flood event would remove smaller channel sediments represented by the soft bed levels; there was also more complete data around hard bed levels compared to soft bed levels.

A comparison of Existing model cross-sections and surveyed cross-sections around Collyhurst Weir has been undertaken, shown in Figure 5 – 9 (see Figure 2 for the locations of the cross-sections compared). Broadly, the comparisons show that the cross-section shape is the same between the Existing model (shown in black) and the newly surveyed sections (shown in red).

[Note, for visual comparison purposes, the x coordinates of new survey cross sections have been shifted along the x-axis in the figures below].

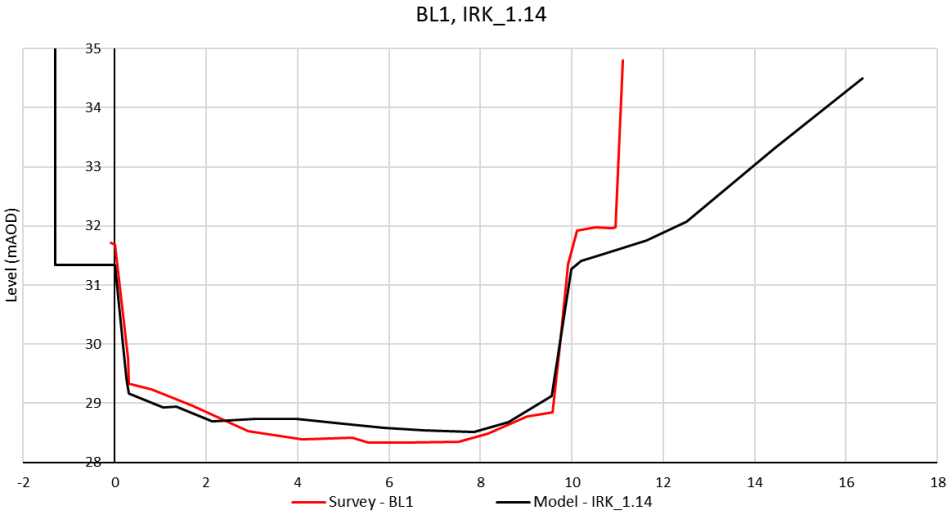


Figure 5: Comparison of the existing model section, IRK_1.14, and the surveyed cross-section, BL1

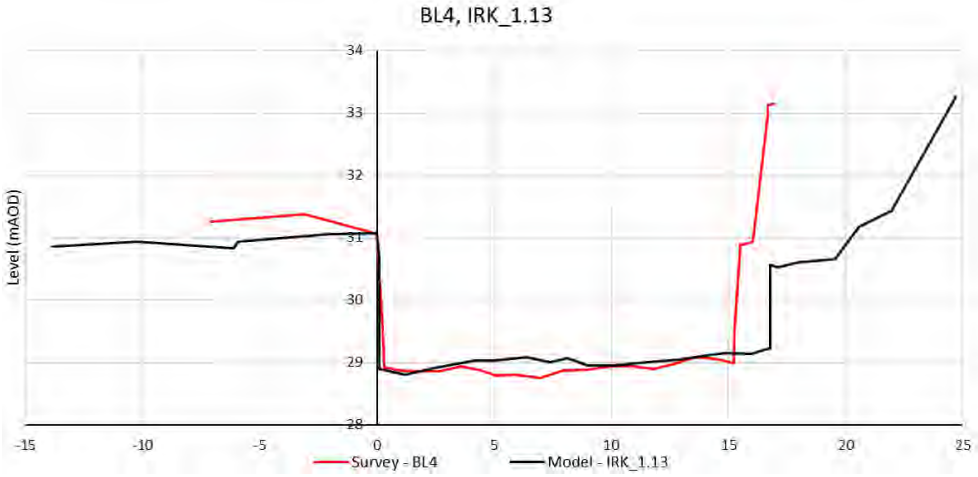


Figure 6: Comparison of the Existing model section, IRK_1.13, and the surveyed cross-section BL4

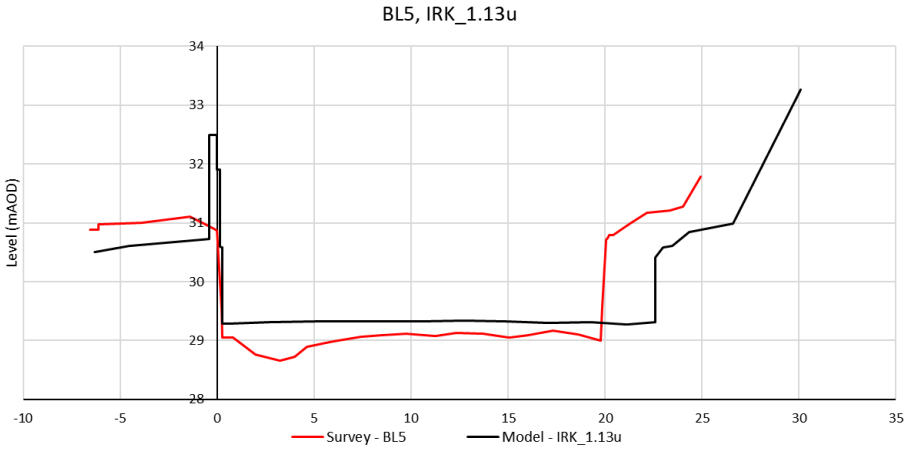


Figure 7: Comparison of the Existing model section, IRK_1.13u, and the surveyed section BL5

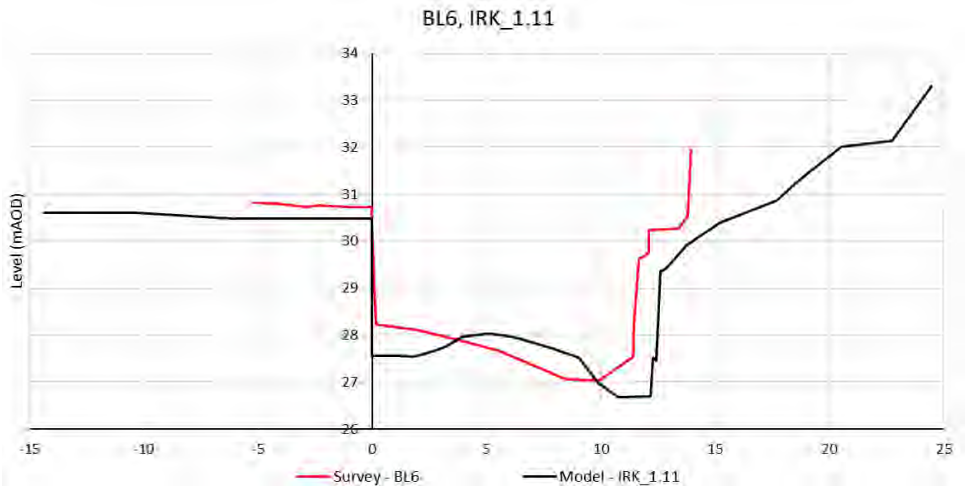


Figure 8: Comparison of the Existing model section, IRK_1.11, and the surveyed cross-section BL6

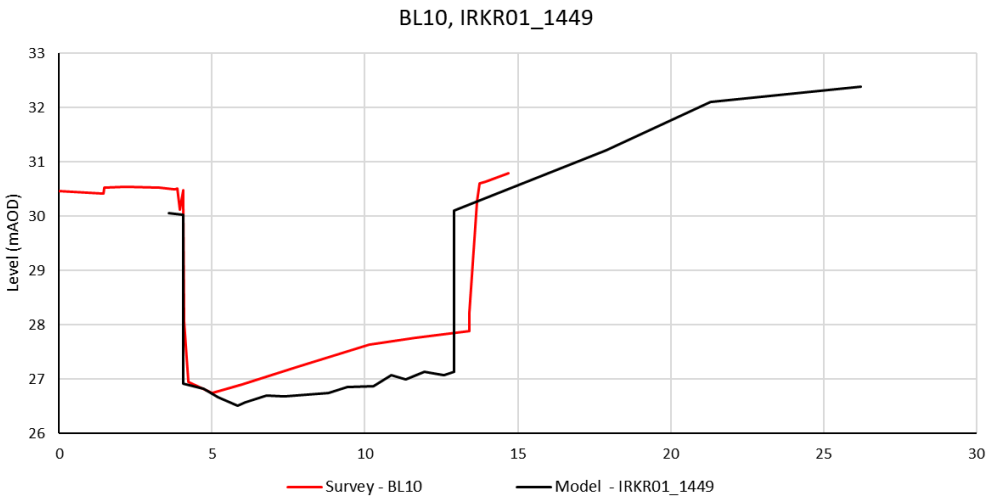


Figure 9: Comparison of the Existing model section, IRKR01_1449, and the surveyed cross-section BL10

Similarly, a comparison between the Existing model sections and surveyed cross-sections around Union Bridge was undertaken, shown in Figure 10 – 21 (Figure 3 shows the location of the sections compared). Broadly, the comparison shows that the cross-section shape is the same between the Existing model and surveyed sections.

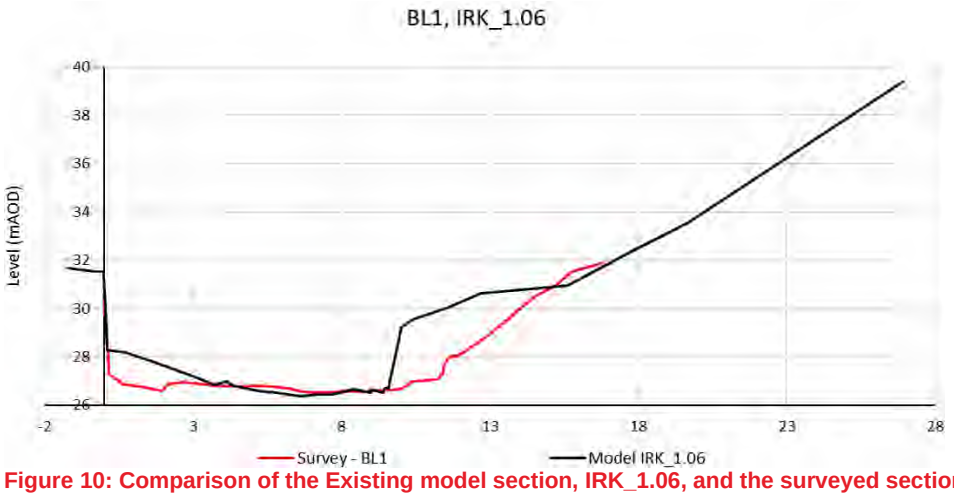


Figure 10: Comparison of the Existing model section, IRK_1.06, and the surveyed section BL1

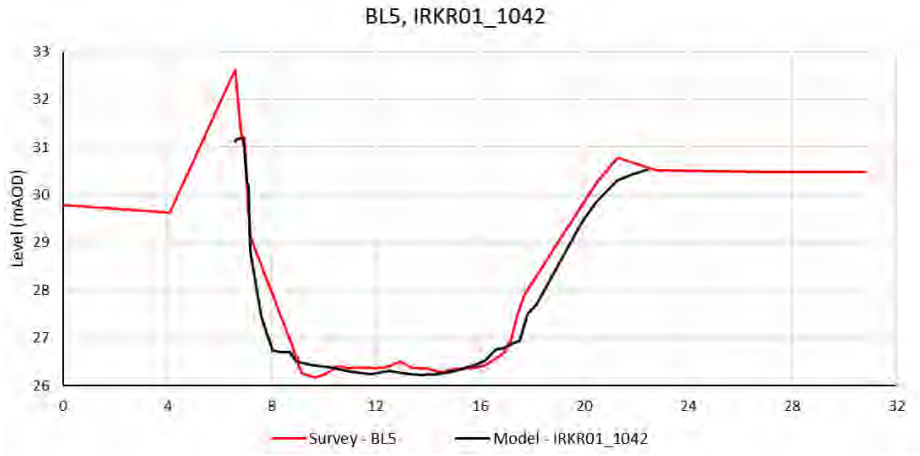


Figure 11: Comparison of the Existing model section, IRKR01_1042, and the surveyed section BL5

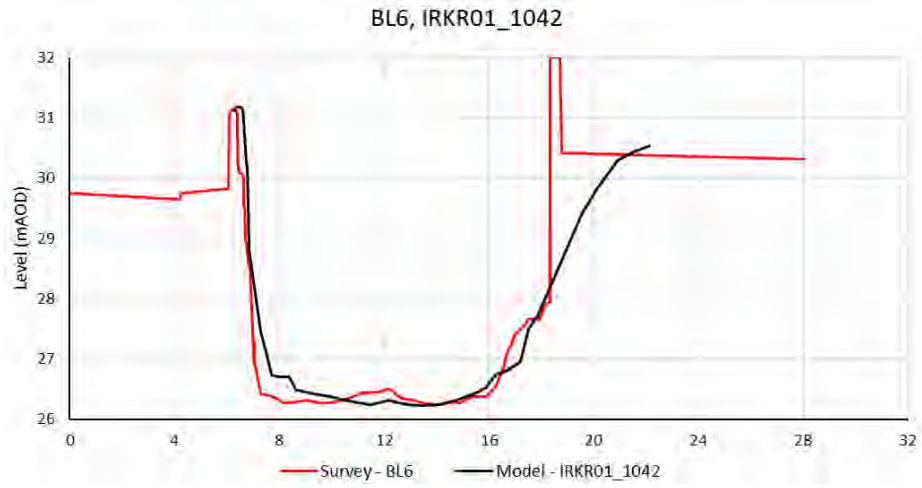


Figure 12: Comparison of the Existing model section, IRKR01_1042, and the surveyed section BL6

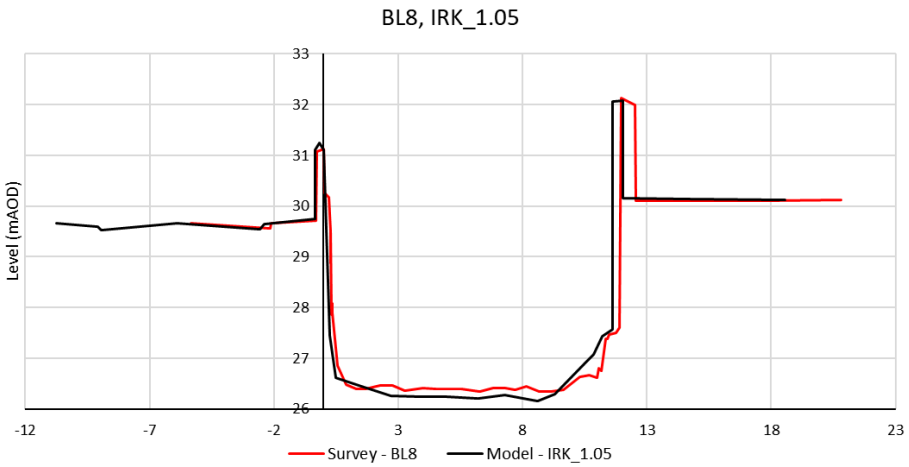


Figure 13: Comparison of the Existing model section, IRK_1.05, and the surveyed section BL8

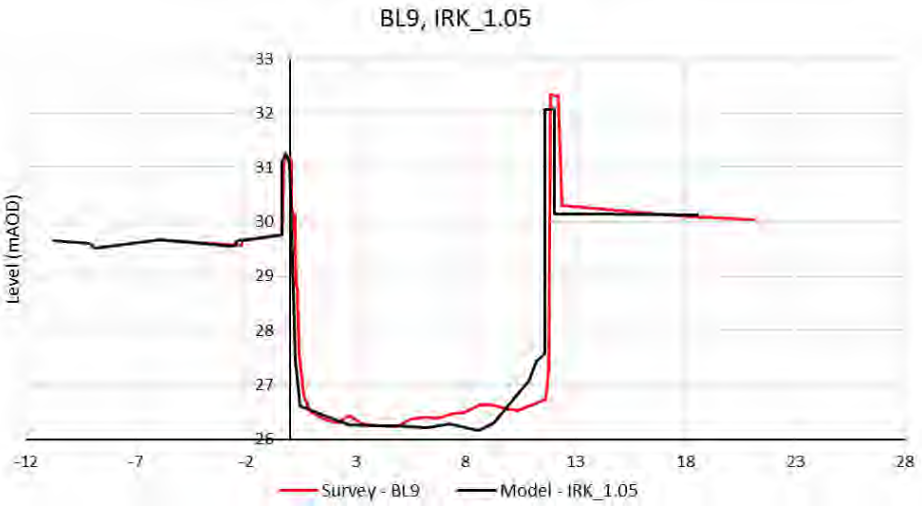


Figure 14: Comparison of the Existing model section, IRK_1.05, and the surveyed section BL9

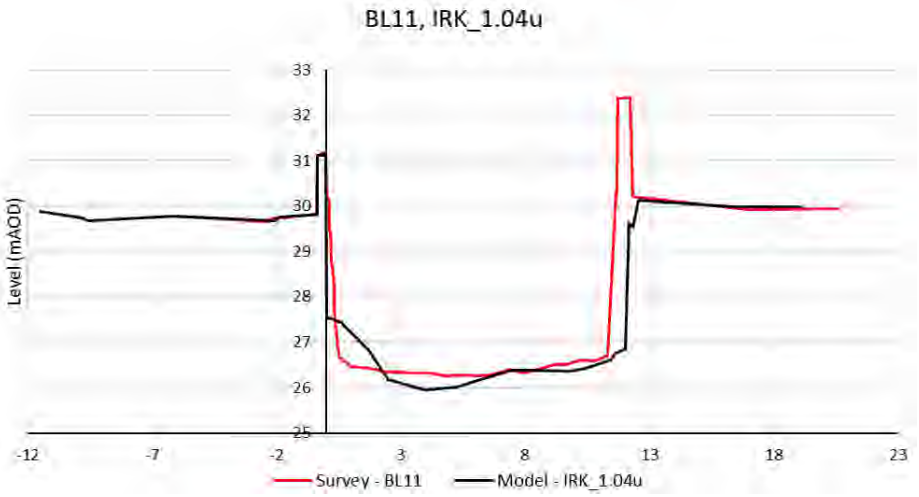


Figure 15: Comparison of the Existing model section, IRK_1.04, and the surveyed section BL11

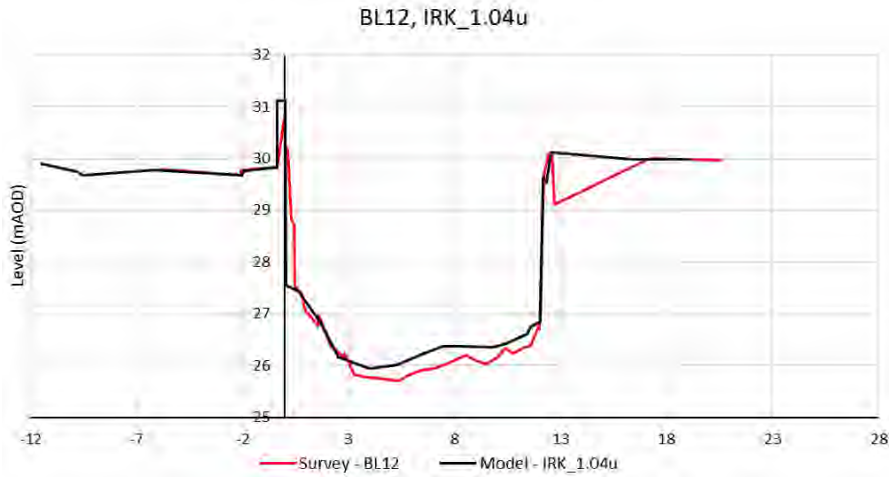


Figure 16: Comparison of the Existing model section, IRK_1.04u, and the surveyed section BL12

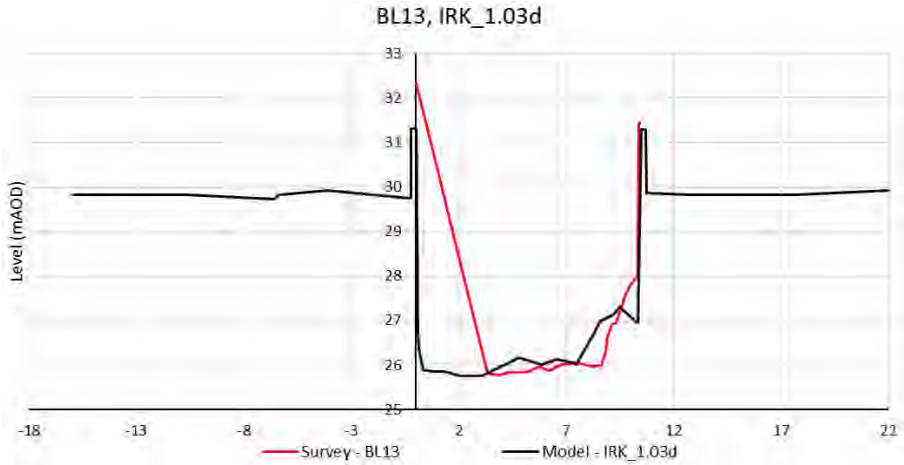


Figure 17: Comparison of the Existing model section, IRK_1.03d and the surveyed section BL13



Figure 18: Comparison of the Existing model section, IRK_1.02, and the surveyed section BL17

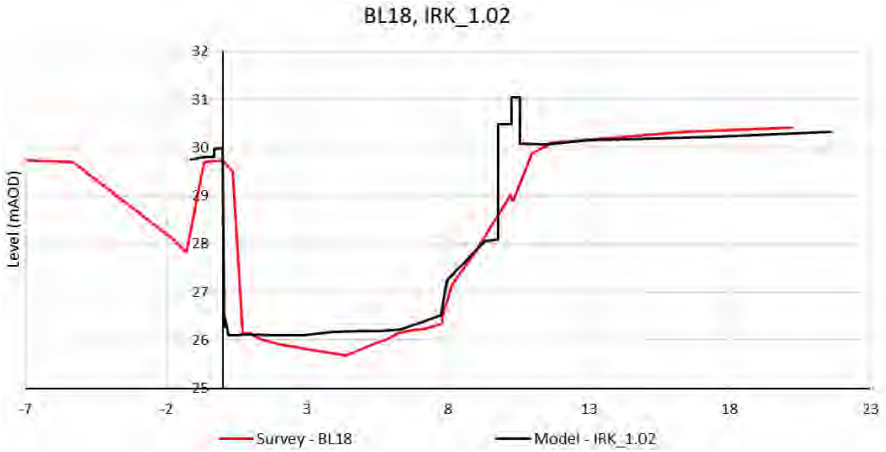


Figure 19: Comparison of the Existing model section, IRK_1.02, and the surveyed section BL18

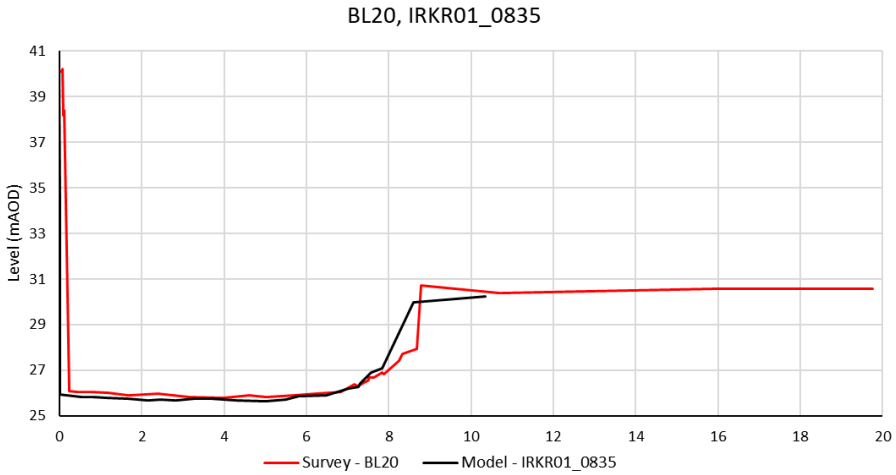


Figure 20: Comparison of the Existing model section, IRKR01_0835 and the surveyed section BL20

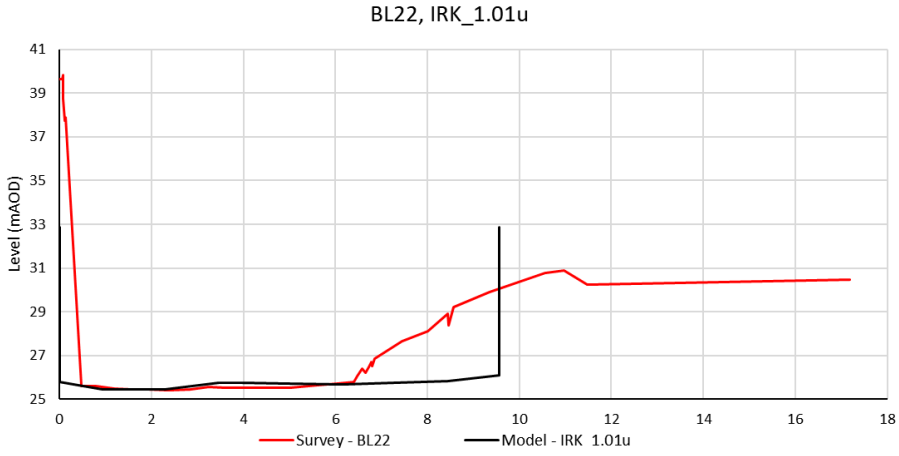


Figure 21: Comparison of the Existing model section, IRK_1.01u and the surveyed section BL22

Similarly, a comparison between the Existing model sections and surveyed cross-sections around Aspin Lane culvert and Aspin Lane Bridge was undertaken, shown in Figure 22– 26 (Figure 4 shows the location of the sections compared). Broadly, the comparison shows that the cross-section shape is the same between the Existing model and surveyed sections.

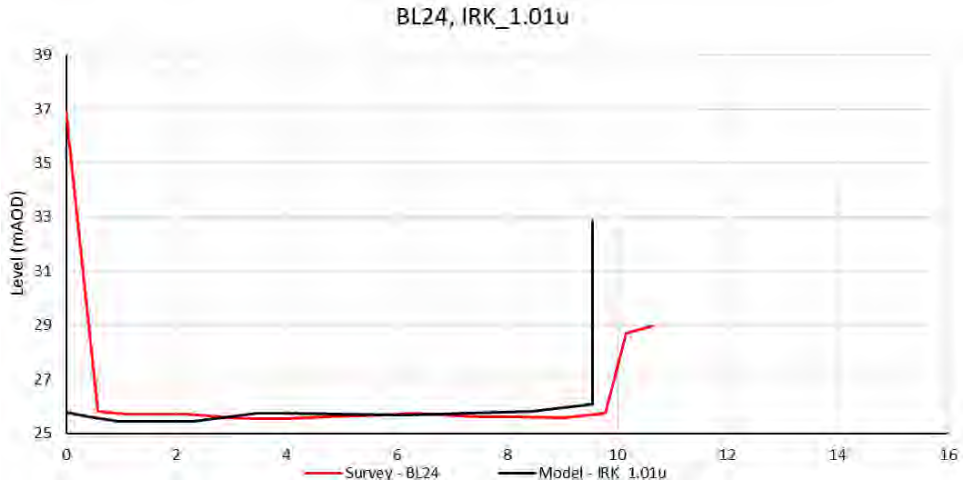


Figure 22: Comparison of the Existing model section IRK_1.01u and surveyed section BL24



Figure 23: Comparison of the Existing model section IRKR01_0685E and surveyed section BL33

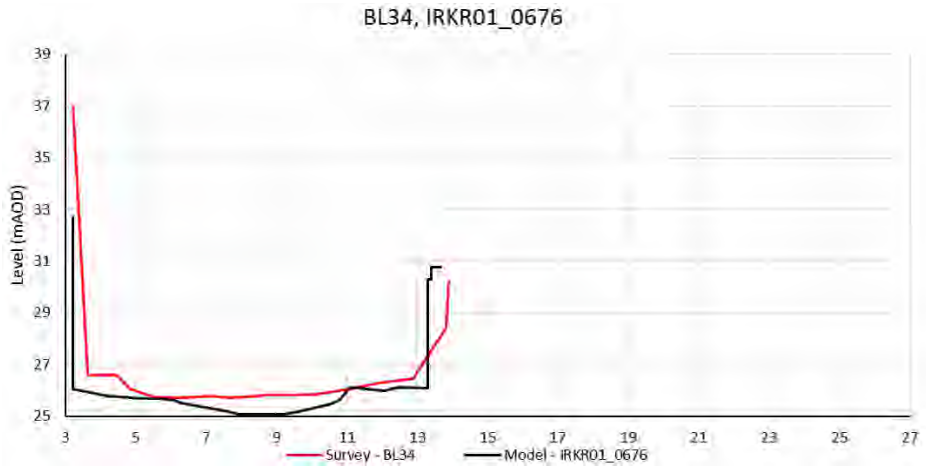


Figure 24: Comparison of the Existing model section IRKR01_0676 and surveyed section BL34

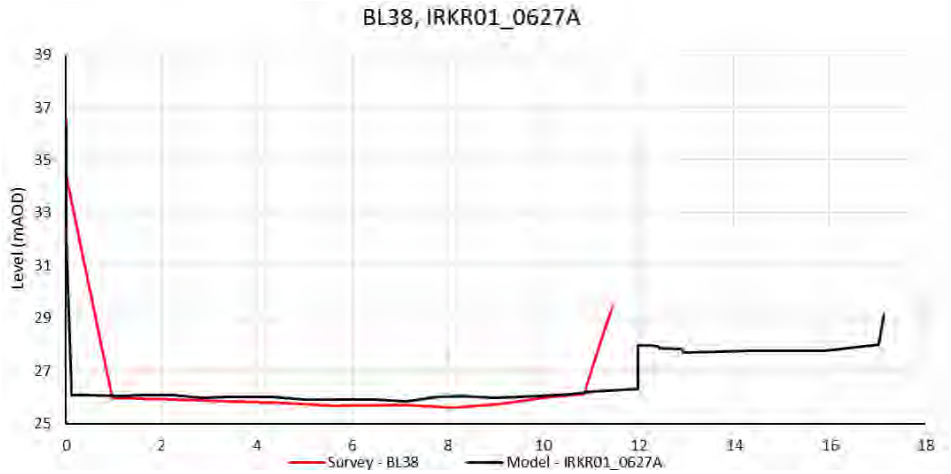


Figure 25: Comparison of the Existing model section IRKR01_0627A and surveyed section BL38

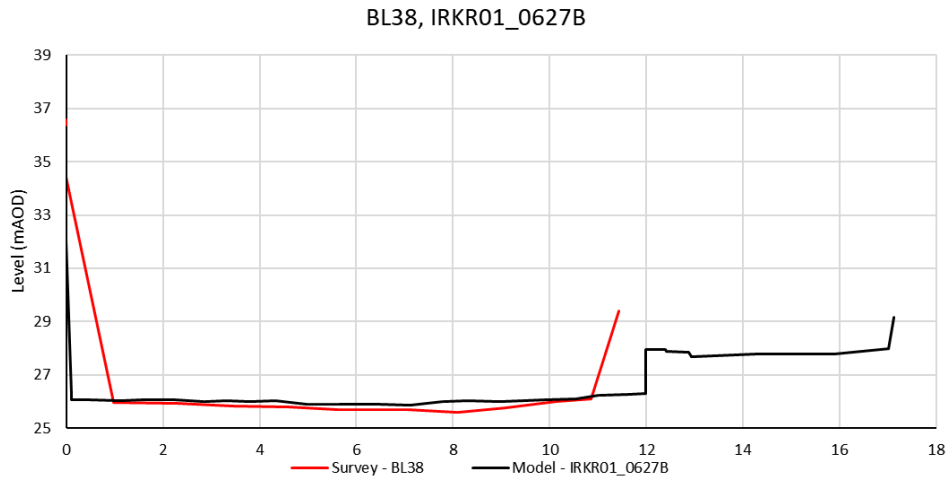


Figure 26: Comparison of the Existing model section IRKR01_0627B and surveyed section BL38

3. Model update methodology

The survey was used to replace the Existing model cross-sections, rather than supplementing them, as the sections were surveyed with a spacing of approximately 15m (although this spacing is variable). Supplementing existing model sections would have created short channel reaches, which may have affected model stability. While the naming of the newly surveyed cross-sections did not reference chainage, this was updated by measuring distances in GIS software, between the received surveyed sections and the existing model cross-sections, which do reference chainage. In some locations, the addition of interpolate units was necessary to ensure that cross-section spacing is not considered to be erratic. Both the 1D and 2D domains of the model were updated to account for the addition of the survey.

3.1 Survey - 1D model updates

3.1.1 Collyhurst Weir

Collyhurst Weir was previously modelled using a Flood Modeller "General Weir" unit; while it was initially considered that a "Broad-crested Weir" unit would be perhaps more representative of the weir profile, the "General Weir" unit was retained as it provided more accurate calibration results (see Section 3.3 for a description of the hydrology updates made). The geometry of the weir unit was updated based on the received survey, while the *"Discharge Coefficient"*, *"Modular Limit"* and *"Exponent"* values were optimised to ensure the model accurately represents the behaviour of Collyhurst Weir, based on observed gauge station data.

Surveyed sections *BL2*, 49m upstream of Collyhurst Weir, was considered to be skewed (Figure 27); as such, the skew angle was measured and used to adjust the cross-section width. This led to a reduction in the width of the cross-section, from 18.673m measured from survey, to 17.059m when adjusted for cross-section skew. Section IRKR01_1509u, immediately upstream of the weir, was taken from the 2021 Interim Model, as this was shown to provide the best match to observed gauge data (Section 3.3.1).

While these changes were initially made to improve the model performance during calibration, they were also applied to the Baseline model to ensure model performance was optimised. See Section 3.3.1 for more information on the calibration.



Figure 27: Surveyed cross-section data plotted, clearly showing the skew of sections BL2 and BL5

3.1.2 Union Bridge

Survey cross-sections *BL12* and *BL13* represent the upstream and downstream sections of Union Bridge respectively, as shown in Figure 3. The survey of section *BL12* is complete, however the survey of section *BL13* is not complete, due to access and associated safety issues at the time of survey. As a result of this, section *BL12* was used to represent both the upstream bridge section and bridge geometry, in the model unit *IRKR01_0941u*. Where survey of section *BL13* is available, this was used to represent the downstream face of the bridge in section *IRKR01_0941d*; section geometry from *BL12* was used where data from section *BL13* is not available. Figure 28 illustrates the upstream and downstream section geometry, as defined in the model.

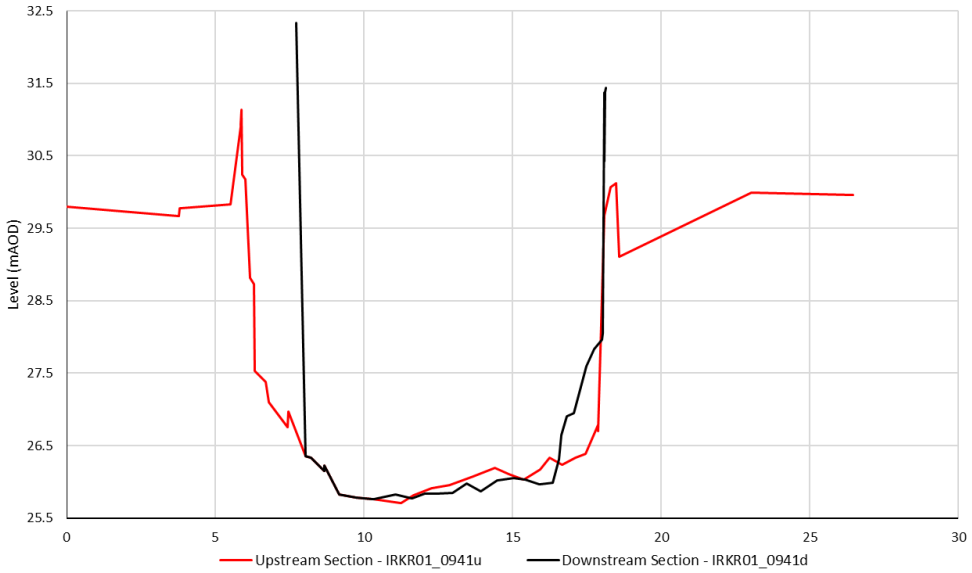


Figure 28: Comparison of upstream and downstream section geometry at Union Bridge

3.1.3 Aspin Lane culvert and Aspin Lane (Scotland) Bridge

Previously, the model represented the Aspin Lane culvert as a sprung-arch type culvert, 89m in length; the 2022 survey shows that there are multiple shape changes over 130m. The culvert was updated using asymmetrical conduit units, enabling the model to represent the shape and bed level changes shown in the surveyed cross-sections. Culvert outlet loss units were applied where the cross-sections illustrated a change in shape, between survey sections *BL25* and *BL26*, *BL26* and *BL27*, *BL28* and *BL29*, *BL29* and *BL30*, and *BL31* and *BL32*. As such, to enable the model to run while using culvert outlet loss units, copies of sections are used to represent the upstream and downstream faces of the culvert where these shape changes occur. While the survey indicated the presence of beams in the culvert cross-sections, these were represented by an increased roughness of the culvert soffit, rather than being explicitly represented in section geometry. A value of 0.03 was used for the soffit roughness where beams were present, increased from a value of 0.015 where beams were not present. These values were based on the values for brickwork closed conduits in the 1959 Chow roughness tables.

Similarly, Aspin Lane Bridge was updated, and represented using an irregular conduit unit, rather than an arch bridge unit, as a result of the 12m bridge length, and the change in soffit level through the bridge shown in the surveyed cross-sections. Compared to the 2021 Interim Baseline Model, the bridge is a more restrictive structure. The 2022 survey shows the soffit level of the bridge to be 28.28 – 28.37mAOD, with a width of 8.27 – 9.32m, while the 2021 model shows the soffit level to be 28.67mAOD, with a width of 9.92m.

3.1.4 Roughness values

To represent roughness in the model cross-sections, Manning's n values were assigned to the additional surveyed cross-sections in the model, based on the 1959 Chow roughness tables. The values were compared to the Existing model sections upstream and downstream of additional sections. In the absence of survey photos, values were checked for suitability against online imagery, and cross-section descriptions. Panel markers were also added at changes of Manning's n values (across channel width).

3.1.5 Cross-section naming convention

The model cross-sections added from the 2022 survey were named as such: *IRKR01_XXXX*, where *XXXX* varies for each cross-section, and represents cross-section chainage. The chainage value used in the naming convention was measured for each additional cross-section, based on existing model cross-sections. Table 1 details the model node name for each of the surveyed cross-sections.

Table 1: The model cross-section naming convention, listing the received survey cross-section names, with the names given to the node when added to the model. Not all nodes added to the Aspin Lane sections are detailed, as some are related to the addition of culvert outlet loss units, rather than corresponding to a specific surveyed section

Collyhurst Weir sections		Union Bridge Sections		Aspin Lane Sections	
Survey name	Model name	Survey name	Model name	Suvey name	Model name
BL1	IRKR01_1576	BL1	IRKR01_1111	BL23	IRKR01_00794
BL2	IRKR01_1558	BL2	IRKR01_1096	BL24	IRKR01_00775u
BL3	IRKR01_1548	BL3	IRKR01_1081	BL25	IRKR01_00761
BL4	IRKR01_1539	BL4	IRKR01_1066	BL26	IRKR01_00742
BL5	IRKR01_1509u	BL5	IRKR01_1051	BL27	IRKR01_00731
BL6	IRKR01_1509d	BL6	IRKR01_1036	BL28	IRKR01_00713
BL7	IRKR01_1501	BL7	IRKR01_1022	BL29	IRKR01_00700
BL8	IRKR01_1492	BL8	IRKR01_1005	BL30	IRKR01_00684
BL9	IRKR01_1480	BL9	IRKR01_0991	BL31	IRKR01_00673
BL10	IRKR01_1470	BL10	IRKR01_0976	BL32	IRKR01_00660
		BL11	IRKR01_0961	BL33	IRKR01_00648d
		BL12	IRKR01_0941u	BL34	IRKR01_00641
		BL13	IRKR01_0941d	BL35	IRKR01_00631
		BL14	IRKR01_0925	BL36	IRKR01_00621
		BL15	IRKR01_0912	BL37	IRKR01_00609
		BL16	IRKR01_0897	BL38	IRKR01_00598
		BL17	IRKR01_0883	BL39	IRKR01_00585
		BL18	IRKR01_0868	BL40	IRKR01_00573

		BL19	IRKR01_0852	BL41	IRKR01_00561
		BL20	IRKR01_0837		
		BL21	IRKR01_0825		
		BL22	IRKR01_0809		

3.2 Survey - 2D model updates

In addition to the 1D-domain model updates, the 2D-domain was also updated to include the 2022 survey. In order to connect the additional cross-sections, added to the 1D model based on survey, nodes were added to the 2D model, in addition to CN and HX lines to connect each node to the 1D domain. The inactive code layer, representing the River Irk channel, and ensuring that the channel is represented in the 1D domain only, was edited and snapped to the updated HX lines. This ensures that flow is not double counted. The 1D channel width was compared to the 2D channel width, again to ensure that flow is not double counted; edits were made to the position of HX and CN lines, in addition to deactivation markers on 1D cross-sections. To ensure that the 2D spilling level is accurate in the model, bank levels were defined using levels taken from the 1D model cross-sections.

Similarly, the positioning of the 1D-2D channel location was altered downstream of the Aspin Lane culvert, to better match the position of the channel in the LiDAR used in the model. The associated nodes layer, HX and CN lines, and bank lines were also adjusted to account for the change in the channel position.

The LiDAR Digital Terrain Model (DTM) used in the model appeared to show a channel through the Aspin Lane culverts due to incorrect filtering; to ensure this does not impact model results, *2d_zsh_AspinLane_TopoPatch_001_R.shp* was used to smooth this inaccuracy. The LiDAR also appeared to have incorrectly removed the viaduct through the site, between Bromley Street and Manchester Victoria Station, resulting in incorrect overland flow paths being represented by the model. *2d_zsh_AspinLaneViaduct_001_R.shp* and *2d_zsh_AspinLaneViaduct_001_P.shp* were added to the model to ensure that the viaduct is correctly included in the model. The A665 junction with Cheetham Hill Road was also represented in this layer, to account for its removal in the LiDAR DTM. Similarly, the disused railway sidings at Red Bank, appeared to be removed from the LiDAR, and so was added to the model using *2d_zsh_DisusedViaduct_001_R.shp*, and *2d_zsh_DisusedViaduct_001_P.shp*. This included an opening to represent Faber Street. The LiDAR Digital Surface Model, which has not been filtered for surface features, was used to define these features.

Definition of the deck geometry and levels of Union Bridge, and parapet wall on the downstream face of the structure, in the 2D-domain have been updated using topographic survey from BAM.

3.3 Hydrology update

Updates to the hydrology inflows used in the model were also updated as described in technical note *VNR-ARP-00-YYY-RP-CH-0001_Flood Estimation Report*.

There has been a negligible change in flow estimates as a result of the updates made to the hydrology inflows, however they have been brought in line with latest flood estimation techniques. The Flood Zone 2 and 3 extents occupy more of the site than historically, shown in Figure 29 and Figure 30, which is dominantly driven by the model updates.



Figure 29: Current flood zones, taken from the Environment Agency Flood Map for Planning. Accessed here: https://flood-map-for-planning.service.gov.uk, on 20/07/2022.

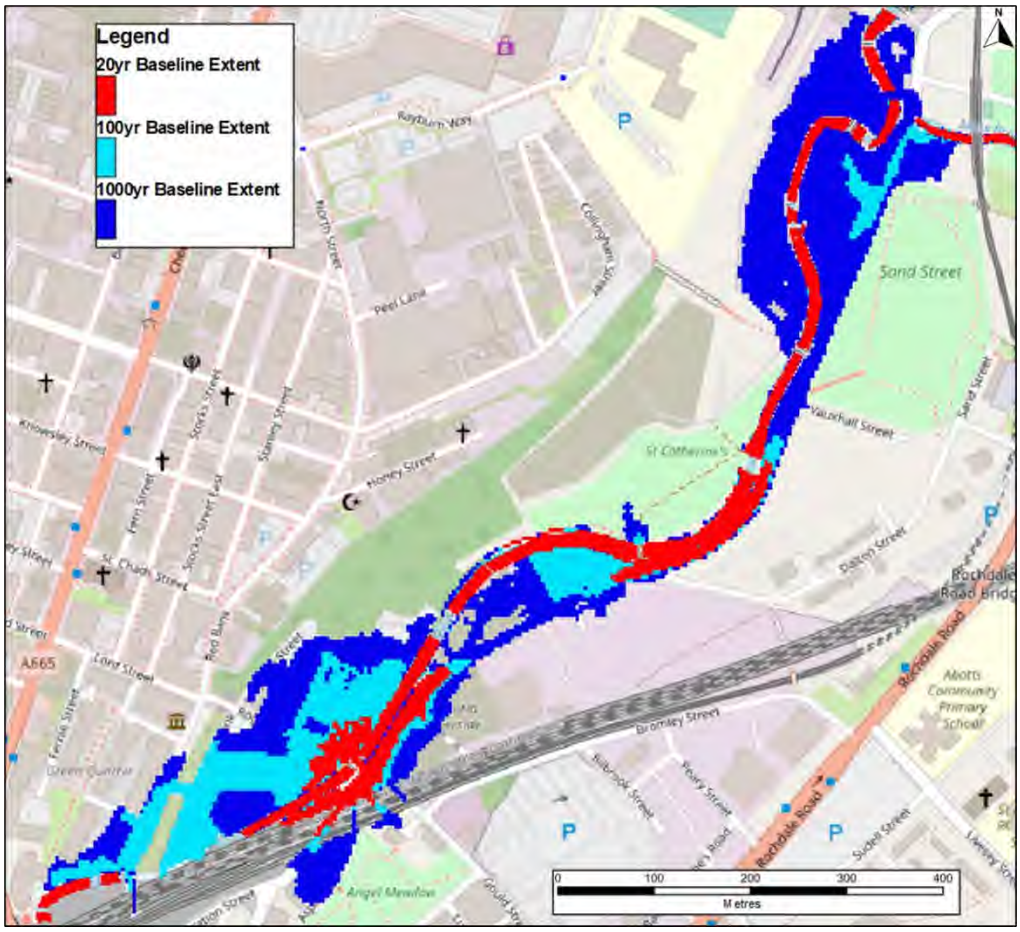


Figure 30: Updated flood extents, taken from the 2022 Baseline model and run using the 2022 hydrology.

3.3.1 Calibration at Collyhurst weir

Recent spot gauging data collected at Collyhurst Weir in winter 2021/22 has allowed the rating at Collyhurst Weir gauge to be revisited. Survey data collected (detailed in Section 2.1) was used to update the hydraulic model and a sensitivity testing exercise was carried out to test how elements such as cross section skew, weir representation (such as the Discharge Coefficient, Modular Limit and Exponent) impacted on the rating. The sensitivity testing exercise also sought to use the survey data in the model to fit to the empirical gauge data.

To aid analysis of the rating, the full hydraulic model was truncated to between nodes IRK_1.15d, approximately 120m upstream of Collyhurst Weir, and IRKR01_1188A, 320m downstream of the structure, and was run in 1D domain only. This allowed the lower part of the rating curve to be assessed, but was not suitable for the higher limb of the rating curve due to not capturing the 2D flow routes or a minor backwater effect. The truncated model allowed a range of runs for multiple model configurations to be undertaken without the long simulation times associated with the full 1D-2D hydrodynamic model.

The truncated model was initially based on the full Baseline model, which included the additional survey (received April 2022) in the reach around Collyhurst Weir. As detailed above, the rating models were initially run in the 1D domain only, with Table 2 detailing the key changes made to the different iterations of the models.

Table 2: Details of the models used to support the hydrology rating exercise.

Model	Key modifications
Rating	Representation of Collyhurst Weir using a broad crested weir unit Skew in surveyed sections at the weir, IRKR01_1509 and at IRKR01_1558 accounted for
Rating A	Representation of Collyhurst Weir using a general weir unit Skew in surveyed sections at the weir, IRKR01_1509 and at IRKR01_1558 accounted for
Rating B	Representation of Collyhurst Weir using a broad crested weir unit Skew not accounted for at any surveyed cross-sections
Rating C	Collyhurst Weir represented using a broad crested weir unit, with the p2 value amended to represent the downstream cross-section bed level Skew in surveyed sections at the weir, IRKR01_1509 and at IRKR01_1558 accounted for
Rating D	Collyhurst Weir represented using a broad crested weir unit Skew in surveyed sections at the weir, IRKR01_1509 and at IRKR01_1558 accounted for – however using a slightly smaller skew angle than in previous models
Rating E	Collyhurst Weir represented using a broad crested weir unit, with the p2 value amended to represent the downstream cross-section bed level (as in Rating_15c.dat) Skew in surveyed sections at the weir, IRKR01_1509 and at IRKR01_1558 accounted for to the same extent as in Rating_15d.dat
Rating F	Skew at surveyed section IRKR01_1558 accounted for IRKR01_1509 taken from the 2021 Interim model, with a width of 22.61m; Collyhurst Weir taken from the 2021 Interim model, represented using a general weir unit, with a breadth of 21.3m (frrom 2019 weir crest survey) and elevation of 29.31mAOD
Rating G	Skew at surveyed section IRKR01_1558 and IRKR01_1509 accounted for Collyhurst Weir taken from the 2021 Interim model, represented using a general weir unit, with a breadth of 21.3m (from 2019 weir crest survey) and elevation of 29.31mAOD
Rating H	Collyhurst Weir represented using a broad crested weir unit Skew at surveyed section IRKR01_1558 accounted for IRKR01_1509 taken from the 2021 Interim model, with a width of 22.61m
Rating I	Collyhurst Weir represented using a general weir unit, with the skew of the weir not accounted for Skew at surveyed cross-sections IRKR01_1558 and IRKR01_1509u accounted for
Rating J	Collyhurst Weir represented using a general weir unit, with the skew of the weir not accounted for, and using a modular limit of 0.6 Skew at surveyed cross-section IRKR01_1558 accounted for IRKR01_1509 taken from the 2021 Interim model, with a width of 22.61m
Rating K	Collyhurst Weir represented using a general weir unit, with the skew of the weir not accounted for, and using a modular limit of 0.7 Skew at surveyed cross-section IRKR01_1558 accounted for IRKR01_1509 taken from the 2021 Interim model, with a width of 22.61m
Rating L	Collyhurst Weir represented using a general weir unit, with the skew of the weir not accounted for, and using a modular limit of 0.8 Skew at surveyed cross-section IRKR01_1558 accounted for IRKR01_1509 taken from the 2021 Interim model, with a width of 22.61m

Model	Key modifications
Rating M	Collyhurst Weir represented using a general weir unit, with a modular limit of 0.55, exponent of 1.6 and discharge coefficient of 1.65 Bank roughness increased to 0.065 Skew at surveyed cross-sections IRKR01_1558 and IRKR01_1509 accounted for
Rating N	Collyhurst Weir represented as a general weir unit, taken from the previous rating model NorthernGateway_FMT_BAS_2021_010_hyd_Collyhurst_weir_v1.dat Skew at surveyed cross-sections IRKR01_1558 and IRKR01_1509 accounted for

Figure 31 illustrates the gauge data, compared to the model runs outlined in Table 2. The most suitable 1D results were subsequently run in 1D-2D, allowing flow routes along the road to be captured.

