Manor Road, Richmond

Technical Note 1: Model Review and Response to LLFA Comments

12th July 2023

Document Status

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1 Introduction

1.1 This Technical Note has been prepared in response to comments made by AECOM on behalf of the Greater London Authority (GLA) in response to documents submitted and a meeting held between Avanton Richmond Developments (applicant), Avison Young and Hydrock via team on 5th June 2023. This meeting was to discuss previous consultation comments received from GLA but focused on the previously submitted Flood Risk Assessment (ref: 14075-HYD-XX-XX-RP-FR-0001 P12, dated: 27/02/2023 and 14075-HYD-XX-XX-RP-FR-0001 P12, dated: 04/04/2023) that was prepared by Hydrock.

1.2 Further to this Brookbanks have been appointed to undertake a review of the modelling works undertaken in order to address the latest comments provided (Ref: Manor Road: Stage 3 Comments (20-06-2023). For ease the comments have been included below (in bold) with a response to each laid out below. In addition to a response to the comments a section has been included to provide a summary of the modelling review undertaken by Brookbanks on the previously submitted Hydrock modelling files.

2 Response

GLA Comment: The primary risk of flooding at the site is from pluvial sources. The Applicant developed a pluvial hydraulic model to accurately assess the baseline and with-scheme flood risk to and from the site. The model does not include an allowance for drainage or infiltration so therefore provides conservative results. The proposed scheme includes localised lowering of public realm areas to maintain the existing flow route through site. Results show that key flow routes from the southwest corner would be maintained.

The hydraulic modelling report has been reviewed, with specific comments provided in the attached table.

2.1 As outlined above, Brookbanks have undertaken a detailed review of the previous modelling for both the pre- and post- development modelling files. This is to act as a further peer review of the works completed to provide further confirmation that the modelling, as confirmed by GLA, remains appropriate and a summary of the findings of this review are outlined below.

2.2 On review the 2d-code area (model domain) has been based on the contributing catchment area with this having been taken from the FEH generated areas. This is a sensible approach as will make an allowance for both all contributing flow routes and volumes through the site.

2.3 The input rainfall has been taken from an FEH unit within Flood Modeller to generate the Net Rainfall, which is a standard approach and acceptable. This has been applied via a bc_base with losses having been applied using a loss based on the Percentage Impermeable. It is also noted that these losses have been separated out within the domain for permeable (area of parkland at the upper reaches of the catchment) and for impermeable (built form around the site and downstream) areas. This again provides a detailed assessment and accurate representation of accumulation of flows and routes through the catchment.

2.4 The rainfall events used within the model are all considered as being appropriate with a suitable range having been modelled – including the 1 in 5 year and 1 in 1,000yr. The modelling has focussed on the 1 in 100 year plus 40% allowance for climate change event as the design event and this is again in line with standard requirements. It is this event that has been modelled for the post development scenario which has been agreed with the GLA.

2.5 The modelling report prepared explains that the modelling does not include any below ground drainage either for the baseline or proposed event. This approach, as detailed within the report, follows general guidance for direct runoff modelling but has been highlighted as being a conservative approach.

2.6 The model type used, TUFLOW is acceptable and it is agreed that this is a suitable approach as all features within this model are 2D elements only – i.e. there are no floodplain features (channels, culverts etc) that have been included. This is something the report discusses and confirms as, again, being conservative. However it should be noted that given the railway line located to the immediate north of the site is located within a cutting, no obvious features are present that would affect the level of flooding at the site and therefore this assumption is unlikely to impact flow routes or predicted depths at the site. This is considered a suitable assumption.

2.7 With respect to the grid this has been generated predominantly through LiDAR but where topographical survey is available (i.e. the application boundary) this has been utilised but is limited to the site boundary only. This is

an accepted approach provided that a ground truthing exercise has been undertaken to ensure that use of these two data sets (LiDAR and Topographical survey) combined well without any artificial stepping at the boundaries of the data sets. Whilst this hasn't been detailed within the Hydrock report a check of the provided modelling files confirms good correlations with no stepping being shown on review of the DEM-Z files.

2.8 Having reviewed the ground levels it is also evident that the provided modelling files have included both 'stubby buildings' and lowered the surrounding road network. The report details this was a request from the GLA in a previous review but it should be noted as also being a national requirement for this type of modelling. A review of the DEM_Z has confirmed that the modelling includes buildings being raised 300mm above surrounding ground levels and the road network being lowers by 125mm. Therefore the guidance, and previous GLA request has been met.

2.9 Within the model it is noted that the downstream limit of the domain is around 550m downstream of the proposed development site. On initial review this is considered as being excessive but it would not impact flood levels at the site. However, and for determining the impacts of any of the proposals this provide a significant distance to better understand the impacts of any change in flood levels are a result of the development.

2.10 A review of the modelling has confirmed that this was run using TUFLOW HPC and therefore an important check of outputs is to review the dt, Nu, Nc and Nd values to understand the general health of the model. All of provided outputs are within tolerance at and immediately around the peak of the rainfall event and therefore any areas where tolerance are exceeded (albeit negligibly) wouldn't impact the peak flood levels for further use within this assessment. It should be noted however that whilst all are acceptable the Nc plot does reach a value of 1 which suggests low cell elevations which may result in artificially increase depths. When comparing the location of these Nc values with the provided flood depth outputs the depths are in excess of 1.5m – which justifies the Nc value – but are around 750m south of the site and localised. As such this would again result in not impact on peak flood levels and a check run has been run and confirms the difference in flood depths with lower Nc values at the site is 0.001m and therefore inconsequential.

2.11 A review of the Mass Balance outputs have also shown the model to be well within the acceptable tolerance of +/- 1%. This along with the other checks have confirmed that the model is considered as being stable and therefore acceptable.

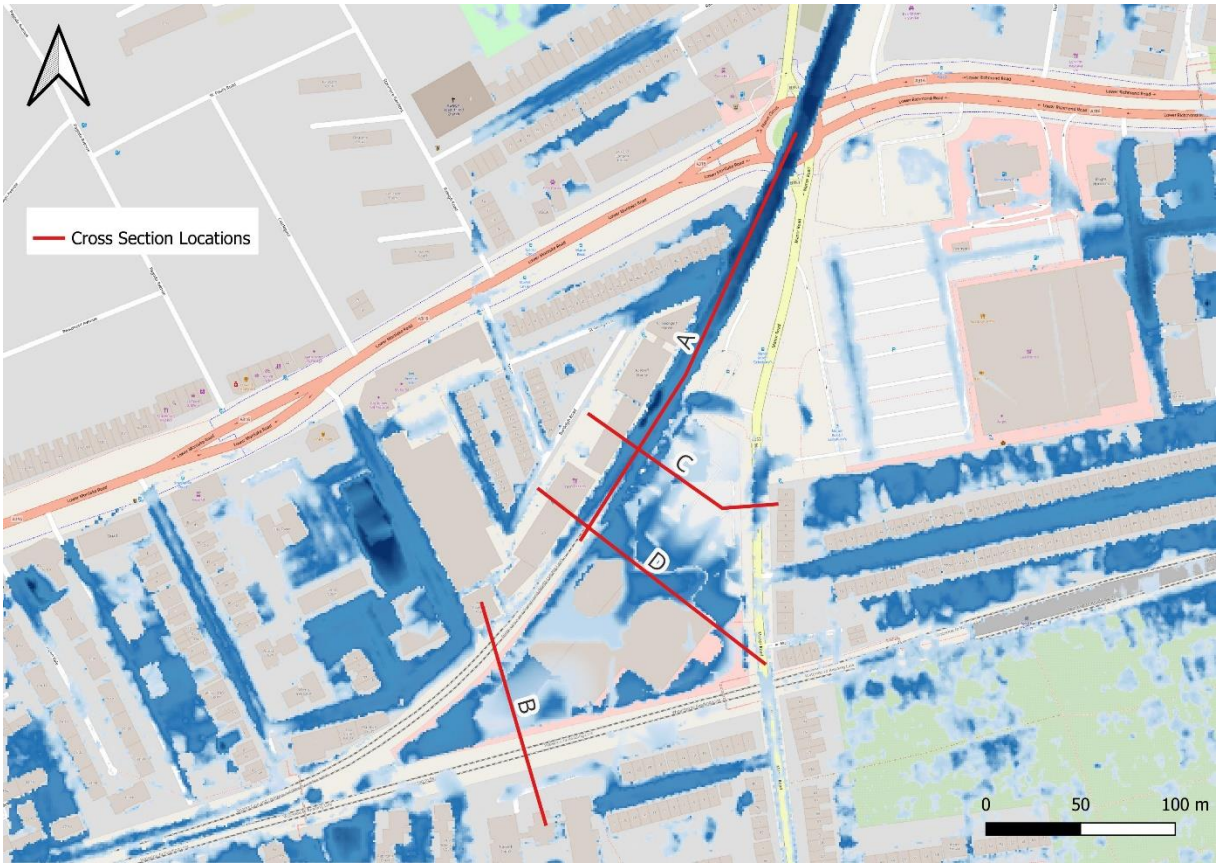
2.12 The provided modelling files include a post development scenario. These have been reviewed to ensure they provide consistency with the latest site and engineering plans for the proposed development site. This has been undertaken and confirms the level represented within the modelling have a good correlation with the engineering plans and therefore suitable for use in assessing any impacts of the proposals. It would appear that with the exception of the proposed building blocks all of the proposed changes for ground levels are to provided lowered areas and therefore this would provide increase storage within the site.