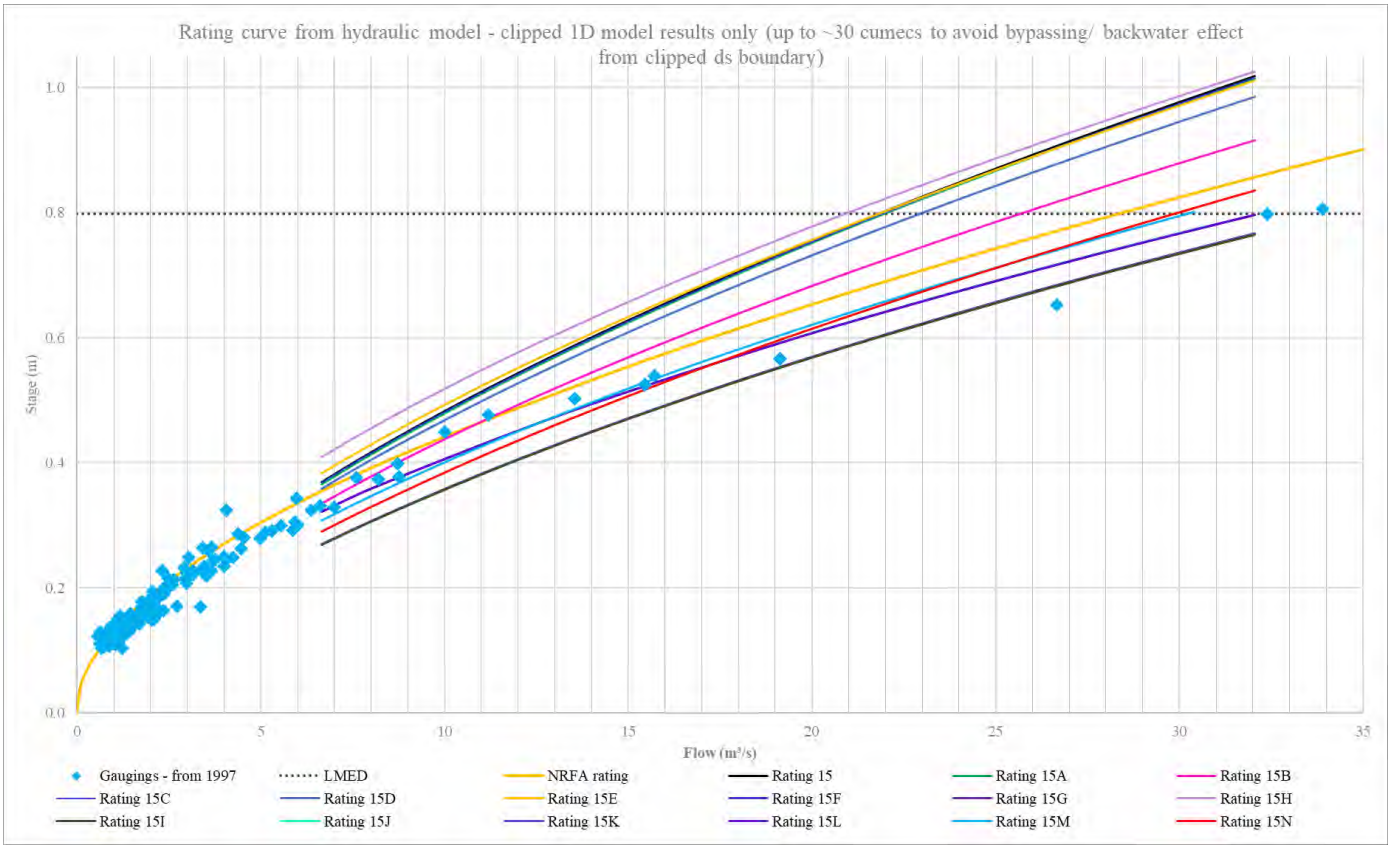


Figure 31: Performance of the 1D only rating models compared to the observed recent gauge data

Ratings F, J, L and M were considered to provide good fits to the observed gauge data, and as such the edits made to the representation of the river channel around Collyhurst Weir, in addition to the weir itself, were copied into the full 1D-2D model. The results are shown below, in Figure 32. While the ratings perform to a similar degree when fitting to the lower observed gauge data, Rating F is considered to provide the best fit to the higher recorded gauge data.

To best match the empirical data, therefore, it was determined that the cross-section immediately upstream of the weir should match the weir crest, rather than surveyed section BL5. Due to its location between 1m and

4m upstream of the weir (depending on whether measured at the centre of the crest or the bank), cross-section BL5 represents a narrower channel than is observed immediately upstream of the weir; as a result, the section constrained the channel to a greater extent than in reality, leading to higher water levels for a given flow than the empirical data suggests, while also not representing the channel effectively (shown in Figure 33). It was therefore considered that the 2022 survey insufficiently captured the channel width upstream of the weir, thus requiring the 2019 survey to be used. This unit was therefore replaced by the original cross section, without accounting for skew, which provided a good match to empirical data. The original cross-section was taken from survey completed in 2019; the 2019 survey also provided a full cross-section of the weir, including bank levels in csv format, compared to the survey taken in 2022 which provided only values along the crest of the weir in drawing format rather than in a csv. The crest level of the weir is consistent between the 2019 and 2022 survey.

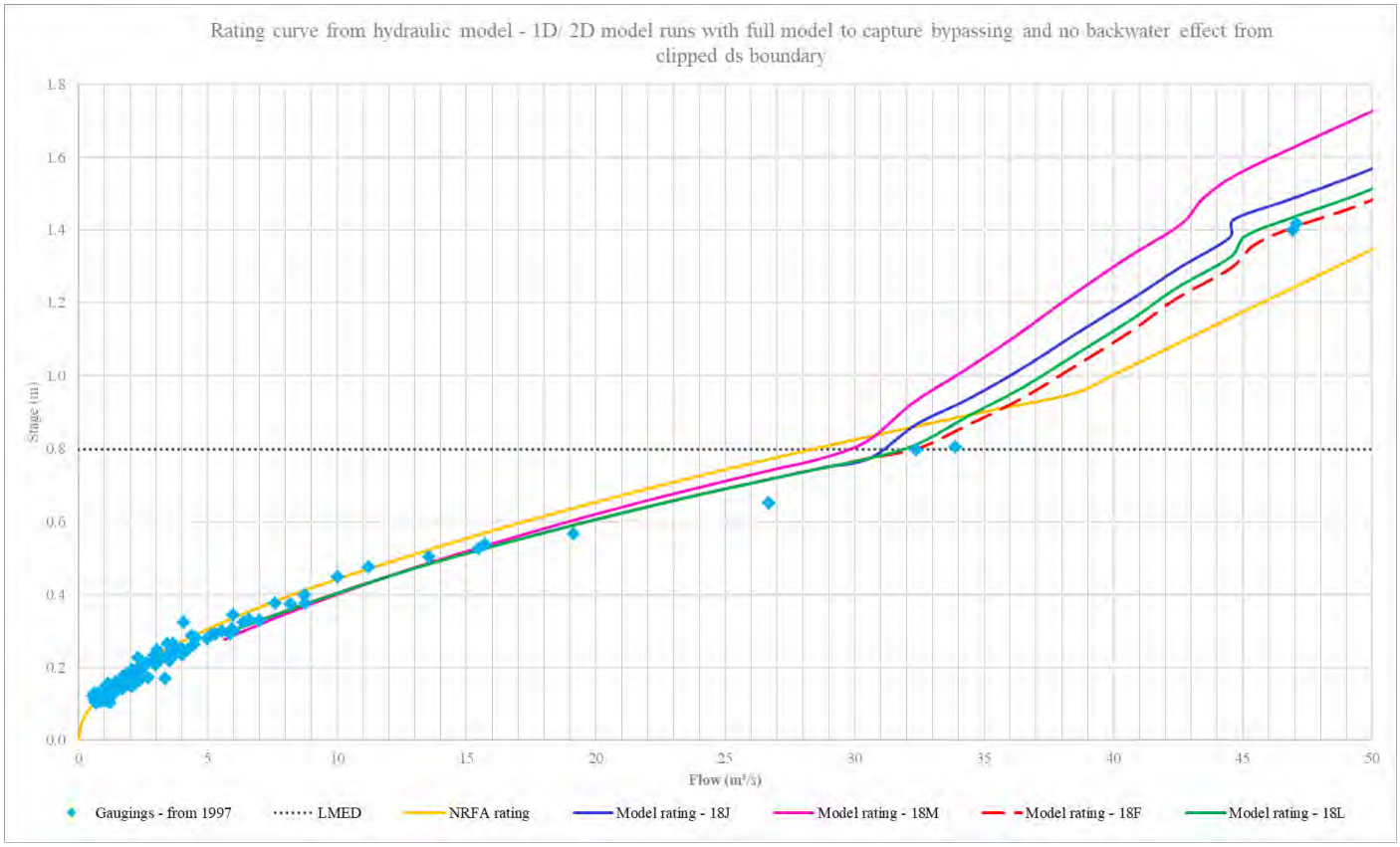


Figure 32: Comparison of the full 1D-2D model results with recent observed gauge data.



Figure 33: Location of Collyhurst Weir, and associated cross-sections surveyed in 2019 and 2022.

Figure 27 represents the location of the surveyed cross-sections with the context of Collyhurst Weir, clearly demonstrating the reduction in channel width downstream of the weir; the spacing of the surveyed cross-sections was considered to be suitable to ensure that the model represented this narrowing. The dominant floodplain flow paths at this location are tied to overtopping of the right bank of the channel downstream of the weir, and the function of Collyhurst Road as a flow route for out-of-bank-flow. This flow route is therefore represented in the 2D model, and was captured during the rating exercise using 2d_po lines. Further detail about model results and flood mechanisms can be found in Section 5.

The changes around Collyhurst Weir made to the Rating F model, as described above, were incorporated into the 2022 Baseline model, which was run using the subsequently updated 2022 hydrology; a comparison of the FEH statistical peak flow with the Baseline modelled results, at Collyhurst Weir, is shown in Table 3.

Table 3: Results from the Baseline model, when run using the 2022 hydrology at Collyhurst Weir. The FEH statistical peak flow is also shown, in addition to the scaling factor used in the model. The modelled results account for the in-channel, 1D model results extracted at node IRKR01_1039, in addition to the 2D floodplain flow, captured using 2d_po lines *Q LB* and *Q RB*. Since the hydrology updates have been completed, and accepted, there have been updates to the Baseline hydraulic model, and so it should be acknowledged that the results presented in the hydrology reporting may differ slightly when compared to results extracted from the most recent iteration of the Baseline model.

Return Period	FEH Statistical Peak Flow (m^3/s)	Scaling factor	Baseline Modelled Peak Flow (m^3/s)
20yr	50.5	0.912	50.5
30yr	53.6	0.87	53.8
100yr	63.4	0.74	63.4
100yr, 2020 climate change allowance	71.0	0.83	70.7
100yr, 2050 climate change allowance	75.4	0.895	75.7
100yr, 2080 climate change allowance	85.6	1.02	85.8
1000yr	105.1	0.76	104.5

3.4 Outstanding Environment Agency review comments

Several comments made in the Environment Agency review of the 2021 Interim Model remained outstanding when work on the 2022 Baseline Model commenced. The updates to the model to address these comments are described here, noting that model sensitivity tests are described in Section 5.1.

The 2022 Baseline Model was run using the updated 2022 hydrology, as described above, in Section 3.3; the model was run for a greater number of return periods than the 2021 Interim Model, namely the 20yr, 30yr, 100yr and 1000yr events. The 100yr event was also run for the 2025, 2050 and 2080 climate change epochs. The model was run for the 9.5hr duration event, summer season.

The 2021 Interim Model was considered to be unstable in the 1000yr event, as shown by the hydrograph in Figure 34 taken from IRK_1.13, the location of the gauging station close to Collyhurst Weir, with clear instabilities near the peak of the event. When running the 2022 Baseline Model with the updated hydrology, the instabilities in the hydrograph are no longer present, as shown in Figure 35. This is a result of the lower FEH flow estimates in the hydrology updates, described in VNR-ARP-00-YYY-RP-CH-0001_Flood Estimation Report.

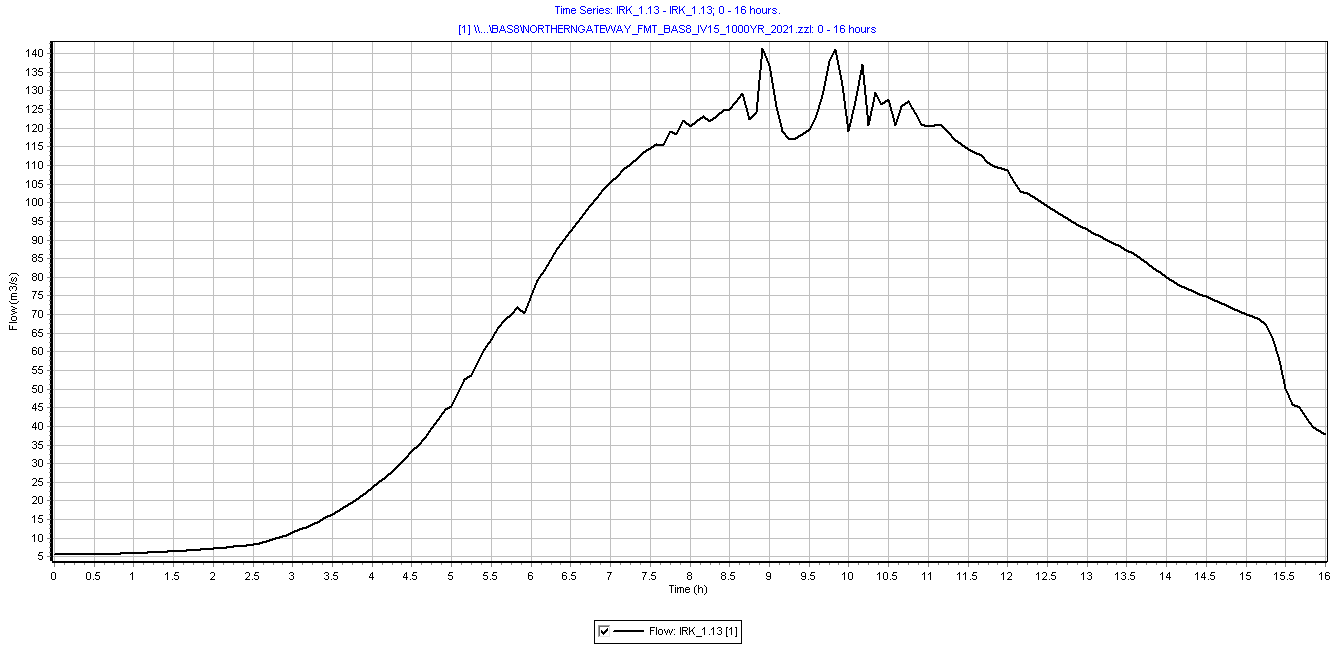


Figure 34: Hydrograph extracted from the 2021 Interim Model, for the 1000yr event at IRK_1.13, the site of the gauging station upstream of Collyhurst Weir

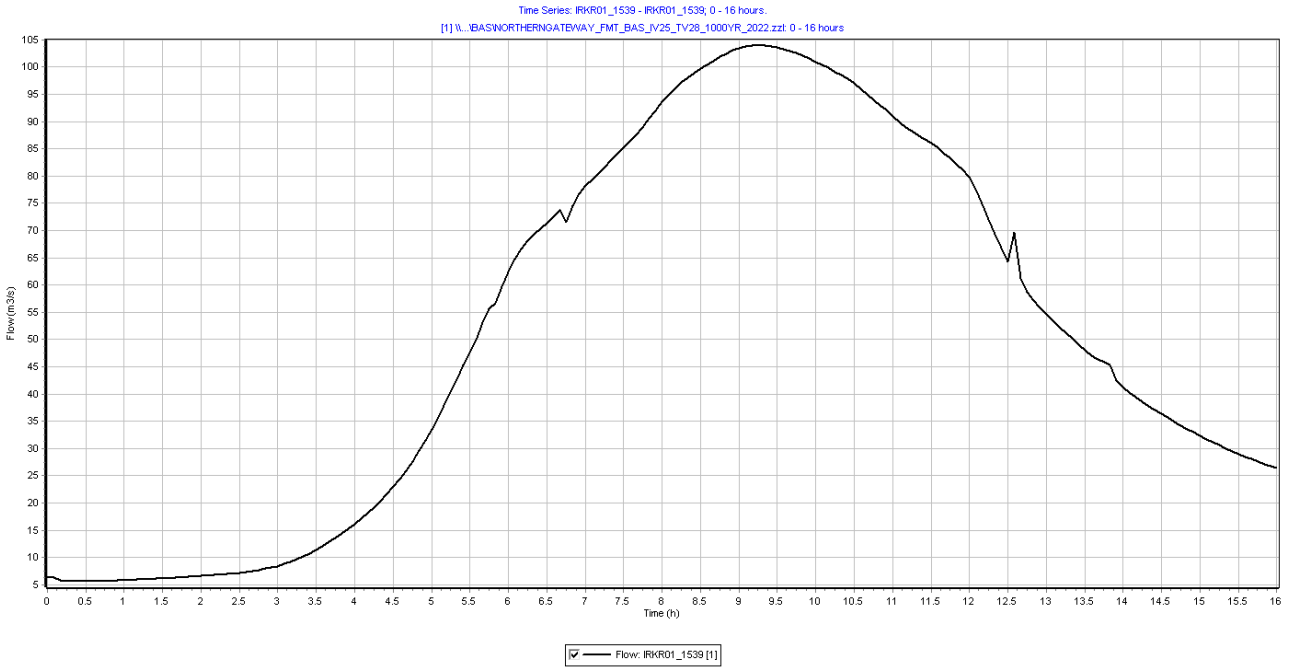


Figure 35: Hydrograph extracted from the 2022 Baseline model, using 2022 hydrology, for the 1000yr event at IRKR01_1539, at the site of the gauging station upstream of Collyhurst Weir

The two roughness layers used in the 2D domain of the baseline model, *2D_mat_Irk.shp* and *2d_mat_FMT_NorthernGateway_2021_010_R.shp*, were merged into a single layer, *2d_mat_FMT_NorthernGateway_2021_011_R.shp*. The roughness values applied to the 2D domain have not been updated, however they are considered appropriate based on OS Open Map Local data and online imagery. The justification for the use of roughness values in the additional surveyed sections can be found in Section 3.1.4.

3.4.1 2022 Baseline model review comments

Following the review of the 2021 Interim Model, an initial submission of the 2022 Baseline model was made. Comments in the 2022 Baseline model review have been addressed and are outlined below.

Detailed EA comments and Arup responses are given in document *FT-OCT-3 EA 2022 Baseline Model Review_Arup_1st_response.xls dated 11/11/22.*

Additional interpolates have been included to improve node spacing, and the addition of panel markers to improve conveyance. In response to the review, the soffit shape of the USBPR unit representing Union Bridge was updated to *"ARCH"*, and the footbridge at MOST01_4980A was removed, as this was represented as an orifice which was causing two instances of model non-convergence.

Warnings of different GIS projections and Water Level Lines not crossing a network line have been corrected.

Checks were undertaken throughout the model to ensure than top of bank levels assigned in the 1D model matched those being stamped in the 2D model by z-lines.

Attempts to improve the *"dVol"* signature were made, as follows:

- The alignment of boundary lines between the 1D and 2D model domains were updated where model bank lines were not following LiDAR data correctly – subsequent realignment updates were made to inactive code polygons and z-line bankline shapefiles;
- The location of the MOST01_000H confluence was realigned in 2D, as it was located in the incorrect place; the left bank of the cross-section was raised to 33.241mAOD, as shown on Google Earth to match the River Irk cross-section. The junction with the River Irk was moved downstream of the bridge at IRKR01_1788, as per aerial imagery;
- The spill into the 2D domain at MOST01_0177 was updated to correctly represent a wall above the culvert entrance, as can be seen in Google Streetview; prior to this update, flow was overtopping the culvert entrance into cells set at an incorrect level;
- The footbridge in St Catherine's Wood, at IRK_1.09, was extended in 1D to reduce 2D flooding which was potentially a cause of an instability; realignments were made to the necessary 2D shapefiles, and the soffit shape of the USBPR unit representing the footbridge was updated to *"ARCH"*;
- 1D-2D boundary connections at Union Bridge were re-schematised, giving an additional set of CN lines delineating the cells assigned to the level of the bridge parapet, from those assigned to the bank level;
- The Manning's n roughness value of the spill over Union Bridge was updated from 0.025, to 0.10, in an attempt to reduce mass balance errors occurring where flow spills out of bank, and onto the bridge deck. Deck levels were also altered to align with the most up to date topographic survey;
- A roughness patch, set at a Manning's n of 0.065, was added on the left bank of the Irk, downstream of Union Bridge, to attempt to slow the high, out of bank velocities, where flows rush to re-enter the

channel – this roughness value was not raised any higher, to prevent the inadvertent diversion of flow south, along Dantzic Street;

- The face of the Aspin Lane culvert was realigned in the 2D domain to include the height of the culvert face, reducing mass balance errors. The threshold of the commercial building on the right bank of the channel, next to the culvert face, was added, based on BAM's survey;
- The orifice flow transition distance at the IRK_1.16 structure was adjusted from 0.1m, to 0.05m, to attempt to reduce an instability caused by the spill at the structure becoming active during events less than the 100yr event, with a climate change allowance to the 2050 epoch. The spill of the structure was also missing the brick wall on the left side of the channel, which formed part of the bridge parapet – this was updated using available survey.

Whilst the attempts to smooth the dVol curve were able to calm mass balance issues in the 2D domain within the study focus area, the dVol plot remained largely unchanged. By utilising the .zzx output from Flood Modeller, this supplementary results file shown in Figure 36 highlighted the location of erratic oscillations occurring between the 1D and 2D model domains. Oscillations on the upper Moston Brook, particularly in areas upstream of model node MOST01_4350, are likely to be largely responsible for the spikiness of the overall model dVol output plot. Plots from the same supplementary results file do not display any notable spikes, especially over the peak of the event through the downstream study area of interest. Consequently, it should also be noted that model results through the study area are not affected by instabilities in the Upper Moston Brook area of the model.

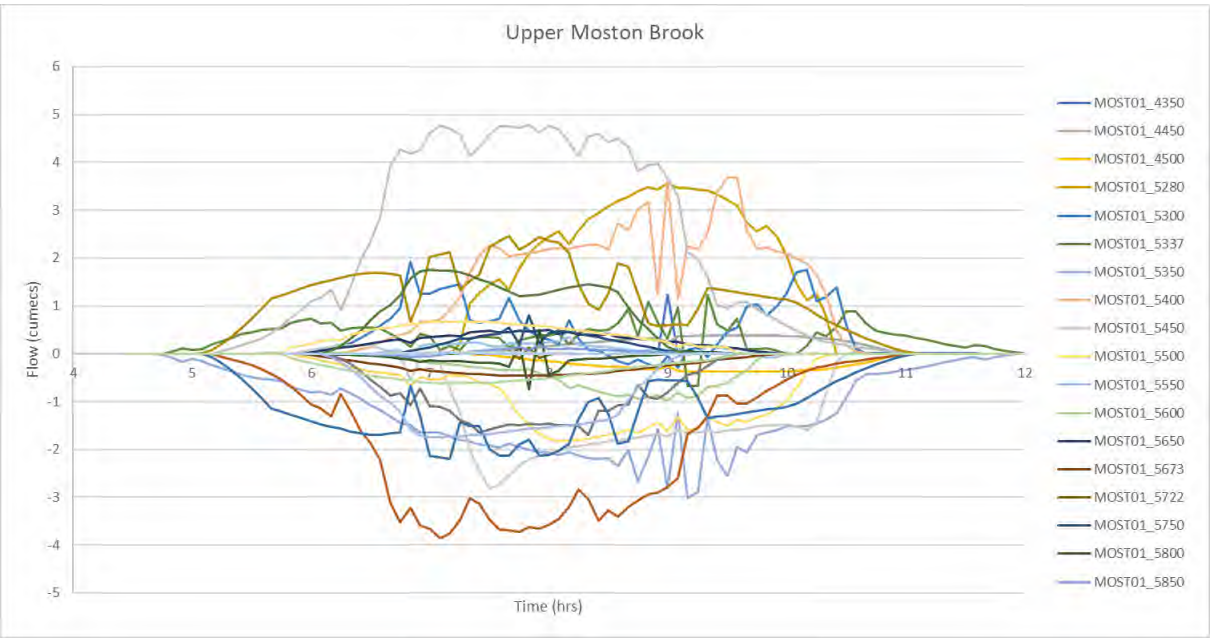


Figure 36: Flood Modeller supplementary results (Link Inflow) for Upper Moston Brook (1000yr event)

Union Plaza Wall

Several upstanding walls situated on the banks of the River Irk throughout the study area are included in the model. In absence of any formal structural assessments being made, these are assumed to be structural sound and could withstand the hydrostatic water loading from a flood event, however concerns were raised during the model review of the structural integrity of the Union Plaza Wall on the right bank upstream of Union Bridge. This brickwork wall looks to be the remains of a former building however no asset structural

assessment has been undertaken to ascertain the strength of this approximate 85m length of wall. From historic images available from Google StreetView as shown in Figure 37, the wall has deteriorated in recent years. Sensitivity testing was undertaken to understand the change to flood risk/extents on the plots if this wall was not represented in the model and following discussions with the project team, it was decided that the Baseline model should not include representation of the Union Plaza Wall.

This stretch of upstanding wall at Union Plaza has been removed from the 1D and 2D models. Model nodes IRK01_0961 upstream to IRK01_0136 have had the wall shown in survey sections BL6 to BL11 removed, and the corresponding bank lines in the 2D model have been adjusted.



Figure 37 - Time lapse photo of the Union Plaza Wall taken from StreetView

4. Assumptions

There are several key assumptions that have been made due to irregularities in geometry of existing structures:

1. The Aspin Lane culvert changes shape multiple times over its length, as discussed in Section 3.1.3. The model represents the most hydraulically restrictive downstream face, as well as the more significant changes within the culvert such that storage provided by the culvert itself is taken account of. Culvert outlet loss units have been used to represent the culvert shape changes, and as such, copies of culvert sections have been used to represent the upstream and downstream faces of the culvert where these shape changes occur, also allowing the model to run successfully. The application of loss units along the length of the culvert results in stepped headloss through the culvert. It is not thought that this methodology has an adverse effect on model results or one that propagates through the model.
2. Scotland Weir is represented using a regular spill unit, to ensure that the geometry of the weir is correctly included in the model. The geometry of the spill was taken from the survey undertaken in 2022, with a spill coefficient set at 1.7 to correctly represent the weir as a round-nosed horizontal-crested weir. The skew of the weir was also accounted for, leading to a reduction in the width of the surveyed weir from 19.41m to 13.72m. The wall to the left of the weir included as part of the survey has been included as part of the weir profile as this occupies a significant portion of the channel as it turns into the culvert downstream.

Non-default values were used in the Baseline model, in all modelled return periods, for the *Matrix Dummy* and *Global Matrix Dummy* coefficients to prevent the following 1D-solver error: *"E1196: Matrix numerically singular. iflag = -2"*.

5. 2022 Existing condition Baseline results

The 2022 Baseline model was run for the 20yr, 30yr, 100yr and 1000yr; the 100yr was also run with a climate change allowance for the 2025, 2040 and 2080 epochs. Appendix A illustrates the modelled hydrographs for each of the hydrology inflow boundaries.

Figure 38 is a long section showing maximum water level for cross-sections between IRK_1.14 and IRKR01_0564. The long section demonstrates head loss at key structures, such as Union Bridge, Aspin Lane Bridge and Scotland Weir. Scotland Weir appears to not drown out in any modelled event, showing head loss over the weir in all return periods modelled; in the 20yr event, there is a 2.33m reduction in maximum water level between IRKR01_0579F (upstream of Scotland Weir) and IRKR01_0579G (downstream of Scotland Weir), which decreases to a 0.17m reduction in the 1000yr event. Similarly, the long section appears to show that the Aspin Lane Culvert is not a major hydraulic control on the River Irk, as a result of the high soffit levels (of up to 36.32mAOD), and large cross-sectional areas through the culvert system. Aspin Lane Bridge, however, is shown to be a significant hydraulic control on the river system, resulting from the large constriction which the structure places on flow; there is a reduction in soffit level from 35.38mAOD to 28.28mAOD at the culvert outlet. In the 1000yr event, the maximum water level at IRKR01_0660u, the conduit unit immediately upstream of Aspin Lane Bridge, is 30.65mAOD, falling to 29.92mAOD at IRKR01_0660d, the upstream conduit unit representing the bridge.

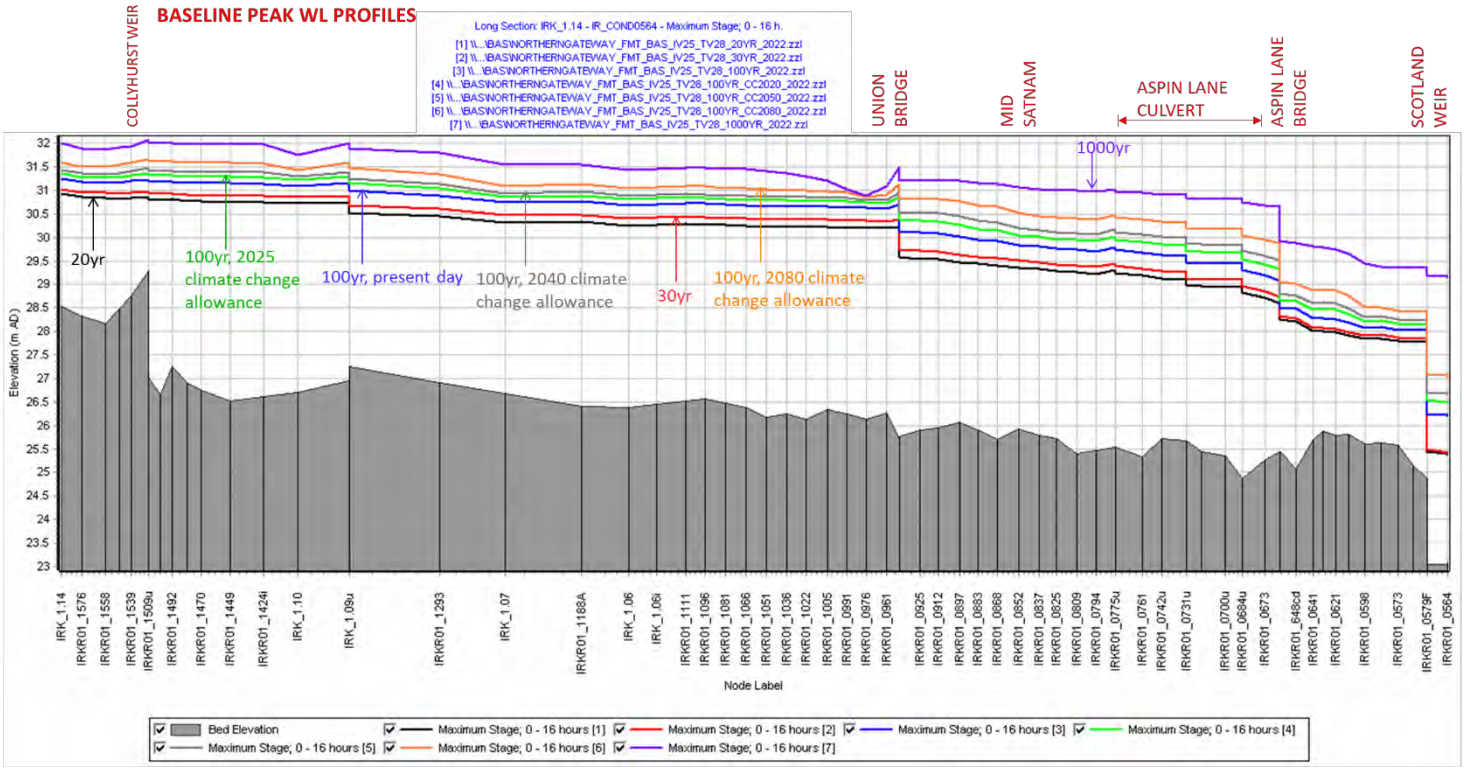


Figure 38: Long section from the 2022 Baseline model, illustrating maximum water level for a range of return periods, run using the 2022 hydrology

Figure 39 shows the updated flood extents for the 20yr, 30yr, 100yr and 1000yr events, using the 2022 Baseline model and 2022 hydrology. The flood extents have reduced since the previous modelling, based on the Interim 2021 Baseline model, as a result primarily of the implementation of the lower flows associated with the 2022 hydrology.

Figure 39 illustrates that the 20yr and 30yr events largely remain in-channel, particularly around Harpurhey Reservoirs in the upstream area of the model. Further downstream, there is some out of bank flow close to Collyhurst Weir; flow leaves the left bank of the channel downstream of the weir, and moves downstream along Collyhurst Road. As the updated Baseline model does not represent the wall along the right bank of the channel upstream of Union Bridge, there is some out of bank flow here; flow also leaves the left bank of the channel upstream of the bridge, flowing along Dantzic Street to re-enter the channel. Figure 40 illustrates these two key flood mechanisms in the 20yr event, which are also demonstrative of mechanisms in the 30yr event.

Flood mechanisms in the 20yr and 30yr events, as shown in Figure 40, are also present in the 100yr, 100yr with climate change allowances, and 1000yr events. Figure 39 illustrates a considerable flood extent in the 1000yr event; in addition to flow leaving the channel upstream of Collyhurst Weir, flows leave the Moston Brook, and the River Irk upstream of the confluence with the Moston Brook, and flows along Collyhurst Road. This provides a continuous flow path also along Dantzic Street, which is similarly seen in the 100yr events with climate change allowances. Flows leave the channel on the right bank of the River Irk between the Moston Brook confluence and Collyhurst Weir, in the 100yr events, with climate change allowances for the 2040 and 2080 epochs, in addition to the 1000yr event. Similar to the mechanisms illustrated in Figure 40, flow leaves the left and right banks of the channel upstream of Union Bridge, and flows upstream and

downstream, both along the road networks and across the floodplain. Figure 41 demonstrates the additional key flood mechanisms in the 1000yr event, which are broadly applicable in the 100yr events with climate change allowances.

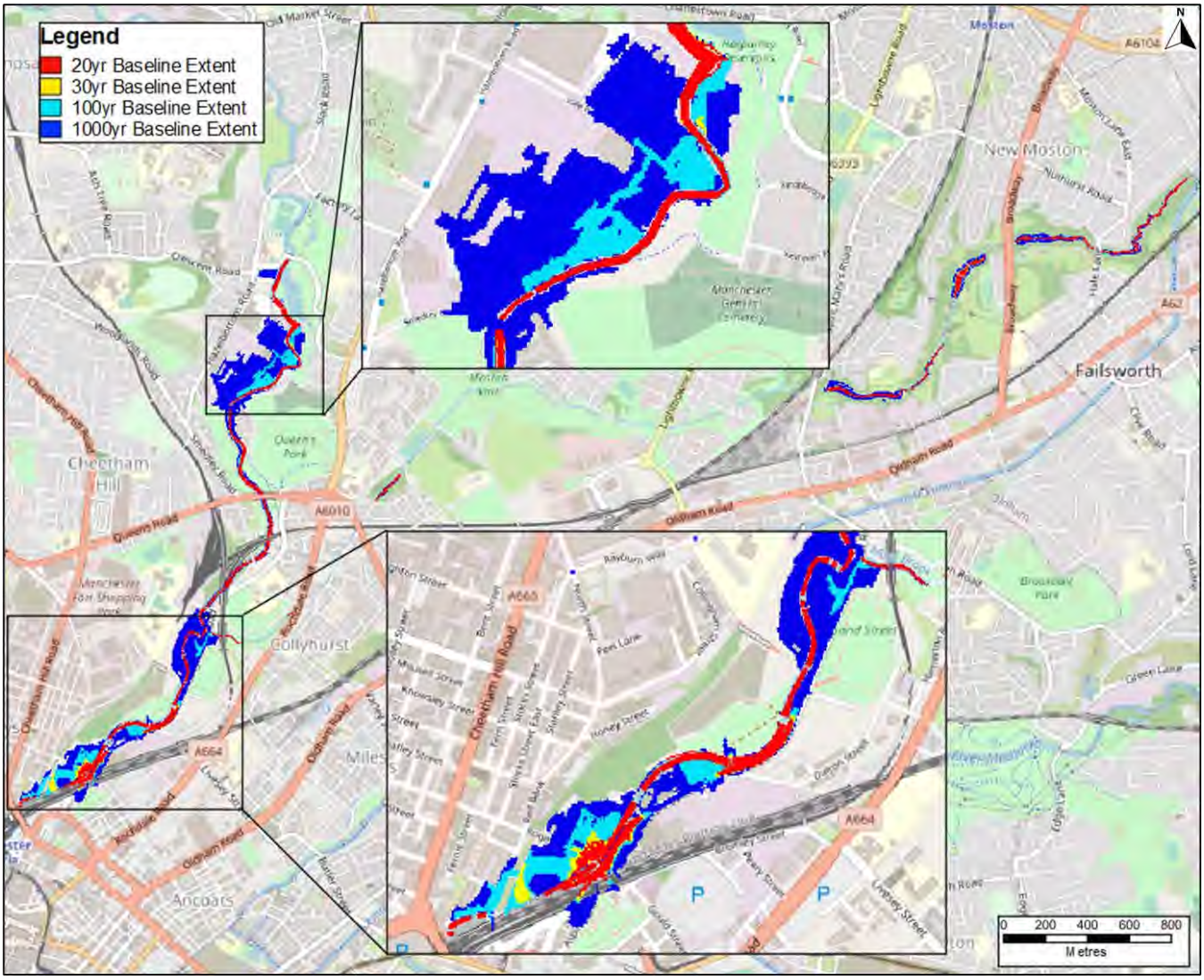


Figure 39: Updated flood extents for the 20yr, 30yr, 100yr and 1000yr events, based on the 2022 Baseline model and 2022 hydrology.

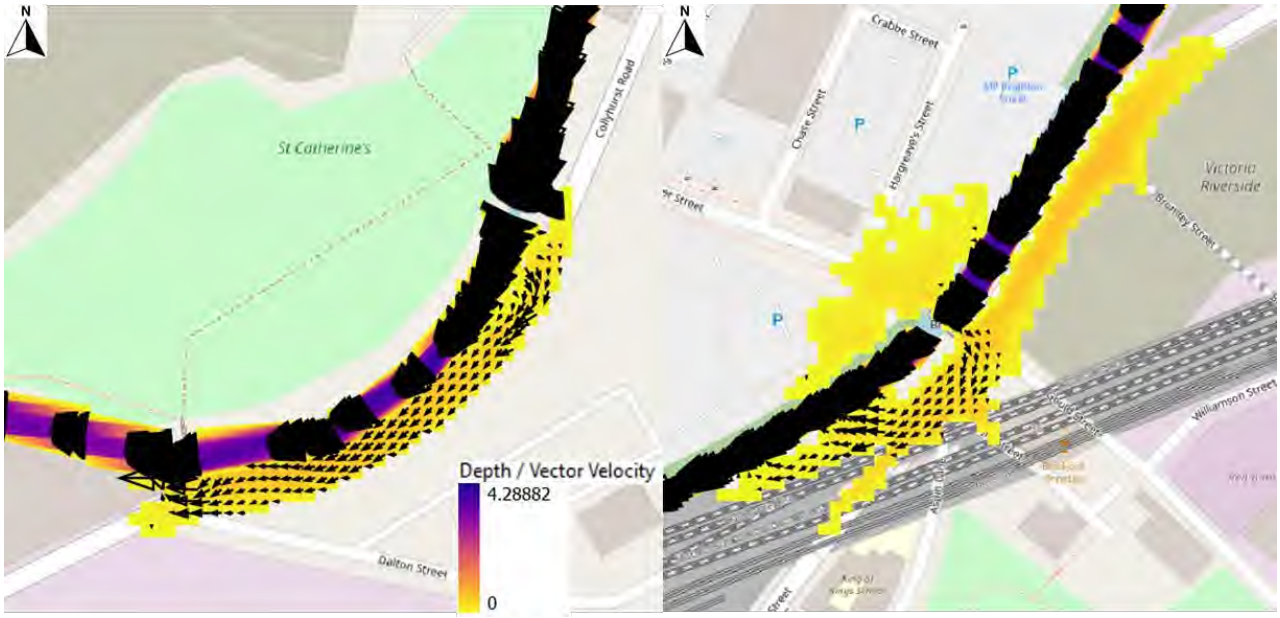


Figure 40: Key flood mechanisms around Collyhurst Weir and Union Bridge in the 20yr event, also demonstrative of flow paths in the 30yr event. The black arrows indicate vector velocity, showing flows leaving the channel downstream of Collyhurst Weir and upstream of Union Bridge



Figure 41: Key flood mechanisms around Collyhurst Weir and Union Bridge, in the 1000yr event, but also broadly applicable to the 100yr events with climate change allowances. Black arrows indicate vector velocity, clearly showing the flow along Collyhurst Road and Dantzic Street

5.1 Model sensitivity tests

A full suite of model sensitivity tests was completed for the 100yr event, comprising of the addition of culvert outlets along Moston Brook, increases and decreases to inflows, increases and decreases to roughness, increases and decreases to the downstream boundary, increased 2D grid resolution, grid rotation, and the use of the *"DFloodB"* value in .IEFs. Following the decision to remove the Union Plaza wall as part of the Baseline model, a sensitivity test has been included to demonstrate the change to flood risk if the wall remains in the model as discussed in Section 3.4.1.

The *"DfloodB"* value is needed in the model Advanced Parameters to ensure that the model initialises in Flood Modeller Pro. Using the default value of 10, rather than 15 as is used, leads the model to fail with the following error: *"*** error E1577 *** at label: MOST01_0249D, Bridge soffit is more than 10m above cross section".* Similarly, the introduction of culvert outlets along the Moston Brook, replacing spill units at MO_1504A and MO_0655 caused significant model instability.

Figure 42 shows a long section of the 2022 Baseline model results, compared to results from the inflow and grid resolution sensitivity tests. The increases and decreases to the inflows led to an expected increase and decrease in water level through the long section, respectively. The 20% increase to the inflows led to a maximum of a 0.43m increase in peak water level between IRK_1.14 and IRKR01_0564, presented in the long section below, while the 20% decrease to the inflows led to a maximum decrease in peak water level of 0.61m through the same long section. The increases and decreases achieved by altering the inflows is minimised downstream of Scotland Weir; at section IRKR01_0579d. Immediately downstream of Scotland Weir, the 20% increased inflows led to an average of a 0.08m increase in peak water level, with a 20% reduction in inflows leading to an, on average, 0.07m decrease in peak water levels. This indicates that Scotland Weir is a large control on the behaviour of the watercourse acting as a hydraulic break, with the downstream boundary and influence of the River Irwell exerting a control on the River Irk downstream of the weir.

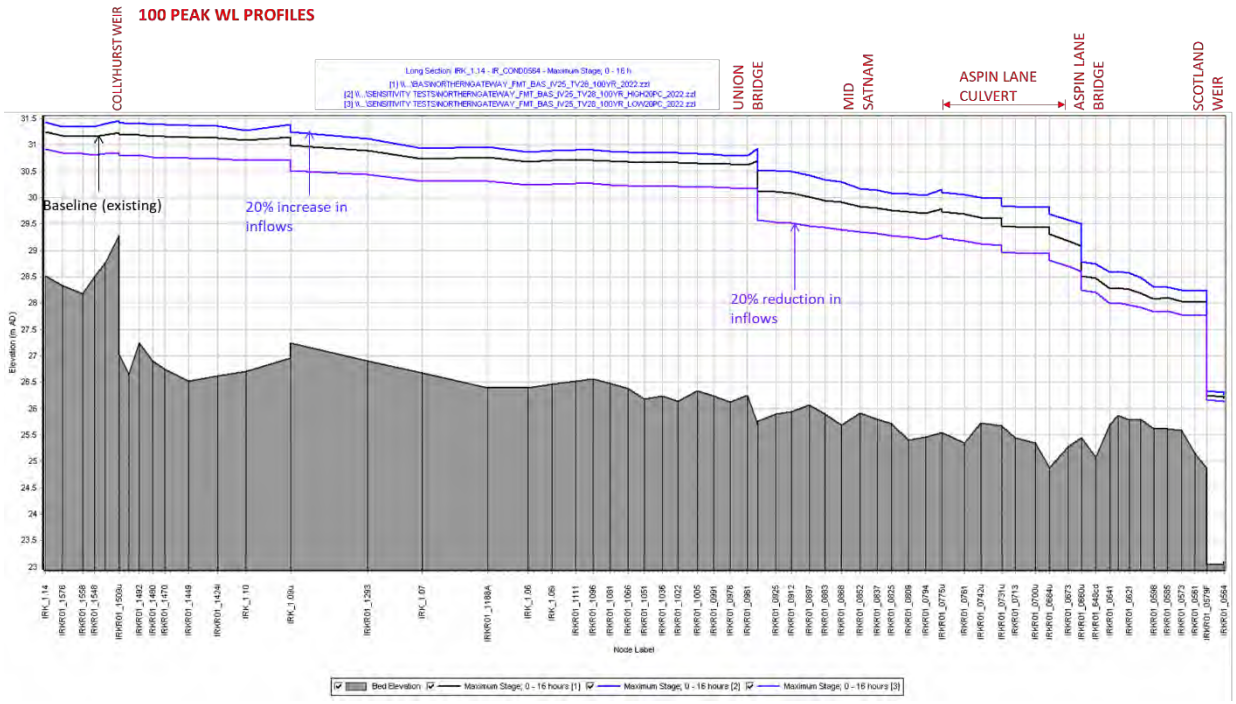


Figure 42: Long section of 1D results, showing the 2022 Baseline 100yr results compared to the results of the sensitivity tests increasing and decreasing inflows by 20%.

The Baseline model at present uses water levels extracted from the Manchester Ship Canal model to represent the downstream boundary at the River Irk – River Irwell confluence; the downstream boundary used in the 20yr Baseline event for instance, is based on 20yr water levels extracted from the Manchester Ship Canal model, while the downstream boundary implemented in the 1000yr Baseline event is based on 1000yr Manchester Ship Canal model water levels. Figure 43 shows a long section of the 2022 Baseline model results, compared to results from the downstream boundary tests; high and low downstream boundary tests were undertaken. The "Low downstream boundary" test was run with the 100yr 2022 hydrology inflows, but additionally took the downstream boundary used for the 20yr model event, originally from the 20yr event results for the Manchester Ship Canal model. The "High downstream boundary" test was also run with the 100yr 2022 hydrology inflows, with the 100yr event downstream boundary scaled to a peak of 28.37mAOD, taken, from LiDAR to be bankfull in the River Irwell (an increase in boundary water level of approximately 2.35 m).

Figure 43 illustrates that the influence of the low downstream boundary is significantly smaller than the influence of the high downstream boundary, with Scotland Weir the upstream extent of the differences in water levels achieved by the low downstream boundary. There is a 0.7m reduction in water level at Scotland Weir when using the low downstream boundary, compared to the Baseline model.

The high downstream boundary causes an increase in water levels of 2.22m at the downstream face of Scotland Weir compared to the Baseline model; this increase, however, is significantly reduced upstream of the key hydraulic structures along the River Irk, namely Scotland Weir, Aspin Lane Bridge and Union Bridge. At the downstream face of Collyhurst Weir, for instance, there is a negligible change in peak water levels. The sensitivity of the model to the downstream boundary at present therefore appears to be somewhat muted by the influence of Scotland Weir over water levels in the model, however may be significant if future works were undertaken to remove or modify Scotland Weir significantly (modifications to the weir are currently being proposed as part of the Victoria North River and Flood Alleviation Scheme), perhaps increasing the frequency with which the weir is drowned out.

The "High downstream boundary" sensitivity test represents a bankfull event on the River Irwell, however the levels of this event are below the levels extracted from the Manchester Ship Canal model 1000yr event. While the results presented in Figure 43 show that the sensitivity test does impact water levels along the River Irk, although the impact is minimised upstream of Scotland Weir, it is considered that the current approach to the downstream boundary remains appropriate, as a result of the consistency achieved in the Baseline model between the lower and higher magnitude events while using the approach. Similarly, at high magnitude events, such as the 1000yr event, the current approach remains conservative.

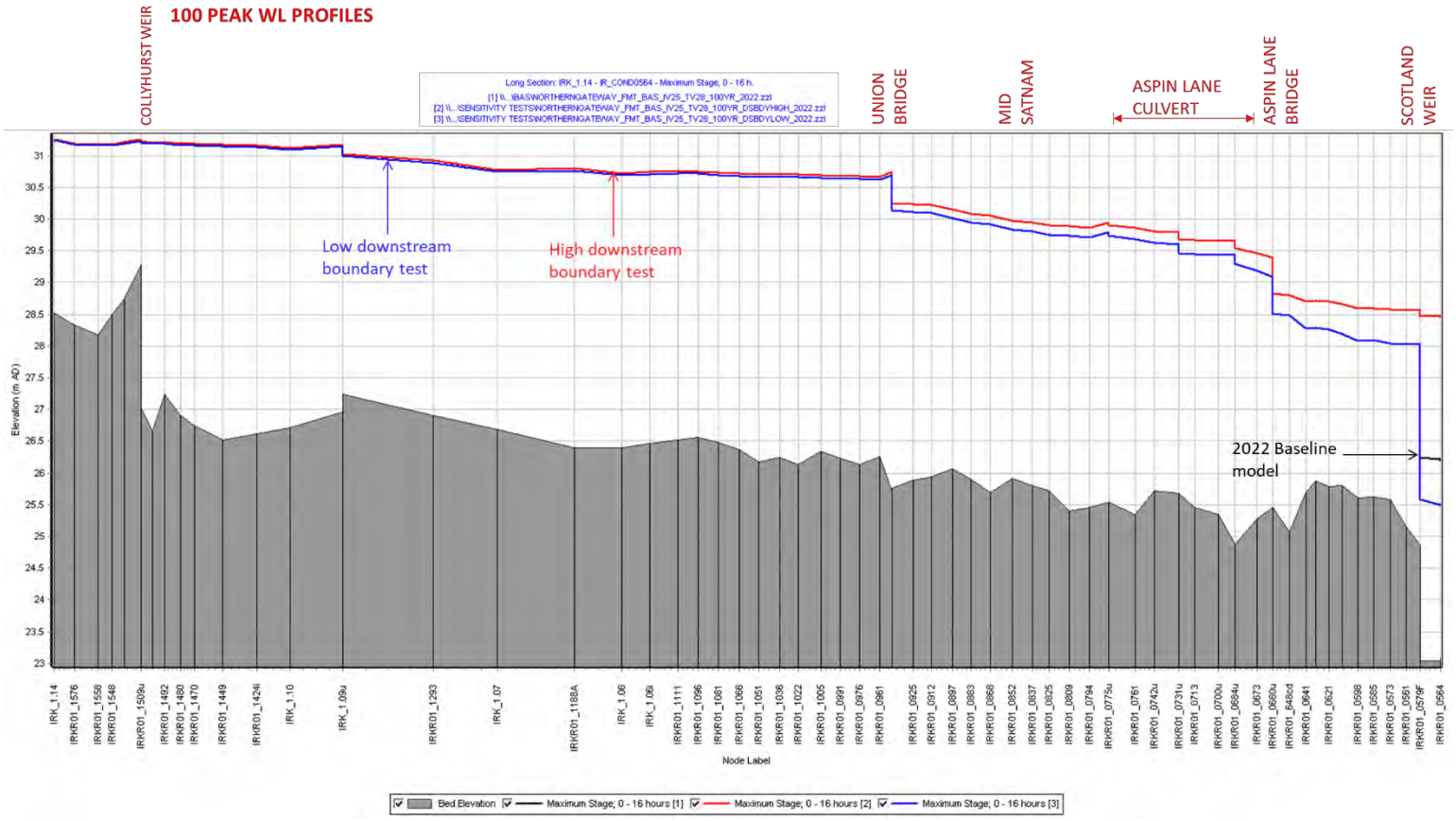


Figure 43: 2022 Baseline model 100yr results, compared to results of the downstream boundary sensitivity tests.