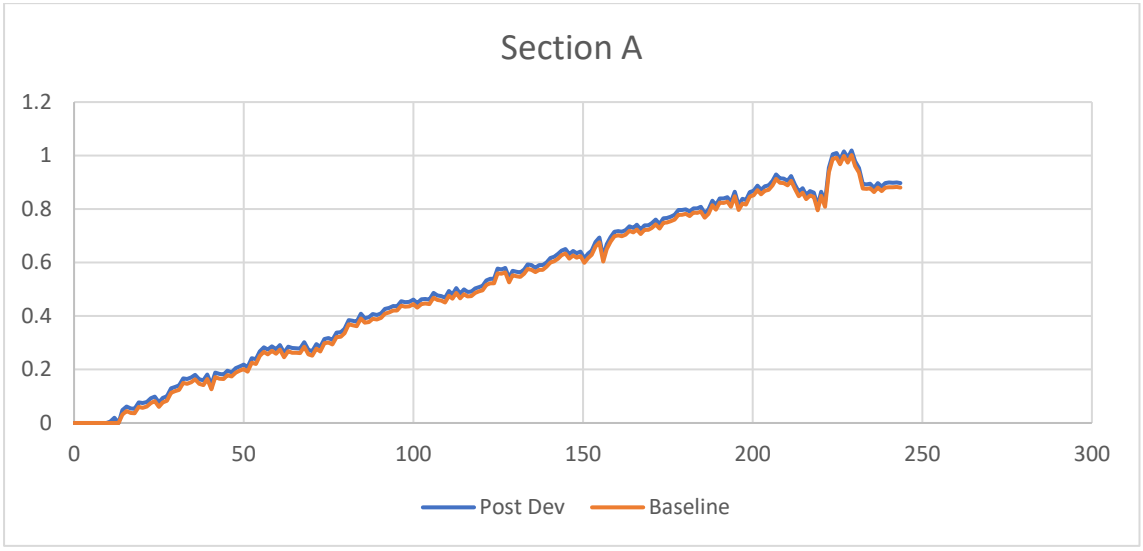
2.13 The works undertaken have not included a review of the outputs of the modelling as it is noted that the main outstanding comment from GLA relates to the increases off site as a result of the proposals. Given all input values has been undertaken and confirmed as ok, and all check files reviewed and confirmed the model is stable the specifics of the outputs has been addressed in response to specific GLA comments below.

GLA Comments: With-scheme model results show an increase in flood depths between 20-25mm on the adjacent railway which is stated to be within accepted model tolerance for surface water modelling. There is no reference to back up the statement that 20-25mm is within model tolerance; this needs to be provided in order to demonstrate that these increases could be considered negligible. The impact shown on the railway could lead to difficulties with Network Rail.

2.14 Further justification was provided (by Hydrock) which stated that the proposed off-site increase depth only affects a localised area to the immediate north of the site. On review of the outputs, and having done a comparison of the pre and post development grids, the maximum increase was shown to be 23mm for the 1 in 100 year plus 40% allowance for climate change design event. This increase was limited to the existing railway line.

2.15 The only other increases shown as a result of the development are within the application site and areas purposefully designed to provide additional storage – some of which are around 0.4m lowered than current levels. No other increase to third party land is predicted within the modelling that GLA have now approved, see below.

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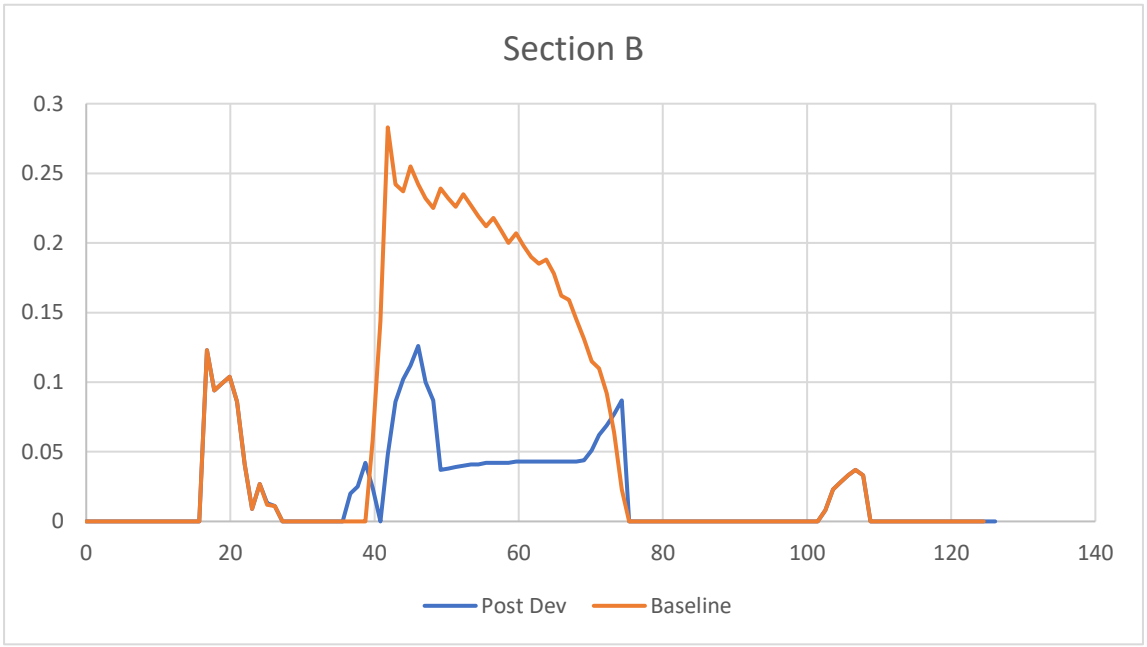
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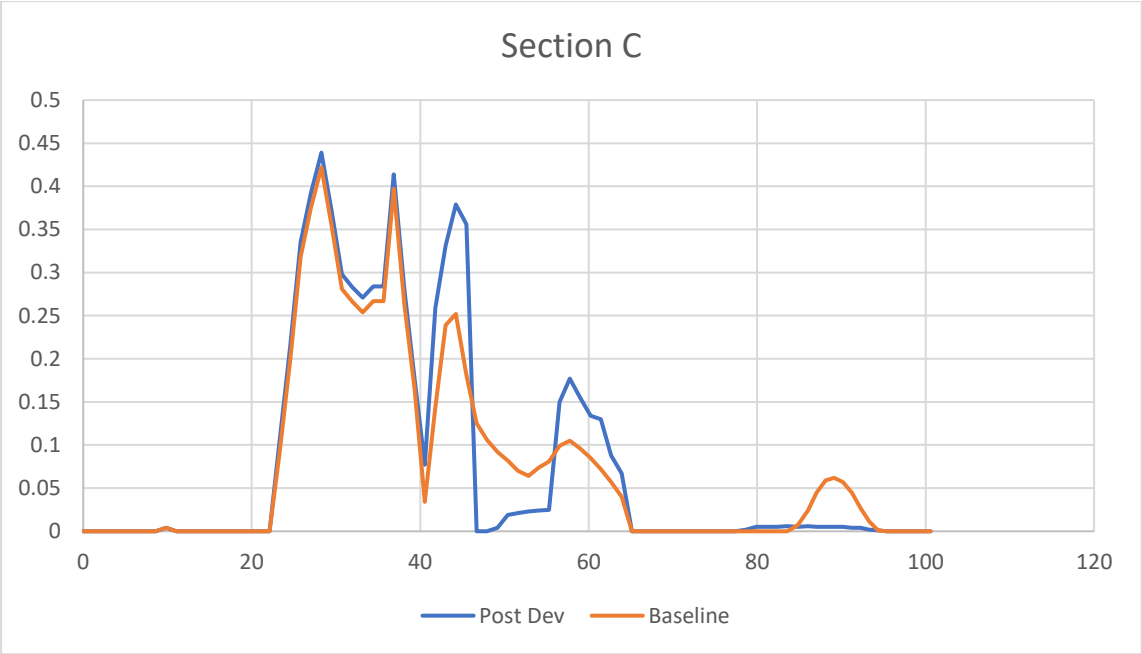
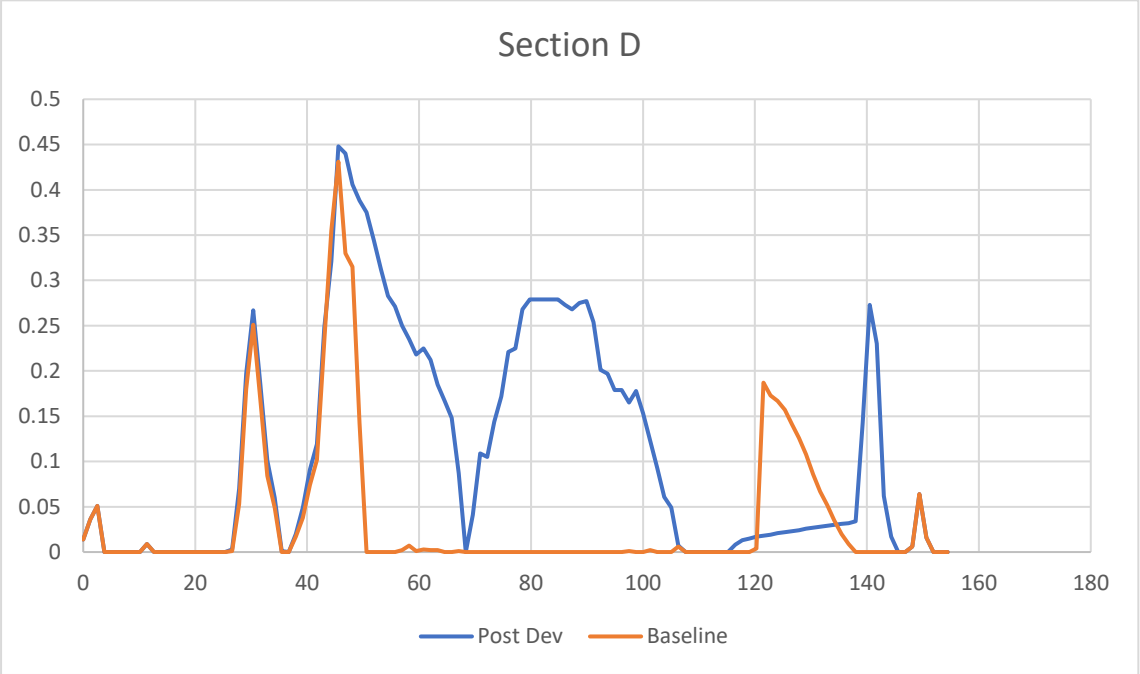