Figure 44 similarly shows the results of the 2022 Baseline model, compared to sensitivity tests with a 20% increase, and 20% decrease, in roughness in the 1D and 2D domains. Overall, increasing the roughness of the model by 20% led to, on average, a 0.07m increase in peak water levels through the site of interest, shown in the long section below; reducing the roughness of the model led to an average of a 0.11m reduction in peak water level. This pattern is expected, as a result of the increased attenuation of water and lower water velocities associated with an increased in-channel, bank and floodplain roughness, with a reduced level of attenuation resulting from a reduction in roughness. The maximum increase in peak water level resulting from increasing the roughness of the model was 0.17m, while the maximum reduction in peak water level caused by the reduction in model roughness was 0.24m; both of these values were achieved at node IRK_1.14, at the upstream extent of the site of interest. Downstream of Scotland Weir, there is a negligible difference between the Baseline model and the roughness models; the average change downstream of the weir achieved by the roughness models is 0.004m, potentially a result of the influence of the downstream boundary, as described above.

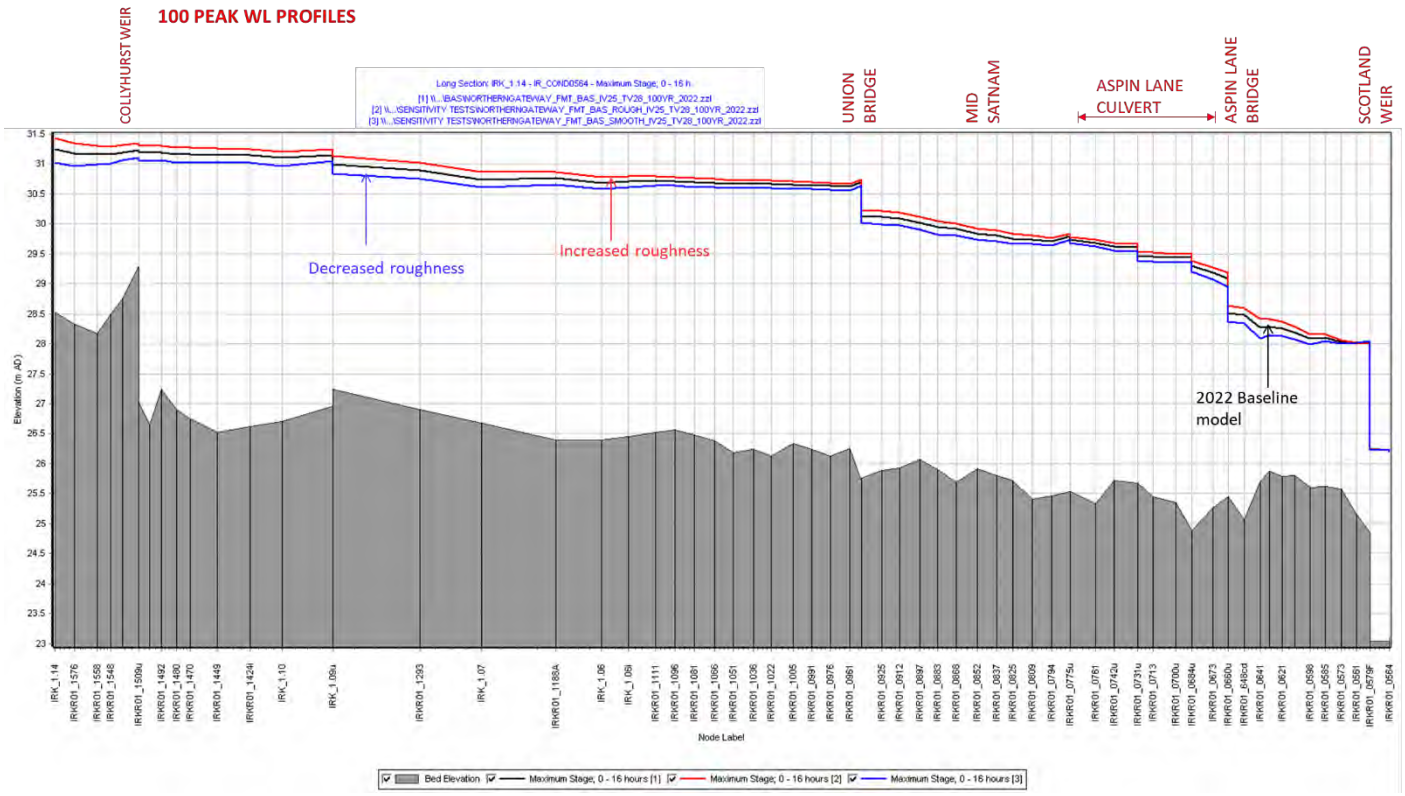


Figure 44: Baseline model 100yr results, compared to results from sensitivity tests increasing and decreasing model roughness by 20%

The use of a 2m grid resolution in the 2D domain, rather than a 4m resolution, similarly has an impact on in-channel water levels, as demonstrated by Figure 45. Through the long section, between cross-sections IRK_1.14 and IRKR01_0564, there is an average reduction in peak water level of 0.04m when using a 2m grid resolution, compared to a 4m grid resolution. Union Bridge appears to exert a large control over water levels when using a 2m grid resolution; at IRKR01_0961, 20m upstream of the bridge, there is a reduction in peak water levels of 0.18m, while 16m downstream of the bridge, at IRKR01_0925, there is a reduction in peak water levels of 0.03m, when compared to using a 4m grid. Figure 45 also illustrates the difference between the baseline model and the grid rotation sensitivity model – which has a 45° rotation of the grid, so that it is orientated north-east to south-west – showing a very minimal impact on water levels through the study site, with an average change of 0.02m caused by the rotated grid. Upstream of Collyhurst Weir, rotating the grid to have a north-east to south-west orientation causes a negligible increase in peak water levels, with an increase of less than 0.01m. Downstream of Collyhurst Weir, rotating the grid orientation causes a decrease in peak water levels, however the average decrease is 0.02m, when compared to Baseline. Figure 46 shows that there is an increased flood extent upstream of the study site, close to Harpurhey Reservoirs, when compared to the Baseline, caused by the 2D grid orientation and dominant overland flow mechanisms in the area.

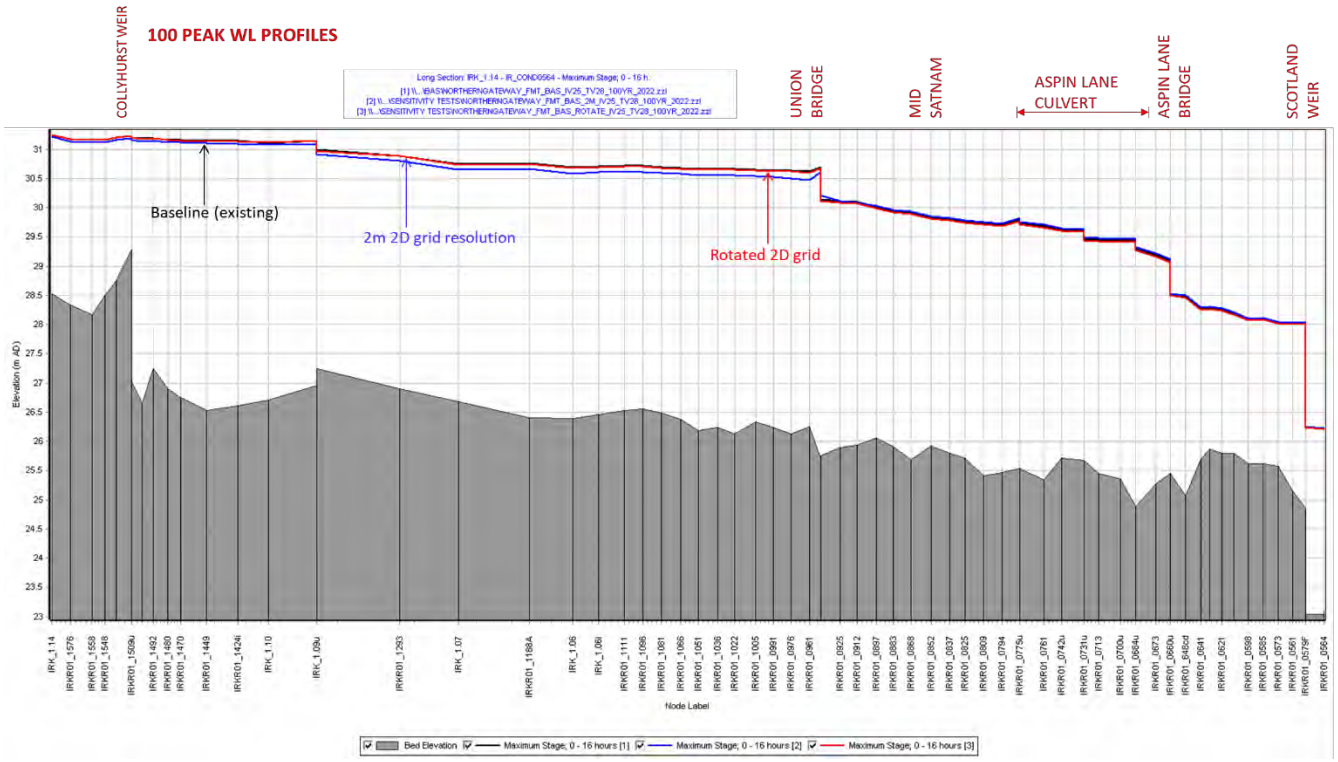


Figure 45: Baseline model 100yr results, compared to results from sensitivity tests decreasing the 2D grid resolution and rotating the 2D grid

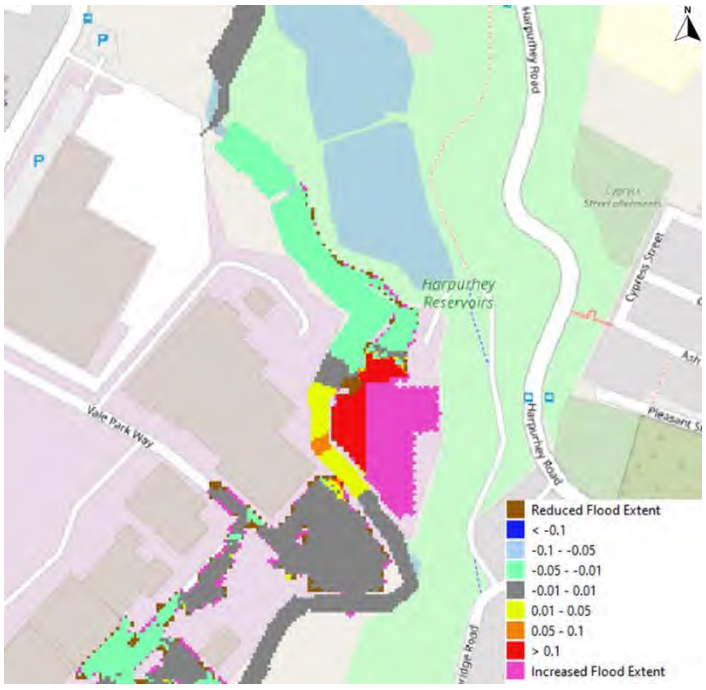


Figure 46: Impact map based on the 100yr events for the 2022 Baseline model, compared to the model with a rotated grid, clearly showing the increased extent close to Harpurhey Reservoirs, caused by the grid rotation.

The sensitivity test to include the Union Plaza wall shows an increase in water levels in the channel of 0.03m immediately upstream of Union Bridge, as shown in Figure 47. This increase in water levels extends approximately 780m upstream of the bridge, at which point the difference between maximum in-channel water levels in the Baseline model, and sensitivity test with the wall at Union Plaza, is below 0.01m. Figure 48 is an impact map showing the difference in flood extents and flood levels between the Baseline model, and "With wall" model. Whilst there are minimal changes to flood extents and depths along the left bank at Dantzic Street, there are areas of reduced flood extent on the right bank, when the wall at Union Plaza is included in the model. Within the plot areas of the 2D domain around Roger Street for the "With wall" sensitivity run, there is a maximum reduction in peak depths of c0.058m during the 100yr event.

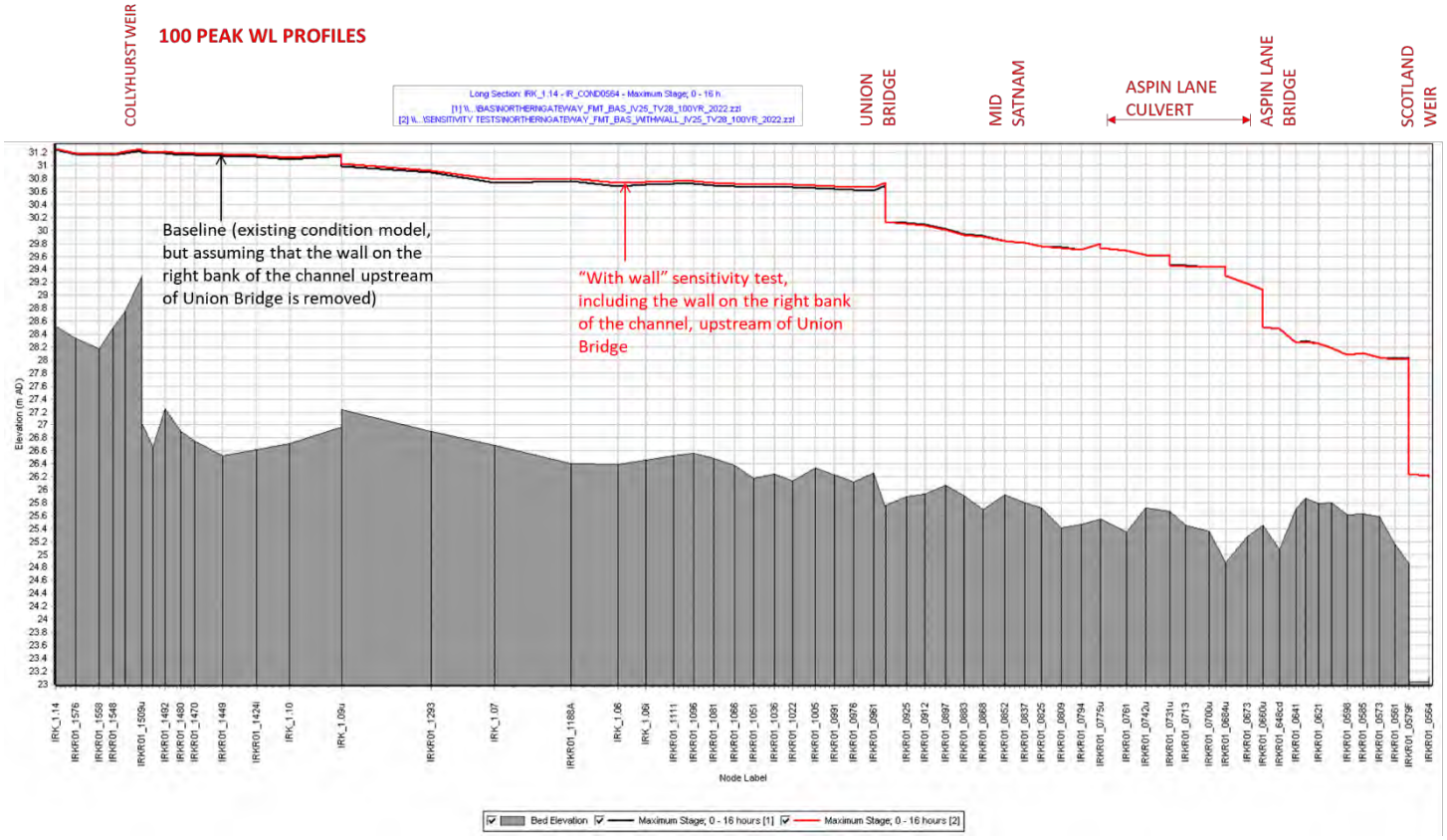


Figure 47: Baseline model 100yr results, compared to results from a sensitivity test without the wall on the right bank of the River Irk upstream of Union Bridge.

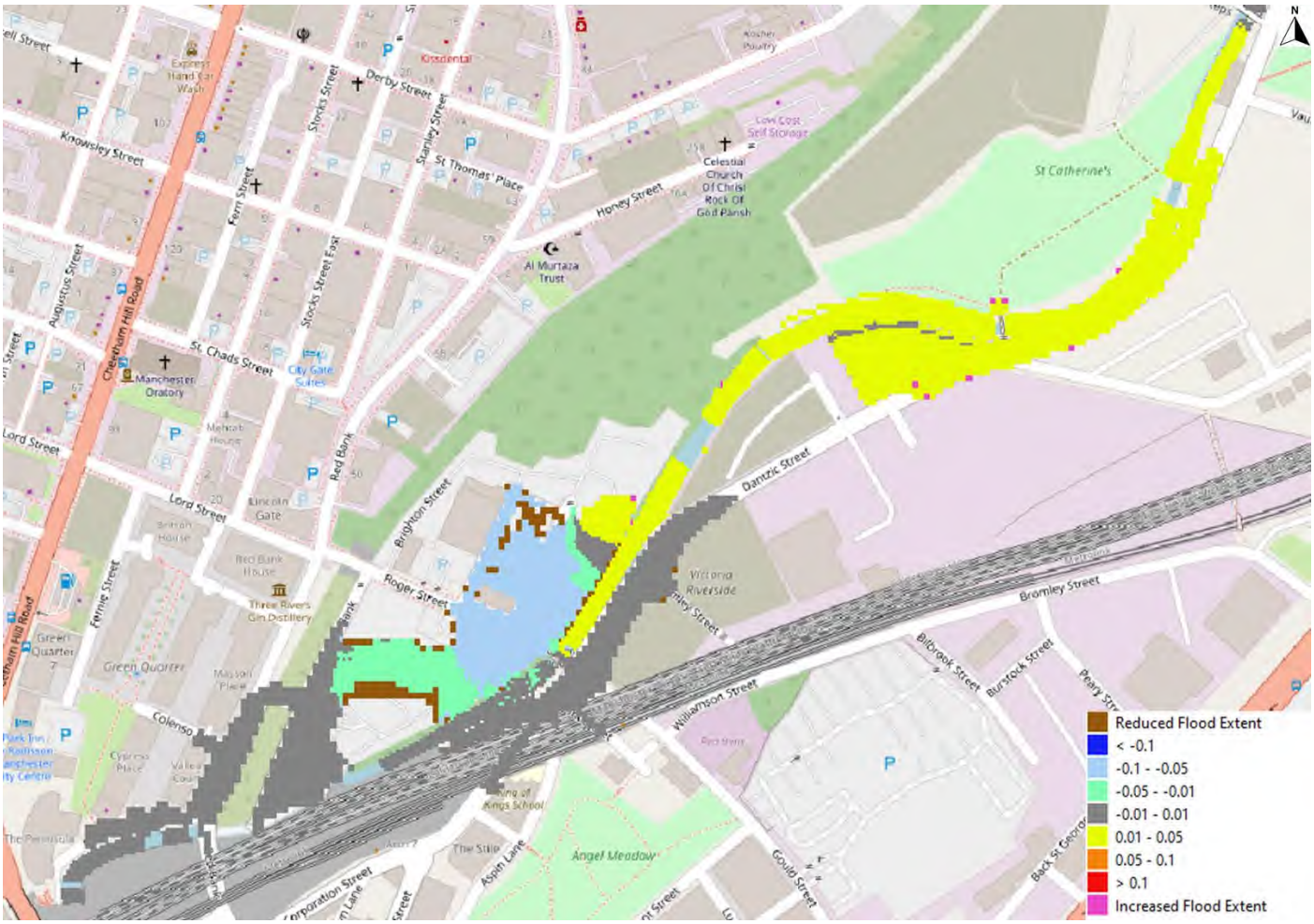


Figure 48: Impact map, showing the difference in 2D flood extent and levels, between the 2022 Baseline model and the sensitivity test in which the wall at Union Plaza is included in the model, run for the 100yr event.

5.1.1 Model Confidence

This hydraulic model aims to provide a best representation of predicted fluvial flooding during a range of rainfall events on the River Irk and Moston Brook. It should be noted that outputs from the model remain estimates of an actual flood event.

The model only represents fluvial flooding from the watercourses and does not include any surface water drainage systems. The model does not take account of antecedent conditions to a rainfall event, nor does it include flooding from other sources such as surface water runoff or groundwater which may exacerbate flooding, depending on the antecedent conditions. The model also assumes that structures are clear of blockages and free flowing; the sensitivity tests outlined above highlight that both Scotland Weir and Aspin Lane Bridge are large hydraulic controls on the River Irk, and so the blockage of these structures is likely to impact water levels along the watercourse.

The model was found to be particularly sensitive to variations in flow and this should be taken into consideration in any future works planned along the watercourse. The results of sensitivity testing of the model inflows, shown in Figure 42, demonstrate that the model outputs vary by a similar level above and below the outputs of the Baseline model results. A 20% increase in inflows led to, on average, a 0.37m increase in maximum water levels, with a 20% decrease in inflows leading to an average reduction of maximum water levels by 0.58m, therefore giving confidence that flood levels are not particularly sensitive to a change in hydrology. The confidence in the hydrology and Collyhurst Weir is discussed in further detail in the associated hydrology reporting, *VNR-ARP-00-YYY-RP-CH-0001_Flood Estimation Report_200922*.

Whilst the Union Plaza wall has been removed from the Baseline model, several walls considered as defacto defences remain in the model and are assumed as structurally sound in their present condition. It should be noted that defacto defences are not maintained as official flood defences and therefore their failure during an extreme rainfall event cannot be ruled out. It is recommended that if any walls lining the watercourse show deterioration in the future, further sensitivity testing should be undertaken to ascertain the resultant change to flood risk should they fail.

6. 2022 Updated Flood Zone Maps

The following, Figure 49, illustrates the updated flood zones map, based on the 2022 Baseline model using the 2022 hydrology, run for the 20yr, 100yr and 1000yr events. Similar to the flood extents presented in Figure 39, the extents presented here have reduced since the Interim 2021 Baseline modelling, primarily as a result of the implementation of the lower flows associated with the 2022 hydrology.

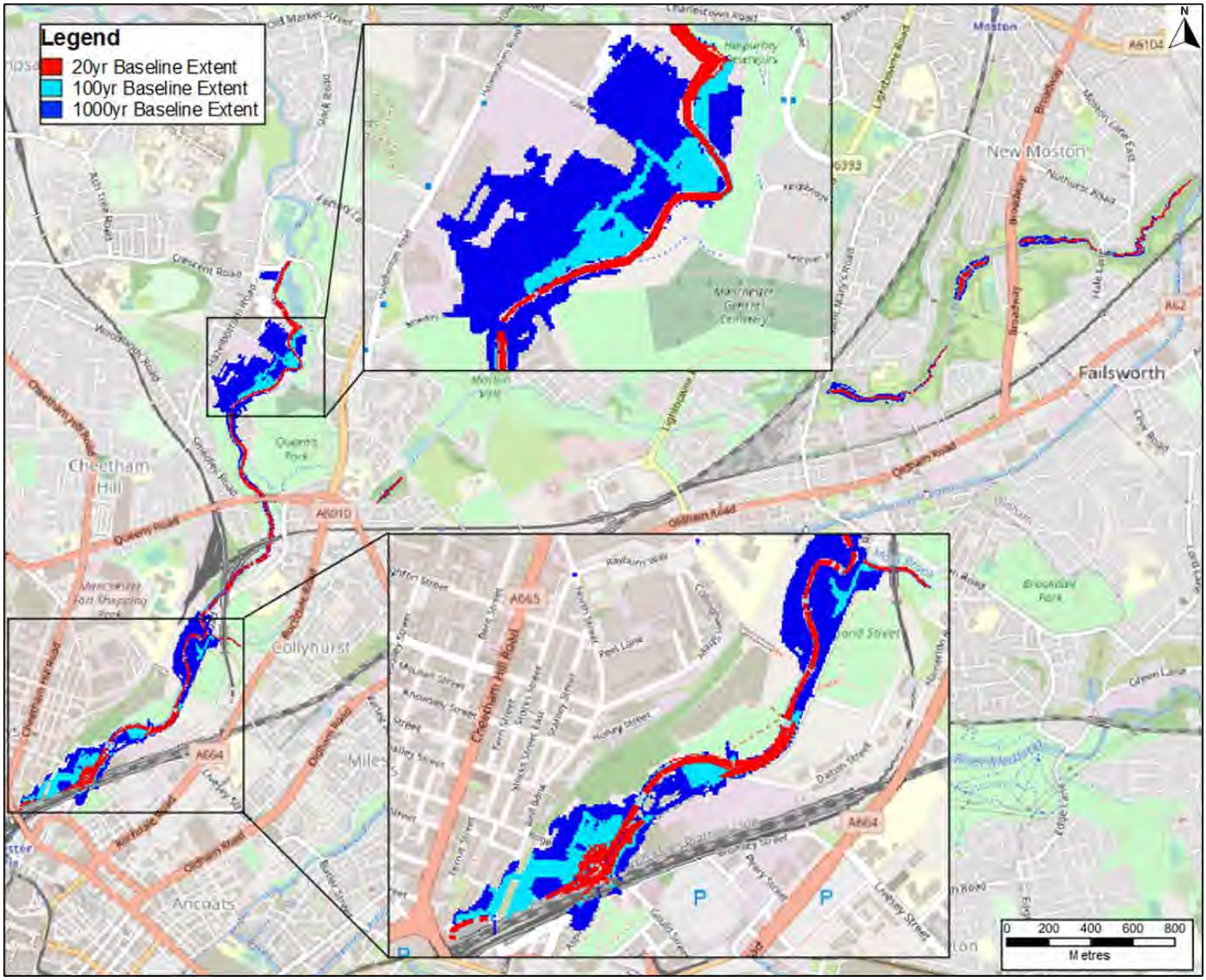


Figure 49: Updated flood zones map, based on the 2022 Baseline model using the 2022 hydrology.

A.1 Appendix A – Modelled Hydrographs

Figures 50 – 56, below, contains the modelled hydrographs for each hydrology boundary, for each return period modelled, showing the application of the updated hydrology in the model.

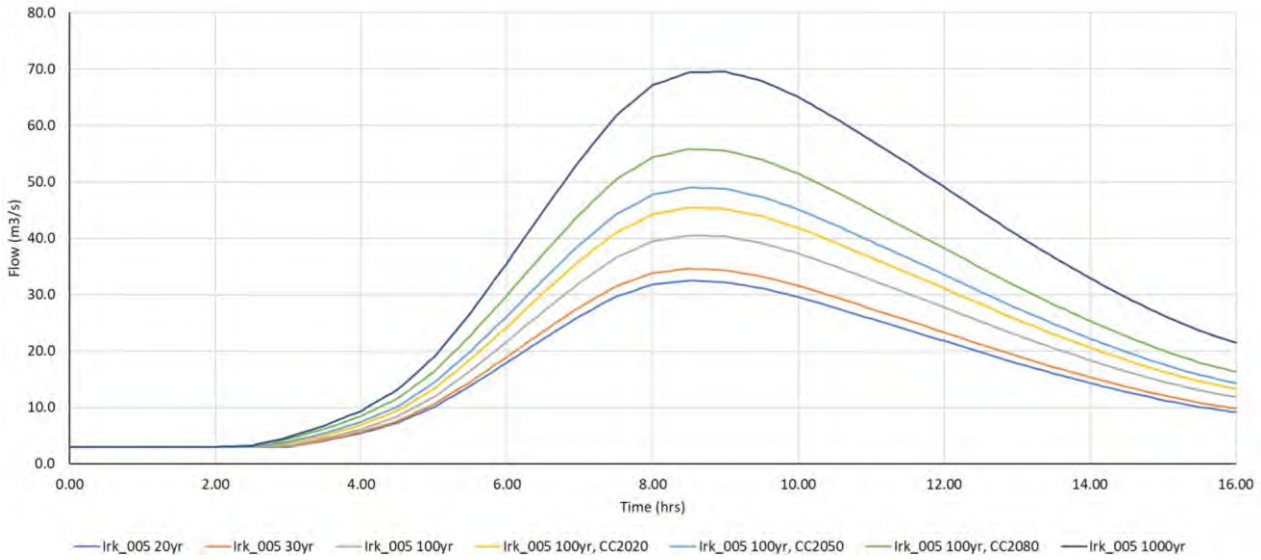


Figure 50: Hydrographs for each modelled return period, at node Irk_005, one of the hydrology inflow boundaries along the River Irk.

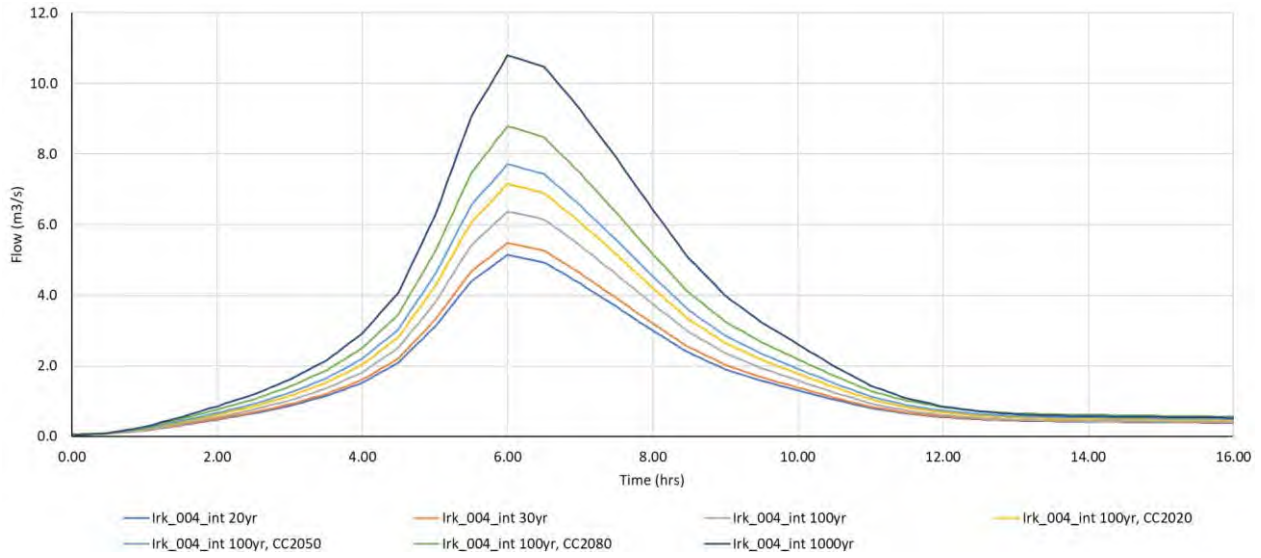


Figure 51: Hydrographs for each modelled return period, at node Irk_004_int, a hydrology inflow boundary along the River Irk.

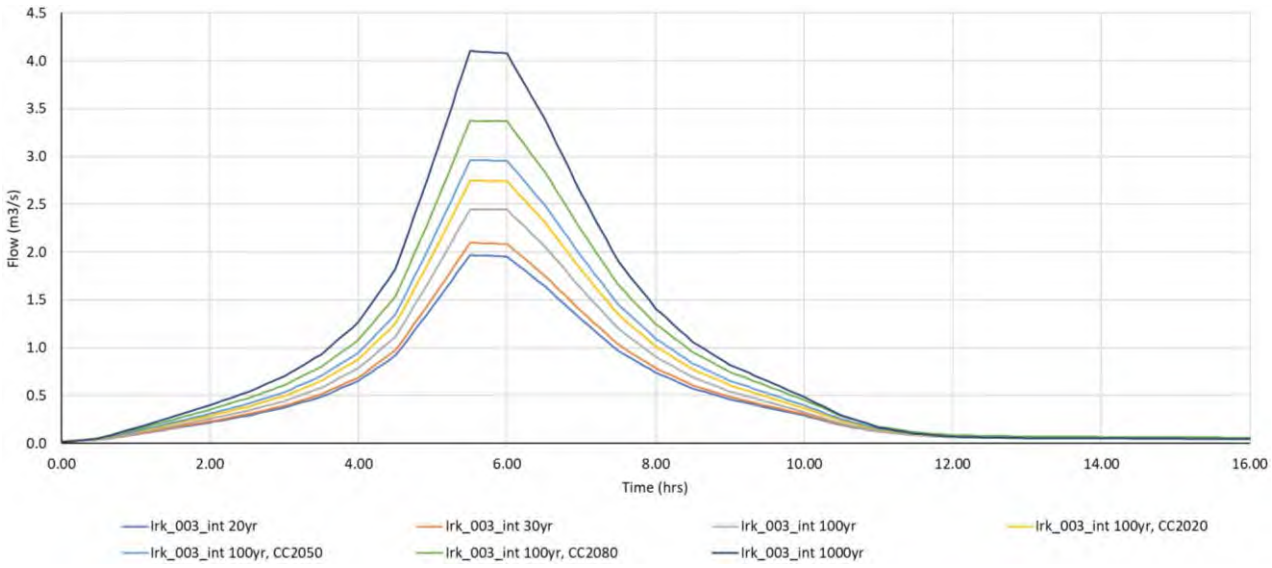


Figure 52: Hydrographs for each modelled return period, at node lrk_003_int, a hydrology inflow boundary along the River Irk.

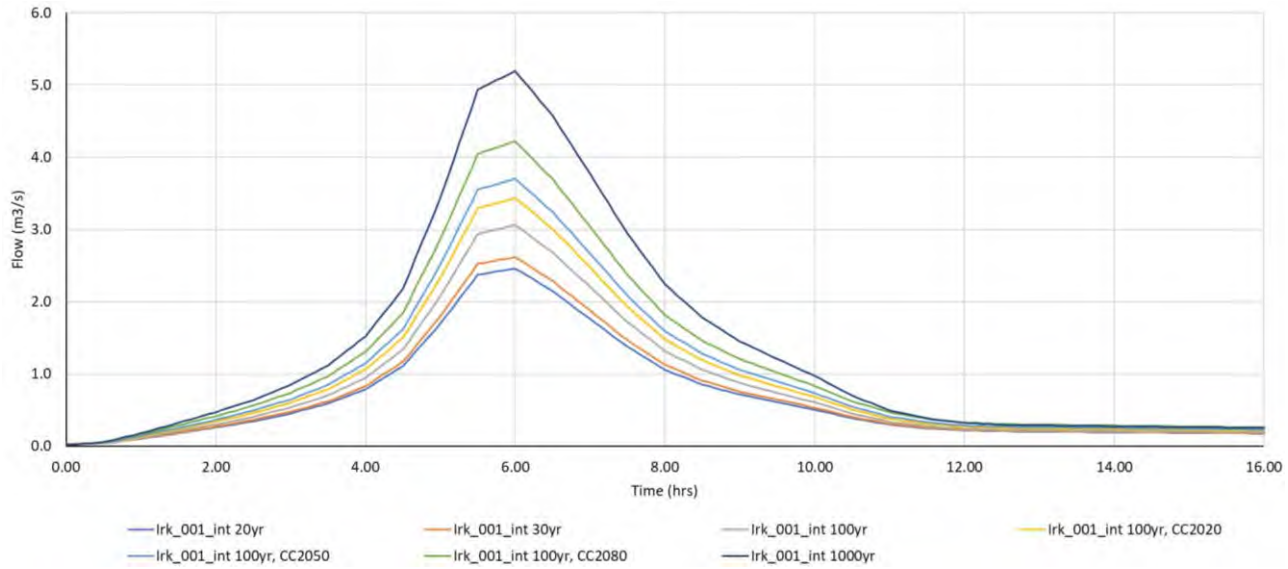


Figure 53: Hydrographs for each modelled return period, at node lrk_001_int, a hydrology inflow boundary along the River Irk.

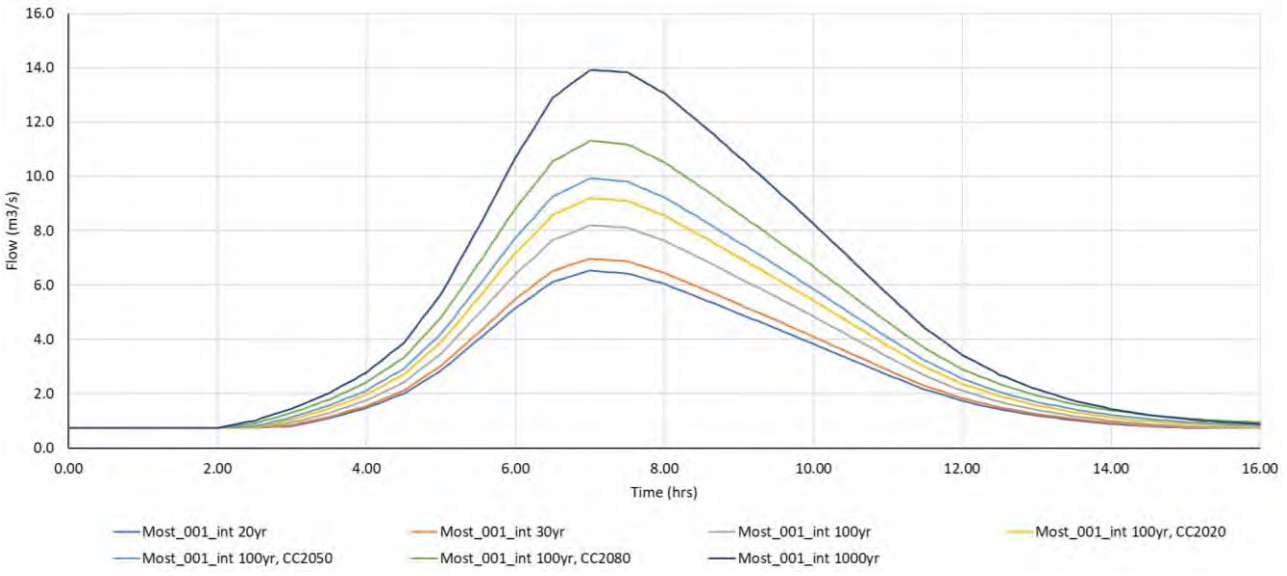


Figure 54: Hydrographs for each modelled return period, at node Most_001_int, a hydrology inflow boundary along the Moston Brook.

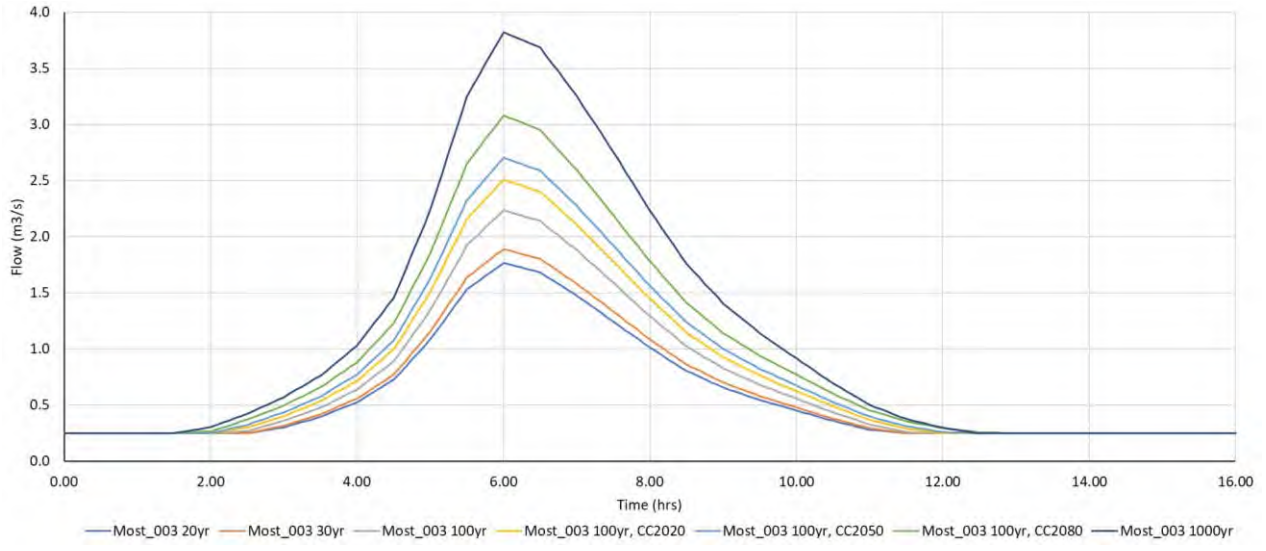


Figure 55: Hydrographs for each modelled return period, at node Most_003, a hydrology inflow boundary along the Moston Brook.

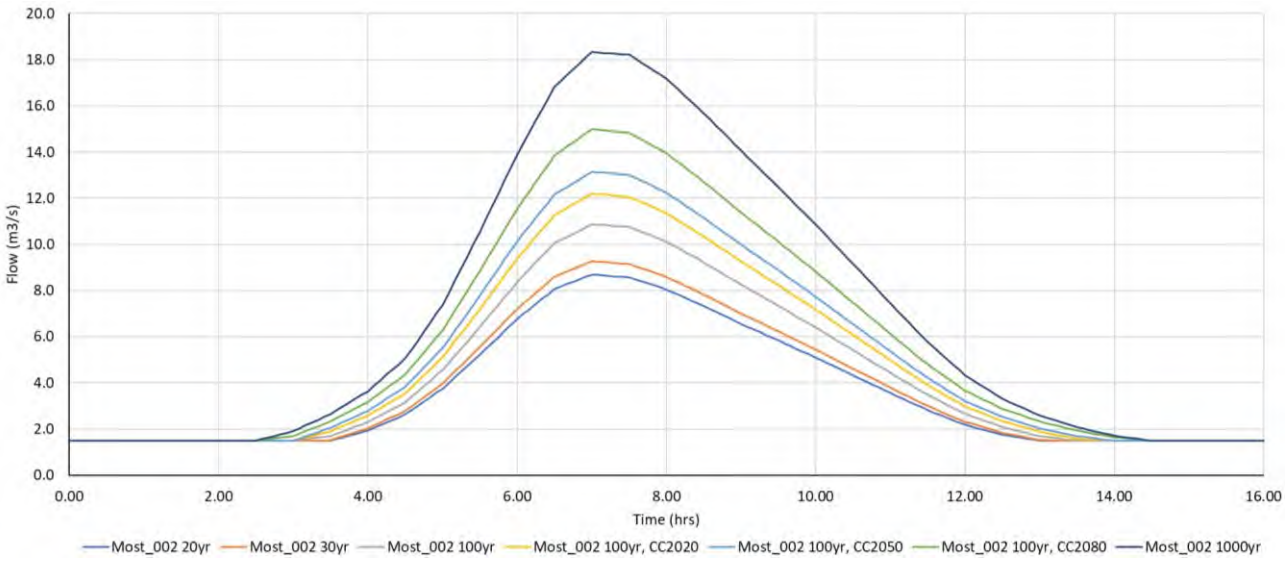


Figure 56: Hydrographs for each modelled return period, at node Most_002, a hydrology inflow boundary along the Moston Brook.

DOCUMENT CHECKING

	Prepared by	Checked by	Approved by
Name	Louise O'Regan/	Frances Dearden	Tom Saville
Signature			



DO NOT SCALE

NOTES:

1. ALL DIMENSIONS ARE IN METRES UNLESS STATED OTHERWISE

P02	13/04/2023	TG	LEVELS UPDATED TO LATEST LAYOUT AND DESIGN	RV	RV
P01	24/03/2023	TG	FIRST ISSUE	RV	RV
REV	DATE	BY	DESCRIPTION	CHK	APP

DRAWING STATUS:

S0 - WORK IN PROGRESS

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PROJECT:

RED BANK AND DANTZIC STREET

TITLE:

PROPOSED SPOT ELEVATIONS

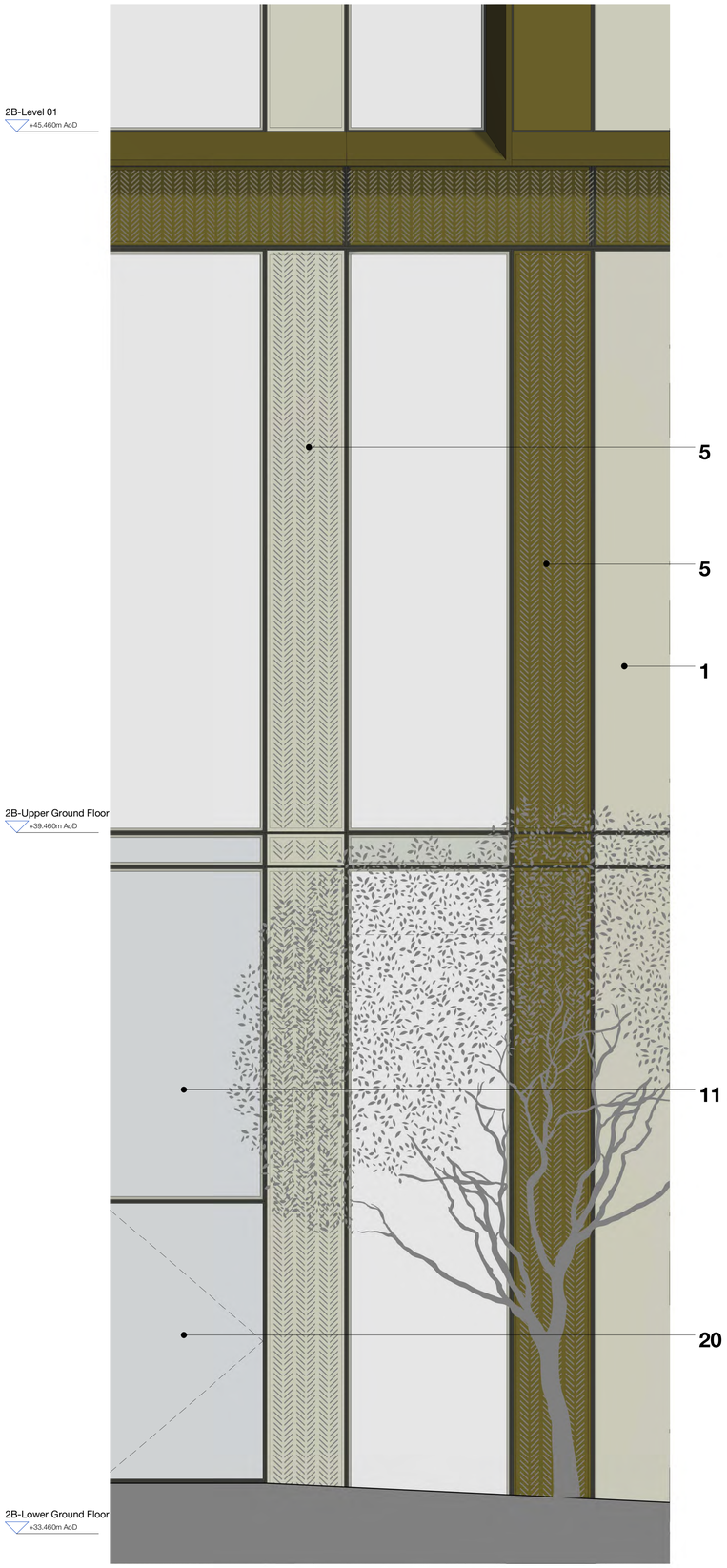
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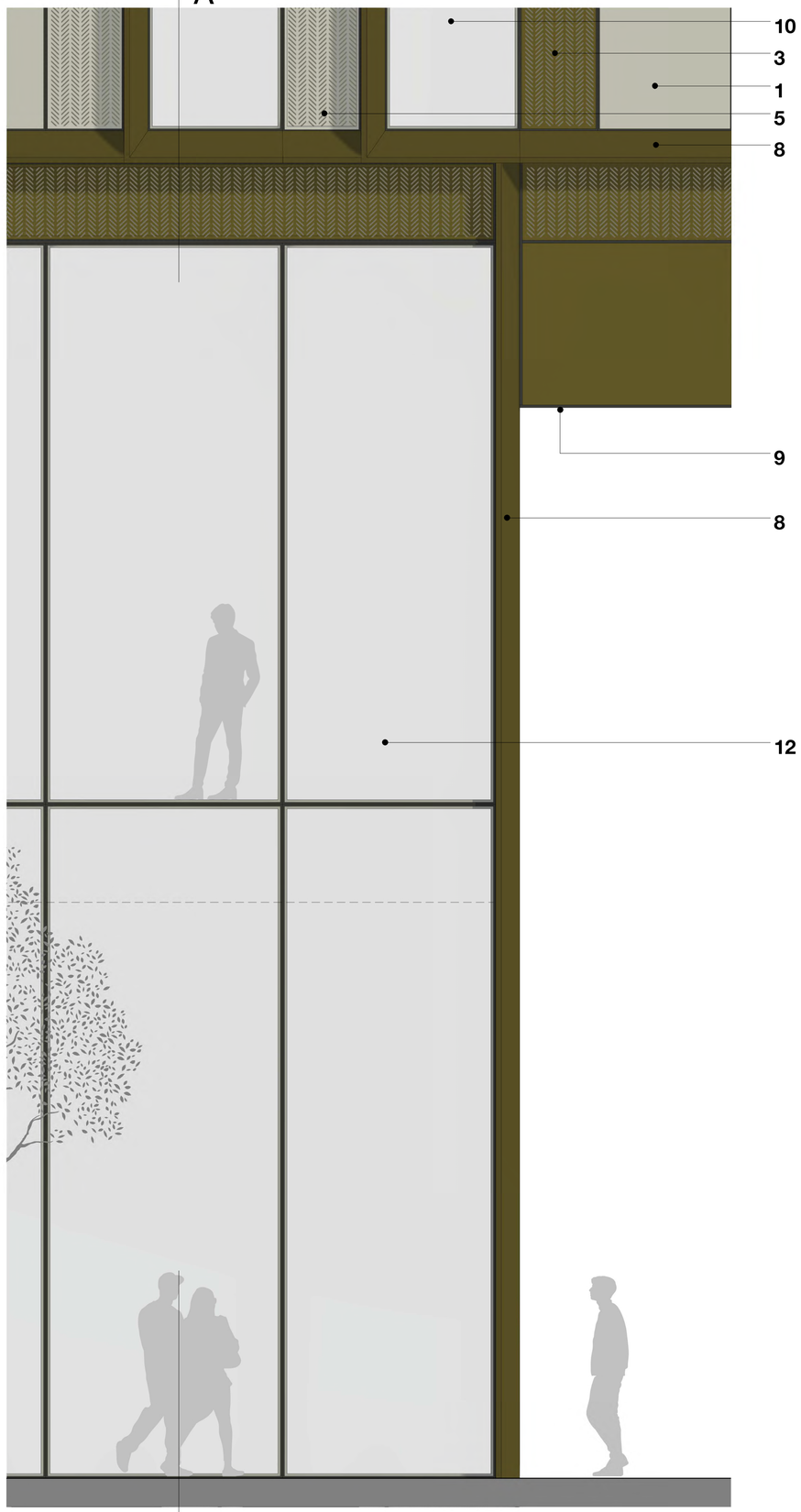
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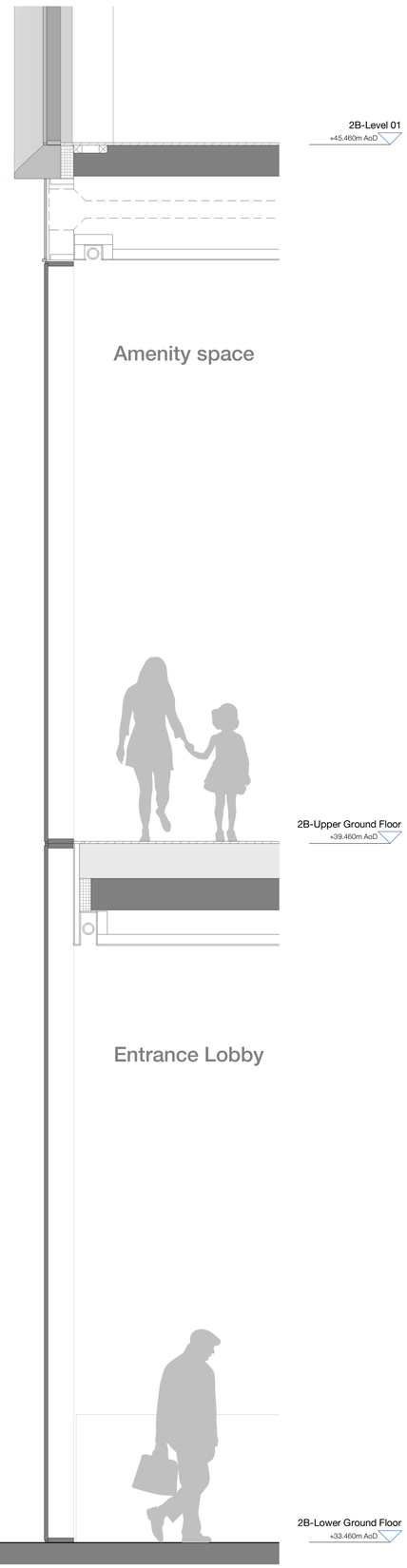
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File name: I:\MYP\GROUP_M_CONCENTRAL FOLDER\SECTOR\XX\XX\XX\CONTROM - RED BANK & DANTZIC STREET MASTERPLAN\02_WIP\03 TRANSPORT & HIGHWAYS\02 DRAWINGS\RDB-WSP-XX-XX-DR-TP-002.DWG, plotted on 13 April 2023 at 9:51:32, by Emma Tidy