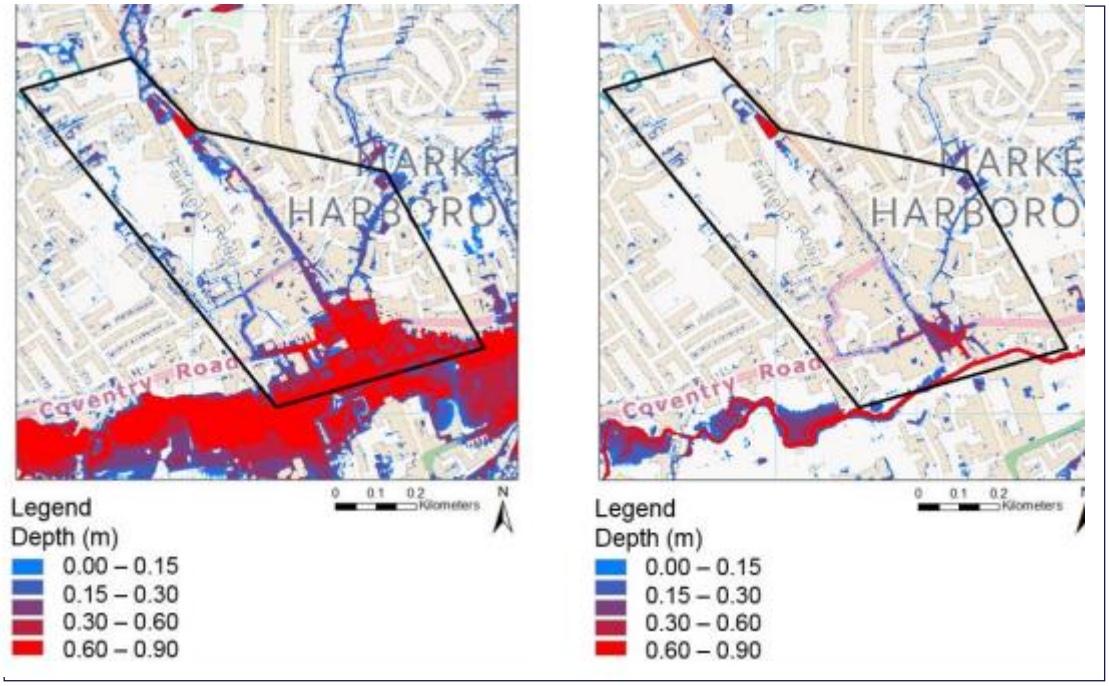
2.16 In order to try and mitigate the increased flood depth on the railway line, a significant number of options for the development have been investigated and modelled. On completion of these options the above outputs are the 'best available' whilst working to other constraints within the site (drainage requirements, level access, viability of the scheme etc). Whilst it is noted there is a localised off-site increase (albeit 23mm), it is considered that, and in line with EA guidance for pluvial modelling, the constructed model is conservative as it makes no allowance for existing or proposed drainage networks. Whilst there is a section of undeveloped/parkland at the upstream limit of the catchment (to the south of the site) the surrounding catchment is shown as being heavily developed and would be served by a complex engineered drainage system. It is therefore widely accepted that the existing network would provide a significant capacity to accommodate surface water flows generated and convey these rather than all rainfall generating overland flows routes (i.e. as the modelling does). On this basis, and as has been discussed, the modelling provides a conservative assessment of surface water flows for urban areas as it assumes all drainage systems have failed. It is therefore considered that the modelling undertaken (which is to replicate the approach taken for the

surface water mapping) provides the 'residual' risk in areas where complex drainage networks exist. Therefore, and in reality, the depths of flooding at the site and the surrounding area would be reduced from those shown.

2.17 The above is something that is well known within the industry and features within an Environment Agency report – Improving Surface Water Flood Mapping : Estimation Local Drainage Rates (Project Number SC120020, Dated February 2019) which states the following:

It is assumed that detailed hydraulic models of urban areas, including underground piped networks, will generate a more robust flood map than simplified direct rainfall methods as applied in the uFMfSW.

2.18 The report continues to focus on 5 catchments to investigate the difference in flow rates and therefore flood extents through using national and local rates. Both of these events were run and the below figure from the same report confirms that using the more local dataset and more detailed base data for generating the depths produces significant reduced flood extents.



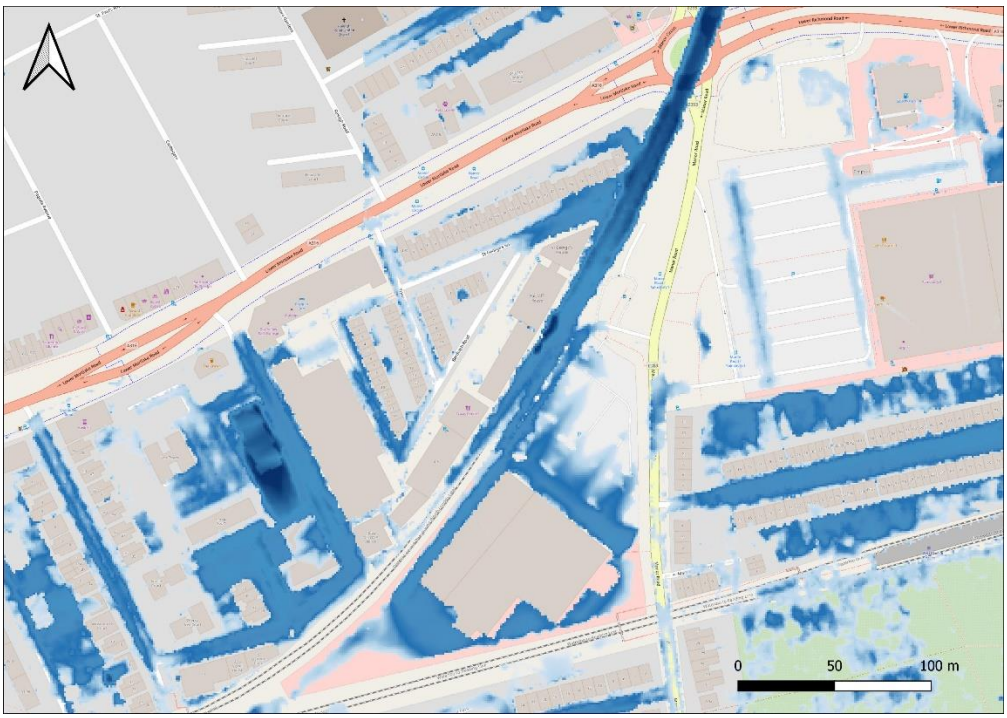
2.19 The approach outlined in this published document confirms that the modelling undertaken for Manor Road is therefore an overestimation and builds in a significant factor of safety. This is further confirmed given the extensive nature of the drainage network serving the catchment.

2.20 Given the significant difference within the report an assessment was undertaken to determine what, if any, impact the inclusion of only the proposed site drainage would have on the flood extents and depths. This was to confirm whether the approach being adopted was almost too conservative. In order to achieve this the proposed attenuation tanks and proposed sewer network (as per the submitted drainage strategy document) were built into the model. The boundary condition for this was modelled as a pumped system again to ensure consistency. Owing to a lack of available data no off-site drainage was included and it was only the proposed on-site drainage.

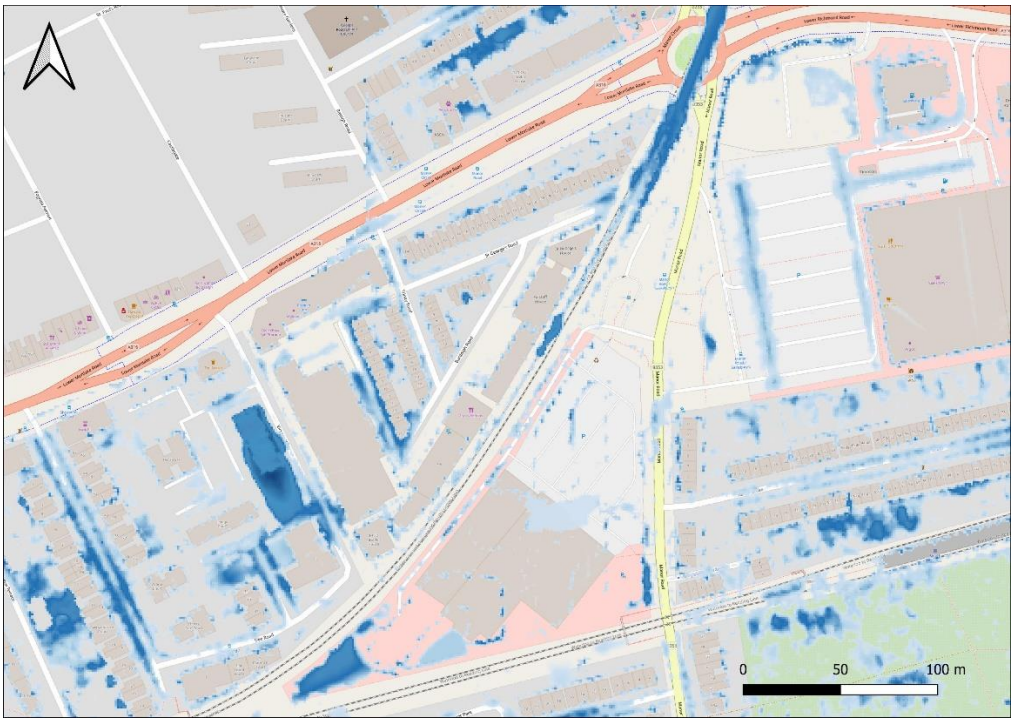
2.21 The outputs from this scenario demonstrate that when including the onsite drainage the flood extents and depths are significantly reduce from the baseline scenario AND the 'no drainage' post development scenario details. To illustrate this the below figure shows both the baseline and the 'post development drainage' option.