1 | Tower 1 Base - Elevation - Entrance





A | Section

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Rev	Description	Date
P01	Issued for Planning	24.03.23
P02	Issued for Planning	31.03.23

Materials Key:

1. Anodised aluminium panel, pale bronze colour
2. Anodised aluminium panel, natural anodised colour
3. Anodised aluminium panel with perforations. Openable panel behind for purge ventilation. (Colour and specification to be agreed upon discharging conditions)
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13. Clear curtain walling vision glass with expressed fin caps to mullions
14. Clear curtain walling vision glass with green terracotta 'baguette' vertical fins fixed to mullions
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16. Fine-textured green terracotta cladding
17. Broad-profiled green terracotta cladding
18. Perforated aluminium sinusoidal veil, with windows concealed behind
19. Aluminium framed window
20. Aluminium framed glazed door
21. Brickwork with colour-matched mortar, stretcher bond
22. Brick detail of Flemish bond with projecting headers
23. Brick vent detail of Flemish bond with removed headers to conceal commercial vent outlets
24. Soldier course brickwork with colour-matched mortar
25. Vertical corduroy brick detail
26. Pigmented pre-cast concrete sill, colour to match brickwork
27. Pigmented pre-cast concrete coping, colour to match brickwork
28. Pigmented pre-cast concrete surround to recessed commercial glazing
29. Slender steel flat bar balcony railings
30. Solid metal screen to one side of balcony
31. Solid metal fascia and soffit to balcony
32. Illuminated signage set behind glazing
33. Large format supergraphic signage, façade-fixed and illuminated
34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

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Project
Red Bank NT02/03
Dantzic Street
Manchester
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Drawing
Bay Study - Tower 1 Base

Scale @ A1	Date
1 : 25	March 2023

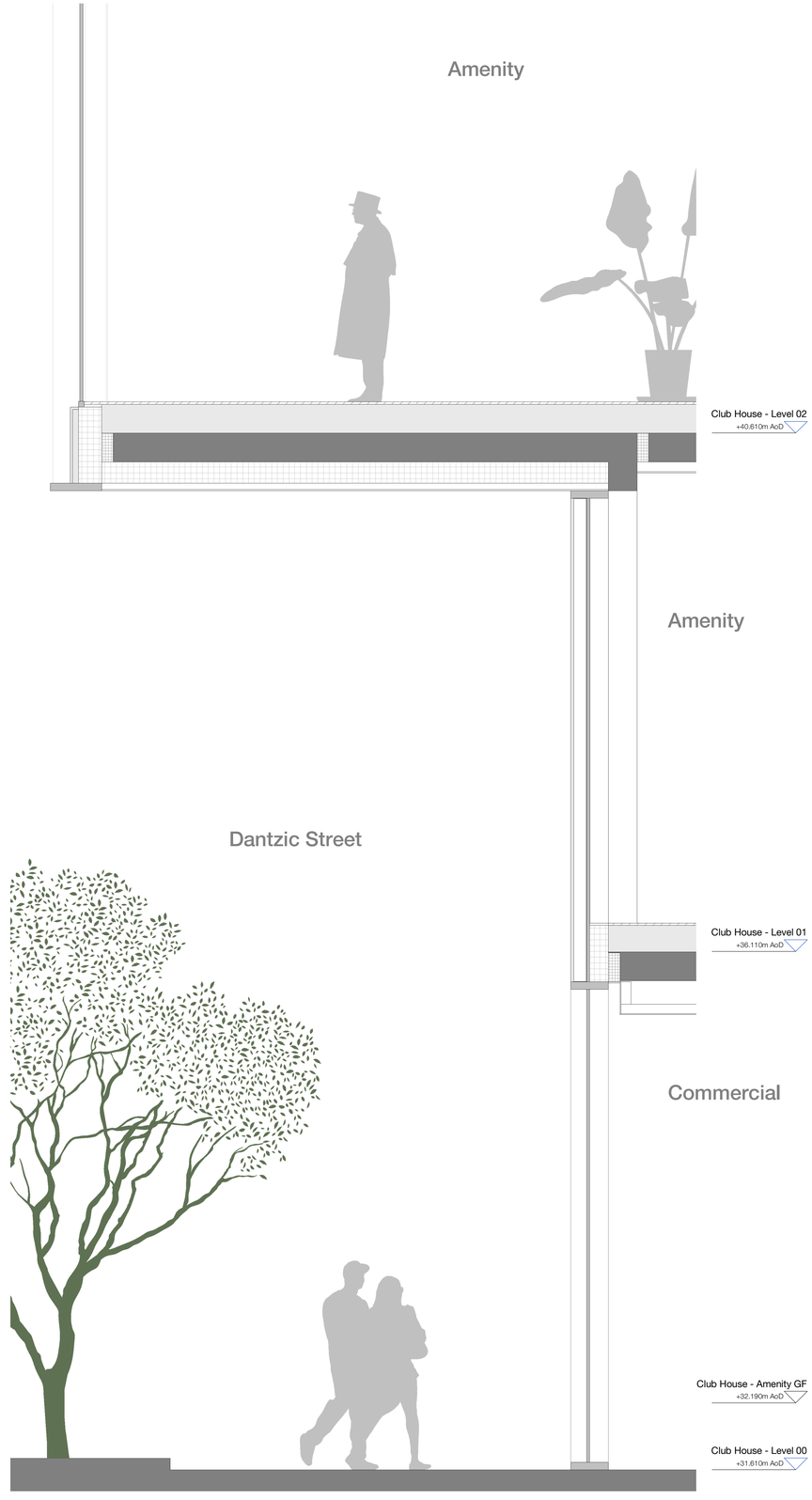
Drawn By	Checked By
MV	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

Drawing No. RDB-HBA-2B-ZZ-DR-AR-080250
Rev P02



1 | Clubhouse Base - Elevation



A | Section

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Rev	Description	Date
P01	Issued for Planning	31.03.23
P02	Issued for Planning	12.04.23

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34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

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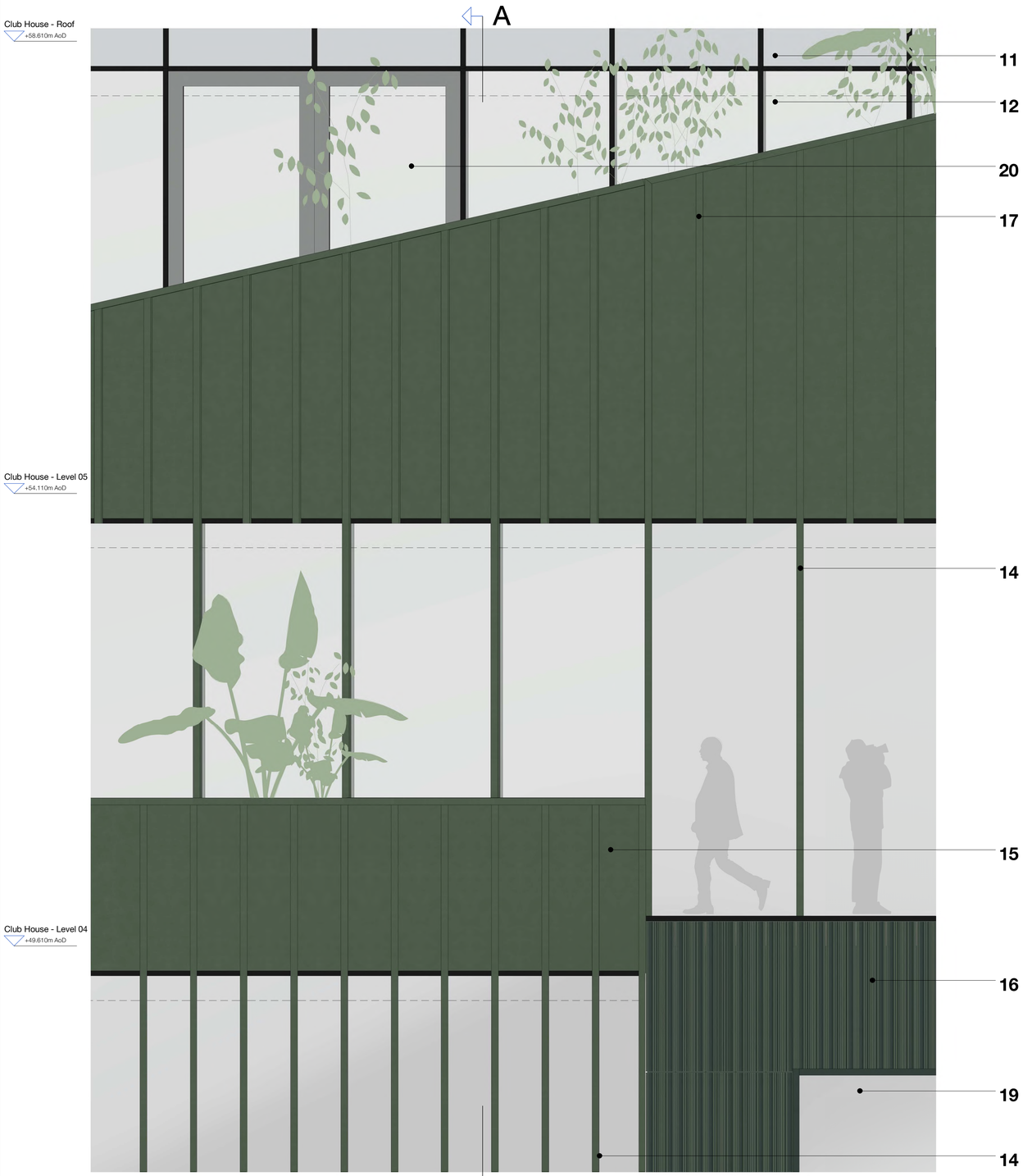
Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

Drawing
Proposed Bay Study - Clubhouse - Lower Levels

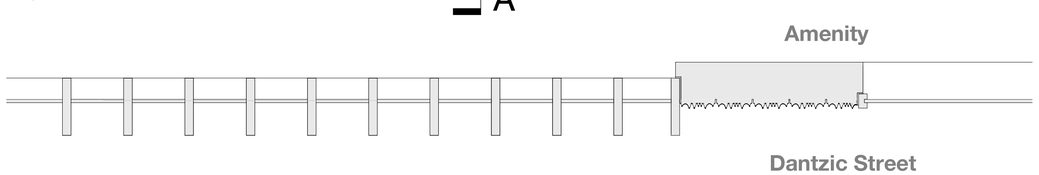
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1 : 25	March 2023
Drawn By	**Checked By**
MV	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

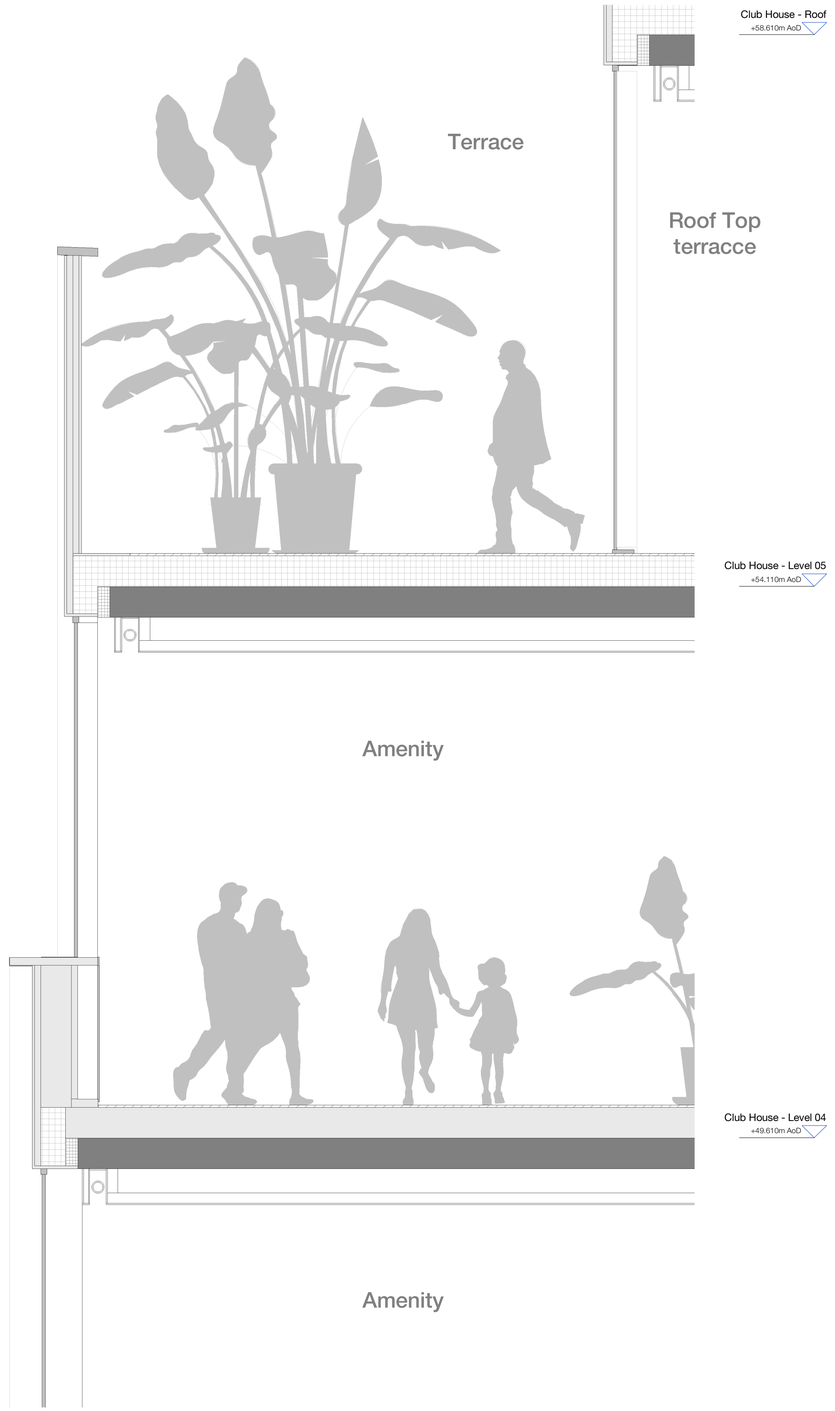
Drawing No. RDB-HBA-2B-ZZ-DR-AR-080252
Rev P02



1 | Clubhouse Upper Levels - Elevation



2 | Clubhouse Upper Levels - Level 03 Plan



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Rev	Description	Date
P01	Issued for Planning	31.03.23
P02	Issued for Planning	12.04.23

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34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

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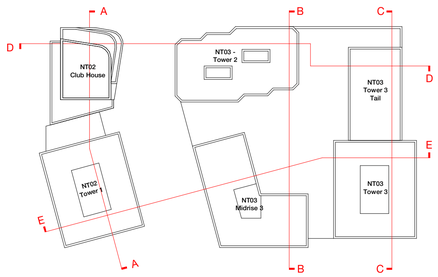
Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

Drawing
Proposed Bay Study - Clubhouse - Upper Floors

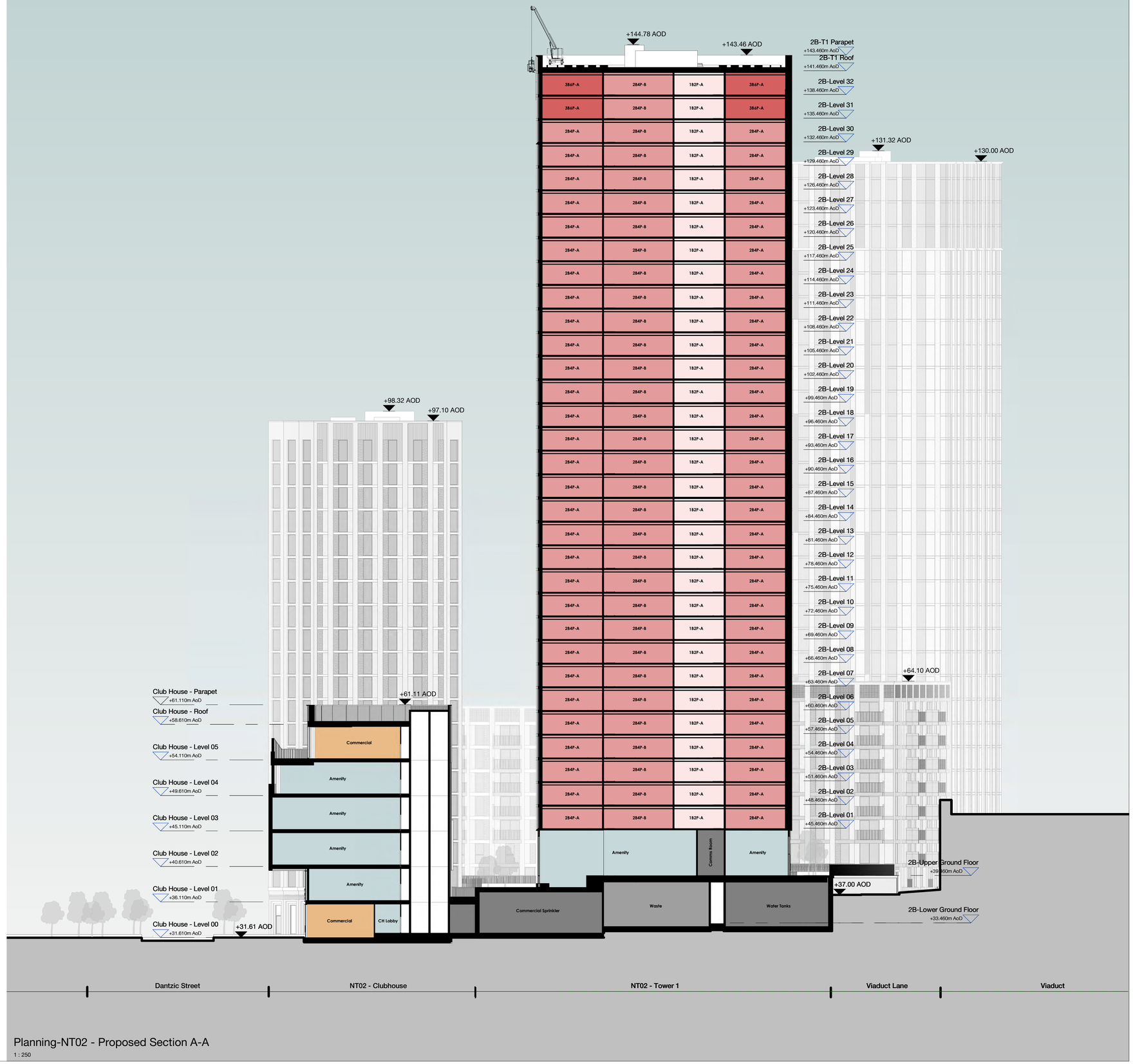
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1 : 25	March 2023
Drawn By	**Checked By**
MV	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

Drawing No. RDB-HBA-2B-ZZ-DR-AR-080253
Rev P02



- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-4P-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste



Planning-NT02 - Proposed Section A-A

1 : 250

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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for Planning	31.03.23
P03	Issued for Planning	12.04.23

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Drawing
Proposed GA Section A-A

Scale @ A1	Date
1 : 250	March 2023
Drawn By	**Checked By**
HECW	JT

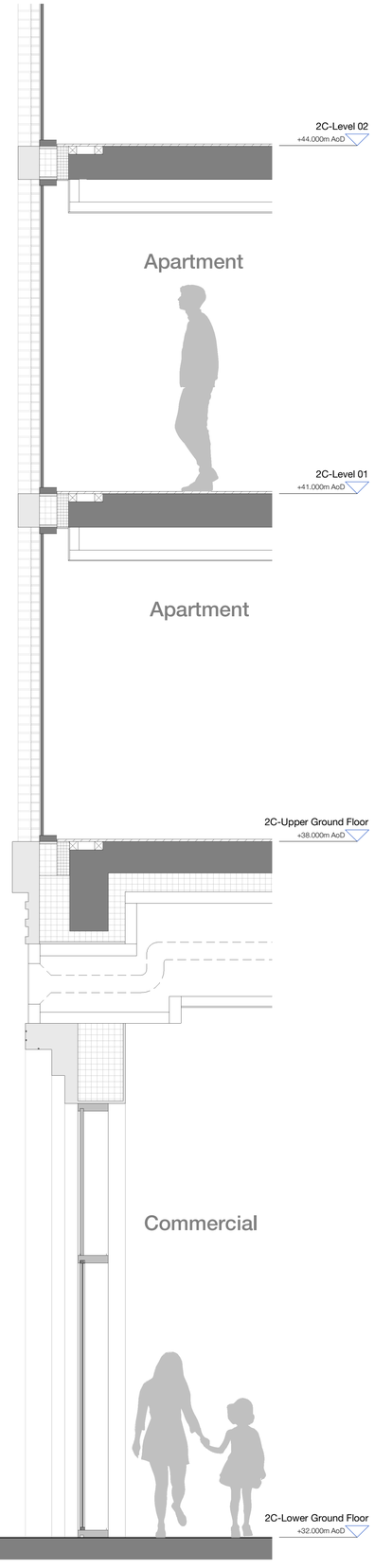
Job Number	Status	Purpose of Issue
210263	S2	For Approval

Drawing No. RDB-HBA-2B-ZZ-DR-AR-080310

Rev P03



1 | Tower 2 Base - Elevation



A | Section

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Rev	Description	Date
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P02	Issued for Planning	31.03.23

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34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

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Project
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Drawing
Bay Study - Tower 2 Base

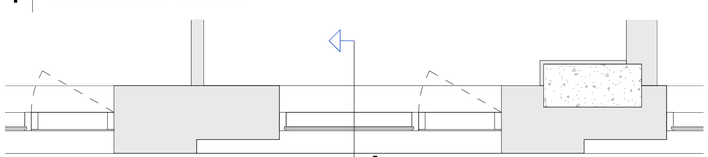
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Drawn By	**Checked By**
MV	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

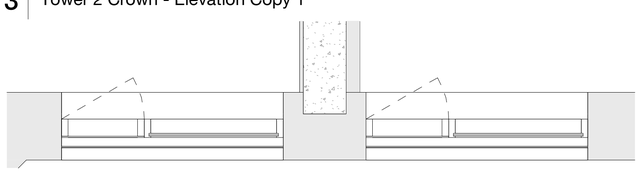
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Rev P02



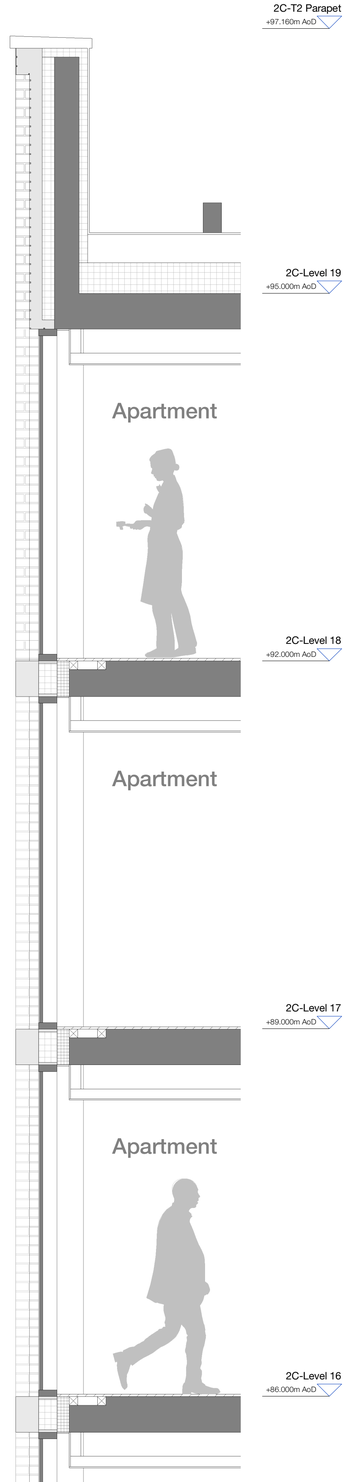
1 | Tower 2 Crown - Elevation



2 | Tower 2 Crown - Plan



3 | Tower 2 Crown - Elevation Copy 1



A | Section

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Rev	Description	Date
P01	Issued for Planning	24.03.23
P02	Issued for Planning	31.03.23
P03	Issued for Planning	12.04.23

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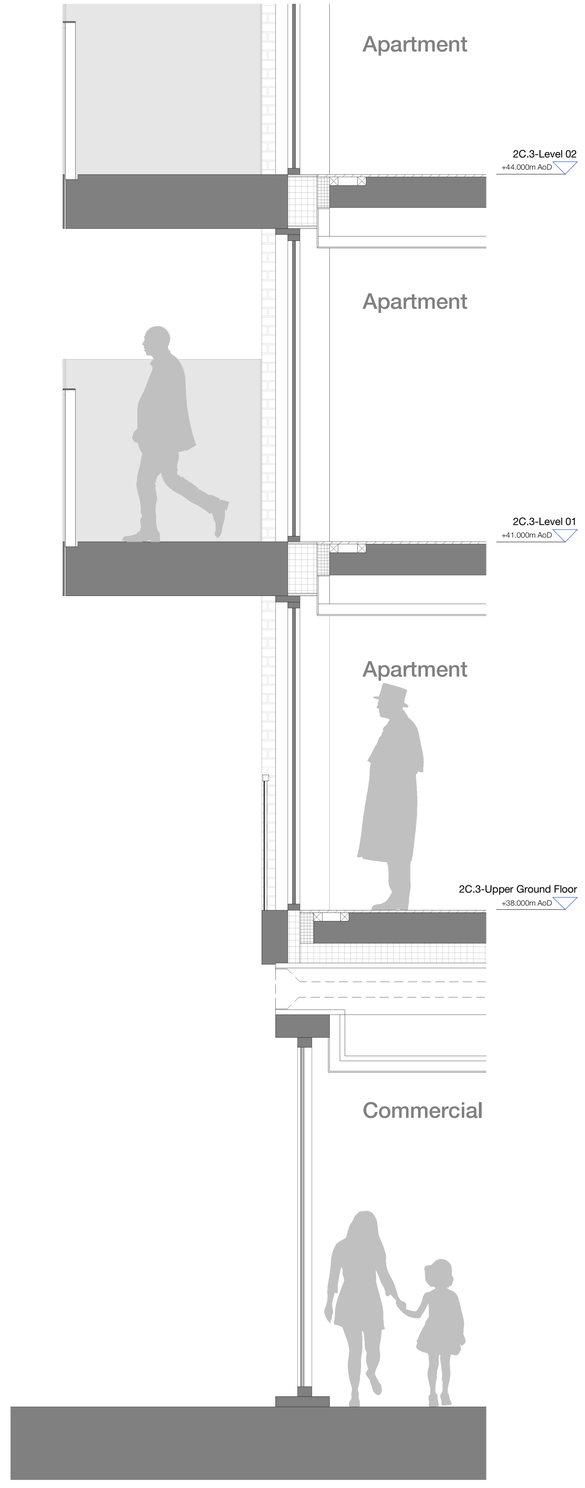
Project
Red Bank NT02/03
Dantzic Street
Manchester
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Drawing
Proposed Bay Study - Tower 2
Upper Levels

Scale @ A1 1 : 25	**Date** March 2023
Drawn By MV	**Checked By** JT
Job Number 210263	**Status** S2
Purpose of Issue For Approval	
Drawing No. RDB-HBA-2C-ZZ-DR-AR-080255	**Rev** P03



1 | Midrise 3 Base - Elevation



A | Section

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Rev	Description	Date
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Project
Red Bank NT02/03
Dantzic Street
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Drawing
Bay Study - Midrise 3 Base

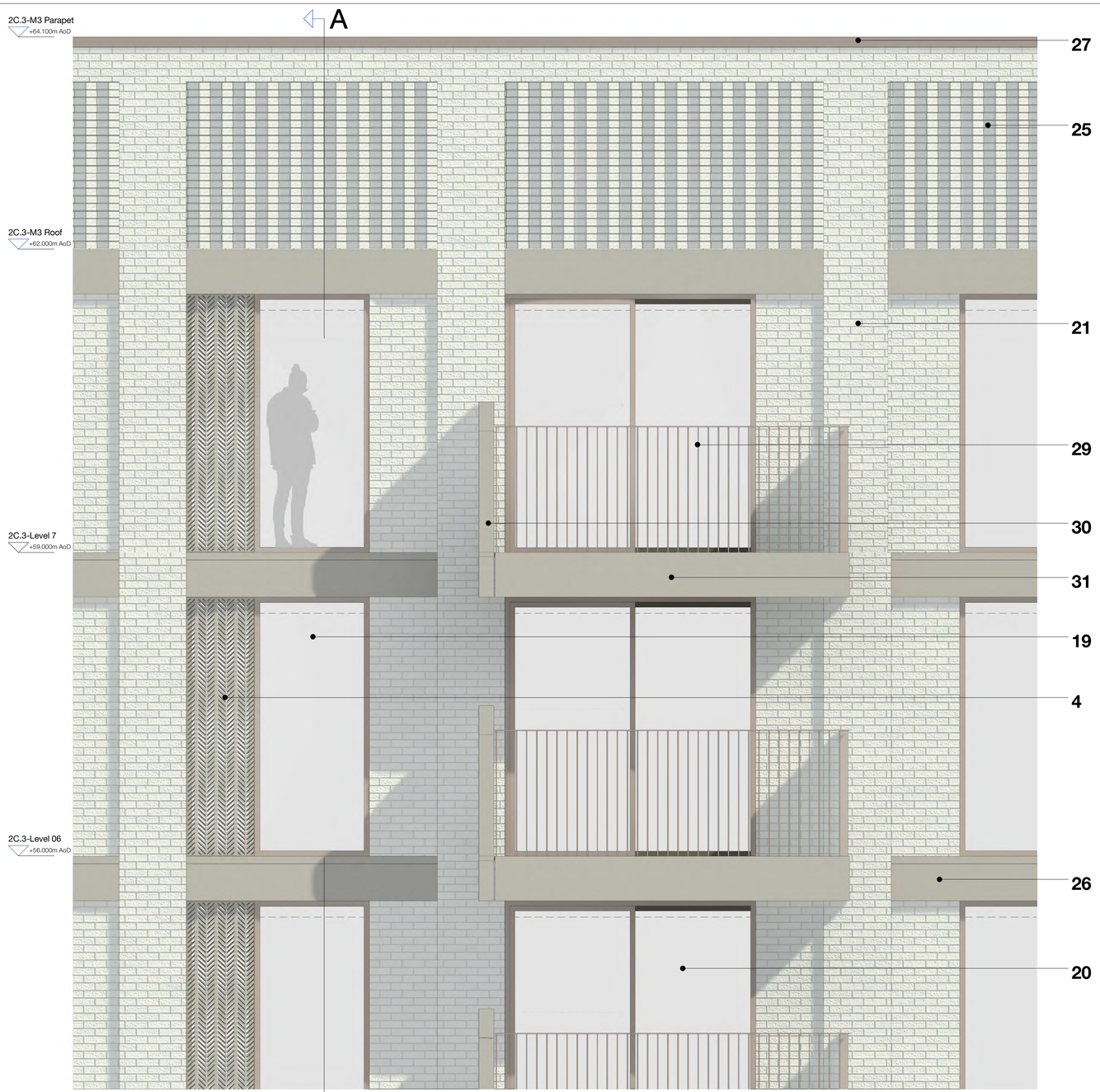
Scale @ A1	Date
1 : 25	March 2023

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MV	JT

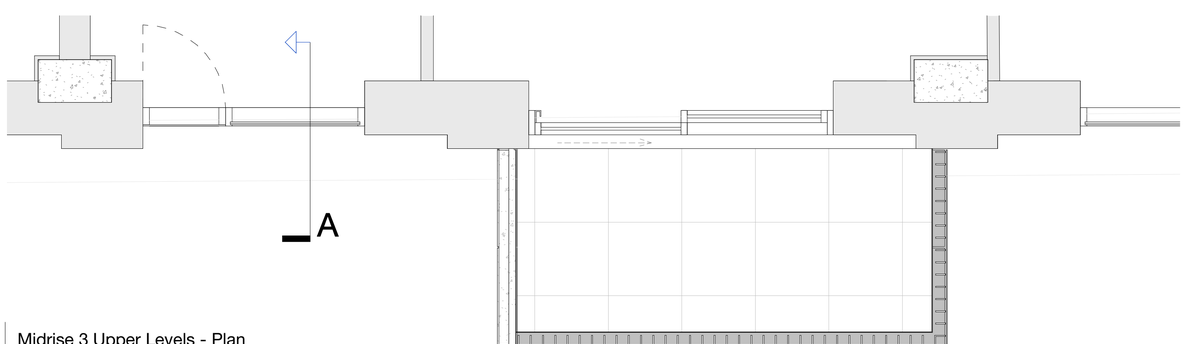
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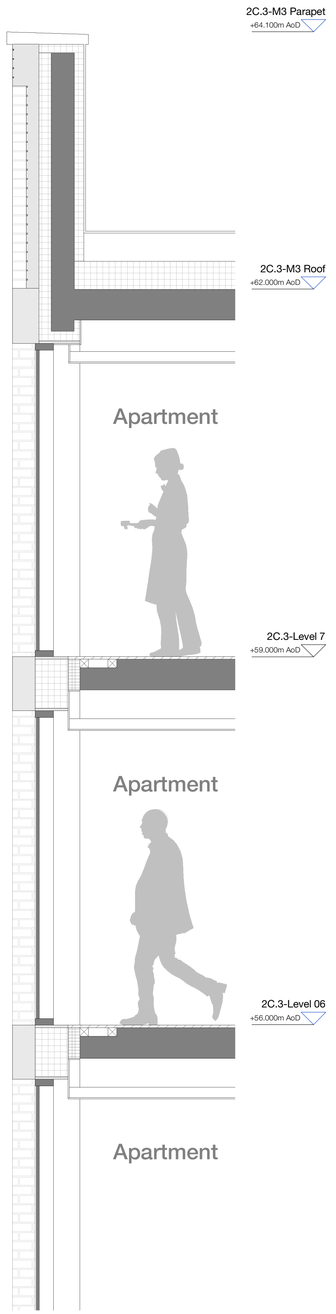
Rev
P02



1 | Midrise 3 Upper Levels - Elevation



2 | Midrise 3 Upper Levels - Plan



A | Section

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Rev	Description	Date
P01	Issued for Planning	24.03.23
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2. Anodised aluminium panel, natural anodised colour
3. Anodised aluminium panel with perforations. Openable panel behind for purge ventilation. (Colour and specification to be agreed upon discharging conditions)
4. Anodic-coated aluminium panel with perforations. Openable panel behind for purge ventilation. (Colour and specification to be agreed upon discharging conditions)
5. Anodised aluminium panel with perforations. Non-openable backing to match appearance of vent panels. (Colour and specification to be agreed upon discharging conditions)
6. Anodic-coated aluminium panel with perforations. Non-openable backing to match appearance of vent panels. (Colour and specification to be agreed upon discharging conditions)
7. Anodic-coated aluminium paneled service door with perforations. (Colour and specification to be agreed upon discharging conditions)
8. Anodised aluminium feature fin (Colour and specification to be agreed upon discharging conditions)
9. Anodised aluminium feature soffit with recessed down-lighting (Colour and specification to be agreed upon discharging conditions)
10. Clear fixed vision glass
11. Glass infill spandrel with opaque back box
12. Clear curtain walling vision glass with structural sealed joint
13. Clear curtain walling vision glass with expressed fin caps to mullions
14. Clear curtain walling vision glass with green terracotta 'baguette' vertical fins fixed to mullions
15. Spandrel of green terracotta between vertical terracotta fins
16. Fine-textured green terracotta cladding
17. Broad-profiled green terracotta cladding
18. Perforated aluminium sinusoidal veil, with windows concealed behind
19. Aluminium framed window
20. Aluminium framed glazed door
21. Brickwork with colour-matched mortar, stretcher bond
22. Brick detail of Flemish bond with projecting headers
23. Brick vent detail of Flemish bond with removed headers to conceal commercial vent outlets
24. Soldier course brickwork with colour-matched mortar
25. Vertical corduroy brick detail
26. Pigmented pre-cast concrete sill, colour to match brickwork
27. Pigmented pre-cast concrete coping, colour to match brickwork
28. Pigmented pre-cast concrete surround to recessed commercial glazing
29. Slender steel flat bar balcony railings
30. Solid metal screen to one side of balcony
31. Solid metal fascia and soffit to balcony
32. Illuminated signage set behind glazing
33. Large format supergraphic signage, façade-fixed and illuminated
34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

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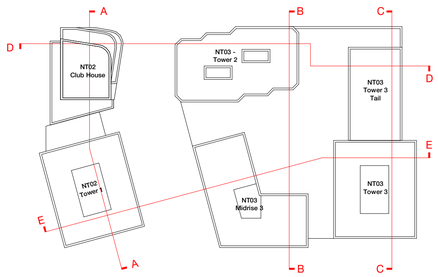
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Drawing
Bay Study - Midrise 3 Upper Levels

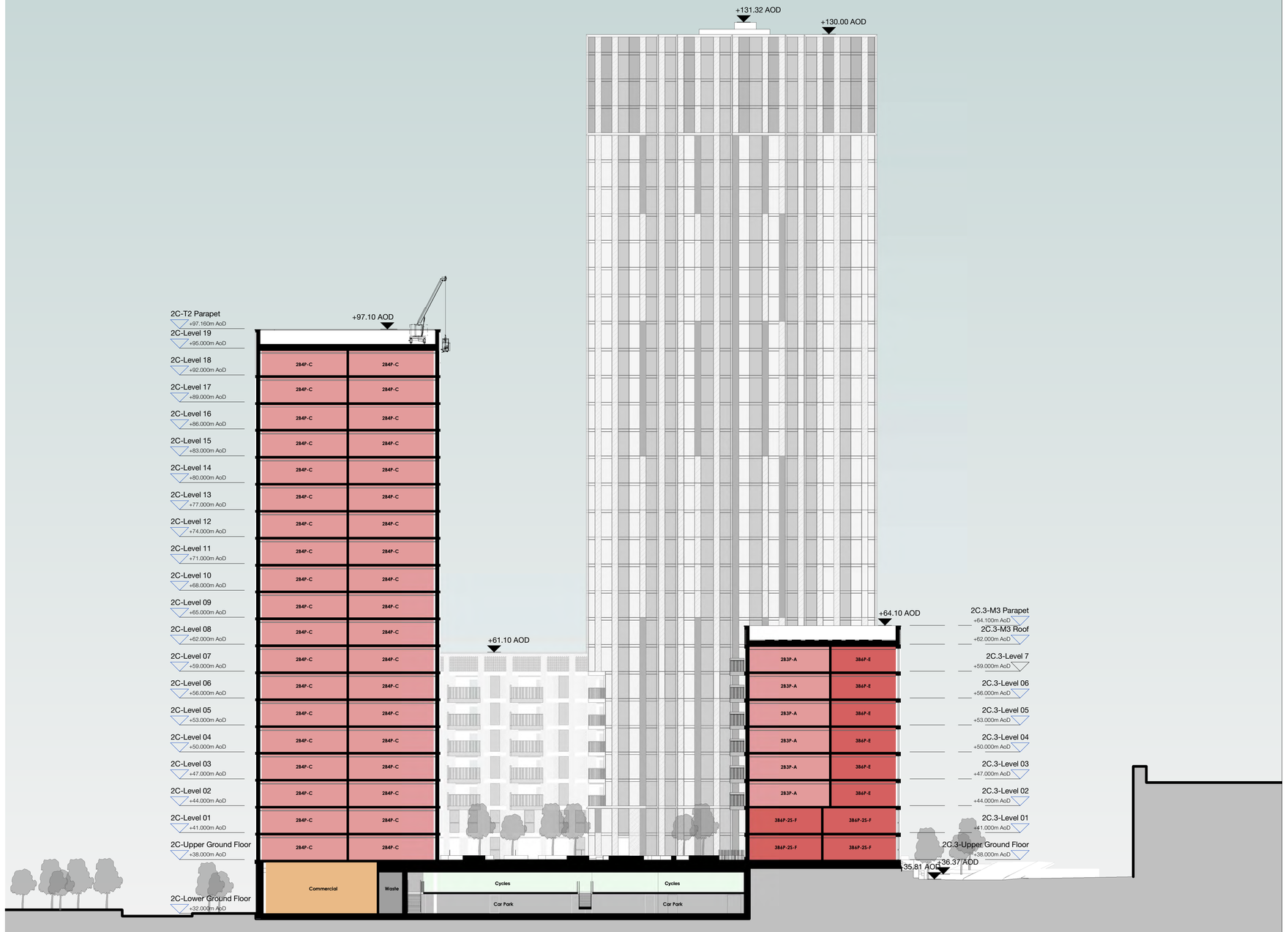
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1 : 25	March 2023
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MV	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

Drawing No. RDB-HBA-2C-ZZ-DR-AR-080257
Rev P02



1B-1P-1S
1B-2P-1S
2B-3P-1S
2B-4P-1S
2B-4P-2S
3B-4P-2S
3B-5P-1S
3B-5P-2S
3B-6P-1S
3B-6P-2S
Amenity
Commercial
Cycles
Lobby
MEP
Parking
Waste



Planning-NT03 - Proposed Section B-B
1 : 250

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Drawing
Proposed GA Section B-B

Scale @ A1	Date
1 : 250	March 2023
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Job Number	Status	Purpose of Issue
210263	S2	For Approval

Drawing No. RDB-HBA-2C-ZZ-DR-AR-080311
Rev P03

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P03	Issued for Planning	12.04.23
P04	Issued for Planning	18.04.23

Dantzic Street

Travis Square

Dulwich Street

Dulwich Street

NT02
Amenity Club House
Amenity
301 m²

NTO2 Tower 1

NT03
Tower 2

NT03 Midrise
3

NTO3 Tower 3

Ventilation extract for commercial unit below

Ventilation extract for commercial unit below

Key:

- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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Drawing
Proposed Level 01 Floor Plan

Scale @ A1	Date
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Job Number	Status	Purpose of Issue
210263	S2	Issued for Information

Drawing No. RDB-HBA-2X-01-DR-AR-080101
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P03	Issued for Planning	12.04.23
P04	Issued for Planning	18.04.23

Dantzic Street

Travis Square

Dulwich Street

Dulwich Street

NT02
Amenity Club House
Amenity
293 m²

NT02 Tower 1

NT03
Tower 2

NT03 Midrise
3

NTO3 Tower 3

Ventilation extract for commercial unit below

Ventilation extract for commercial unit below

Key:

- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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Drawing
Proposed Level 02 Floor Plan

Scale @ A1	Date
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Drawn By	**Checked By**
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Job Number	Status	Purpose of Issue
210263	S2	Issued for Information

Drawing No. RDB-HBA-2X-02-DR-AR-080102
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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for Planning	31.03.23
P03	Issued for Planning	12.04.23
P04	Issued for Planning	18.04.23

Key:

- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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Drawing
Proposed Level 03 Floor Plan

Scale @ A1	Date
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Job Number	Status	Purpose of Issue
210263	S2	Issued for Information

Drawing No. RDB-HBA-2X-03-DR-AR-080103
Rev P04



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P03	Issued for Planning	12.04.23
P04	Issued for Planning	18.04.23

Key:

- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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Drawing
Proposed Level 04 Floor Plan

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Drawing No.	Rev
RDB-HBA-2X-04-DR-AR-080104	P04



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P04	Issued for Planning	18.04.23

Key:

- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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Drawing
Proposed Level 05-06 Floor Plan

Scale @ A1	Date
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Job Number	Status	Purpose of Issue
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Drawing No. RDB-HBA-2X-05-DR-AR-080105
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P03	Issued for Planning	12.04.23
P04	Issued for Planning	18.04.23

Dantzic Street

NT02
Club House (2B.2)

Indicative zone for PVs and rooftop plant

Lift overrun

NT02 Tower 1

NT03
Tower 2

NT03
Tail 3 (2C.2)

NT03 Midrise 3

NT03 Tower 3

Ventilation extract for commercial unit below

Ventilation extract for commercial unit below

Travis Square

Dulwich Street

Dulwich Street

Key:

- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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Drawing
Proposed Level 07 Floor Plan

Scale @ A1	Date
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Job Number	Status	Purpose of Issue
210263	S2	Issued for Information

Drawing No. RDB-HBA-2X-07-DR-AR-080107

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Rev	Description	Date
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P03	Issued for Planning	12.04.23

Dantzic Street

NT02
Club House (2B.2)

Indicative zone for PVs and rooftop plant

Lift overrun

NT02 Tower 1

NT03
Tower 2

NT03
Tail 3 (2C.2)

NT03 Midrise 3 (2C.3)

NTO3 Tower 3

Indicative zone for PVs

Indicative zone for PVs

Ventilation extract for commercial unit below

Ventilation extract for commercial unit below

Dulwich Street

Dulwich Street

Travis Square

Key:

- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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Drawing
Proposed Level 08-18 Floor Plan

Scale @ A1	Date
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Job Number	Status	Purpose of Issue
210263	S2	For Approval

Drawing No. RDB-HBA-2X-08-DR-AR-080108
Rev P03

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P03	Issued for Planning	12.04.23

Dantzic Street

Travis Square

Dulwich Street

Dulwich Street

NT02
Club House (2B.2)

Indicative zone for PVs and rooftop plant

Lift overrun

NT03
Tower 2

BMU track

Indicative zone for PVs

Lift overrun

BMU

Generator housing

Lift overrun

Indicative zone for PVs

Ventilation extract for commercial unit below

Ventilation extract for commercial unit below

NT03
Tail 3 (2C.2)

Indicative zone for PVs

Indicative zone for PVs

Lift overrun

NT03 Midrise 3 (2C.3)

NT02 Tower 1

NT03 Tower 3

Key:

- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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Drawing
Proposed Level 19-27 Floor Plan

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Drawing No. RDB-HBA-2X-19-DR-AR-080119
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P03	Issued for Planning	12.04.23
P04	Issued for Planning	18.04.23

Dantzic Street

Travis Square

Dulwich Street

Dulwich Street

NT02
Club House (2B.2)

Indicative zone for PVs and rooftop plant

Lift overrun

BMU track

NT03
Tower 2

Indicative zone for PVs

Lift overrun

Lift overrun

BMU

Generator housing

Indicative zone for PVs

Ventilation extract for commercial unit below

Ventilation extract for commercial unit below

NT03
Tail 3 (2C.2)

Indicative zone for PVs

Indicative zone for PVs

Lift overrun

NT03 Midrise 3 (2C.3)

NTO2 Tower 1

NTO3 Tower 3

Key:

- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
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- Parking
- Waste

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Drawing
Proposed Level 28-29 Floor Plan

Scale @ A1	Date
1 : 200	March 2023
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Job Number	Status	Purpose of Issue
210263	S2	Issued for Information

Drawing No. RDB-HBA-2X-28-DR-AR-080128
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P04	Issued for Planning	18.04.23

Dantzic Street

NT02
Club House (2B.2)
Indicative zone for PVs and rooftop plant
Lift overrun

BMU track
NT03
Tower 2
Indicative zone for PVs
Lift overrun
Lift overrun
BMU
Generator housing
Indicative zone for PVs

Ventilation extract for commercial unit below

Travis Square

NT03
Tail 3 (2C.2)

Ventilation extract for commercial unit below

Dulwich Street

NT02 Tower 1

Indicative zone for PVs
Indicative zone for PVs
Lift overrun
NT03 Midrise 3 (2C.3)

BMU track
NT03
Tower 3 (2C.2)
Lift overrun
BMU
Indicative zone for PVs

Dulwich Street

Key:
- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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Drawing
Proposed Level 30 Floor Plan

Scale @ A1	Date
1 : 200	March 2023

Drawn By	Checked By
HECW	JT

Job Number	Status	Purpose of Issue
210263	S2	Issued for Information

Drawing No.	Rev
RDB-HBA-2X-30-DR-AR-080130	P04

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Rev	Description	Date
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P03	Issued for Planning	12.04.23
P04	Issued for Planning	18.04.23

Dantzic Street

NT02
Club House (2B.2)
Indicative zone for PVs and rooftop plant
Lift overrun

NT02 Tower 1
38AP-A 96 m²
28AP-S 72 m²
18ZP-A 52 m²
BMU

Dulwich Street

BMU track
NT03
Tower 2
Indicative zone for PVs
Lift overrun
Lift overrun
BMU
Generator housing
Indicative zone for PVs

Ventilation extract for commercial unit below

Ventilation extract for commercial unit below

NT03 Midrise 3 (2C.3)
Indicative zone for PVs
Indicative zone for PVs
Lift overrun

Travis Square

NT03
Tail 3 (2C.2)

BMU track
NT03
Tower 3 (2C.2)
Lift overrun
BMU
Indicative zone for PVs

Dulwich Street

Key:
- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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Drawing
Proposed Level 31-32 Floor Plan

Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
HECW	JT

Job Number	Status	Purpose of Issue
210263	S2	Issued for Information

Drawing No. RDB-HBA-2X-31-DR-AR-080131
Rev P04



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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for landscape co-ordination	29.03.23
P03	Issued for Planning	31.03.23
P04	Issued for Planning	12.04.23
P05	Issued for Planning	18.04.23

Key:

- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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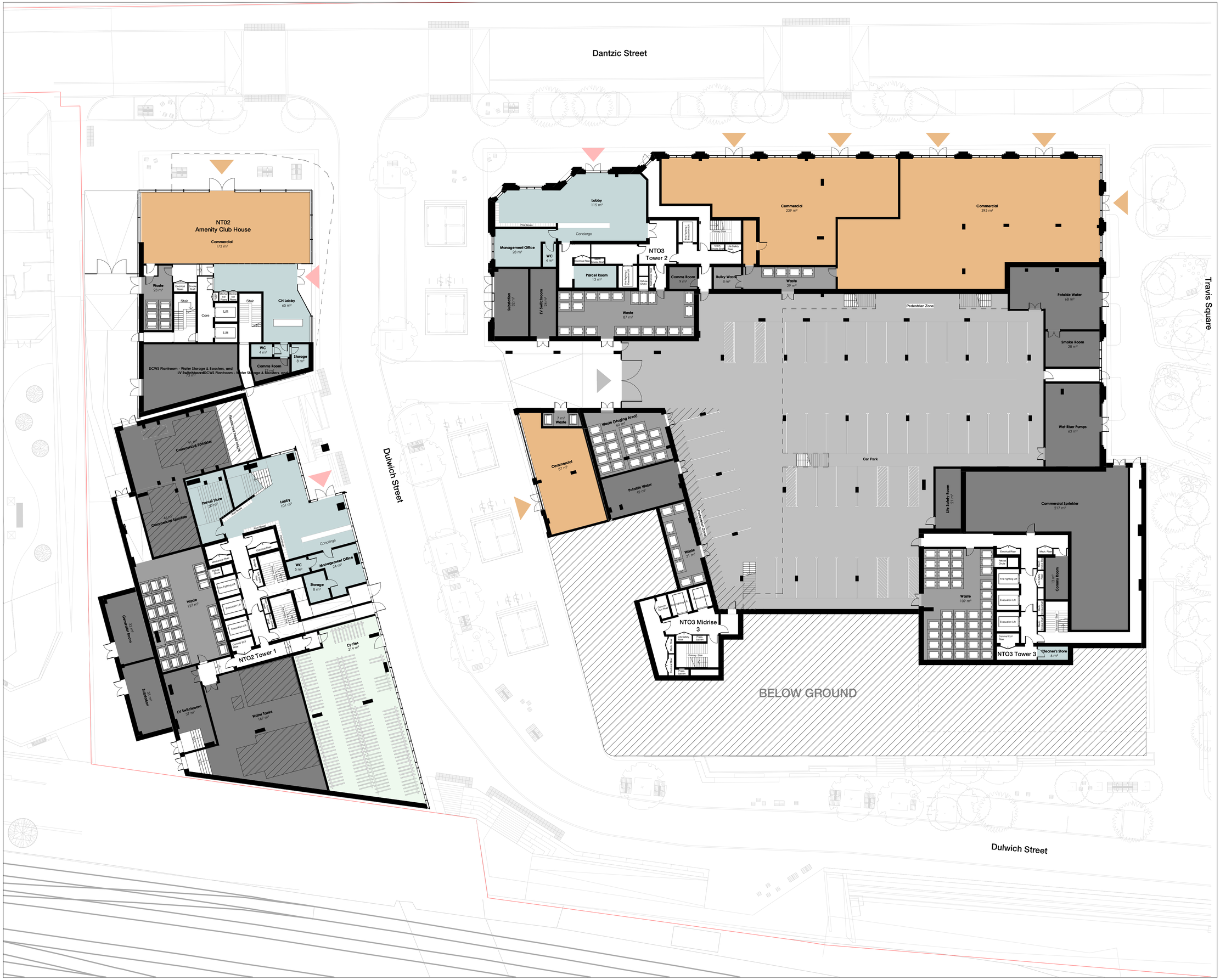
Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

Drawing
Proposed Intermediate Floor Plan

Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
MV	JT

Job Number	Status	Purpose of Issue
210263	S2	Issued for Information

Drawing No. RDB-HBA-2X-IT-DR-AR-080099
Rev P05



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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for landscape co-ordination	29.03.23
P03	Issued for Planning	31.03.23
P04	Issed for co-ordination	11.04.23
P05	Issued for Planning	12.04.23
P06	Issued for Planning	18.04.23

Key:

- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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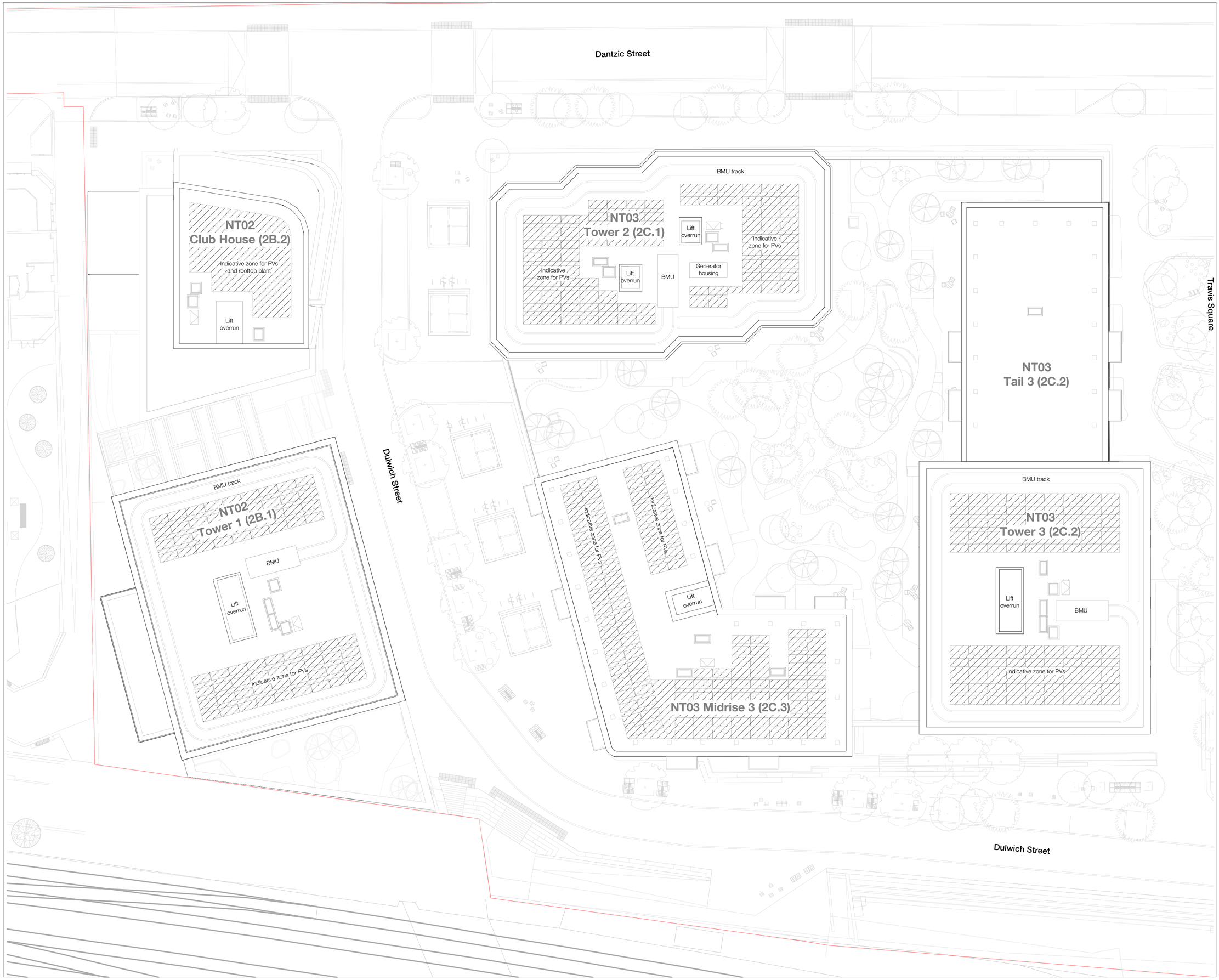
Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

Drawing
Proposed Lower Ground Floor Plan

Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
HECW	JT

Job Number	Status	Purpose of Issue
210263	S2	Issued for Information

Drawing No. RDB-HBA-2X-LG-DR-AR-080098
Rev P06



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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for Planning	31.03.23
P03	Issued for Planning	12.04.23
P04	Issued for Planning	18.04.23

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Project
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Drawing
Proposed Roof Plan

Scale @ A1 1 : 200	**Date** March 2023
Drawn By HECW	**Checked By** JT
Job Number 210263	**Status** S2
Purpose of Issue Issued for Information	
Drawing No. RDB-HBA-2X-RF-DR-AR-080133	**Rev** P04



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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for landscape co-ordination	29.03.23
P03	Issued for Planning	31.03.23
P04	Issued for Planning	12.04.23
P05	Issued for Planning	18.04.23

Key:

- Application Boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 3B-4P-2S
- 3B-4B-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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Project
Red Bank NT02/03
Dantzic Street
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Drawing
Proposed Upper Ground Floor Plan

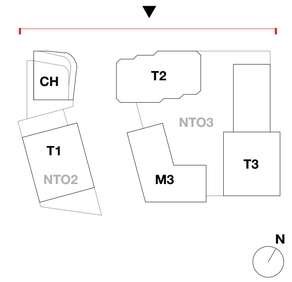
Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
HECW	JT

Job Number	Status	Purpose of Issue
210263	S2	Issued for Information

Drawing No. RDB-HBA-2X-UG-DR-AR-080100
Rev P05

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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for landscape co-ordination	30.03.23
P03	Issued for Planning	31.03.23
P04	Issued for Planning	12.04.23



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Drawing
Proposed GA Site Elevation - Dantzic Street

Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
DN	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

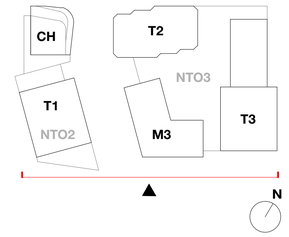
Drawing No. RDB-HBA-2X-ZZ-DR-AR-080200
Rev P04

Building Name Sign
The Cafe
Travis Square
NT03 - Tail 3
NT03 - Courtyard
NT03 - Tower 3
Dulwich Street
NT02 - Club House
Service Access



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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for landscape co-ordination	30.03.23
P03	Issued for Planning	31.03.23
P04	Issued for Planning	12.04.23



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Drawing
Proposed GA Site Elevation - Viaduct

Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
DN	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

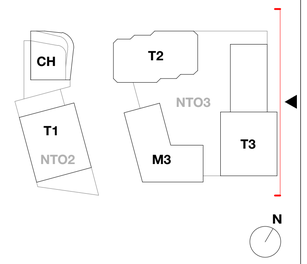
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Rev
P04



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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for landscape co-ordination	30.03.23
P03	Issued for Planning	31.03.23
P04	Issued for Planning	12.04.23



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Drawing
Proposed GA Site Elevation - Travis Square

Scale @ A1 1 : 200	**Date** March 2023
Drawn By DN	**Checked By** JT

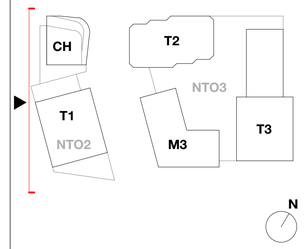
Job Number 210263	**Status** S2	**Purpose of Issue** For Approval

Drawing No. RDB-HBA-2X-ZZ-DR-AR-080202
Rev P04



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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for landscape co-ordination	30.03.23
P03	Issued for Planning	31.03.23
P04	Issued for Planning	12.04.23



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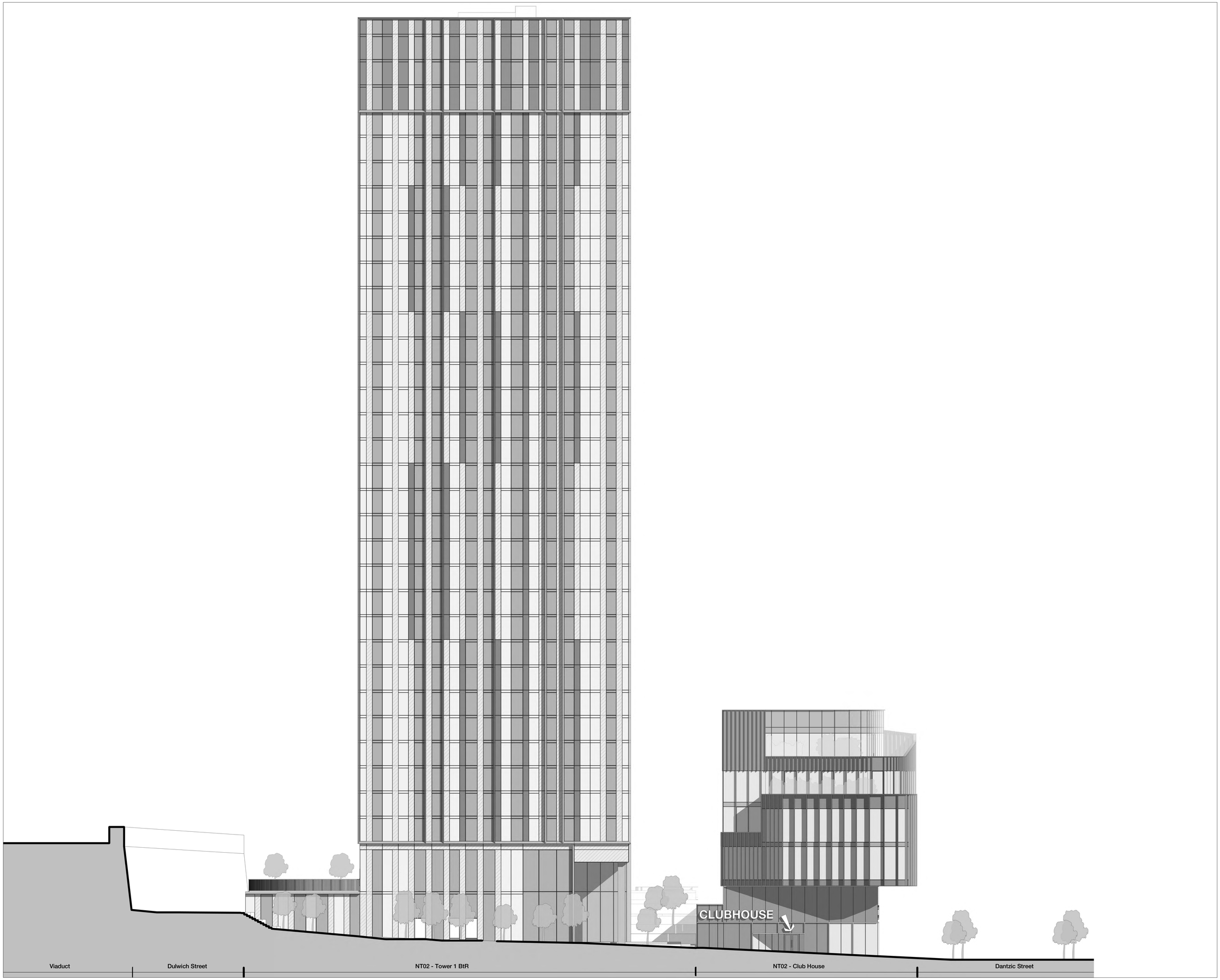
Drawing
Proposed GA Site Elevation - Victoria Riverside

Scale @ A1	Date
1 : 200	March 2023

Drawn By	Checked By
DN	JT

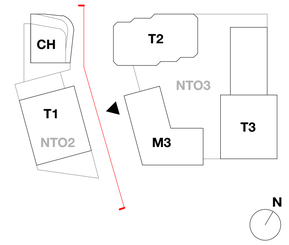
Job Number	Status	Purpose of Issue
210263	S2	For Approval

Drawing No. RDB-HBA-2X-ZZ-DR-AR-080203
Rev P04



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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for landscape co-ordination	30.03.23
P03	Issued for Planning	31.03.23
P04	Issued for Planning	12.04.23



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Drawing
Proposed GA Site Elevation - Dulwich Street - Facing Tower 1

Scale @ A1	Date
1 : 200	March 2023

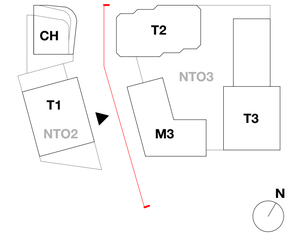
Drawn By	Checked By
DN	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

Drawing No.	Rev
RDB-HBA-2X-ZZ-DR-AR-080204	P04

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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for landscape co-ordination	30.03.23
P03	Issued for Planning	31.03.23
P04	Issued for Planning	12.04.23



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Dantzic Street
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Drawing
Proposed GA Site Elevation - Dulwich Street - Facing Tower 2

Scale @ A1	Date
1 : 200	March 2023

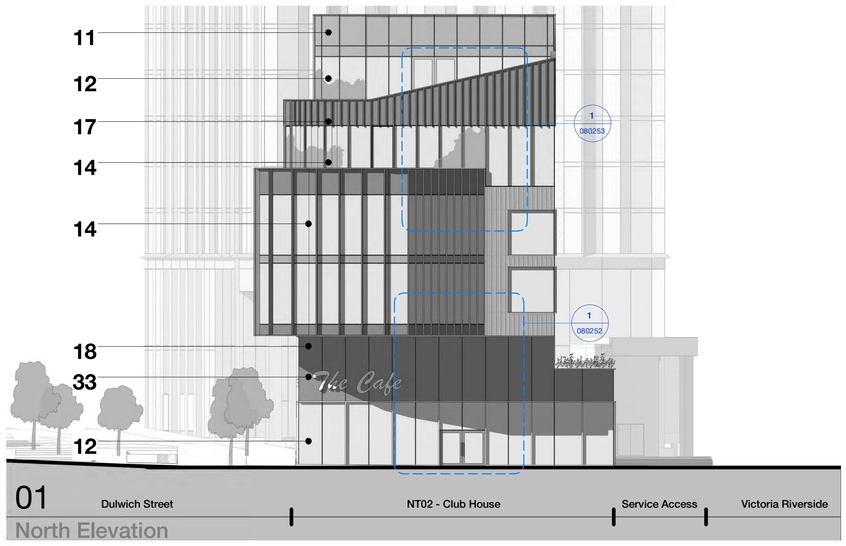
Drawn By	Checked By
DN	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

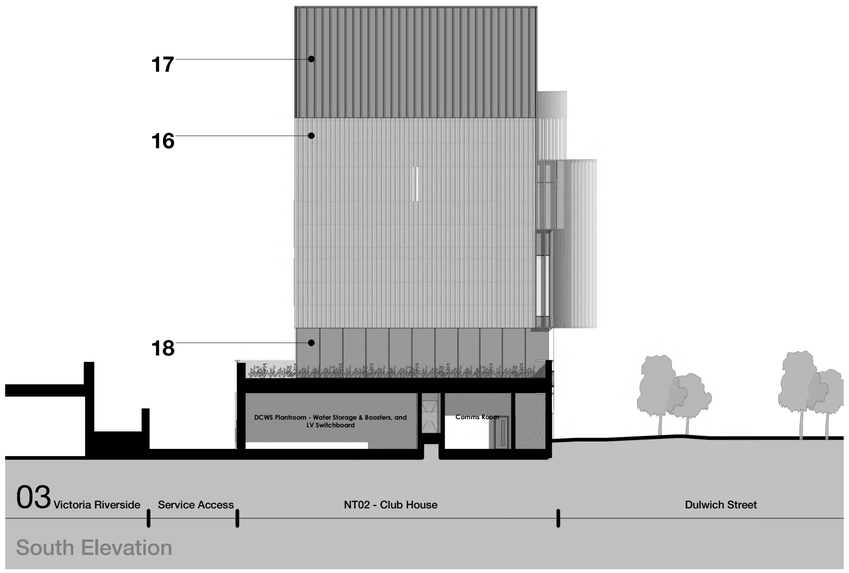
Drawing No.	Rev
RDB-HBA-2X-ZZ-DR-AR-080205	P04

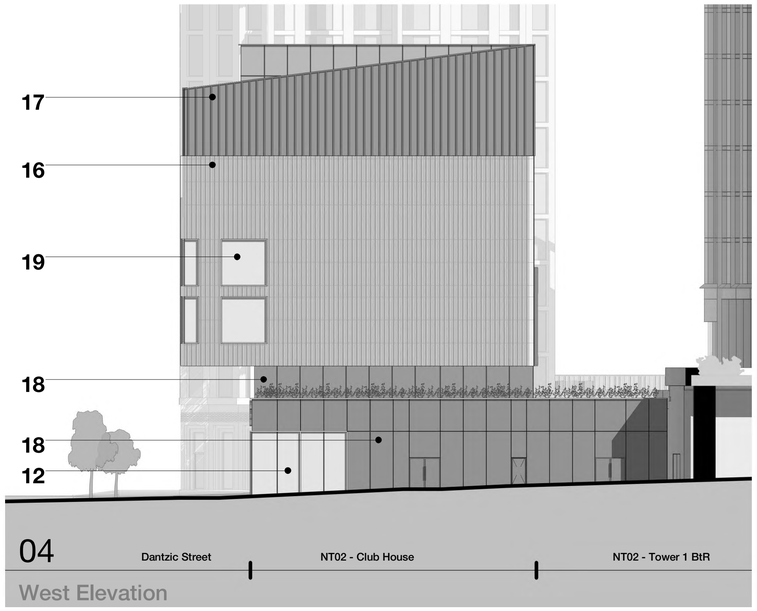
BUILDING NAME SIGN

Dantzic Street | NT03 - Tower 2 | NT03 - Courtyard | NT03 - Midrise 3 | Dulwich Street | Viaduct



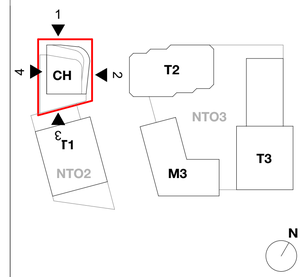






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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for information	22.03.23
P03	Issued for Planning	31.03.23
P04	Issued for Planning	12.04.23



1
XXX
Bay Study Reference

Materials Key:

1. Anodised aluminium panel, pale bronze colour
2. Anodised aluminium panel, natural anodised colour
3. Anodised aluminium panel with perforations. Openable panel behind for purge ventilation. (Colour and specification to be agreed upon discharging conditions)
4. Anodic-coated aluminium panel with perforations. Openable panel behind for purge ventilation. (Colour and specification to be agreed upon discharging conditions)
5. Anodised aluminium panel with perforations. Non-openable backing to match appearance of vent panels. (Colour and specification to be agreed upon discharging conditions)
6. Anodic-coated aluminium panel with perforations. Non-openable backing to match appearance of vent panels. (Colour and specification to be agreed upon discharging conditions)
7. Anodic-coated aluminium paneled service door with perforations. (Colour and specification to be agreed upon discharging conditions)
8. Anodised aluminium feature fin (Colour and specification to be agreed upon discharging conditions)
9. Anodised aluminium feature soffit with recessed down-lighting (Colour and specification to be agreed upon discharging conditions)
10. Clear fixed vision glass
11. Glass infill spandrel with opaque back box
12. Clear curtain walling vision glass with structural sealed joint
13. Clear curtain walling vision glass with expressed fin caps to mullions
14. Clear curtain walling vision glass with green terracotta 'baguette' vertical fins fixed to mullions
15. Spandrel of green terracotta between vertical terracotta fins
16. Fine-textured green terracotta cladding
17. Broad-profiled green terracotta cladding
18. Perforated aluminium sinusoidal veil, with windows concealed behind
19. Aluminium framed window
20. Aluminium framed glazed door
21. Brickwork with colour-matched mortar, stretcher bond
22. Brick detail of Flemish bond with projecting headers
23. Brick vent detail of Flemish bond with removed headers to conceal commercial vent outlets
24. Solider course brickwork with colour-matched mortar
25. Vertical corduroy brick detail
26. Pigmented pre-cast concrete sill, colour to match brickwork
27. Pigmented pre-cast concrete coping, colour to match brickwork
28. Pigmented pre-cast concrete surround to recessed commercial glazing
29. Slender steel flat bar balcony railings
30. Solid metal screen to one side of balcony
31. Solid metal fascia and soffit to balcony
32. Illuminated signage set behind glazing
33. Large format supergraphic signage, façade-fixed and illuminated
34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

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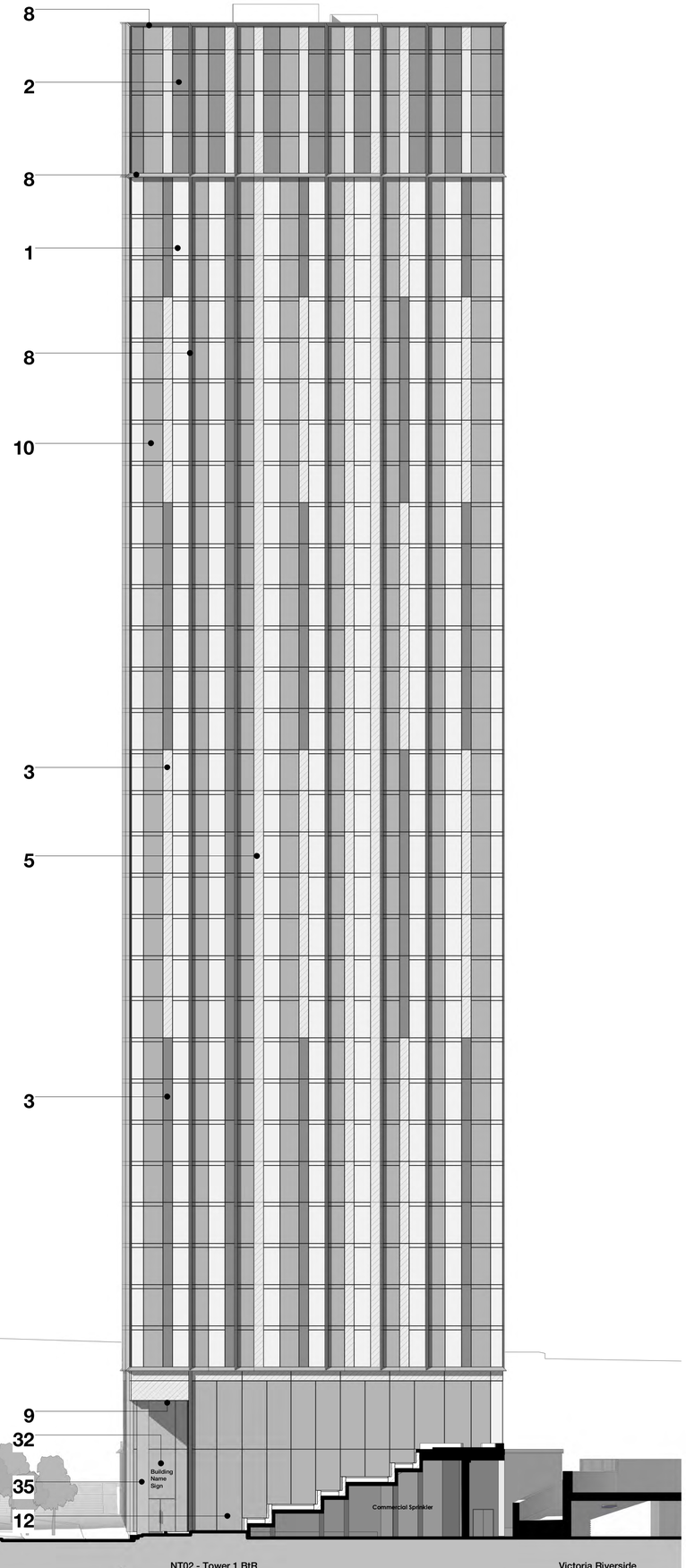
Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

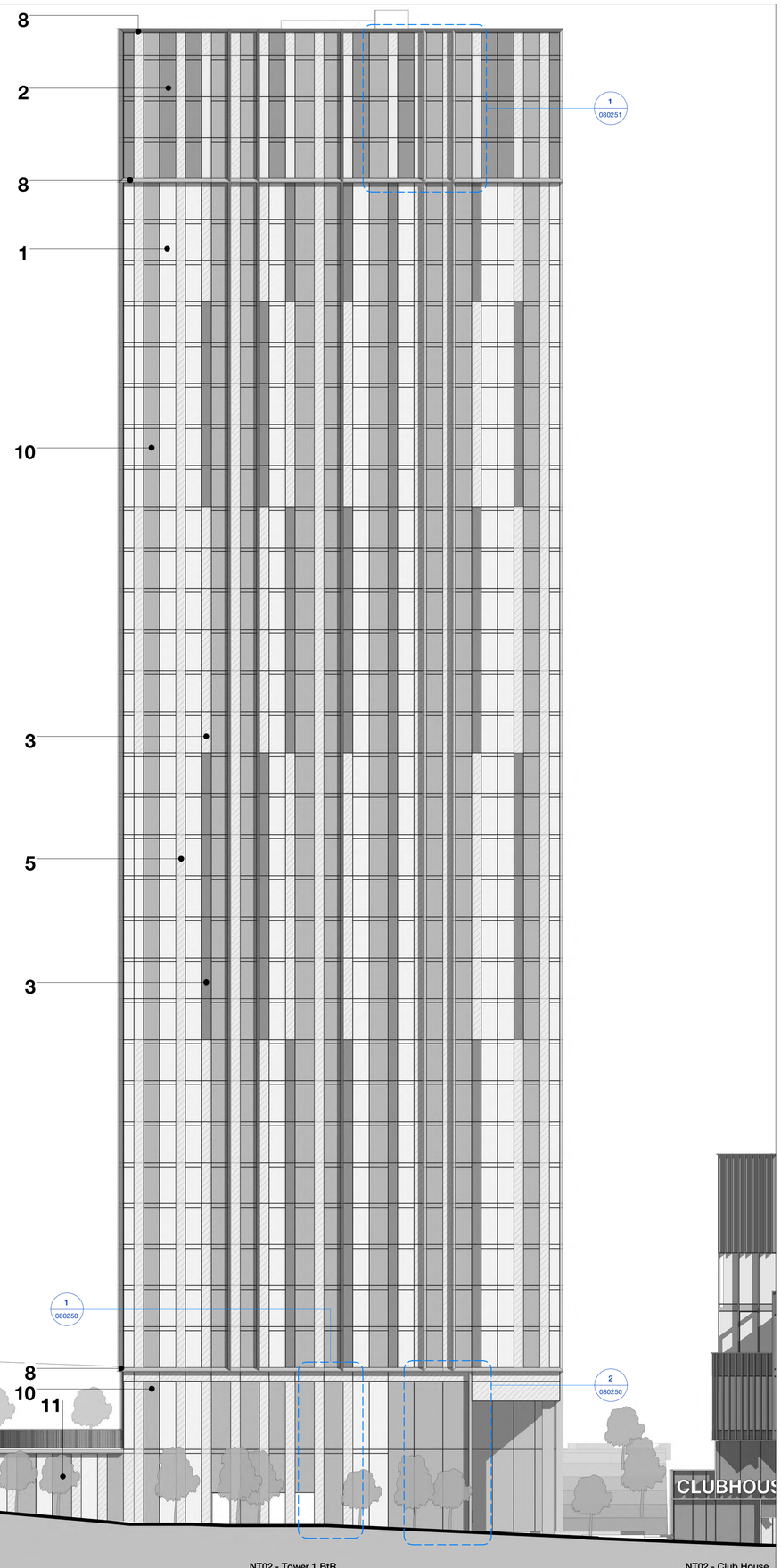
Drawing
Proposed GA Elevation - Club House Elevations

Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
DN	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

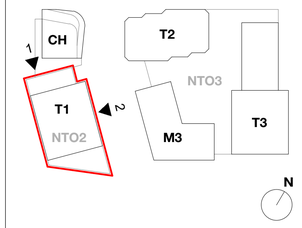
Drawing No. RDB-HBA-2X-ZZ-DR-AR-080210
Rev P04





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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for Planning	31.03.23



Materials Key:

1. Anodised aluminium panel, pale bronze colour
2. Anodised aluminium panel, natural anodised colour
3. Anodised aluminium panel with perforations. Openable panel behind for purge ventilation. (Colour and specification to be agreed upon discharging conditions)
4. Anodic-coated aluminium panel with perforations. Openable panel behind for purge ventilation. (Colour and specification to be agreed upon discharging conditions)
5. Anodised aluminium panel with perforations. Non-openable backing to match appearance of vent panels. (Colour and specification to be agreed upon discharging conditions)
6. Anodic-coated aluminium panel with perforations. Non-openable backing to match appearance oc vent panels. (Colour and specification to be agreed upon discharging conditions)
7. Anodic-coated aluminium paneled service door with perforations. (Colour and specification to be agreed upon discharging conditions)
8. Anodised aluminium feature fin (Colour and specification to be agreed upon discharging conditions)
9. Anodised aluminium feature soffit with recessed down-lighting (Colour and specification to be agreed upon discharging conditions)
10. Clear fixed vision glass
11. Glass infill spandrel with opaque back box
12. Clear curtain walling vision glass with structural sealed joint
13. Clear curtain walling vision glass with expressed fin caps to mullions
14. Clear curtain walling vision glass with green terracotta 'baguette' vertical fins fixed to mullions
15. Spandrel of green terracotta between vertical terracotta fins
16. Fine-textured green terracotta cladding
17. Broad-profiled green terracotta cladding
18. Perforated aluminium sinusoidal veil, with windows concealed behind
19. Aluminium framed window
20. Aluminium framed glazed door
21. Brickwork with colour-matched mortar, stretcher bond
22. Brick detail of Flemish bond with projecting headers
23. Brick vent detail of Flemish bond with removed headers to conceal commercial vent outlets
24. Soldier course brickwork with colour-matched mortar
25. Vertical cordurey brick detail
26. Pigmented pre-cast concrete sill, colour to match brickwork
27. Pigmented pre-cast concrete coping, colour to match brickwork
28. Pigmented pre-cast concrete surround to recessed commercial glazing
29. Slender steel flat bar balcony railings
30. Solid metal screen to one side of balcony
31. Solid metal fascia and soffit to balcony
32. Illuminated signage set behind glazing
33. Large format supergraphic signage, façade-fixed and illuminated
34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

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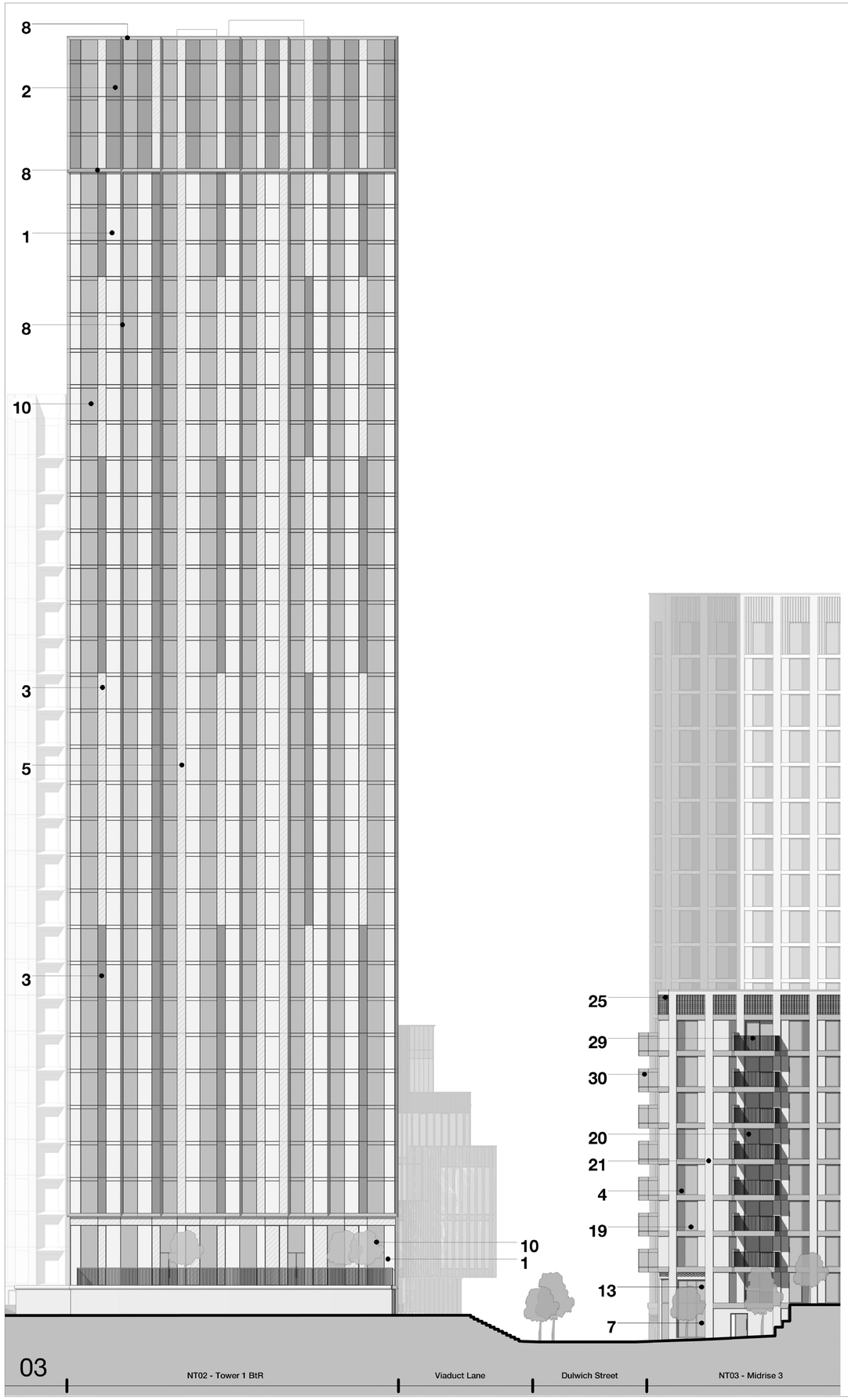
Project
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Manchester
M4 4HF

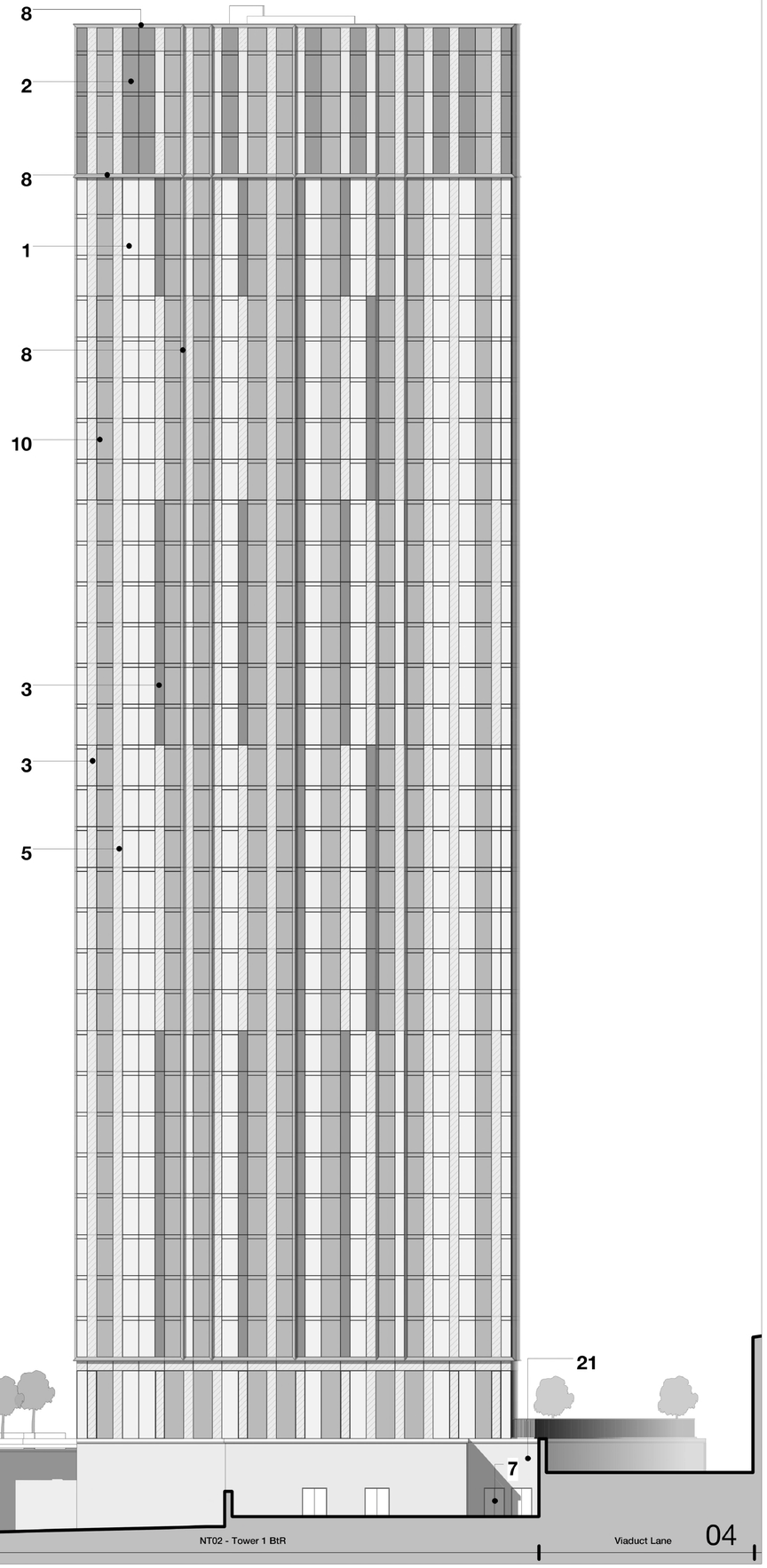
Drawing
Proposed GA Elevation T1 - North and East

Scale @ A1 1 : 200		**Date** March 2023
Drawn By DN		**Checked By** JT
Job Number 210263	**Status** S2	**Purpose of Issue** For Approval

Drawing No.
RDB-HBA-2X-ZZ-DR-AR-080211

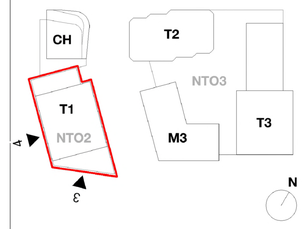
Rev
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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for Planning	31.03.23



Materials Key:

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10. Clear fixed vision glass
11. Glass infill spandrel with opaque back box
12. Clear curtain walling vision glass with structural sealed joint
13. Clear curtain walling vision glass with expressed fin caps to mullions
14. Clear curtain walling vision glass with green terracotta 'baguette' vertical fins fixed to mullions
15. Spandrel of green terracotta between vertical terracotta fins
16. Fine-textured green terracotta cladding
17. Broad-profiled green terracotta cladding
18. Perforated aluminium sinusoidal veil, with windows concealed behind
19. Aluminium framed window
20. Aluminium framed glazed door
21. Brickwork with colour-matched mortar, stretcher bond
22. Brick detail of Flemish bond with projecting headers
23. Brick vent detail of Flemish bond with removed headers to conceal commercial vent outlets
24. Soldier course brickwork with colour-matched mortar
25. Vertical corduroy brick detail
26. Pigmented pre-cast concrete sill, colour to match brickwork
27. Pigmented pre-cast concrete coping, colour to match brickwork
28. Pigmented pre-cast concrete surround to recessed commercial glazing
29. Slender steel flat bar balcony railings
30. Solid metal screen to one side of balcony
31. Solid metal fascia and soffit to balcony
32. Illuminated signage set behind glazing
33. Large format supergraphic signage, façade-fixed and illuminated
34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

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Drawing
Proposed GA Elevation T1 - West and South

Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
DN	JT

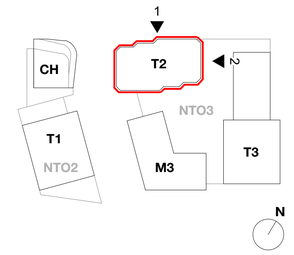
Job Number	Status	Purpose of Issue
210263	S2	For Approval

Drawing No.	Rev
RDB-HBA-2X-ZZ-DR-AR-080212	P02



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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for Planning	31.03.23



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34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

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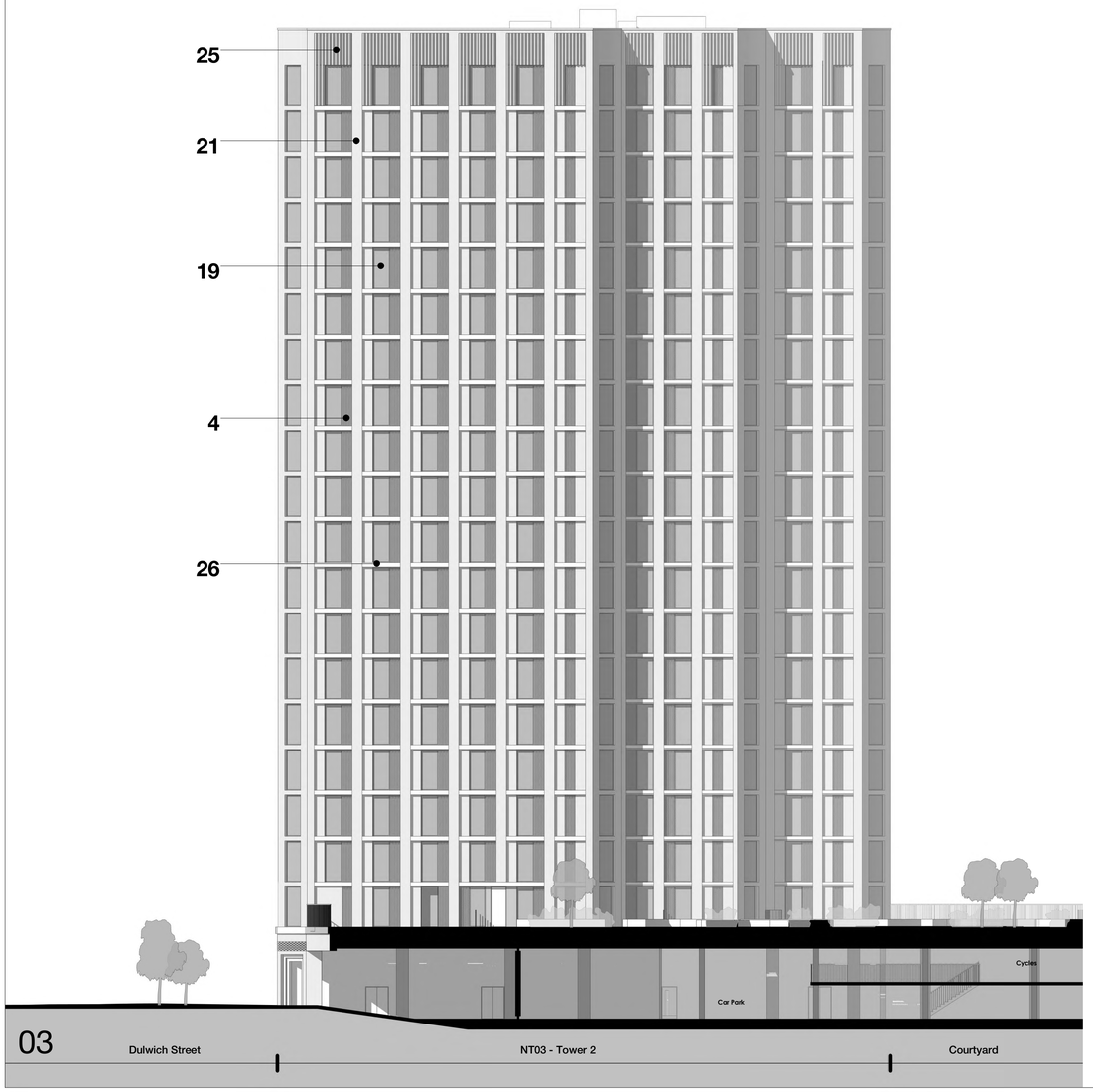
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Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

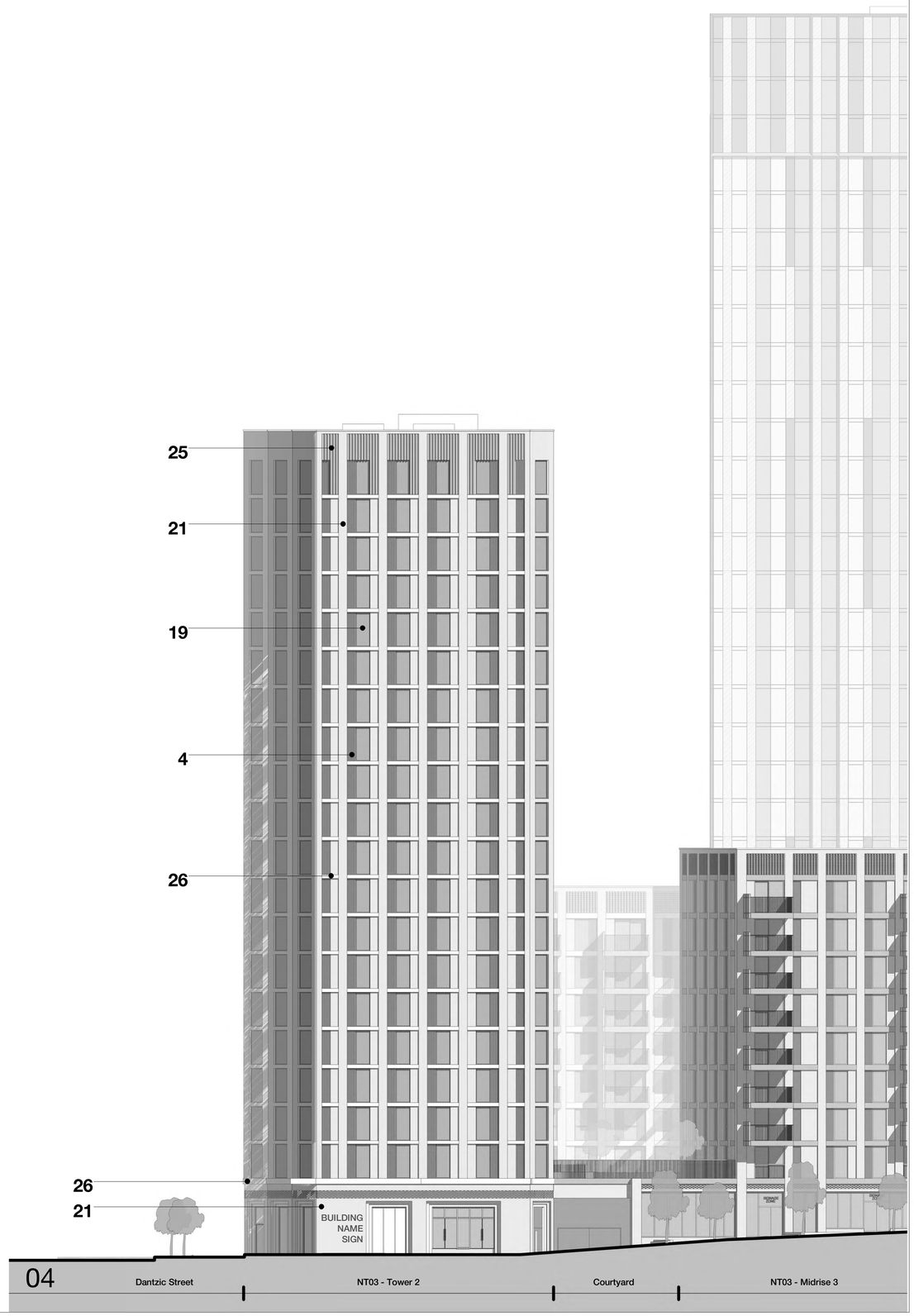
Drawing
Proposed GA Elevation T2 - North and East

Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
DN	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

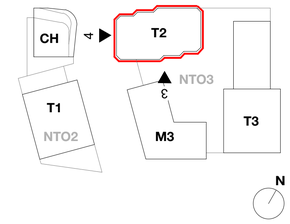
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Rev	Description	Date
P01	Issued for Planning	17.03.23
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26. Pigmented pre-cast concrete sill, colour to match brickwork
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28. Pigmented pre-cast concrete surround to recessed commercial glazing
29. Slender steel flat bar balcony railings
30. Solid metal screen to one side of balcony
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33. Large format supergraphic signage, façade-fixed and illuminated
34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

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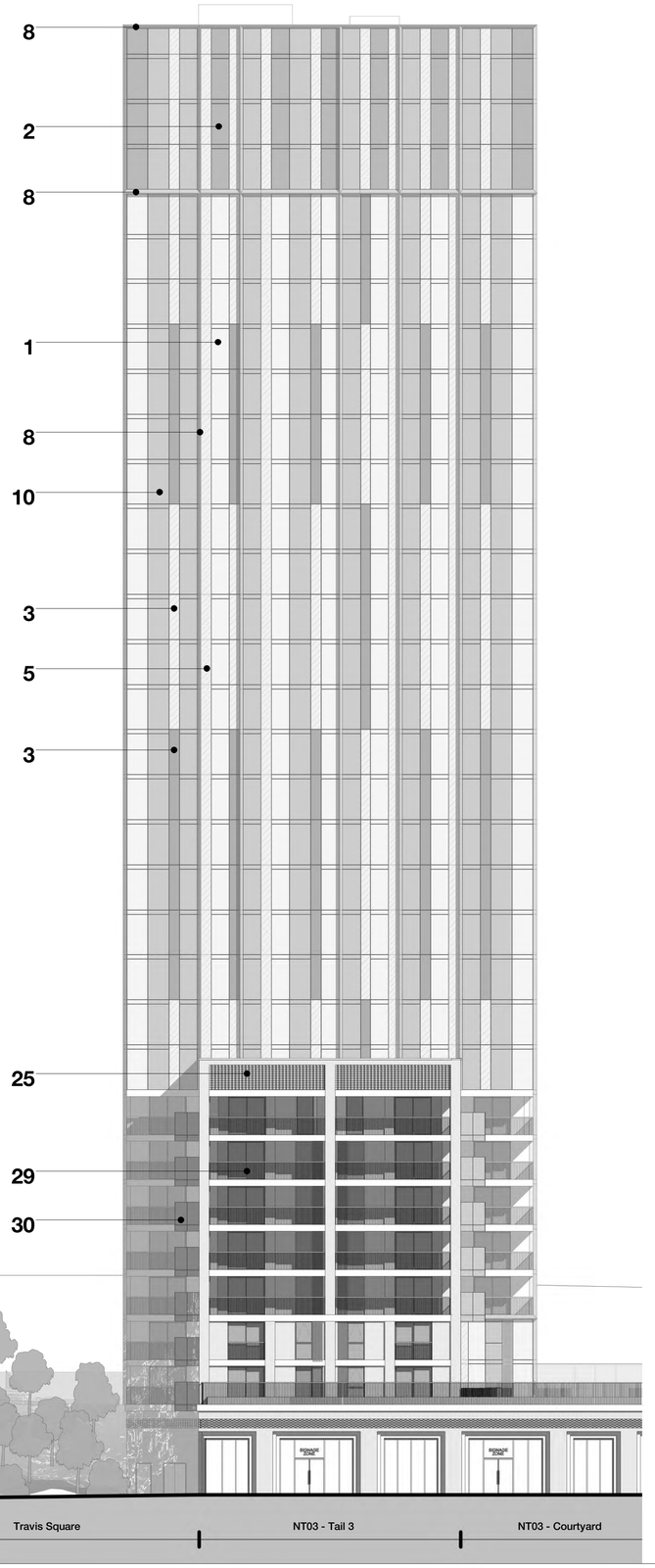
Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

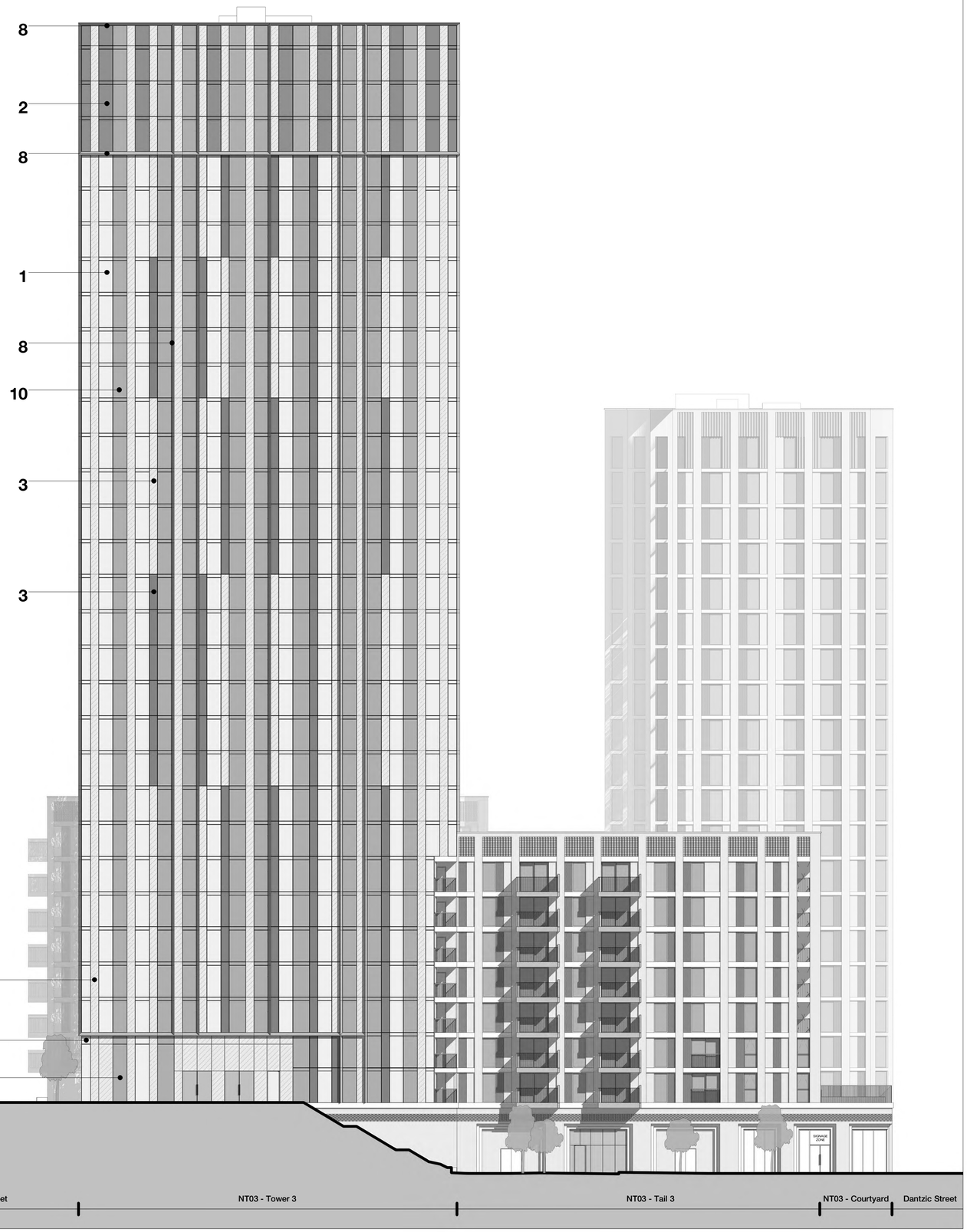
Drawing
Proposed GA Elevation T2 - West and South

Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
DN	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

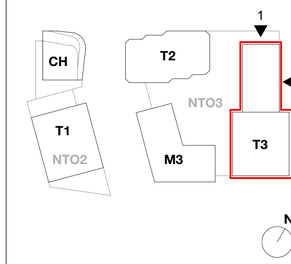
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Rev	Description	Date
P01	Issued for Planning	17.03.
P02	Issued for Planning	31.03.
P03	Issued for Planning	12.04.



1 / XXX Bay Study Reference

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34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

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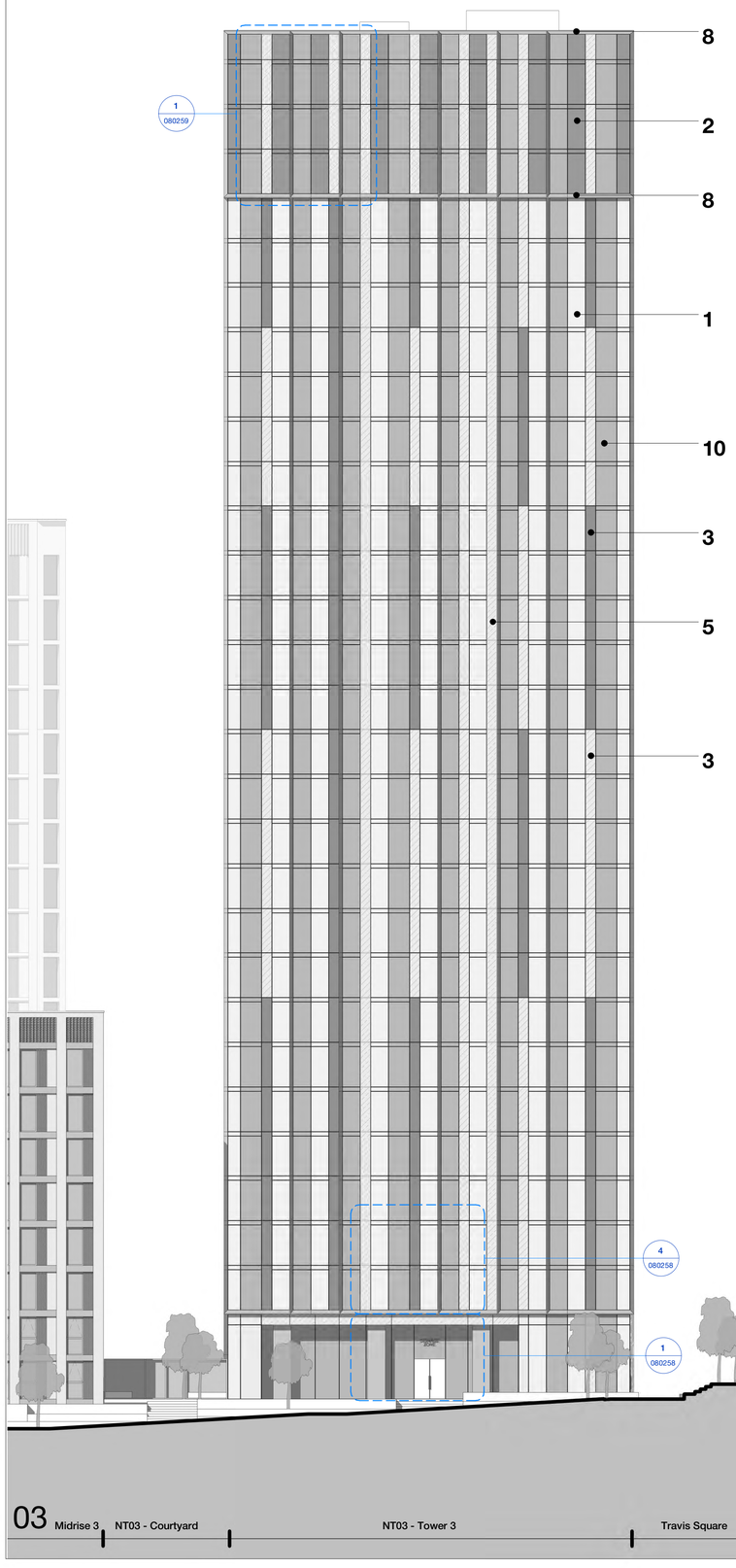
Drawing
Proposed GA Elevation T3 - Nort
and East

Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
DN	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

Drawing No.
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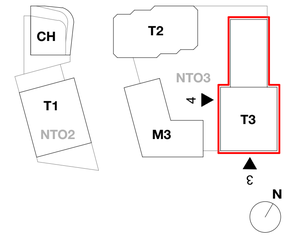
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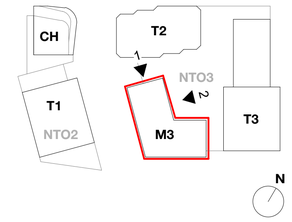
Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

Drawing
Proposed GA Elevation T3 - South and West

Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
DN	JT
Job Number	**Status** / **Purpose of Issue**
210263	S2 / For Approval
Drawing No.	**Rev**
RDB-HBA-2X-ZZ-DR-AR-080216	P03

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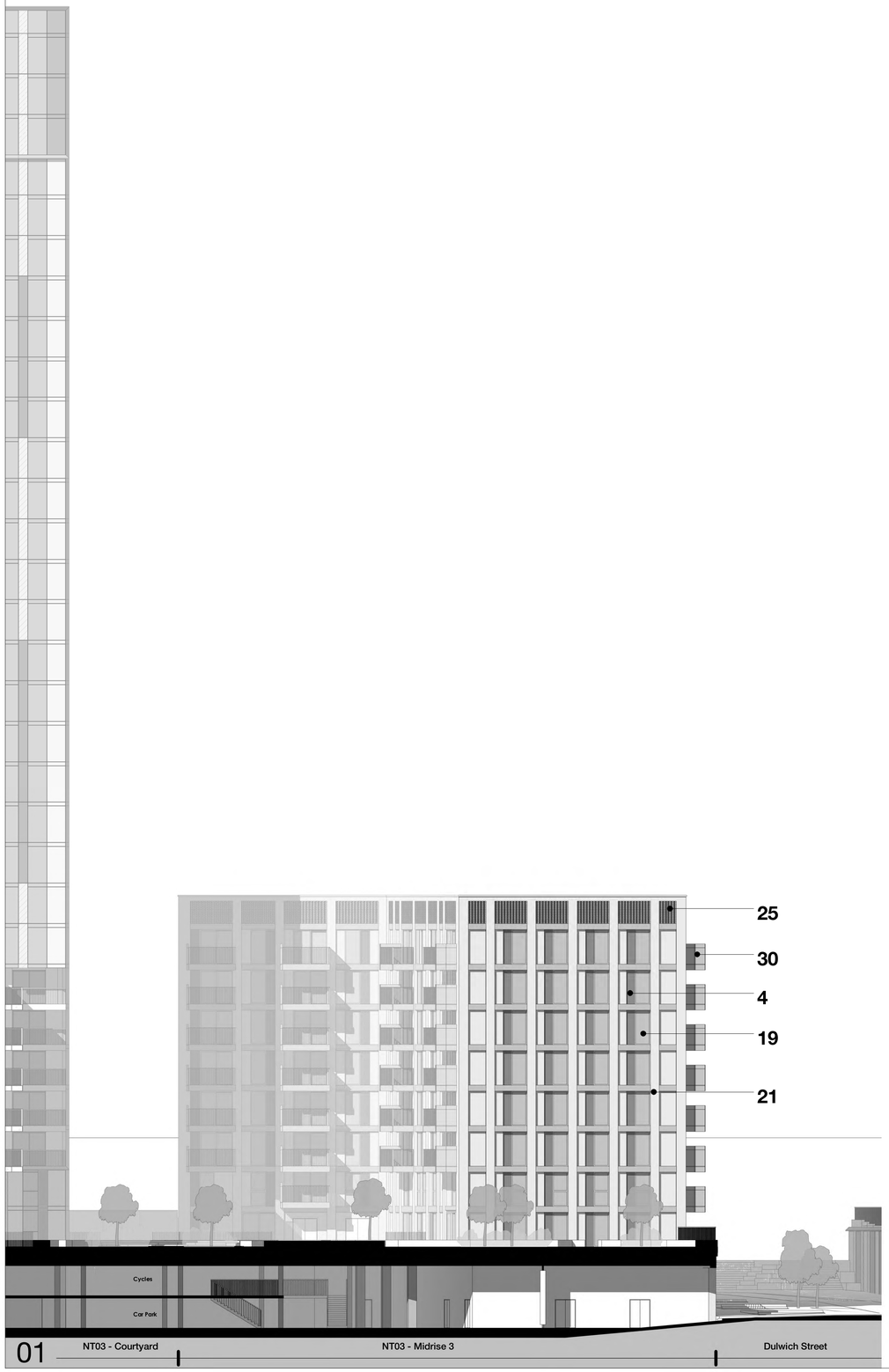
Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for Planning	31.03.23

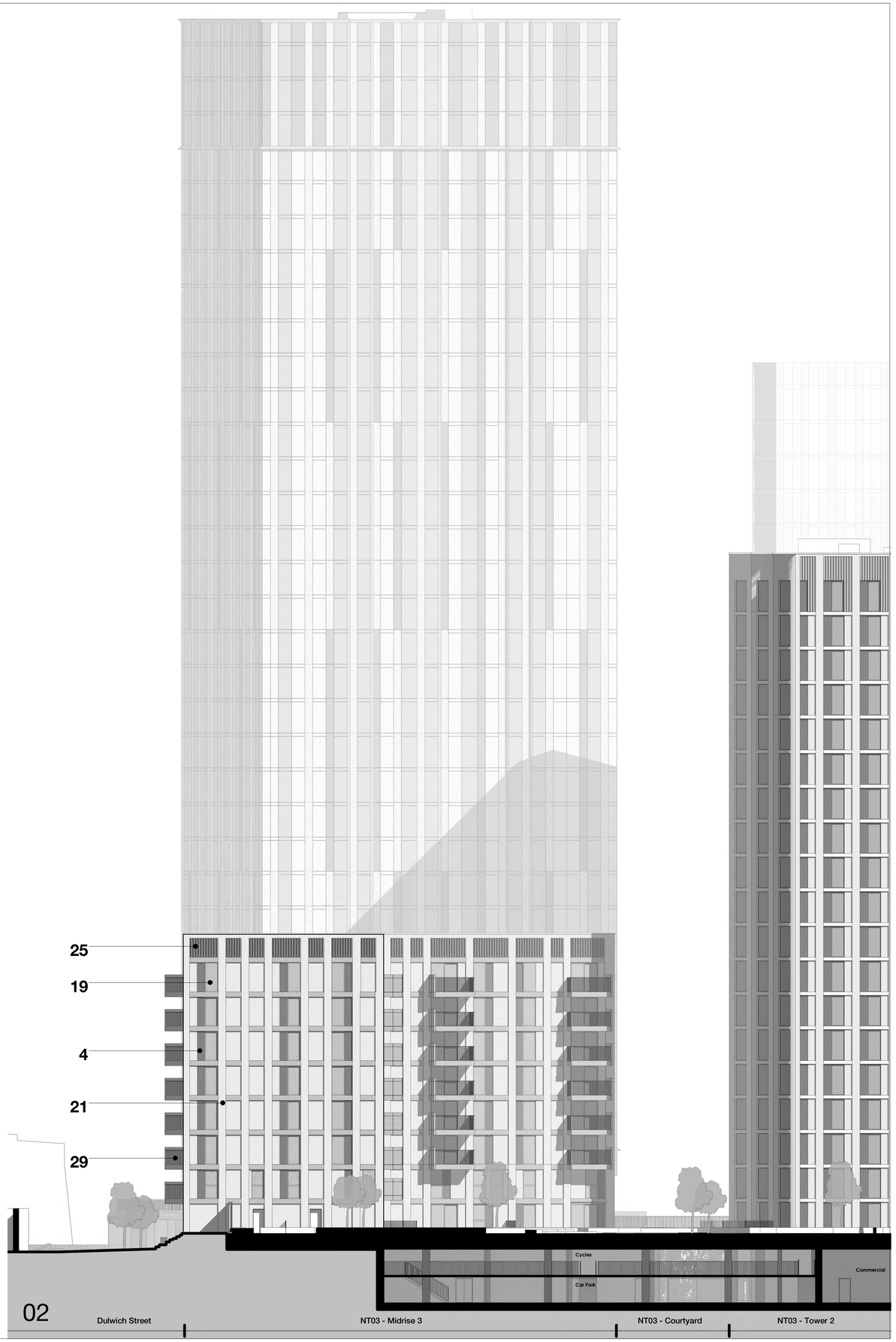


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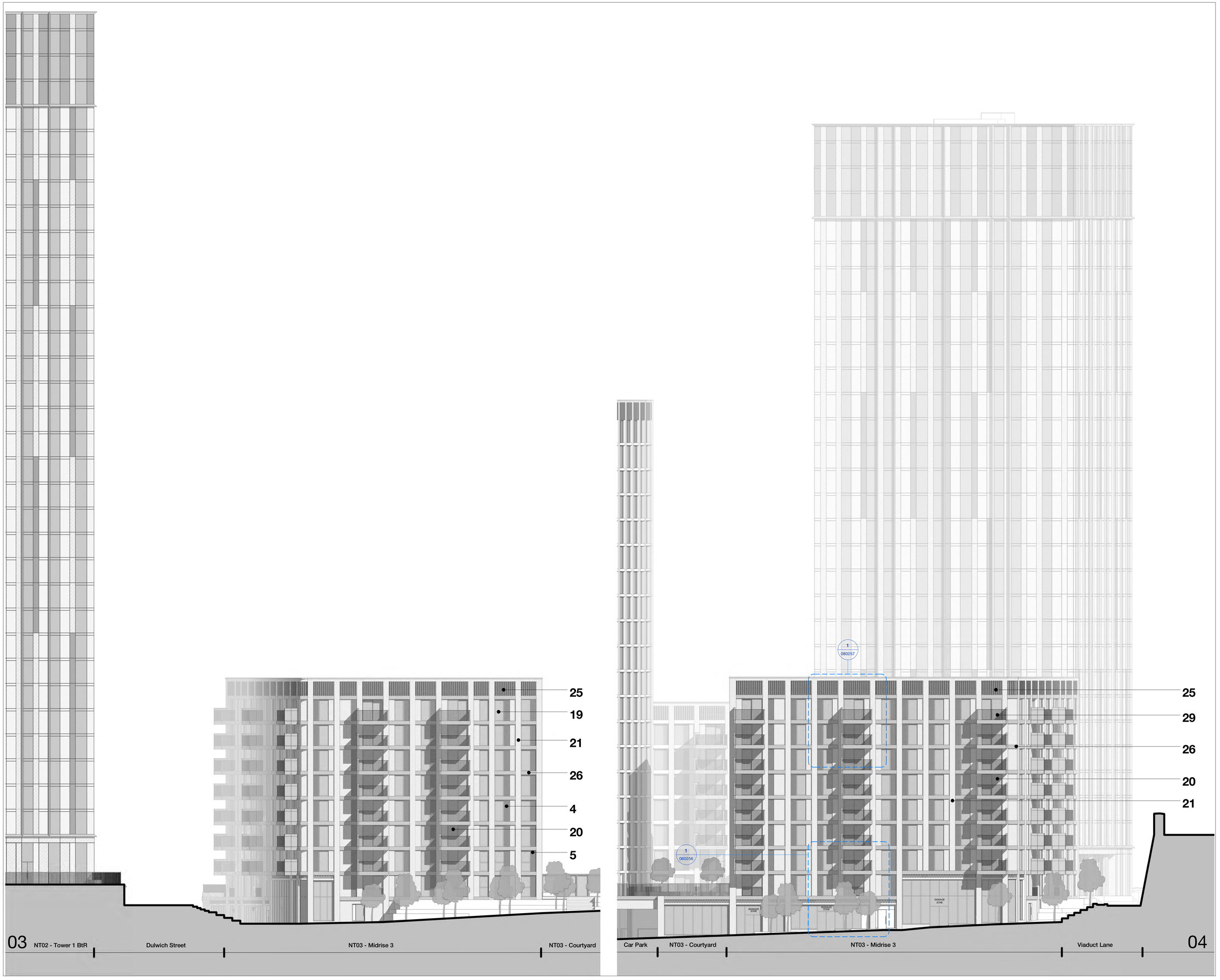
Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

Drawing
Proposed GA Elevation M3 - North and East

Scale @ A1	Date
1 : 200	March 2023
Drawn By	**Checked By**
DN	JT

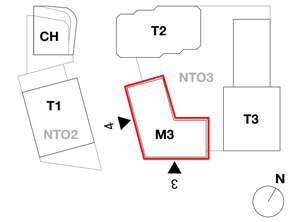
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210263	S2	For Approval

Drawing No. RDB-HBA-2X-ZZ-DR-AR-080217
Rev P02



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Rev	Description	Date
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20. Aluminium framed glazed door
21. Brickwork with colour-matched mortar, stretcher bond
22. Brick detail of Flemish bond with projecting headers
23. Brick vent detail of Flemish bond with removed headers to conceal commercial vent outlets
24. Soldier course brickwork with colour-matched mortar
25. Vertical corduroy brick detail
26. Pigmented pre-cast concrete sill, colour to match brickwork
27. Pigmented pre-cast concrete coping, colour to match brickwork
28. Pigmented pre-cast concrete surround to recessed commercial glazing
29. Slender steel flat bar balcony railings
30. Solid metal screen to one side of balcony
31. Solid metal fascia and soffit to balcony
32. Illuminated signage set behind glazing
33. Large format supergraphic signage, façade-fixed and illuminated
34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

2b-2d Ellen Street
Manchester M4 5EH
mail@hawkinsbrown.com
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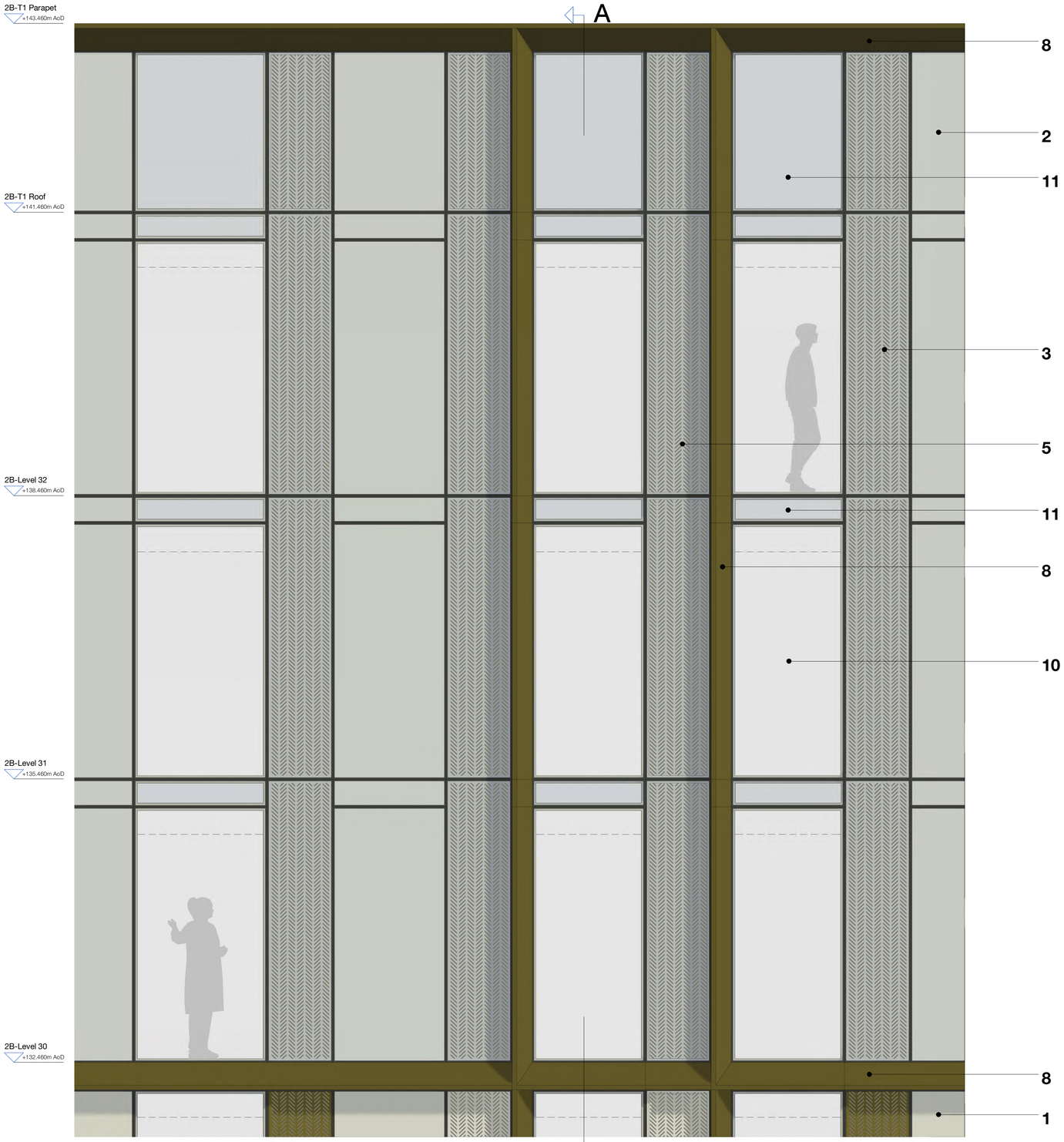
Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

Drawing
Proposed GA Elevation M3 - South and West

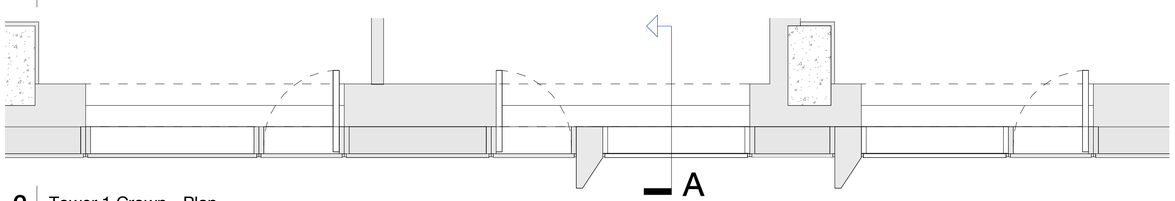
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1 : 200	March 2023
Drawn By	**Checked By**
DN	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

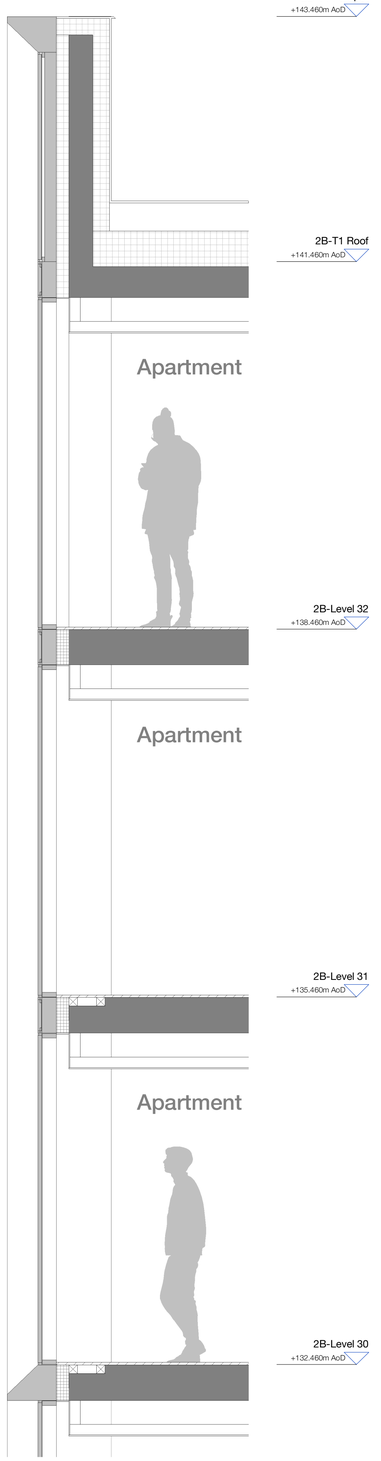
Drawing No. RDB-HBA-2X-ZZ-DR-AR-080218
Rev P02



1 | Tower 1 Crown - Elevation



2 | Tower 1 Crown - Plan



A | Section

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Rev	Description	Date
P01	Issued for Planning	24.03.23
P02	Issued for Planning	31.03.23
P03	Issued for Planning	12.04.23

Materials Key:

1. Anodised aluminium panel, pale bronze colour
2. Anodised aluminium panel, natural anodised colour
3. Anodised aluminium panel with perforations. Openable panel behind for purge ventilation. (Colour and specification to be agreed upon discharging conditions)
4. Anodic-coated aluminium panel with perforations. Openable panel behind for purge ventilation. (Colour and specification to be agreed upon discharging conditions)
5. Anodised aluminium panel with perforations. Non-openable backing to match appearance of vent panels. (Colour and specification to be agreed upon discharging conditions)
6. Anodic-coated aluminium panel with perforations. Non-openable backing to match appearance of vent panels. (Colour and specification to be agreed upon discharging conditions)
7. Anodic-coated aluminium paneled service door with perforations. (Colour and specification to be agreed upon discharging conditions)
8. Anodised aluminium feature fin (Colour and specification to be agreed upon discharging conditions)
9. Anodised aluminium feature soffit with recessed down-lighting (Colour and specification to be agreed upon discharging conditions)
10. Clear fixed vision glass
11. Glass infill spandrel with opaque back box
12. Clear curtain walling vision glass with structural sealed joint
13. Clear curtain walling vision glass with expressed fin caps to mullions
14. Clear curtain walling vision glass with green terracotta 'baguette' vertical fins fixed to mullions
15. Spandrel of green terracotta between vertical terracotta fins
16. Fine-textured green terracotta cladding
17. Broad-profiled green terracotta cladding
18. Perforated aluminium sinusoidal veil, with windows concealed behind
19. Aluminium framed window
20. Aluminium framed glazed door
21. Brickwork with colour-matched mortar, stretcher bond
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33. Large format supergraphic signage, façade-fixed and illuminated
34. Projecting slender box signage fixed to party wall brick pier
35. Exposed concrete feature column

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hawkinsbrown.com
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Brown

Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

Drawing
Proposed Bay Study - Tower 1 Crown

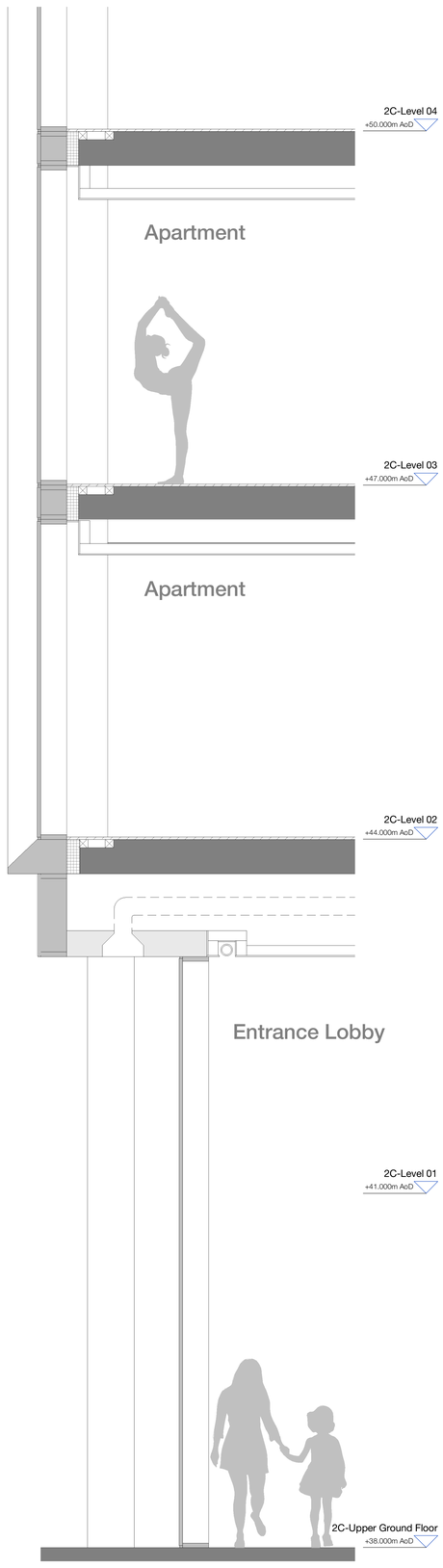
Scale @ A1 1 : 25		**Date** March 2023
Drawn By MV		**Checked By** JT
Job Number 210263	**Status** S2	**Purpose of Issue** For Approval

Drawing No.
RDB-HBA-2X-ZZ-DR-AR-080251

Rev
P03



1 | Tower 3 Base - Elevation



A | Section

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Rev	Description	Date
P01	Issued for Planning	24.03.23
P02	Issued for Planning	31.03.23

Materials Key:

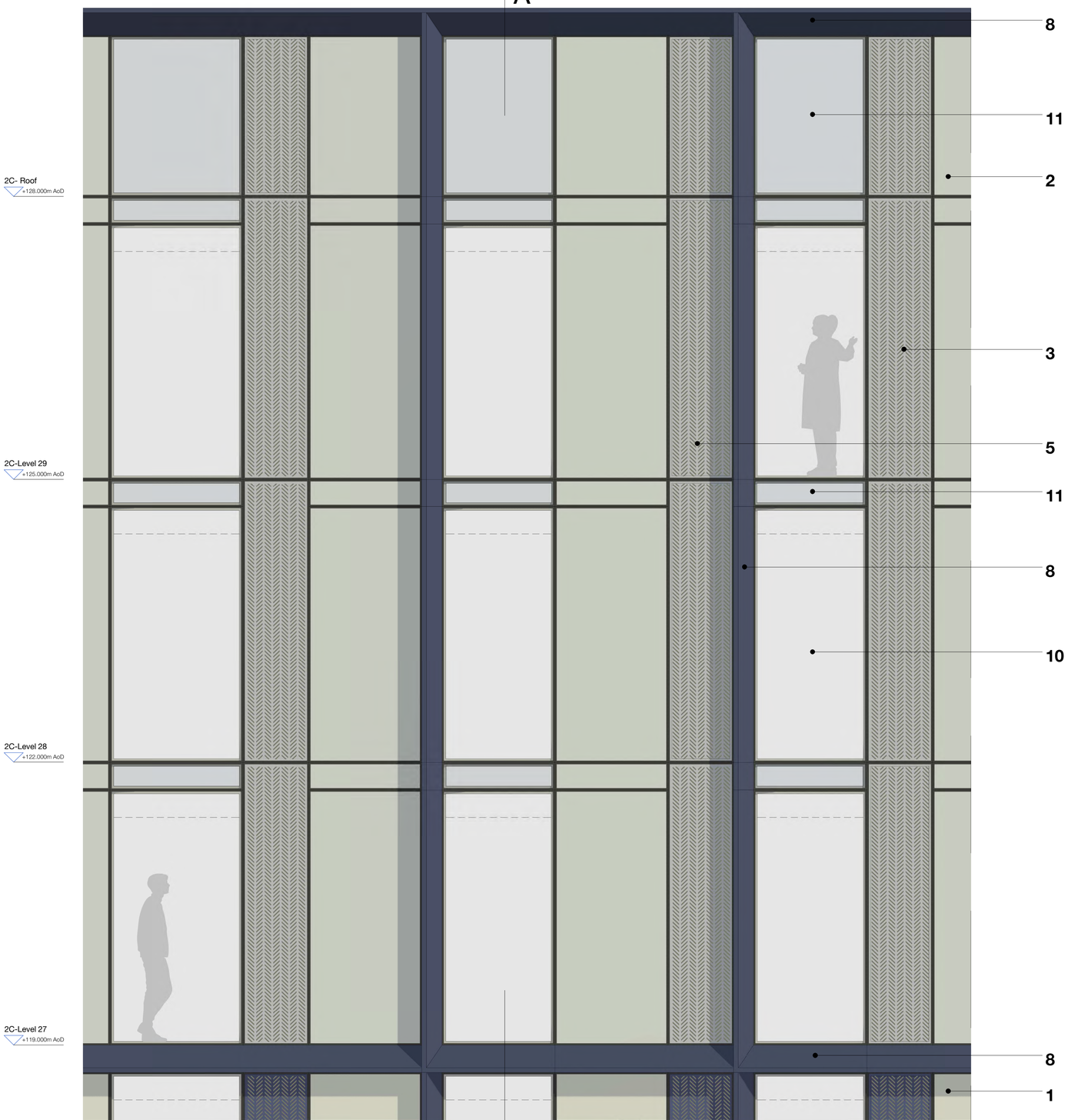
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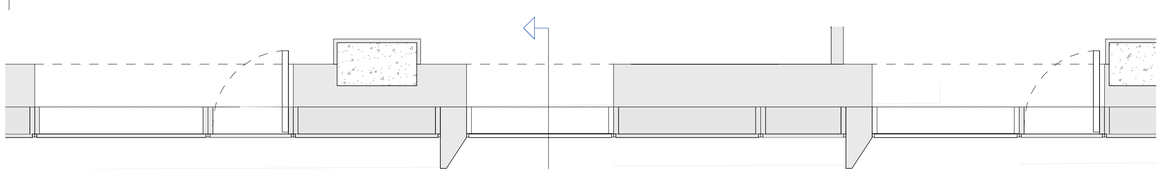
Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

Drawing
Bay Study - Tower 3 Base

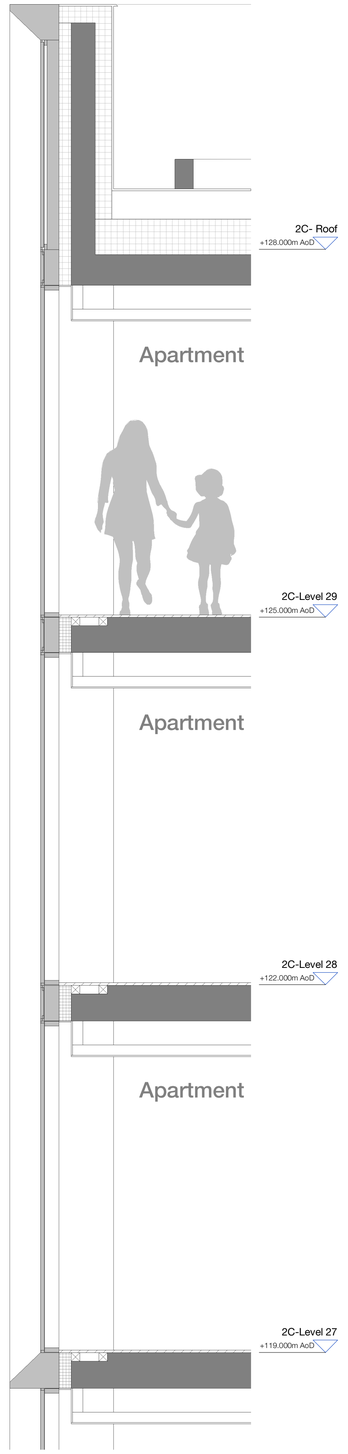
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Drawn By DN		**Checked By** JT
Job Number 210263	**Status** S2	**Purpose of Issue** For Approval
Drawing No. RDB-HBA-2X-ZZ-DR-AR-080258		**Rev** P02



1 | Tower 3 Crown - Elevation



2 | Tower 3 Crown - Plan



A | Section

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Rev	Description	Date
P01	Issued for Planning	24.03.23
P02	Issued for Planning	31.03.23

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mail@hawkinsbrown.com
hawkinsbrown.com
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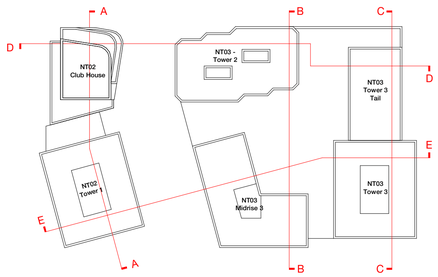
Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

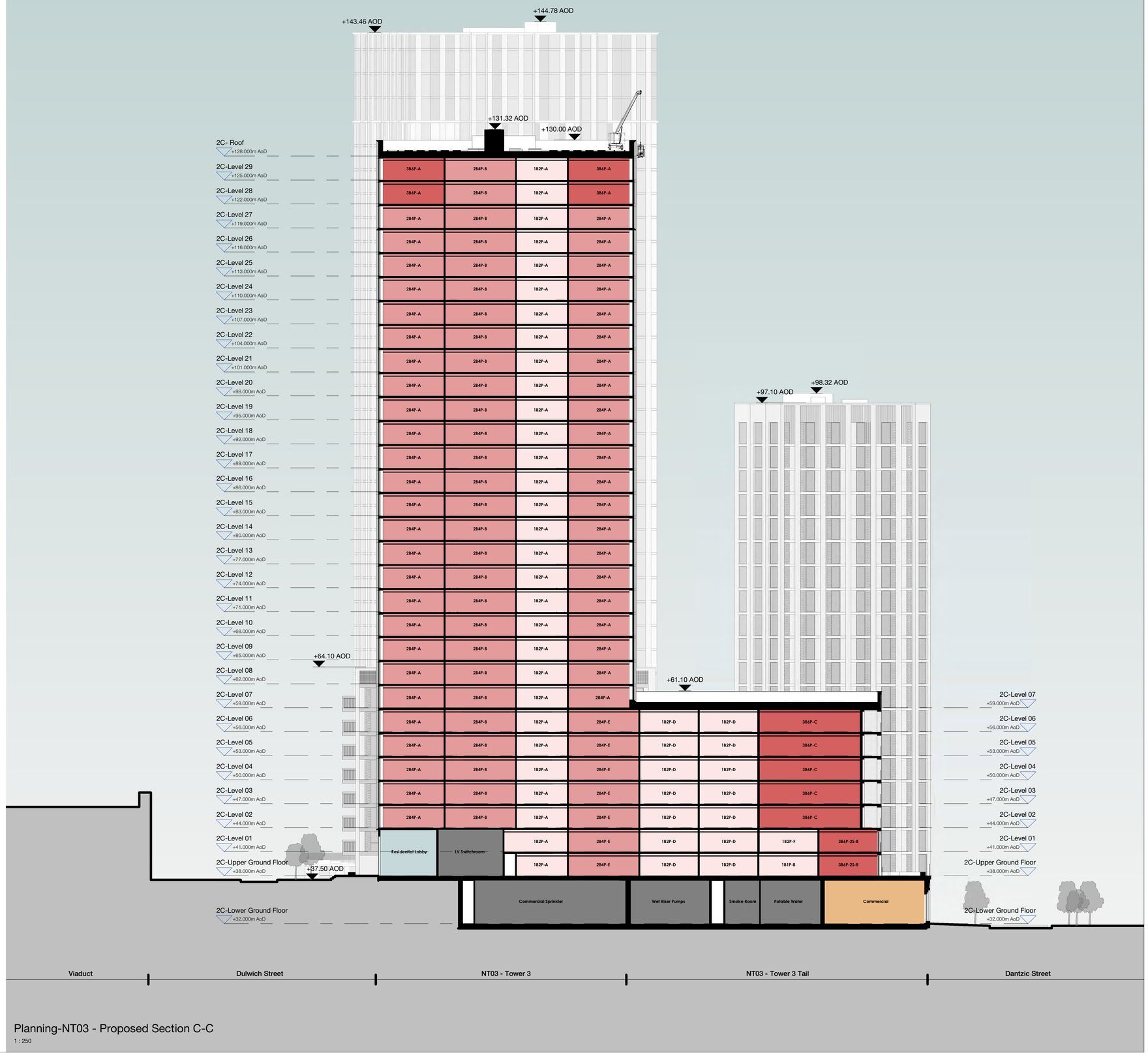
Drawing
Bay Study - Tower 3 Crown

Scale @ A1	Date
1 : 25	March 2023
Drawn By	**Checked By**
DN	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

Drawing No. RDB-HBA-2X-ZZ-DR-AR-080259
Rev P02





- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-4P-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

Planning-NT03 - Proposed Section C-C

1 : 250

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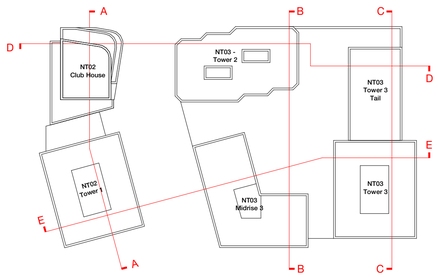
Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for Planning	31.03.23
P03	Issued for Planning	12.04.23

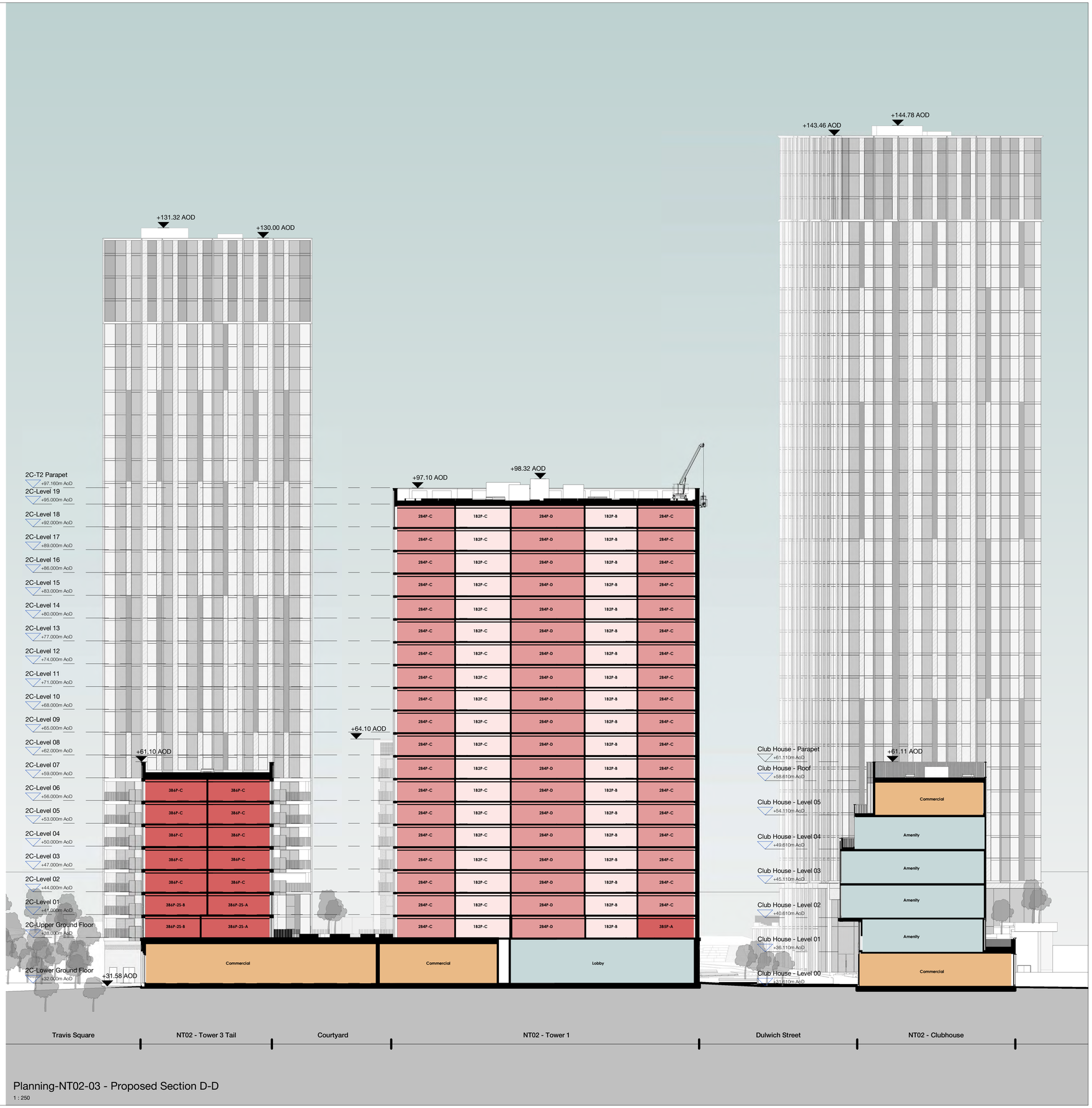
26-28 Hilton Street
Manchester M1 2EH
mail@hawkinsbrown.com
hawkinsbrown.com
Hawkins\
Brown

Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

Drawing
Proposed GA Section C-C

Scale @ A1 1 : 250	**Date** March 2023
Drawn By HECW	**Checked By** JT
Job Number 210263	**Status** S2
Purpose of Issue For Approval	
Drawing No. RDB-HBA-2X-ZZ-DR-AR-080312	**Rev** P03





Planning-NT02-03 - Proposed Section D-D

1 : 250

- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-4P-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for Planning	31.03.23
P03	Issued for Planning	12.04.23

28-32 Dantzic Street
Manchester M4 4HF
mail@hawkinsbrown.com
hawkinsbrown.com
Hawkins\
Brown

Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

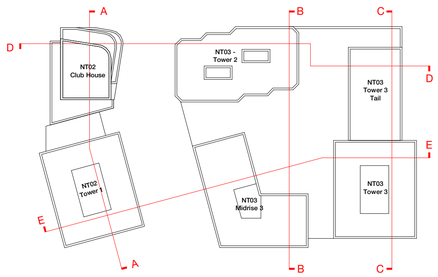
Drawing
Proposed GA Section D-D

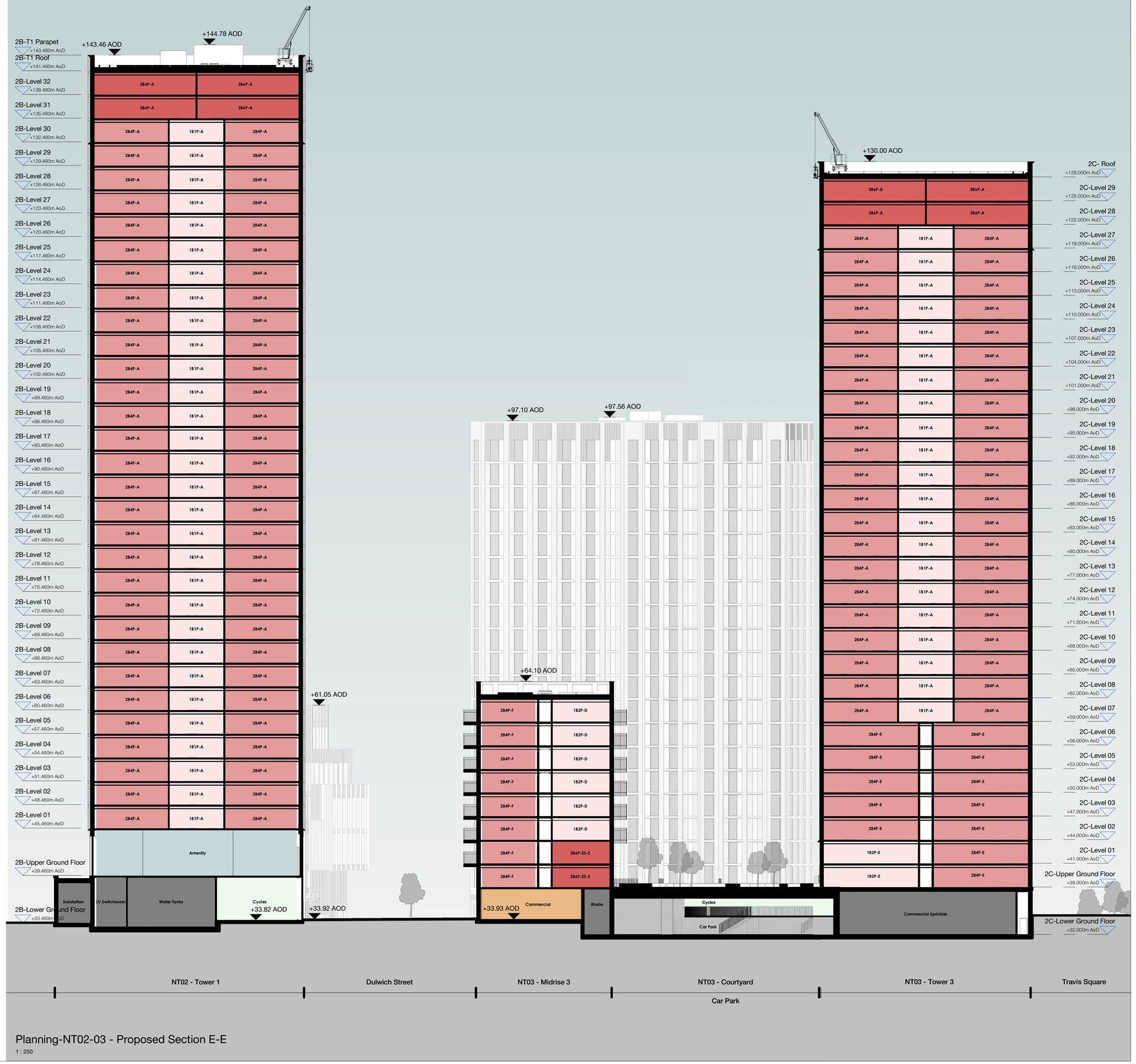
Scale @ A1	Date
1 : 250	March 2023

Drawn By	Checked By
HECW	JT

Job Number	Status	Purpose of Issue
210263	S2	For Approval

Drawing No.	Rev
RDB-HBA-2X-ZZ-DR-AR-080313	P03





Planning-NT02-03 - Proposed Section E-E

1 : 250

- 1B-1P-1S
- 1B-2P-1S
- 2B-3P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-4P-2S
- 3B-5P-1S
- 3B-5P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Waste

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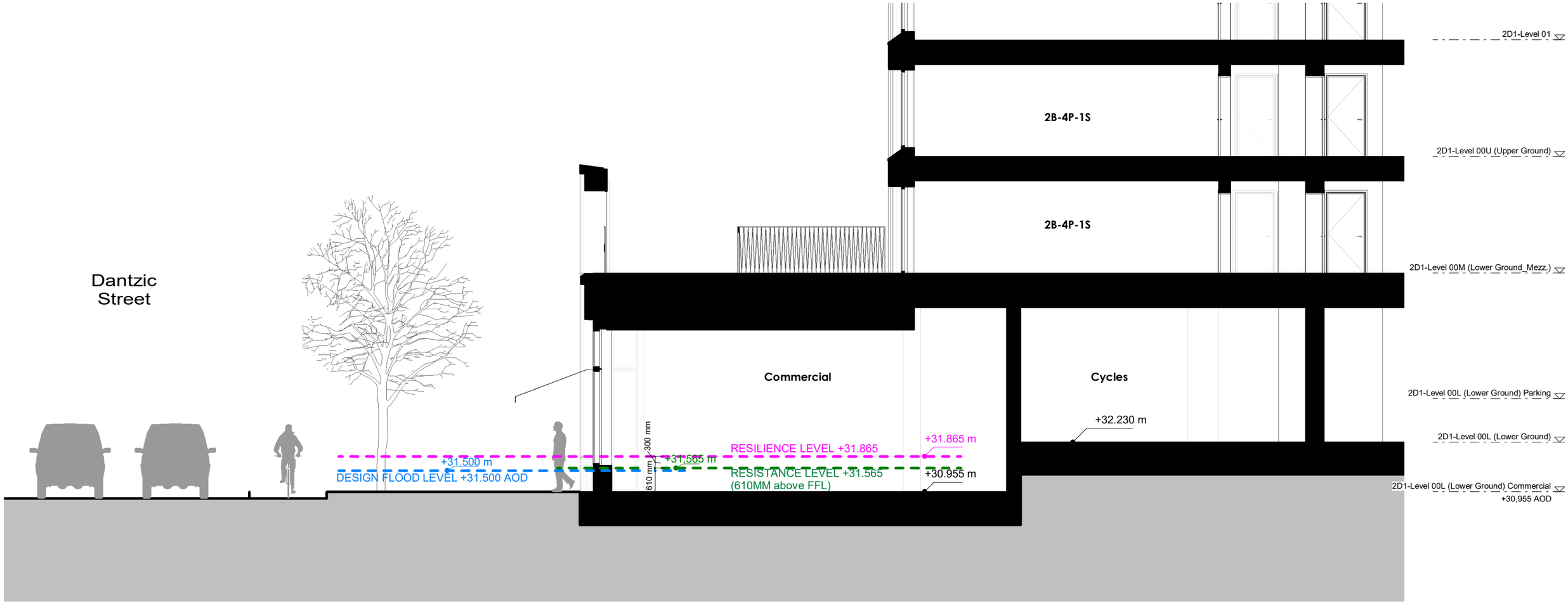
Rev	Description	Date
P01	Issued for Planning	17.03.23
P02	Issued for Planning	31.03.23
P03	Issued for Planning	12.04.23

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Project
Red Bank NT02/03
Dantzic Street
Manchester
M4 4HF

Drawing
Proposed GA Section E-E

Scale @ A1 +1 : 250	**Date** March 2023
Drawn By HECW	**Checked By** JT
Job Number 210263 / **Status** S2	**Purpose of Issue** For Approval
Drawing No. RDB-HBA-2X-ZZ-DR-AR-080314	**Rev** P03



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0 4 12m

Rev	Details	Drwn	Chkd	Date
P09.06	S0-Initial Status			24/04/2023
P09.02	S0-Initial Status			03/04/2023
P07.04	S0-Initial Status			14/03/2023

MACCREANOR LAVINGTON
Viverhofstraat 47
3032 SB Rotterdam The Netherlands
+31(0)10 443 90 60

Proj. No. RDB
Project Red Bank NT04
Client FEC
Sheet Name Flood Level Section
Status S0-Initial Status
CDE ID RDB-MLA-2D-XX-DR-AR-01321101
Scale 1 : 100
Size A1
Rev. P09.06

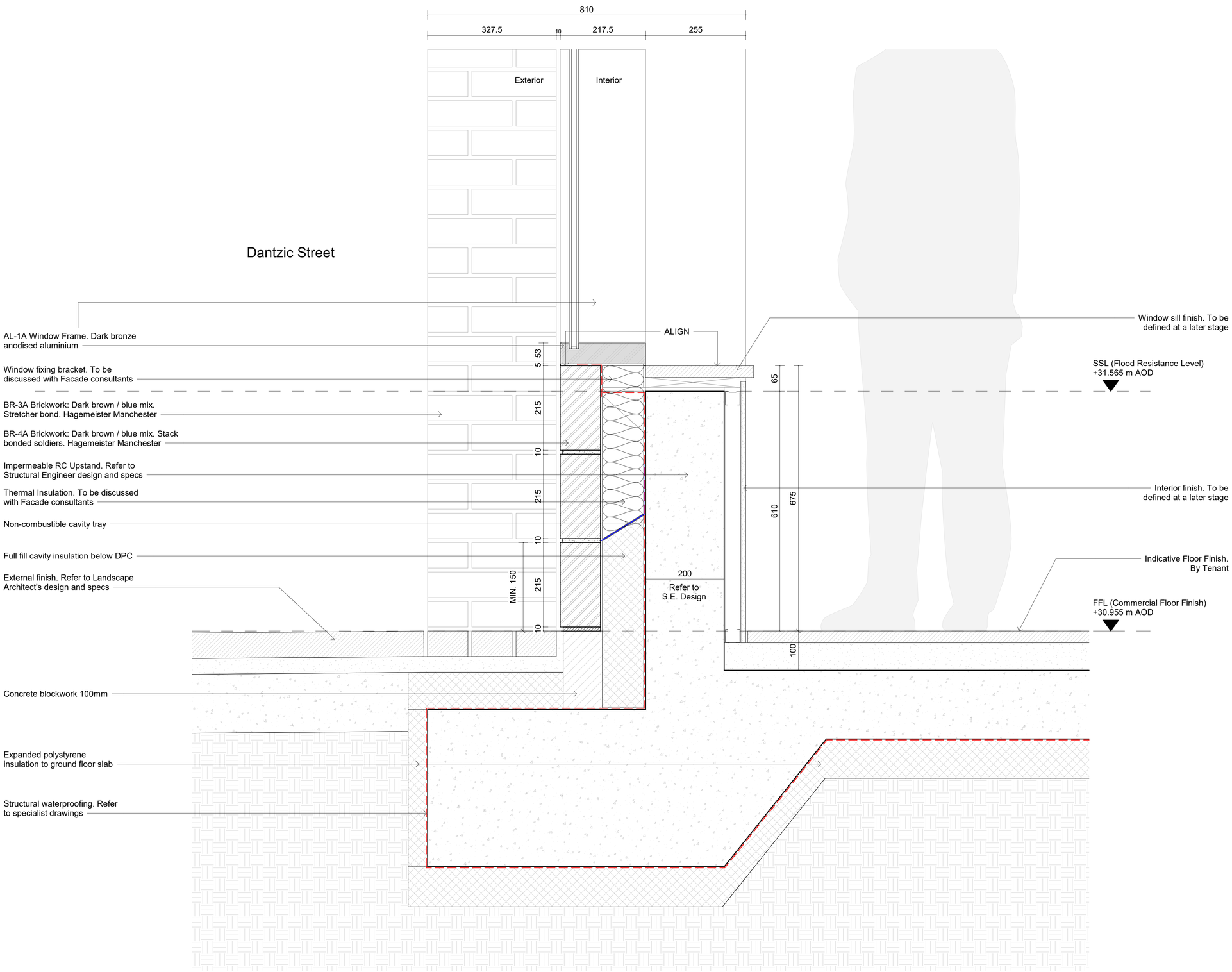
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0 0.1 0.3m

Notes

1. Drawing illustrates design intent. Construction information to be developed by contractor at a later stage.
2. All structural, landscape and civil design information shown is indicative only. Refer to specialist information.



Rev	Details	Date
P09.08	S0-Initial Status	03/05/2023
P07.04	S0-Initial Status	14/03/2023

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3032 SB Rotterdam
The Netherlands
+31(0)10 443 90 60

Proj. No.	Project	Status
RDB	Red Bank NT04	S0-Initial Status

Sheet Name	Client
External Wall Detail - Flood Upstand	FEC

CDE ID	Scale	Size	Rev
RDB-MLA-2D-XX-DR-AR-21720001	1:5	A1	P09.08

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0 25 75m

Legend

- Application boundary
- Land owned or controlled by the applicant

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3032 SB Rotterdam
The Netherlands
+31(0)10 443 90 60

Proj. No.	Project	Date
RDB	Red Bank NT02-04	19/04/2023

Sheet Name: Location Plan

Client: FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-00-XX-DR-AR-00010001	1:1250	A1	P0



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0 10 30m

Legend

SITE AREA: 28,104m²

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Vijverhofstraat 47
3032 SB Rotterdam
The Netherlands
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Proj. No.	Project	Date
RDB	Red Bank NT02-04	13/04/2023

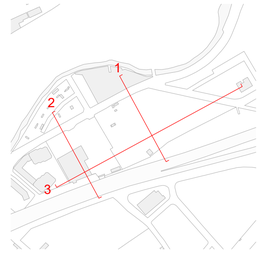
Sheet Name	Client
Existing Site Plan	FEC

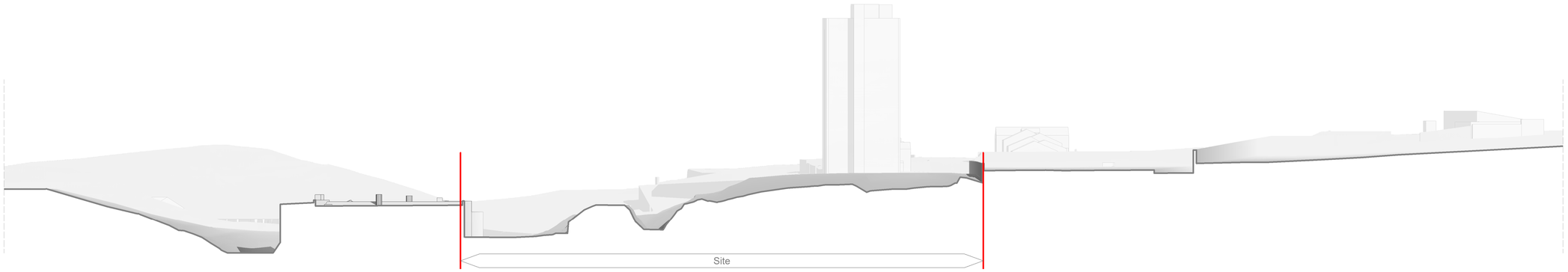
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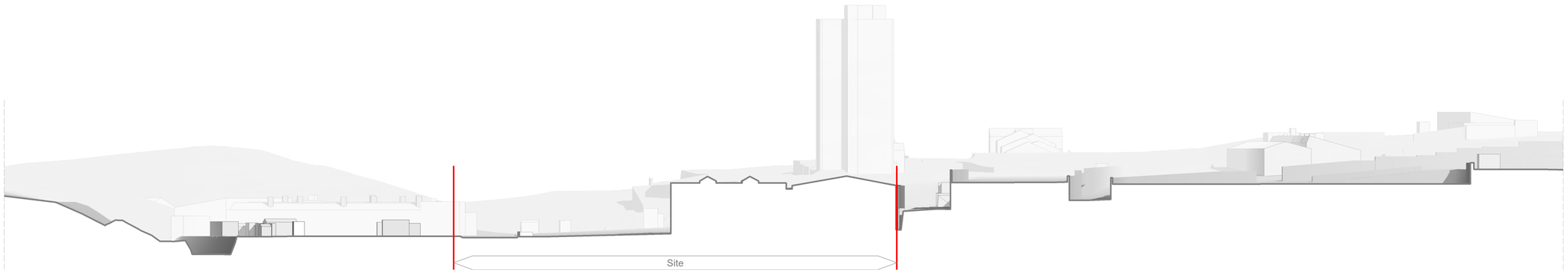
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0 10 30m

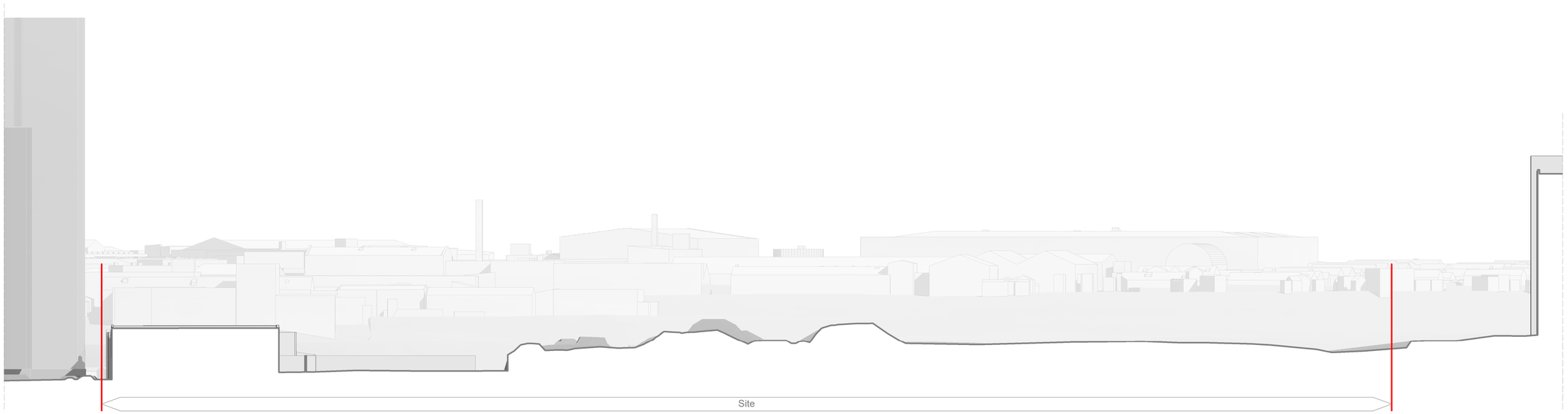




Existing Site Section 1



Existing Site Section 2



Existing Site Section 3

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Proj. No.	Project	Date
RDB	Red Bank NT02-04	13/04/2023

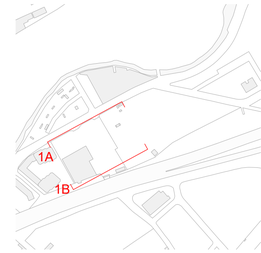
Sheet Name	Client
Existing Site Sections	FEC

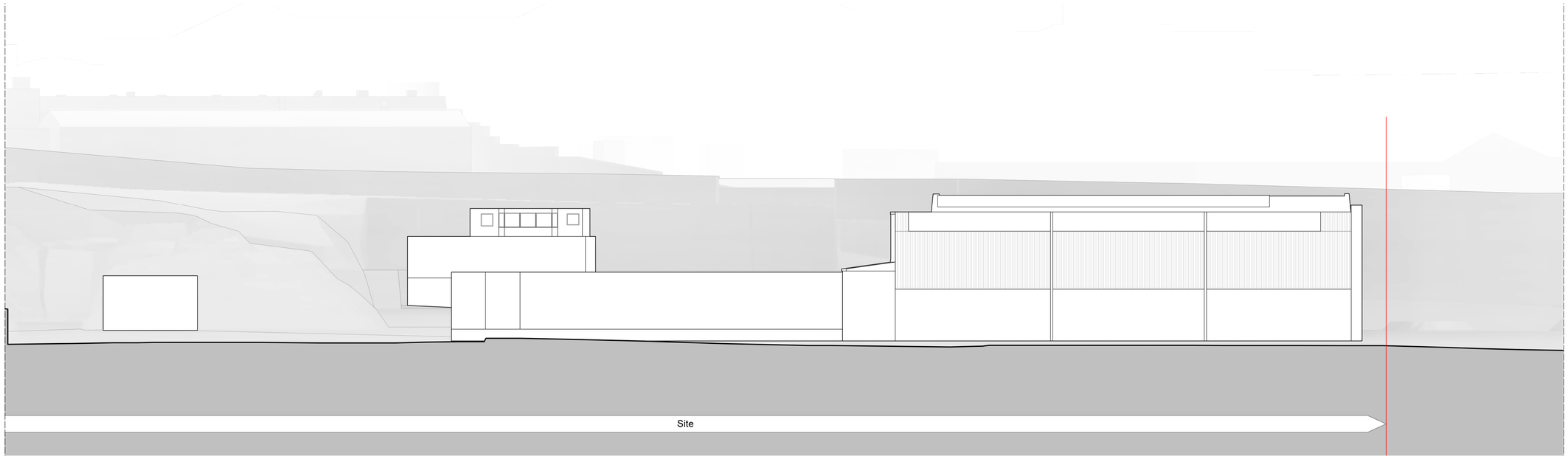
CDE ID	Scale	Size	Rev.
RDB-MLA-00-XX-DR-AR-00120001	1:500	A1	P0

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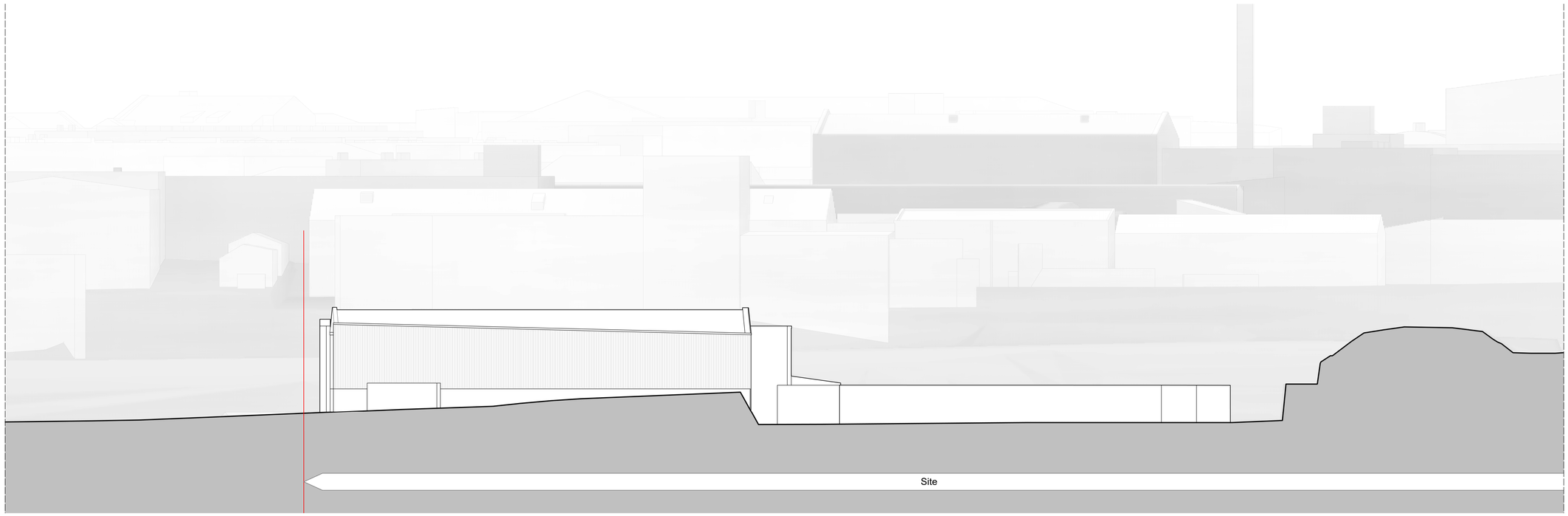
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0 4 12m





Existing Site Elevation 1A



Existing Site Elevation 1B

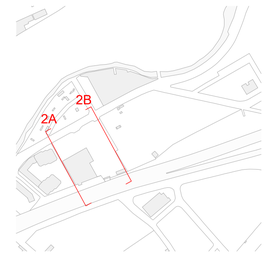
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Proj. No. RDB
Project Red Bank NT02-04
Date 19/04/2023
Sheet Name Existing Site Elevations 1
Client FEC
CDE ID RDB-MLA-00-XX-DR-AR-00130001
Scale 1:200
Size A1
Rev. P0

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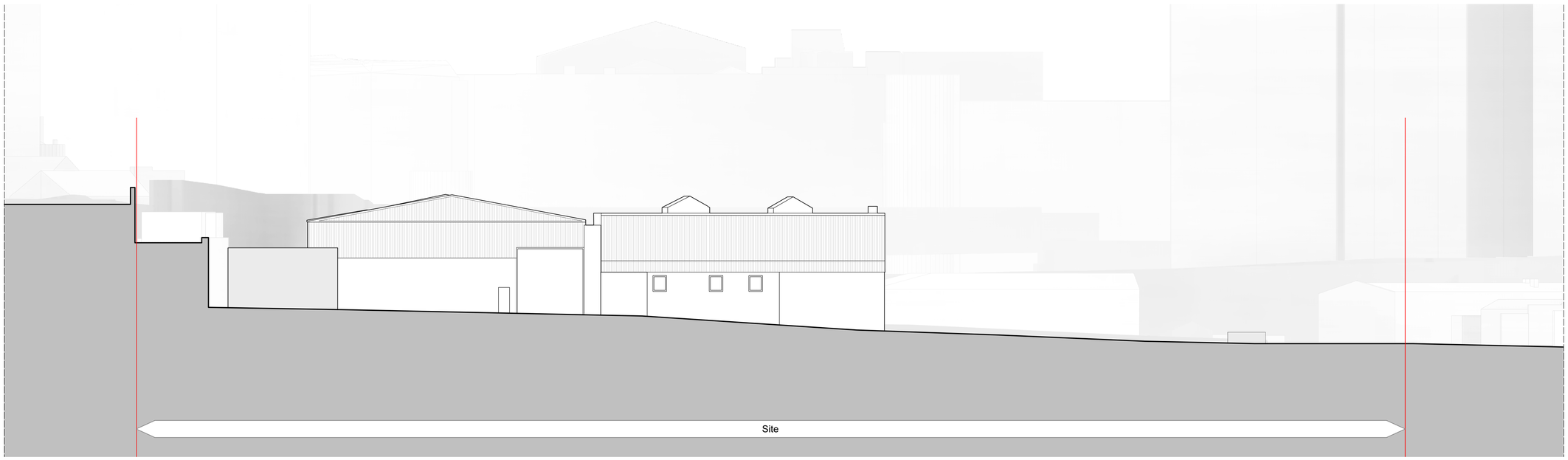
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0 4 12m





Existing Site Elevation 2A



Existing Site Elevation 2B

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Proj. No.	Project	Date
RDB	Red Bank NT02-04	19/04/2023

Sheet Name	Client
Existing Site Elevations 2	FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-00-XX-DR-AR-00130002	1:200	A1	P0



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0 10 30m

Legend

Application boundary

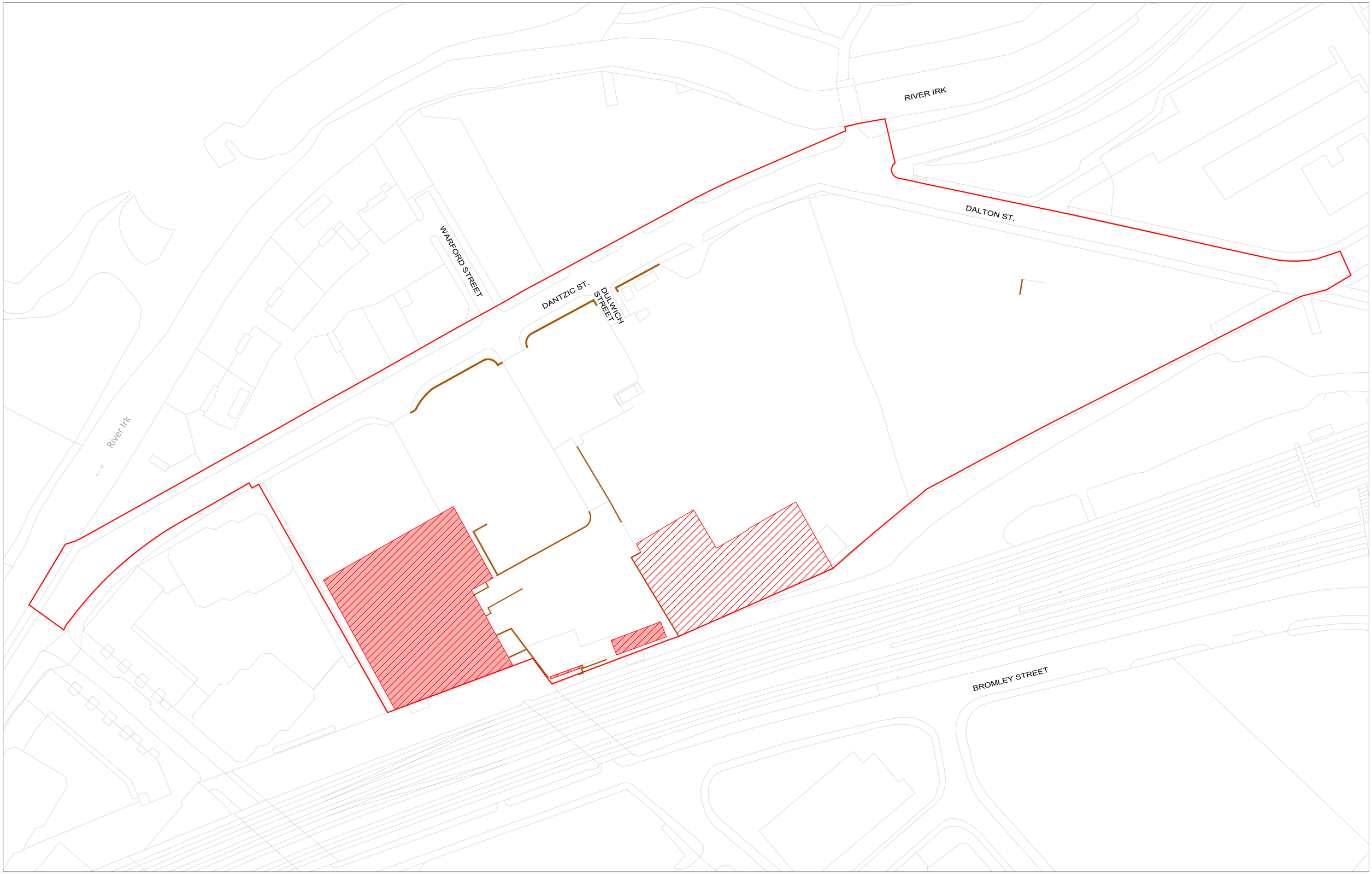
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Proj. No.	Project	Date
RDB	Red Bank NT02-04	13/04/2023

Sheet Name: Proposed Site Plan

Client: FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-00-XX-DR-AR-01110000	1:500	A1	P0



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0 10 30m

Legend

- Demolition of buildings / structures
- Removal of earth mound
- Demolition of walls
- Application boundary

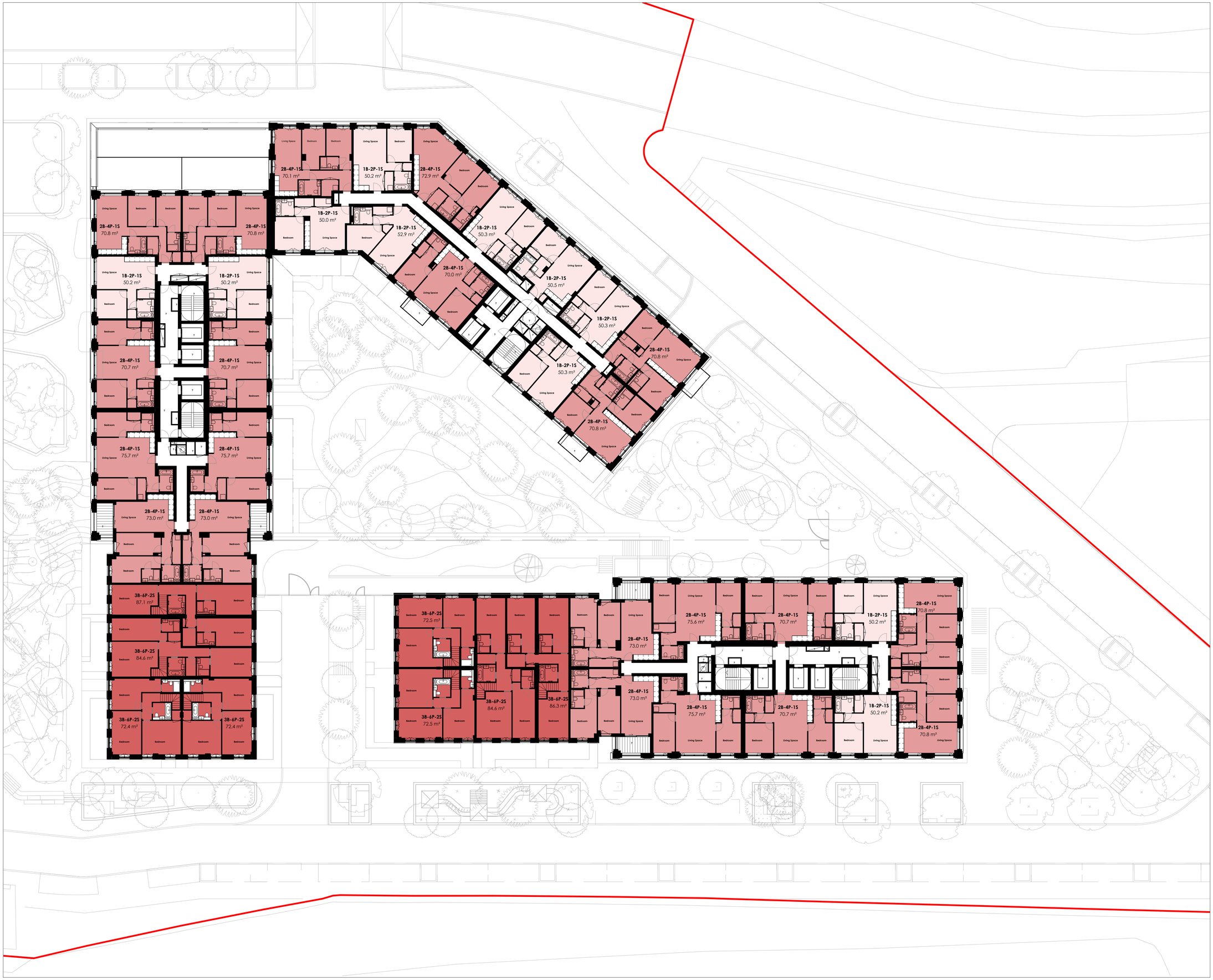
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Proj. No.	Project	Date
RDB	Red Bank NT02-04	13/04/2023

Sheet Name: Proposed Demolition Plan

Client: FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-00-XX-DR-AR-01140000	1:500	A1	P0



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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste

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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name: NT04 Proposed GA Plan - Level 01

Client: FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-2D-01-DR-AR-01310010	1:200	A1	P0



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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste

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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name: NT04 Proposed GA Plan - Level 06

Client: FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-2D-06-DR-AR-01310060	1:200	A1	P0

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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste

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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name: NT04 Proposed GA Plan - Level 07-08

Client: FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-2D-07-DR-AR-01310070	1:200	A1	P0



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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste

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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name: NT04 Proposed GA Plan - Level 09
Client: FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-2D-09-DR-AR-01310090	1:200	A1	P0

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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste

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RDB	Red Bank NT04	13/04/2023

Sheet Name: NT04 Proposed GA Plan - Level 10

Client: FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-2D-10-DR-AR-01310100	1:200	A1	P0

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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste

MEP

MEP

PV Panels

PV Panels

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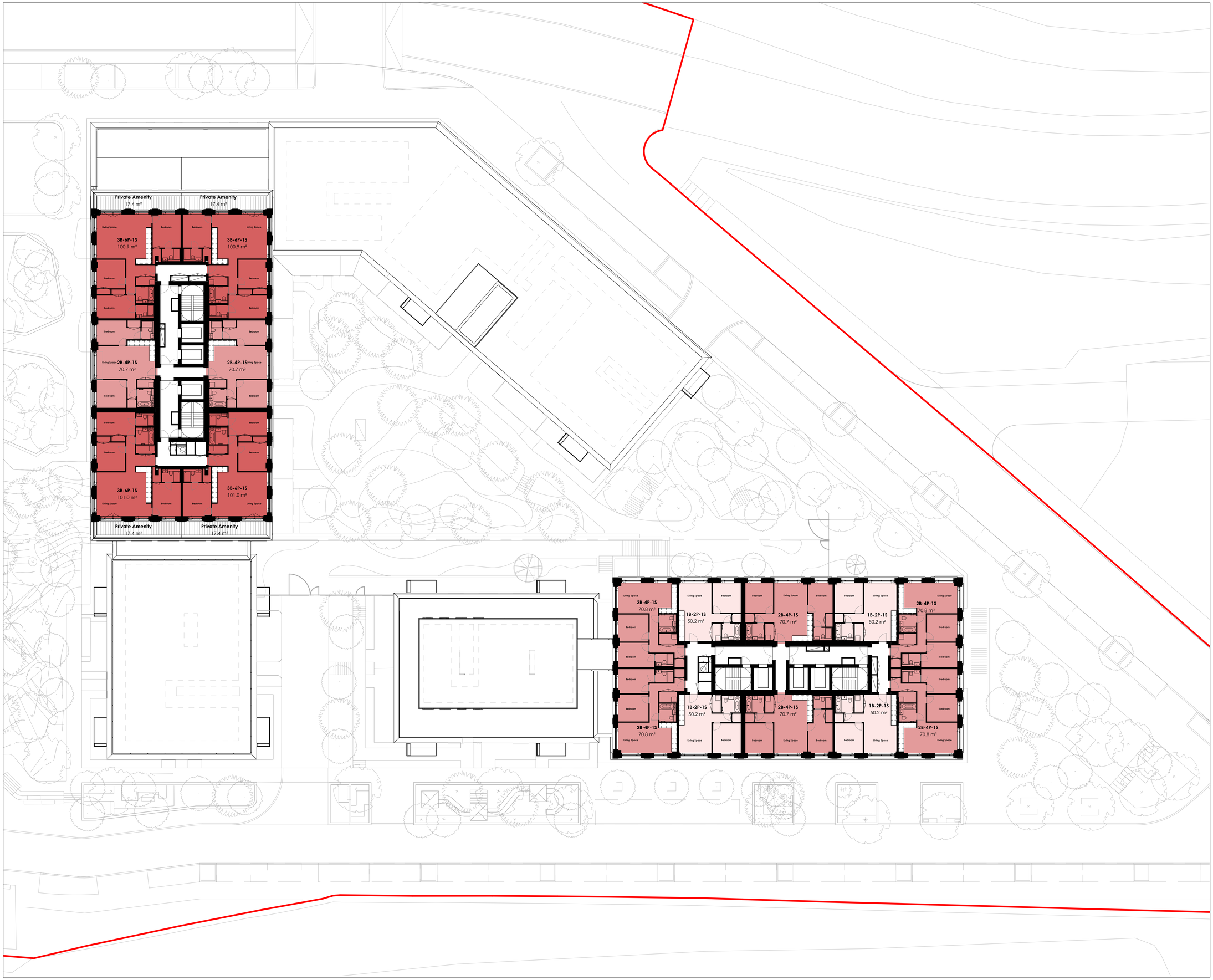
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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name: NT04 Proposed GA Plan - Level 11

Client: FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-2D-11-DR-AR-01310110	1:200	A1	P0



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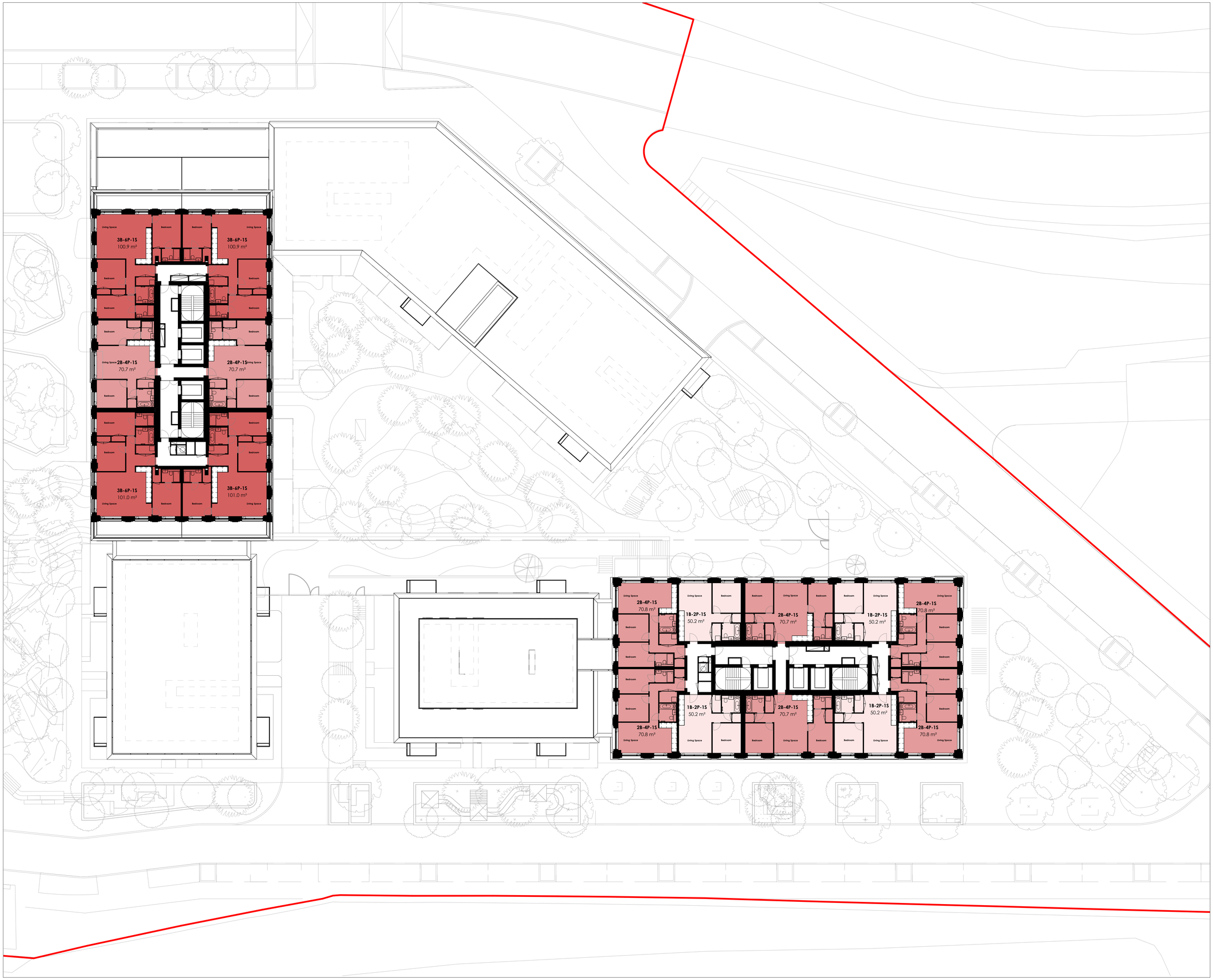
0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste

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Proj. No. RDB
Project Red Bank NT04
Date 13/04/2023
Sheet Name NT04 Proposed GA Plan - Level 19
Client FEC
CDE ID RDB-MLA-2D-19-DR-AR-01310190
Scale 1:200
Size A1
Rev. P0



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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste

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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name: NT04 Proposed GA Plan - Level 20-21

Client: FEC

CDE ID	Scale	Size	Rev.
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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste

2D.1
Green Roof
451.5 m²

PV Panels

MEP

Lift Overru

Lift Overru

Lift Overru

MEP

MEP

PV Panels

Living Space
2B-4P-1S
70.8 m²
Bedroom
Bedroom
Bedroom
Bedroom
Living Space

1B-2P-1S
50.2 m²
Bedroom
Living Space

Bedroom
Living Space
2B-4P-1S
70.7 m²
Bedroom
Living Space

1B-2P-1S
50.2 m²
Bedroom
Living Space

Living Space
2B-4P-1S
70.8 m²
Bedroom
Bedroom
Bedroom
Bedroom
Living Space

1B-2P-1S
50.2 m²

2B-4P-1S
70.7 m²

1B-2P-1S
50.2 m²

Living Space
2B-4P-1S
70.8 m²
Bedroom
Bedroom
Bedroom
Bedroom
Living Space

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RDB	Red Bank NT04	13/04/2023

Sheet Name
NT04 Proposed GA Plan - Level 22

Client
FEC

CDE ID	Scale	Size	Rev.
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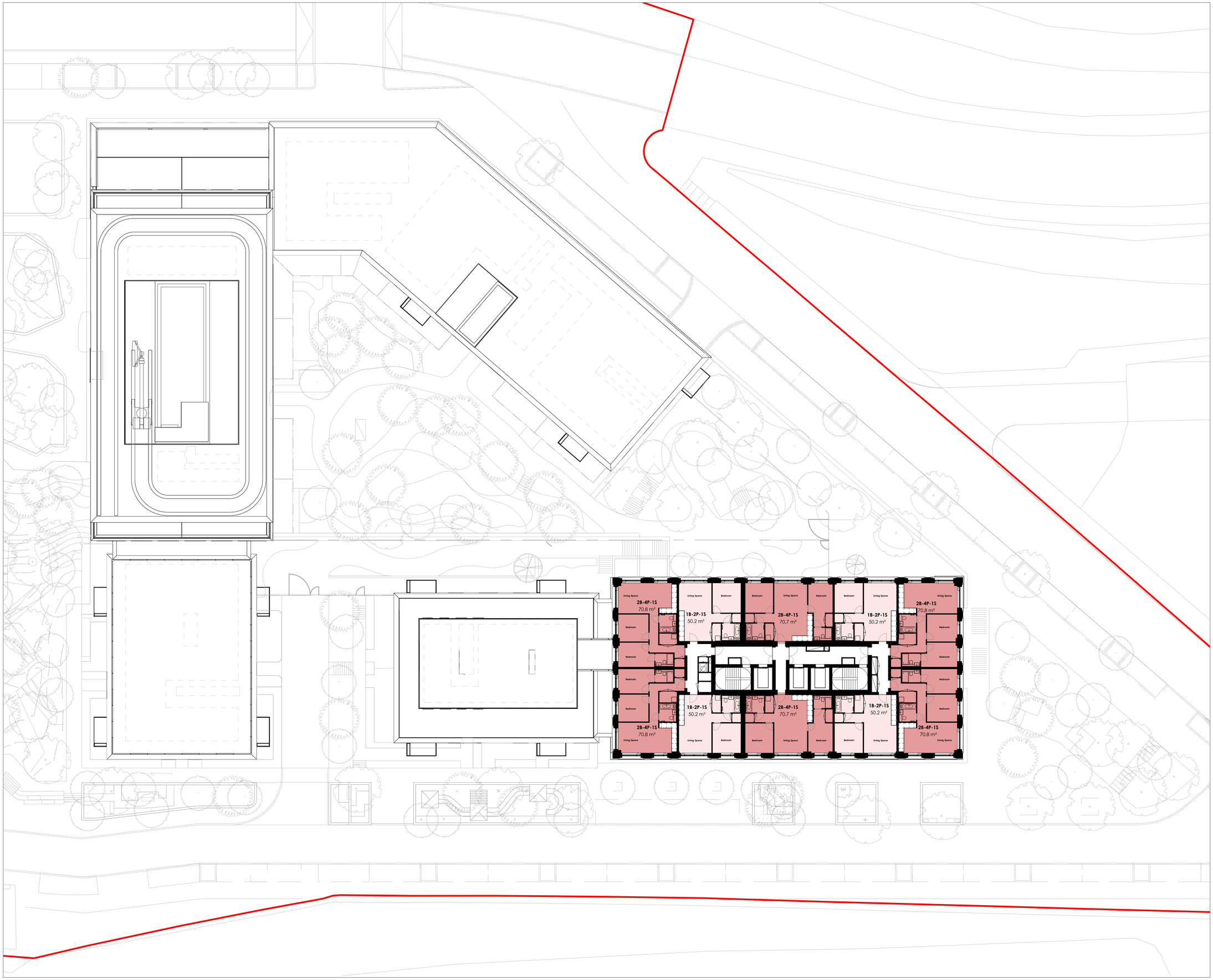
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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste



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Proj. No.	Project	Date
RDB	Red Bank Manchester	13/04/2023