As can be seen there is a significant reduction and specifically to and along the railway line.

Baseline

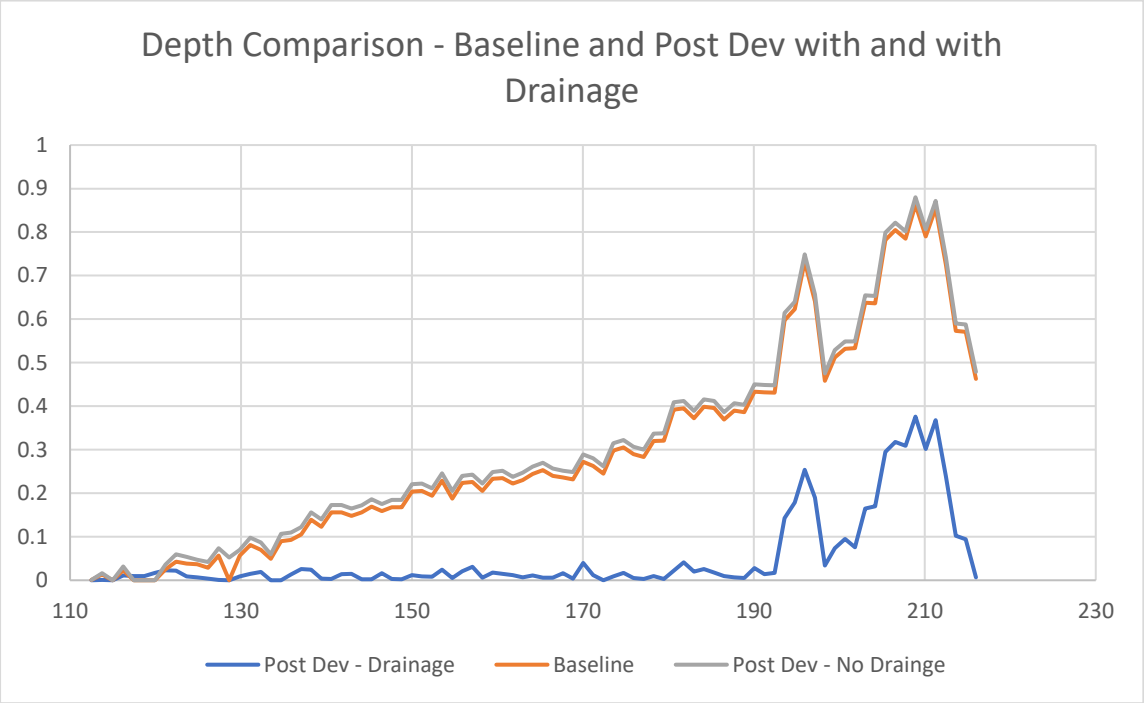


Post Development with Drainage

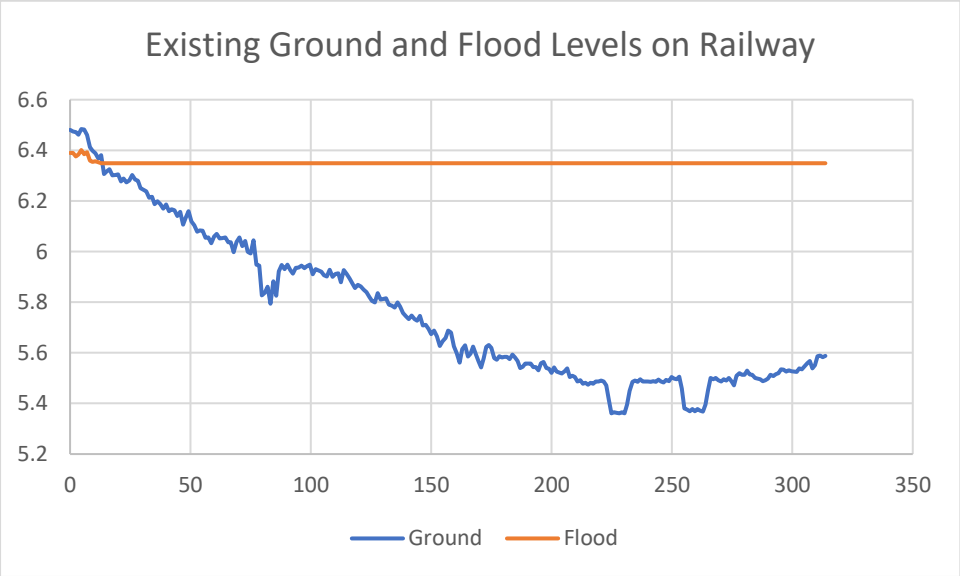


2.22 On comparison of predicted flood depths the on-site drainage results in a significant betterment and removes vast areas of flooding from the adjacent railway – with a maximum decrease compared to baseline of circa 250mm. It is reiterated that this difference is only when including the proposed site drainage and does not