Sheet Name: NT04 Proposed GA Plan - Level 23

Client: FEC

CDE ID	Scale	Size	Rev.
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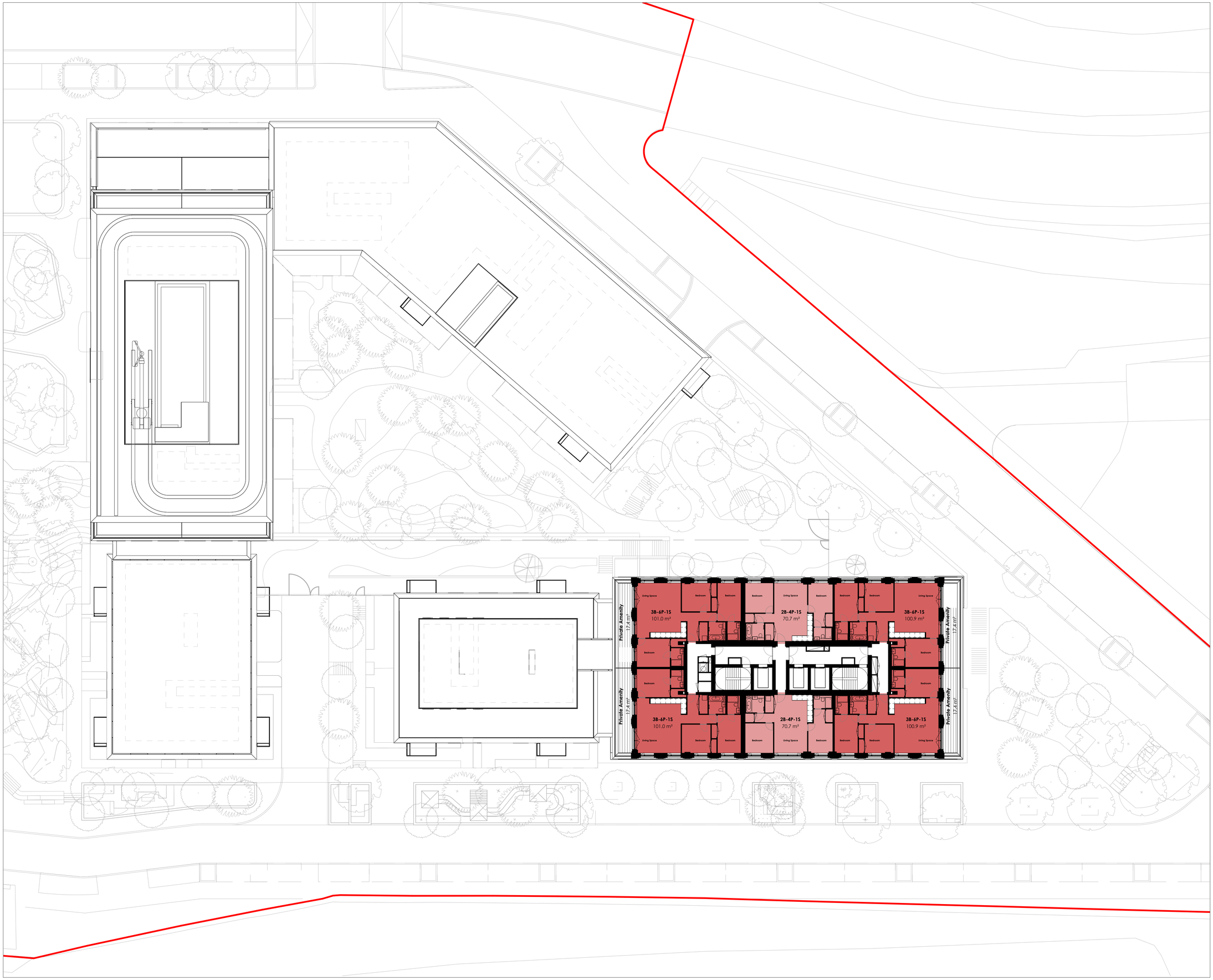
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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste



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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name: NT04 Proposed GA Plan - Level 24

Client: FEC

CDE ID	Scale	Size	Rev.
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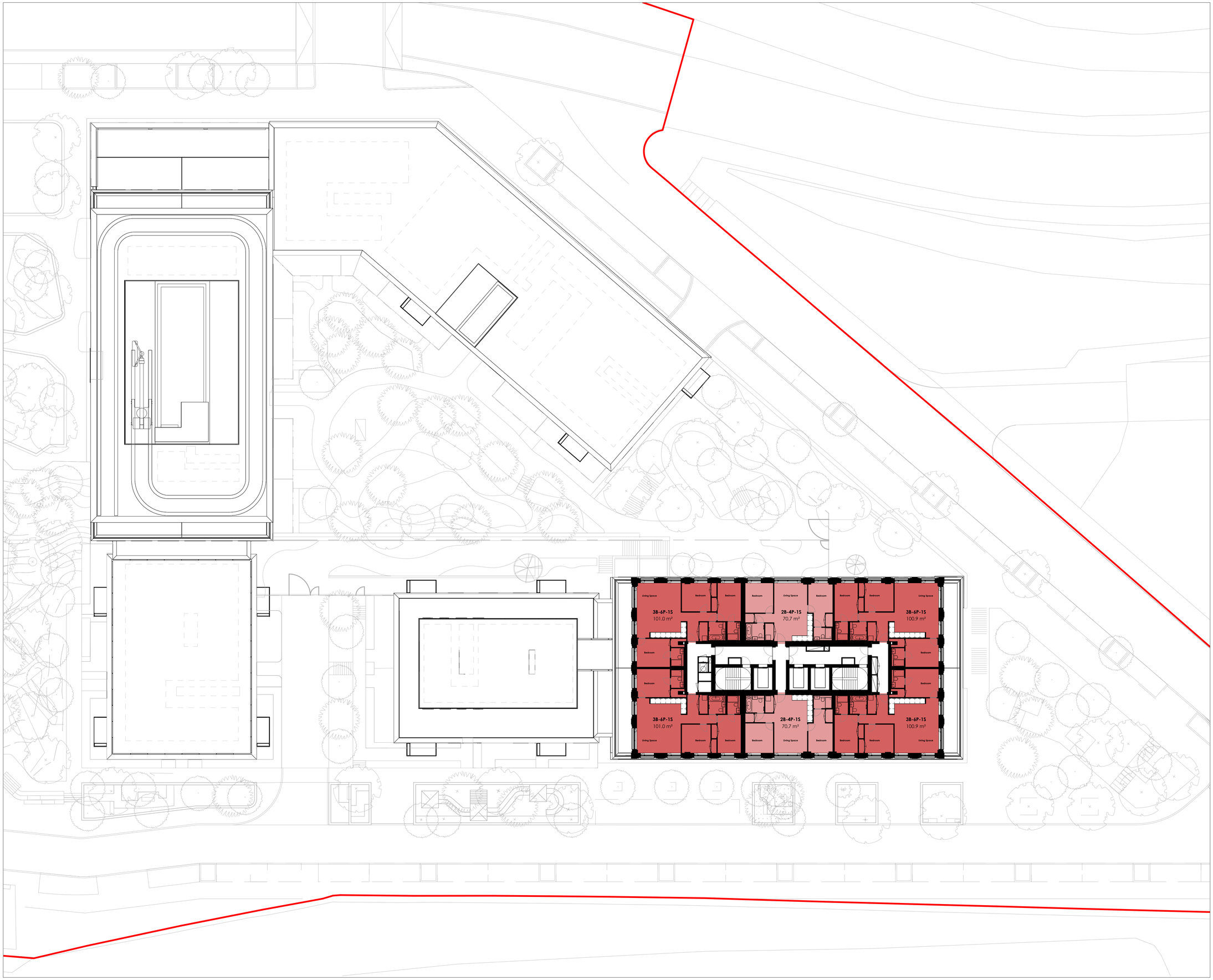
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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste



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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name: NT04 Proposed GA Plan - Level 25-26

Client: FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-2D-25-DR-AR-01310250	1:200	A1	P0

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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste

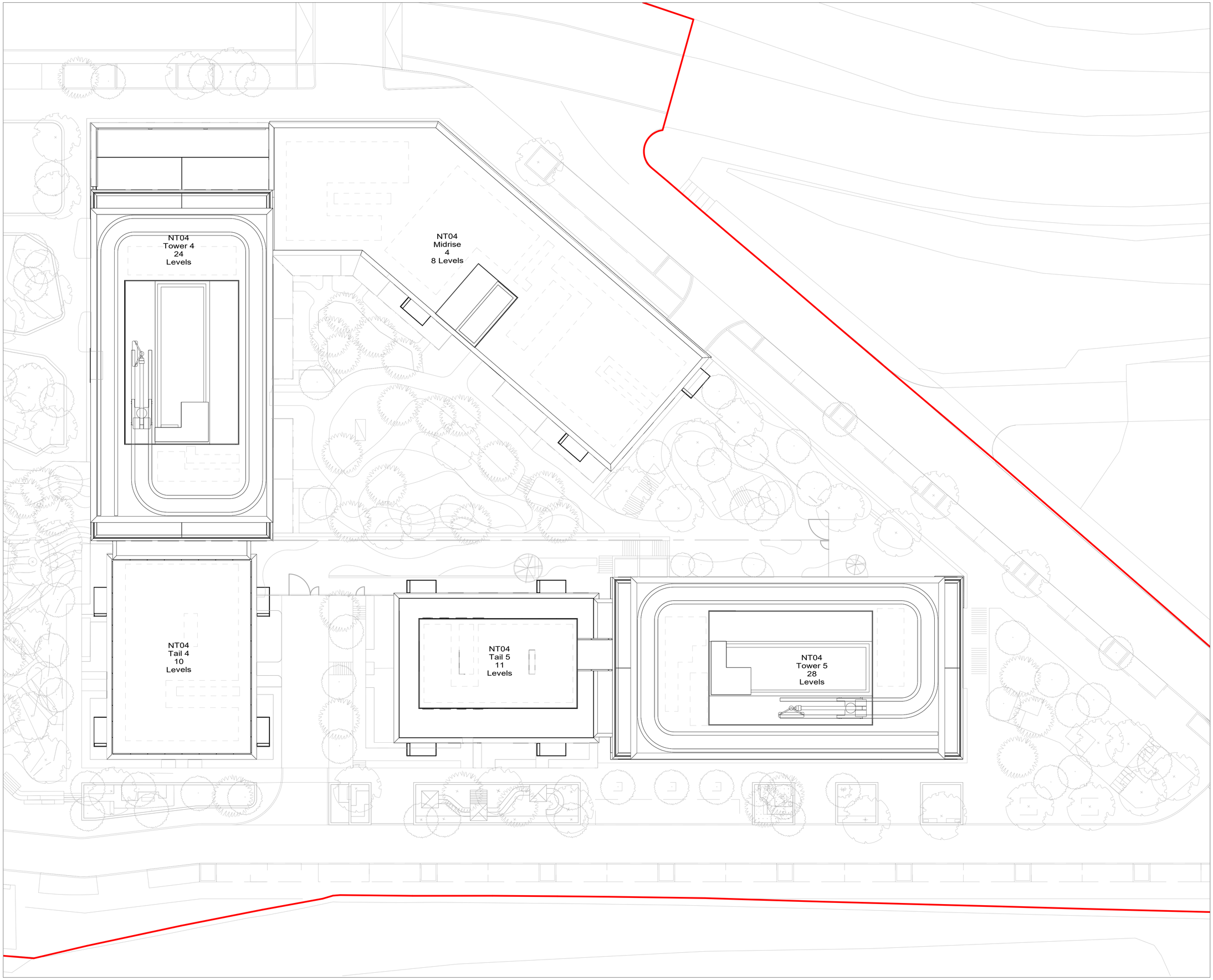
PV Panels
MEP
MEP
PV Panels
Lift Overrun
Lift Overrun
Lift Overrun
MEP
2D.3
Green Roof
451.5 m²

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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name: NT04 Proposed GA Plan - Level 27
Client: FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-2D-27-DR-AR-01310270	1:200	A1	P0



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0 4 12m

Legend

- Application boundary
- 1B-1P-1S
- 1B-2P-1S
- 2B-4P-1S
- 2B-4P-2S
- 3B-6P-1S
- 3B-6P-2S
- Amenity
- Commercial
- Cycles
- Lobby
- MEP
- Parking
- Private Amenity
- Waste

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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name: NT04 Proposed GA Plan - Roof

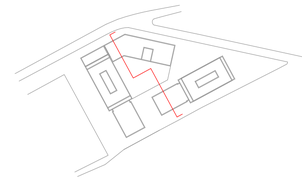
Client: FEC

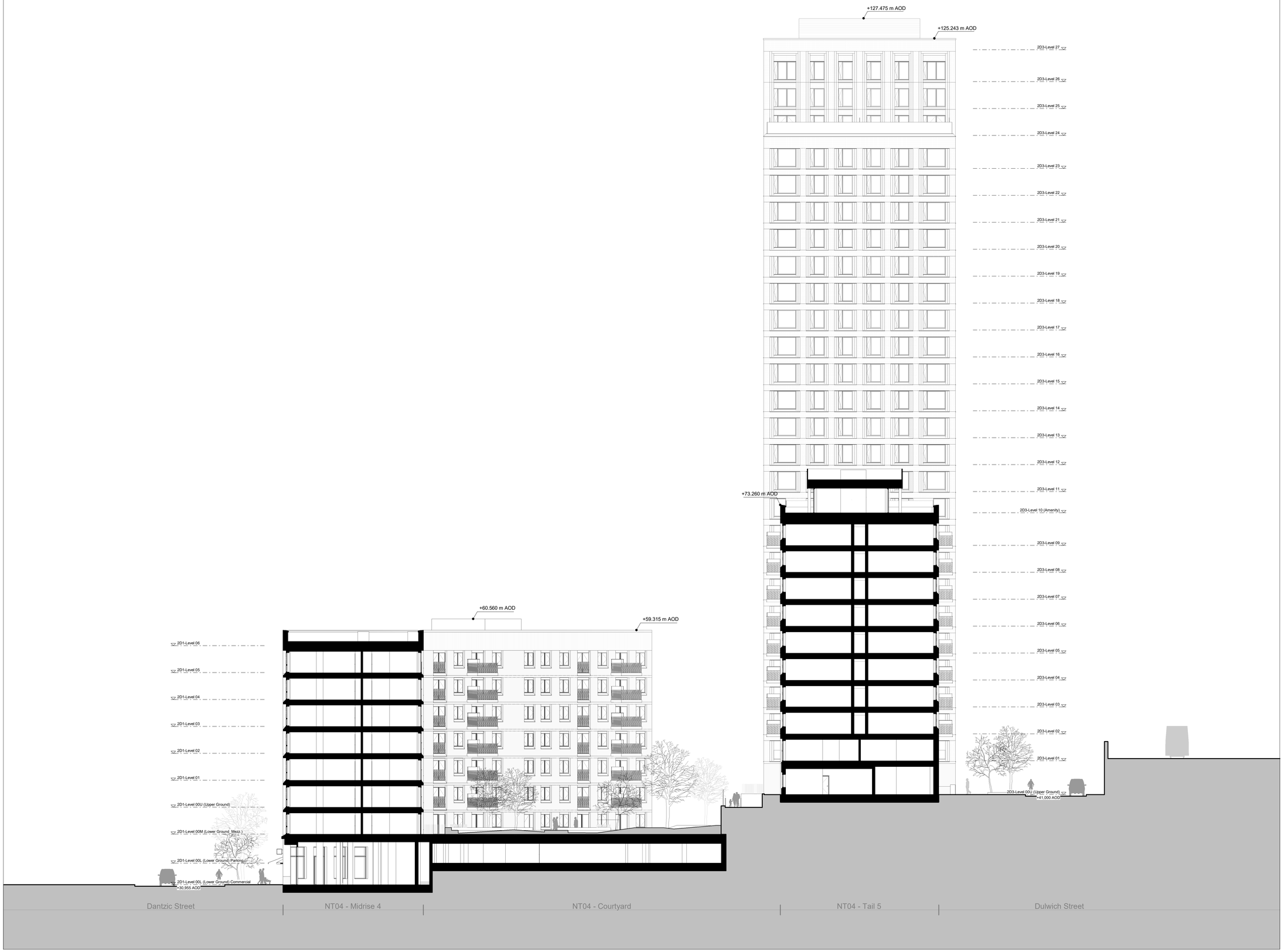
CDE ID	Scale	Size	Rev.
RDB-MLA-2D-34-DR-AR-01310340	1:200	A1	P0

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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name
NT04 Proposed GA Section AA

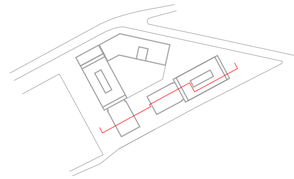
Client
FEC

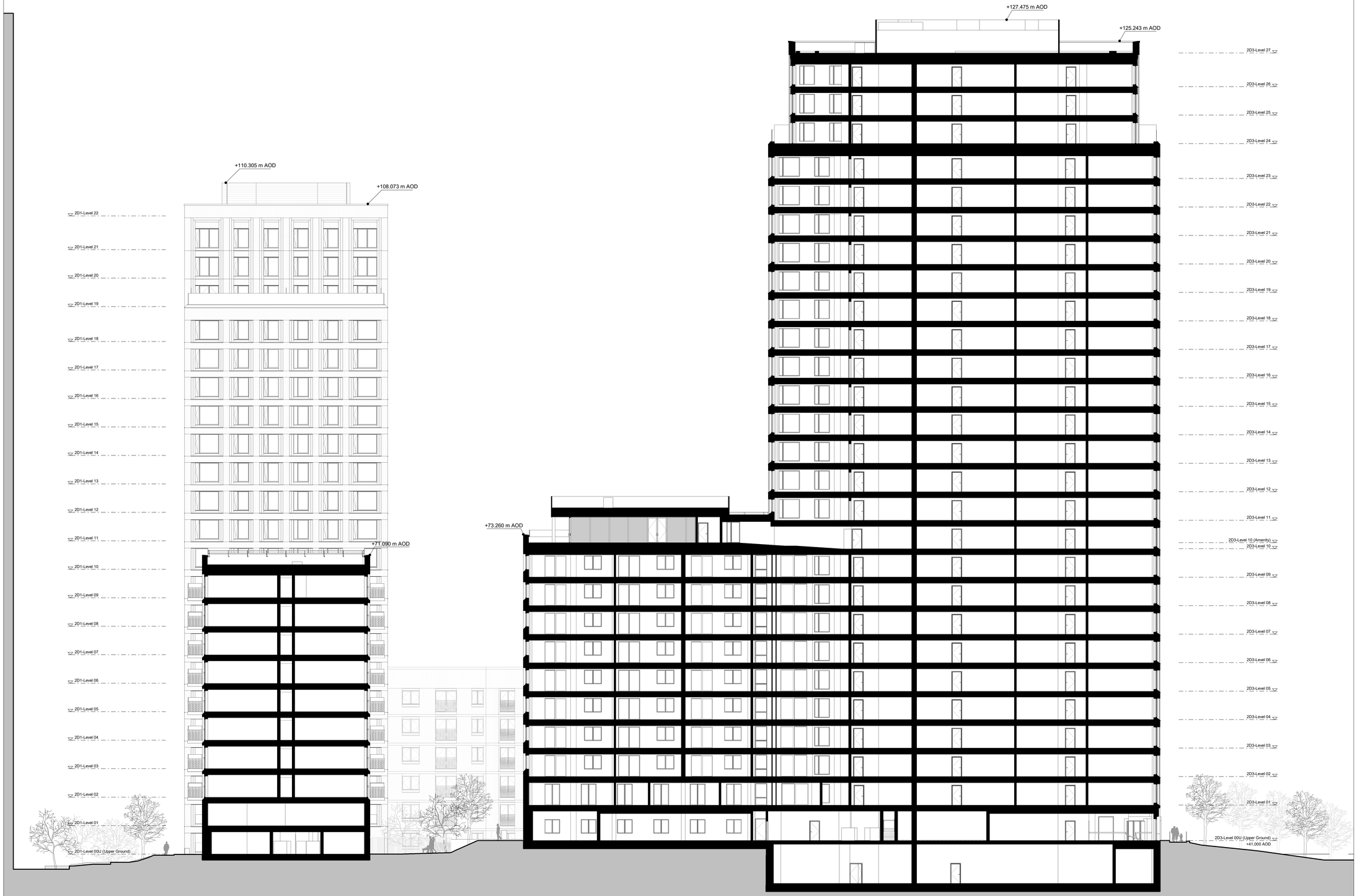
CDE ID	Scale	Size	Rev.
RDB-MLA-2D-XX-DR-AR-01321001	1:200	A1	P0

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0 4 12m





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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name
NT04 Proposed GA Section BB

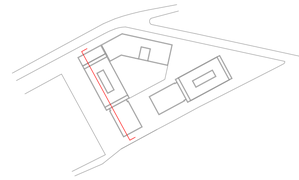
Client
FEC

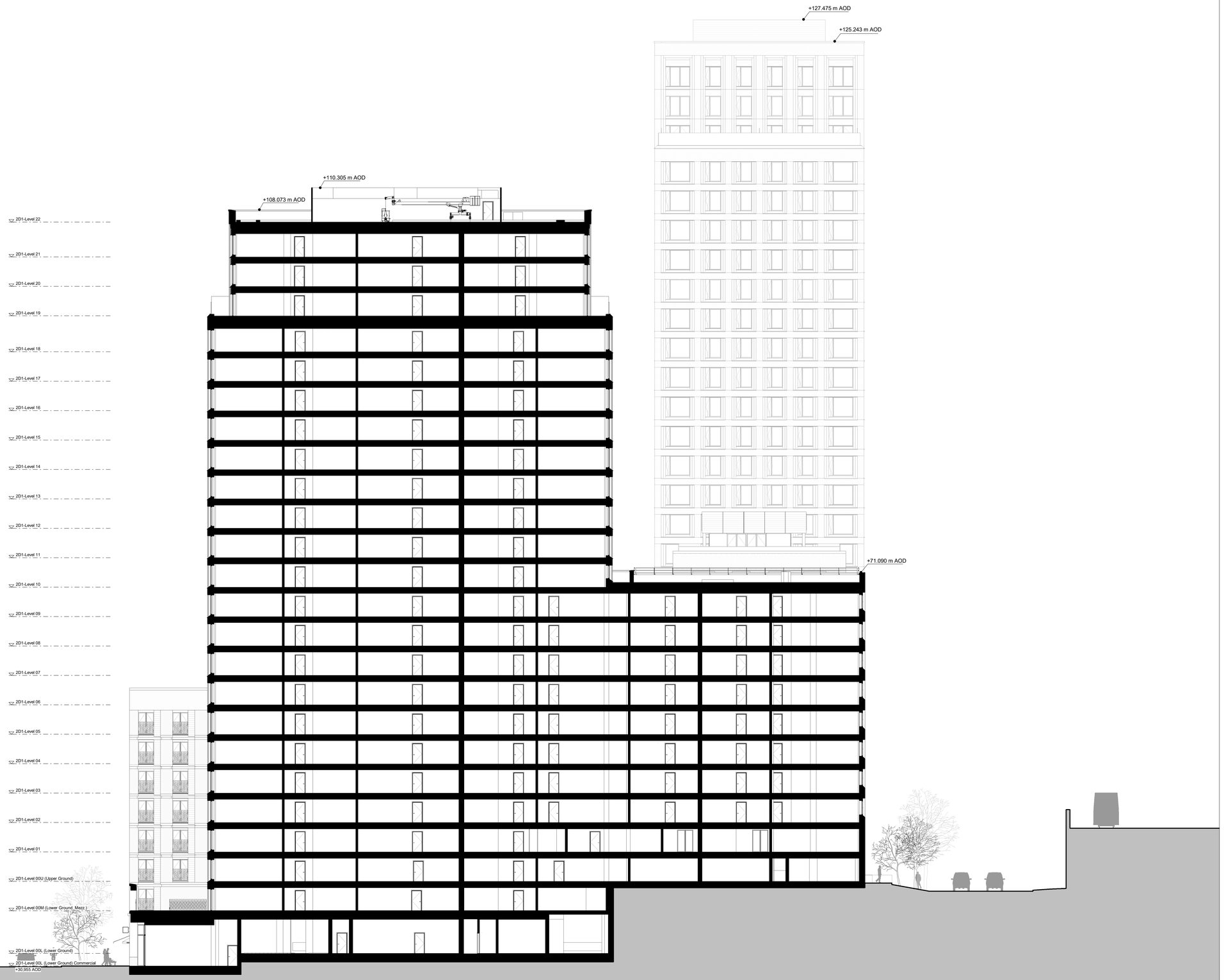
CDE ID	Scale	Size	Rev.
RDB-MLA-2D-XX-DR-AR-01321002	1:200	A1	P0

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0 4 12m





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The Netherlands
+31(0)10 443 90 60

Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name
NT04 Proposed GA Section CC

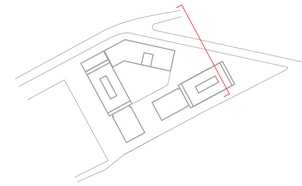
Client
FEC

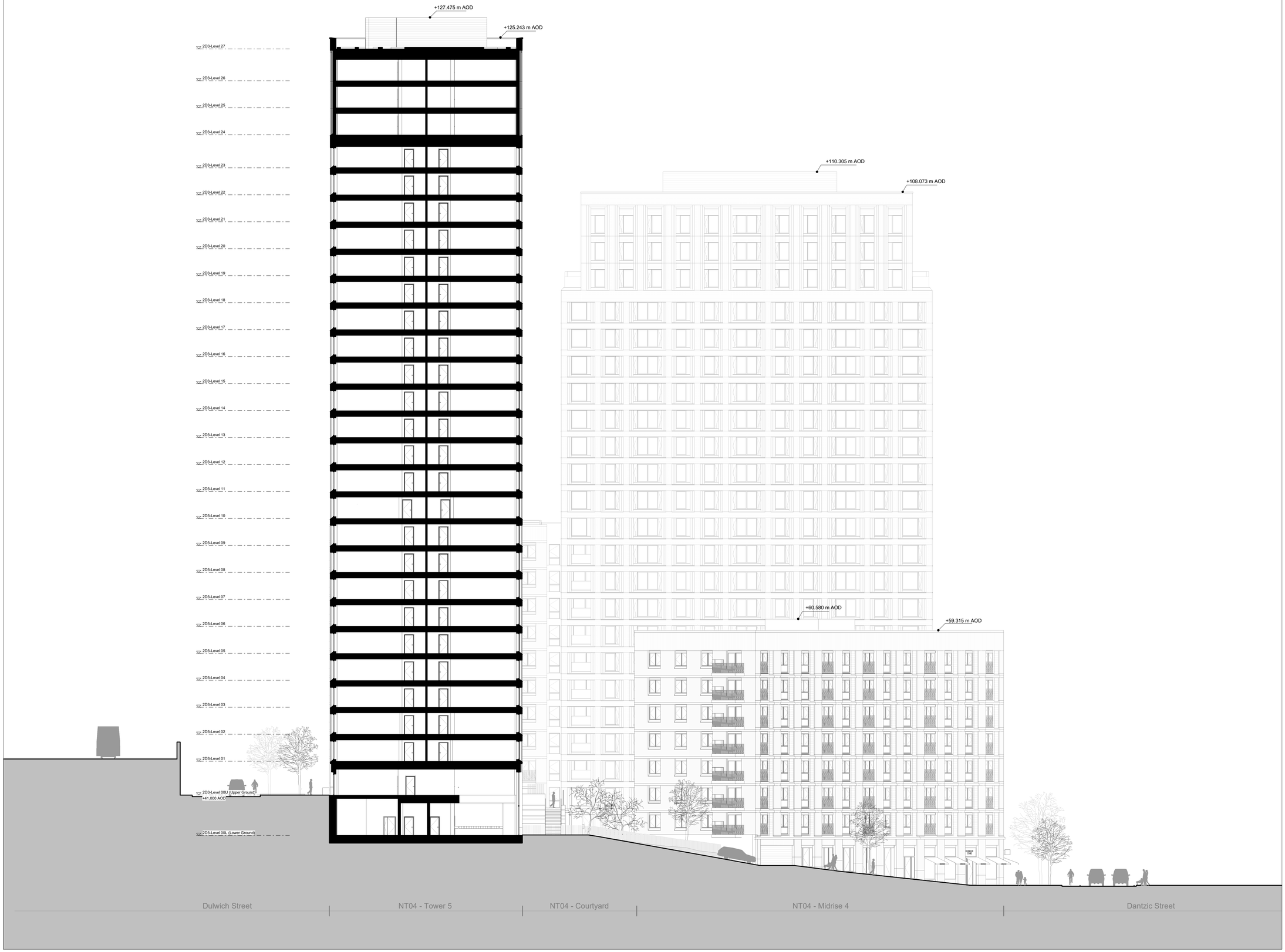
CDE ID	Scale	Size	Rev.
RDB-MLA-2D-XX-DR-AR-01321003	1:200	A1	P0

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0 4 12m





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Proj. No.	Project	Date
RDB	Red Bank NT04	13/04/2023

Sheet Name
NT04 Proposed GA Section DD

Client
FEC

CDE ID	Scale	Size	Rev.
RDB-MLA-2D-XX-DR-AR-01321004	1:200	A1	P0



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0 25 75m

FOR INFORMATION AND NOT FOR APPROVAL

Legend:

- Outline planning application boundary
- Potential bridge (not part of this application)

Rev	Details	Drwn	Chkd	Date
P1	Issed for Planning	AE	BC	21/04/23

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Proj. No.	Project	Status
524	Red Bank Manchester	Issed for Planning

Sheet Name	Client
Illustrative Masterplan	FEC

CDE ID	Scale	Size	Rev.
RDB-MLM-00-RF-DR-AR-211180	1:1250	A1	P1



REV	DATE	DRW	DESCRIPTION	CHK	APP
A	26/04/23	KF	FIRST ISSUE	JC	LG

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Matrix House, Basing View,
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Fax: +44 (0) 1256 318 70
www.wsp.com

CLIENT: FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: ARUP BASELINE VS FEC BASELINE IMPACT MAP 1 IN 100 YEAR EVENT WITH 2080 CLIMATE CHANGE

DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
	1:5000	26/04/23

PROJECT No:	DRAWING No:	REV:
70079268	79268-MR1-001	A

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384100 384350 384600 384850 385100 385350

400250 400000 399750 399500 399250 399000

NT04

NT03

NT02

0 100 200 300 400 m

KEY

Absolute Change

- <= -0.100m Major Beneficial (Decrease)
- -0.100m - -0.050m Moderate Beneficial
- -0.050m - -0.015m Minor Beneficial
- -0.015 - 0.015m Negligible (Transparent)
- 0.015 - 0.050m Minor Adverse
- 0.050 - 0.100m Moderate Adverse
- > 0.100m Major Adverse

Wet/Dry Analysis

- Was Wet Now Dry
- Was Dry Now Wet

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	2/03/2	KF	FIRST ISSUE	JC	LG

STATUS: FOR INFORMATION ONLY

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Fax: +44 (0) 1256 318 70
www.wsp.com

CLIENT: FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: 'Application 5' model vs FEC Baseline Model impact map 1% AEP + 35% climate change allowance

DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
	1:5000	24/04/23

PROJECT No:	DRAWING No:	REV:
70079268	79268-MR1-002	A

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400000 399750 399500 399250 399000 398750



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KEY

Absolute Change
- <= -0.100m Major Beneficial (Decrease)
- -0.100m - -0.050m Moderate Beneficial
- -0.050m - -0.015m Minor Beneficial
- -0.015 - 0.015m Negligible (Transparent)
- 0.015 - 0.050m Minor Adverse
- 0.050 - 0.100m Moderate Adverse
- > 0.100m Major Adverse

Wet/Dry Analysis
- Was Wet Now Dry
- Was Dry Now Wet

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	22/03/23	KF	FIRST ISSUE	JC	LG

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CLIENT: FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: 'Application 4' model vs Baseline Model depth difference map 1% AEP + climate change (central allowance)

DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
	1:5,000	24/04/23

PROJECT No:	DRAWING No:	REV:
70079268	79268-MR1-003	A3

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A	11/04/23	KF	FIRST ISSUE	JC	LG

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CLIENT: FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: 'Application 4' model depth map 20% AEP event

DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
	1:5000	11/04/23

PROJECT No:	DRAWING No:	REV:
70079268	79268-MR1-010	A

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383850 384100 384350 384600 384850 385100

400000 399750 399500 399250 399000

0 100 200 300 400 m

KEY

Depth (m) 3.3% AEP

- <= 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- > 4.0

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	11/04/23	KF	FIRST ISSUE	JC	LG

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CLIENT: FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: 'Application 4' model depth map 3.3% AEP event

DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
	1:5000	11/04/23

PROJECT No:	DRAWING No:	REV:
70079268	79268-MR1-011	A

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383850 384100 384350 384600 384850 385100

400000 399750 399500 399250 399000

0 100 200 300 400 m

KEY

Depth (m) 1% AEP

- <= 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- > 4.0

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	1/04/202	KF	FIRST ISSUE	JC	LG

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CLIENT: FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: 'Application 4' model depth map 1% AEP event

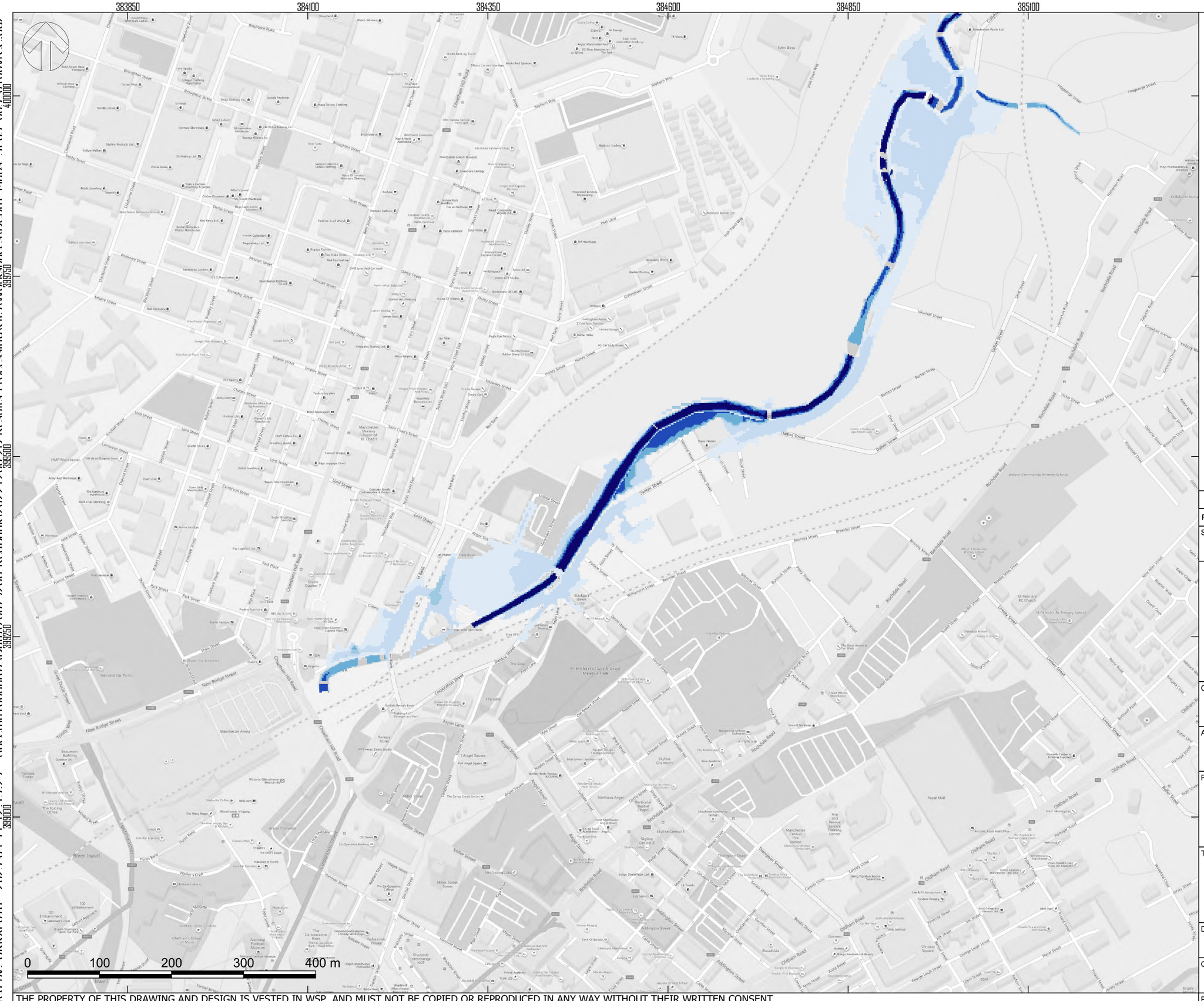
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KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
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PROJECT No:	DRAWING No:	REV:
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KEY

Depth (m) 1% AEP + CC central

- <= 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- > 4.0

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	11/04/23	KF	FIRST ISSUE	JC	LG

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CLIENT:

FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT:

-

PROJECT:

REDBANK & DANTZIC

TITLE:

'Application 4' model depth map 1% AEP event + climate change (central allowance)

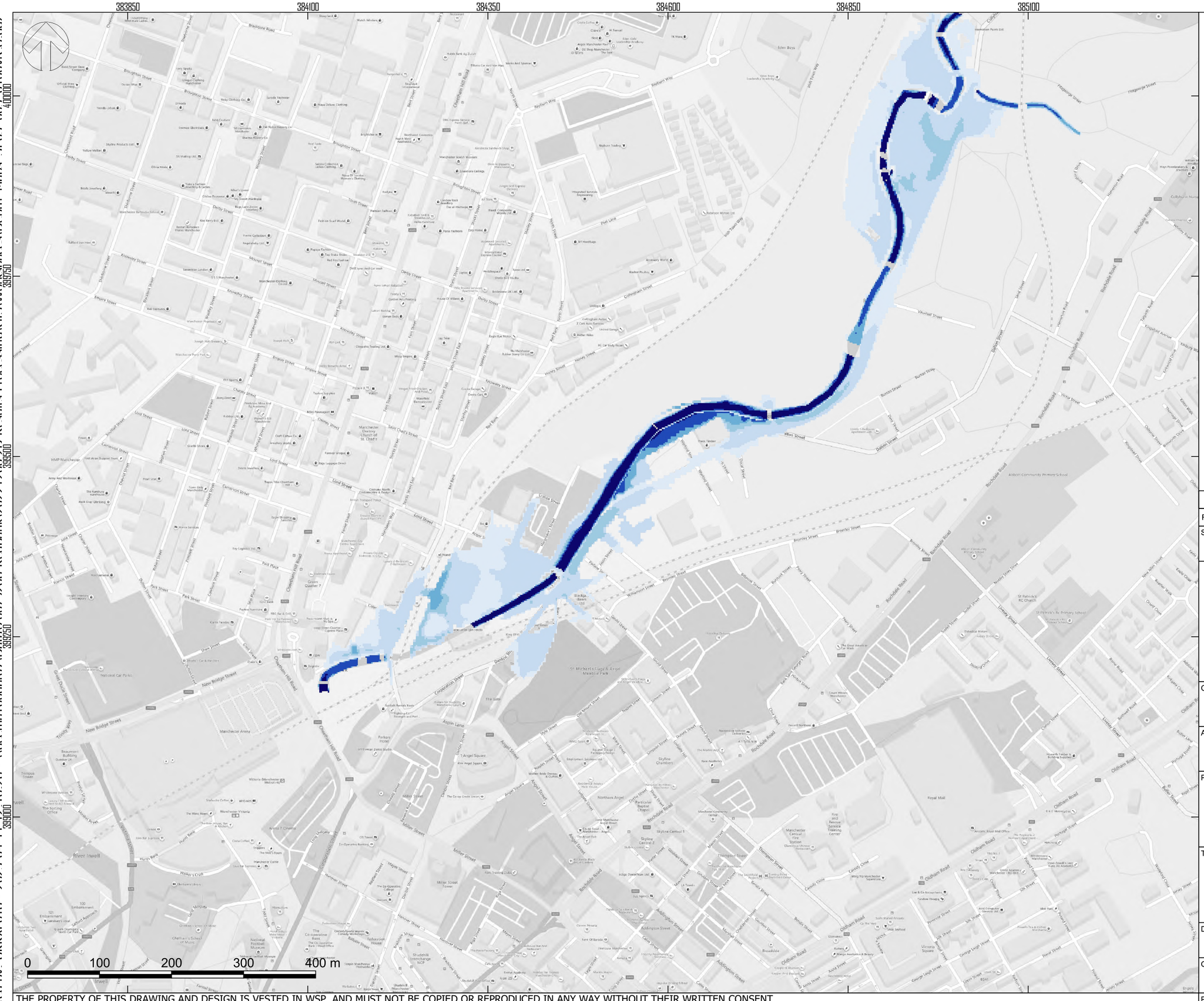
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KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
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PROJECT No:	DRAWING No:	REV:
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KEY

Depth (m) 1% AEP + CC (upper)

- <= 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- > 4.0

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	11/04/23	KF	FIRST ISSUE	JC	LG

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CLIENT: FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: 'Application 4' model depth map 1% AEP event + climate change (upper allowance)

DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
	1:5000	11/04/23

PROJECT No:	DRAWING No:	REV:
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383850 384100 384350 384600 384850 385100

400000 399750 399500 399250 399000

0 100 200 300 400 m

KEY

Depth (m) 0.1% AEP

- <= 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- > 4.0

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	11/04/23	KF	FIRST ISSUE	JC	LG

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CLIENT: FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: 'Application 4' model depth map 0.1% AEP event

DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
	1:5000	11/04/23

PROJECT No:	DRAWING No:	REV:
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KEY

Depth (m) 20% AEP

Band 1

- <= 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- > 4.0

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	21/03/23	KF	FIRST ISSUE	JC	LG

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CLIENT: FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: 'Application 5' model depth map 20% AEP event

DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
	1:5,000	02/05/23

PROJECT No:	DRAWING No:	REV:
70079268	79268-MR1-004	A

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383850 384100 384350 384600 384850 385100

400000 399750 399500 399250 399000

0 100 200 300 400 m

KEY

Depth (m) 3.3% AEP

- <= 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- > 4.0

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	1/03/2	KF	FIRST ISSUE	JC	LG

STATUS: FOR INFORMATION ONLY

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Fax: +44 (0) 1256 318 70
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CLIENT: FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: 'Application 5' model depth map 3.3% AEP event

DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
	1:5000	28/03/23

PROJECT No:	DRAWING No:	REV:
70079268	79268-MR1-005	A

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REV	DATE	DRW	DESCRIPTION	CHK	APP
A	/03/20	KF	FIRST ISSUE	JC	LG

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CLIENT: FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: 'Application 5' model depth map 1% AEP event

DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

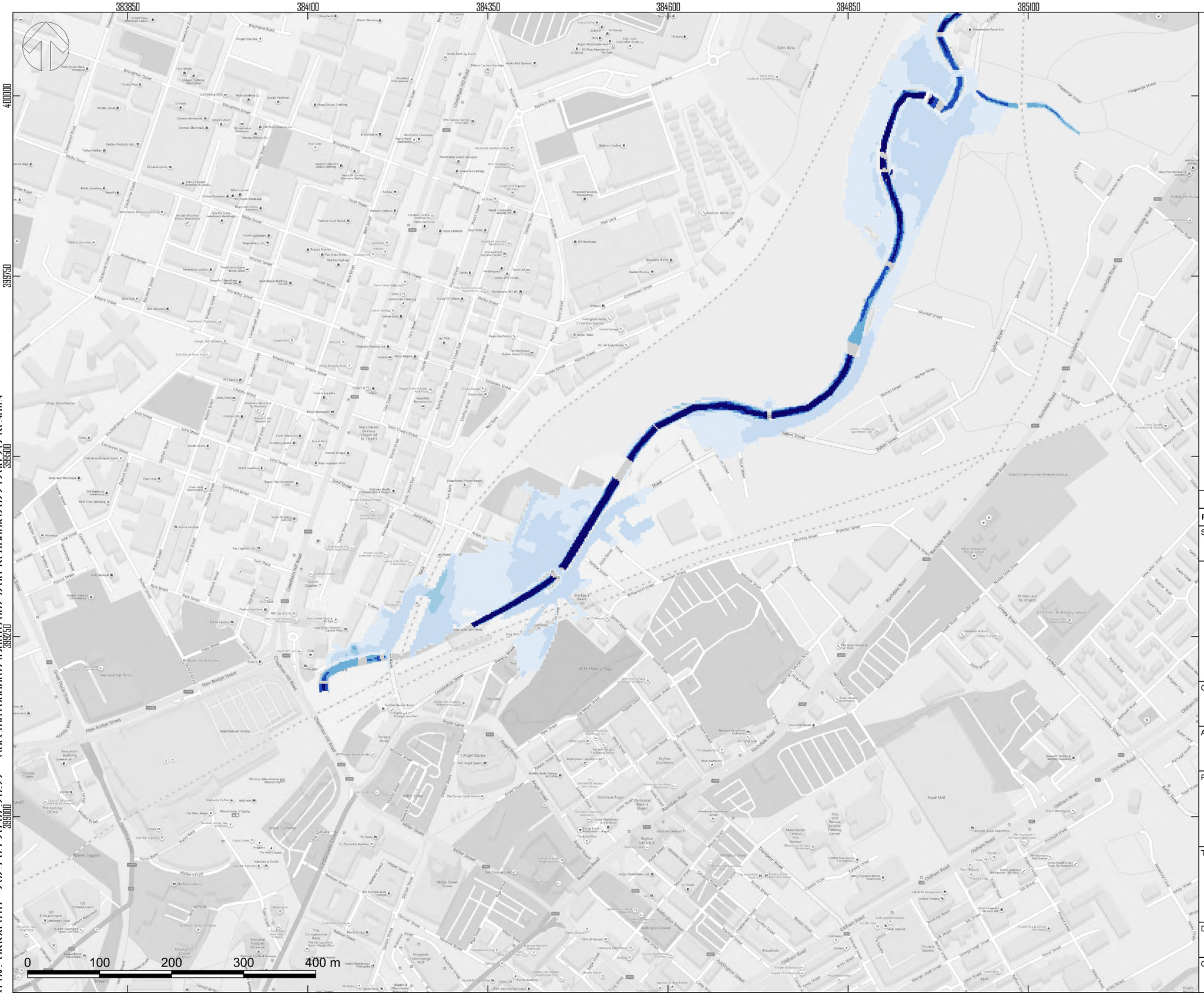
QGIS FILE:	SCALE @A3:	DATE:
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70079268	79268-MR1-006	A

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383850 384100 384350 384600 384850 385100

400000 399750 399500 399250 399000



KEY

Depth (m) 1% AEP CC (central)

- <= 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- > 4.0

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	3/03/2	KF	FIRST ISSUE	JC	LG

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CLIENT: FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: 'Application 5' model depth map 1% AEP event + climate change 35 % (central allowance)

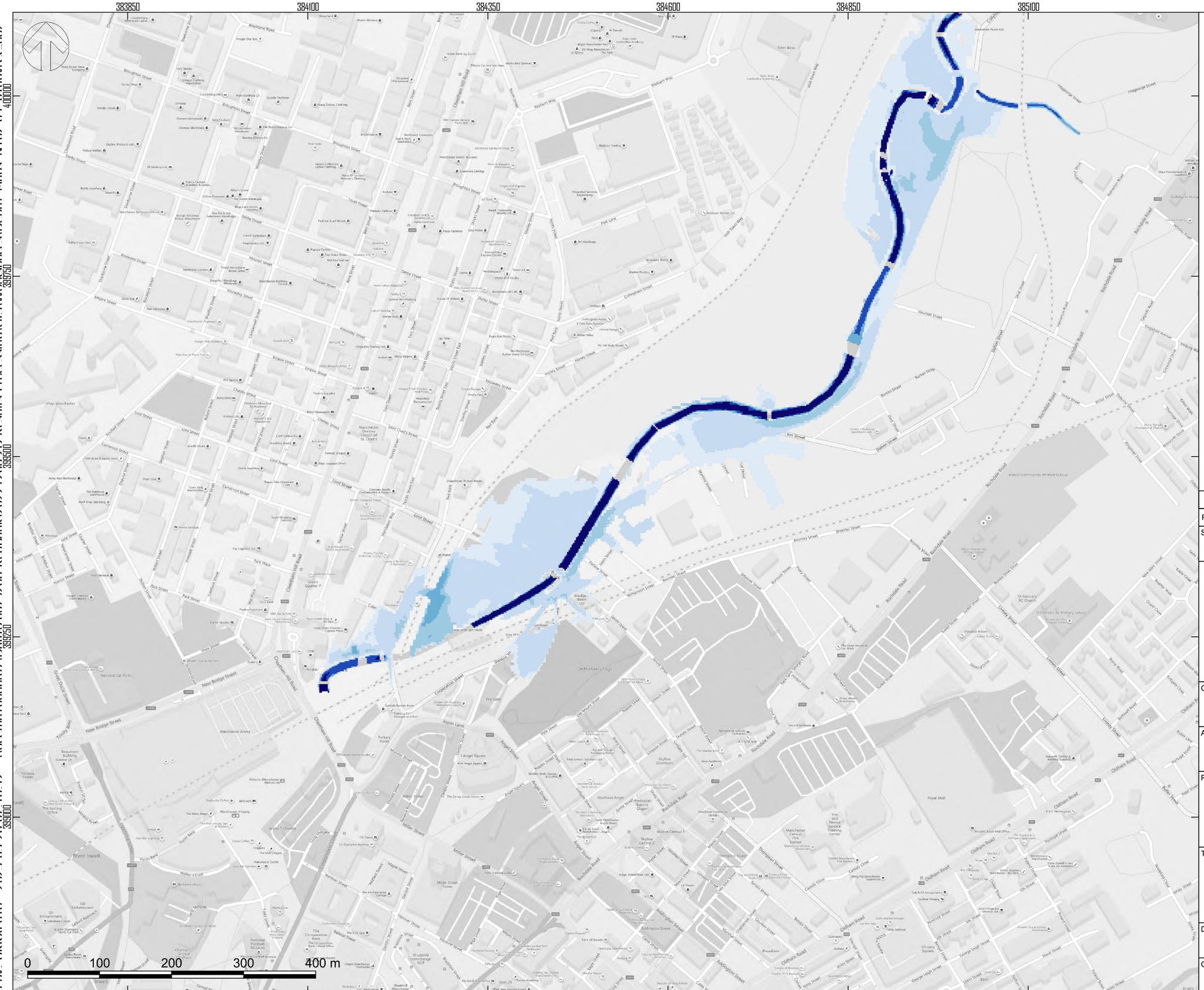
DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
	1:5000	28/03/23

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CLIENT:
FEC NORTHERN GATEWAY DEVELOPMENT LIMITED

ARCHITECT:
-

PROJECT:
REDBANK & DANTZIC

TITLE:
'Application 5' model depth map 1% AEP event + climate change (upper allowance)

DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
	1:5000	28/03/23

PROJECT No:	DRAWING No:	REV:
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383850 384100 384350 384600 384850 385100

400000 399750 399500 399250 399000

0 100 200 300 400 m

KEY

Depth (m) 0.1% AEP

- <= 0.5
- 0.5 - 1.5
- 1.5 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- > 4.0

REV	DATE	DRW	DESCRIPTION	CHK	APP
A	1/03/2	KF	FIRST ISSUE	JC	LG

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ARCHITECT: -

PROJECT: REDBANK & DANTZIC

TITLE: 'Application 5' model depth map 0.1% AEP event

DRAWN:	CHECKED:	APPROVED:
KF	JC	LG

QGIS FILE:	SCALE @A3:	DATE:
	1:5000	28/03/23

PROJECT No:	DRAWING No:	REV:
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