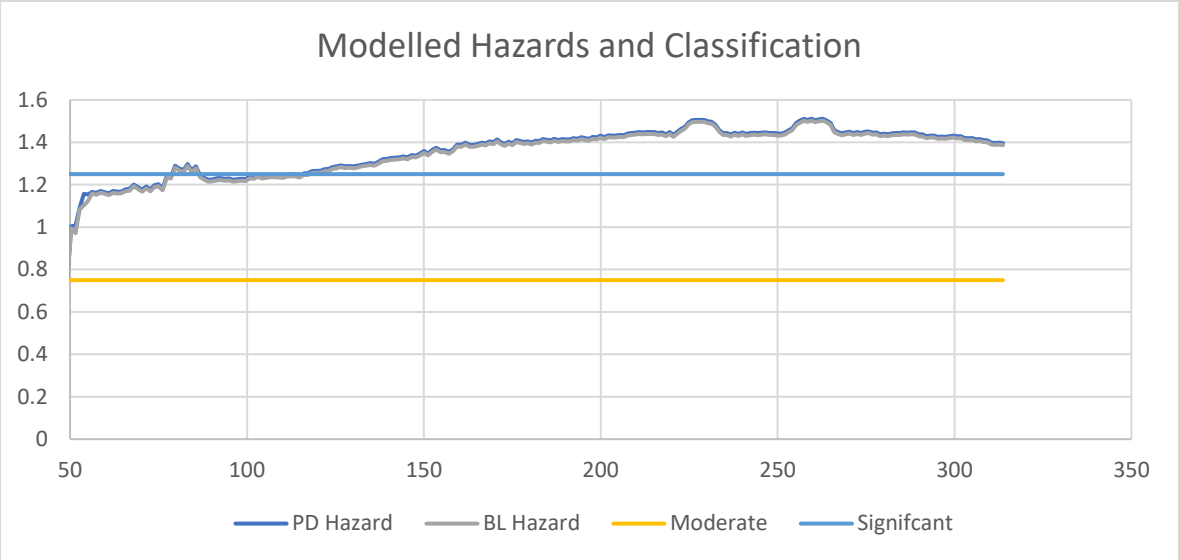
include any existing Thames Water sewers serving the surrounding area so would maintain as given conservative outputs. Along with the outlines a comparison graph showing the difference between the three events is shown below. These values have been taken running west to east along the railway line for the length of the site boundary.



2.23 In the event that the above does not provide significant justification to address the conservative nature of the modelling and the impact of including the on-site drainage on third party increase (i.e. only a betterment) and looking at the comment on a site specific level, it should be noted that the area where increased flooding is predicted is within an existing low point occupied by a railway line. From available topographical data, see below, this area is naturally low compared to the surrounding area and acts as a bowl and is shown in the baseline scenario (i.e. no development) to a maximum depth of >1000mm, see below.



2.24 This therefore confirms that this area is currently liable to extensive flooding and these depths would have a significant impact on the operation of the railway in any such event – the baseline modelling has confirmed that the existing hazard along this section of the railway is 'Significant' in line with DEFRA 2320 guidance document and whilst the values increase by a small amount as a result of the proposals (1.29 in baseline to 1.31 in the proposed) the railway remains unchanged and at a 'significant' risk, see below. As such this would not impact the operation of the railway given it would already be under water and operational procedures would have been enacted by the rail provider and this is unaffected as a result of the development.



2.25 Given the existing level of risk the 23mm increase, which is local to this lowered area only, would represent a 2.3% increase when compared to existing depths. It should be noted that this increase has previously been discussed with the GLA and they confirmed via email on 13 January 2023:

With-scheme model results show an increase in flood depths between 20 – 25mm on the adjacent railway which is stated to be within accepted model tolerance for surface water modelling. These increases are considered negligible (within model tolerance) given the existing large depths (>1000mm) already predicted.

2.26 Given that AECOM have no approved the modelling the level of increase can be confirmed as being 23mm. On the basis of the above paragraph the modelling have confirmed the increase is within the quoted difference and therefore it is considered that the increase is acceptable on this basis. Further to being within this range it is reiterated that this is an area that is currently liable to extensive flooding, the modelling is representative of a residual risk in that all drainage in the area (including site) has failed, and it has no impact on the operation of the railway line as Hazards are unchanged.

2.27 It is considered that given the modelling has been approved both via GLA review and by a Peer Review undertaken by Brookbanks that the statement within the email (dated 13 January 2023) is suitable met. Whilst this is not necessarily in line with policy wording per se it should be noted that significant justification is available to demonstrate acceptability both in relation to the conservative nature of the modelling, the existing level of risk, and the existing hazards to this area being unaffected.

2.28 On review of information provided by GLA they have made reference to an acceptable 'model tolerance' of 10mm. However, on review of the Flood Modelling Standards for River Systems on the .gov.uk website, and through reading the Chartered Institution of Water Environmental Management Urban Drainage Group's 'Rainfall Modelling Guide (dated 2016) which is referred to on the .gov.uk document as a point of reference for

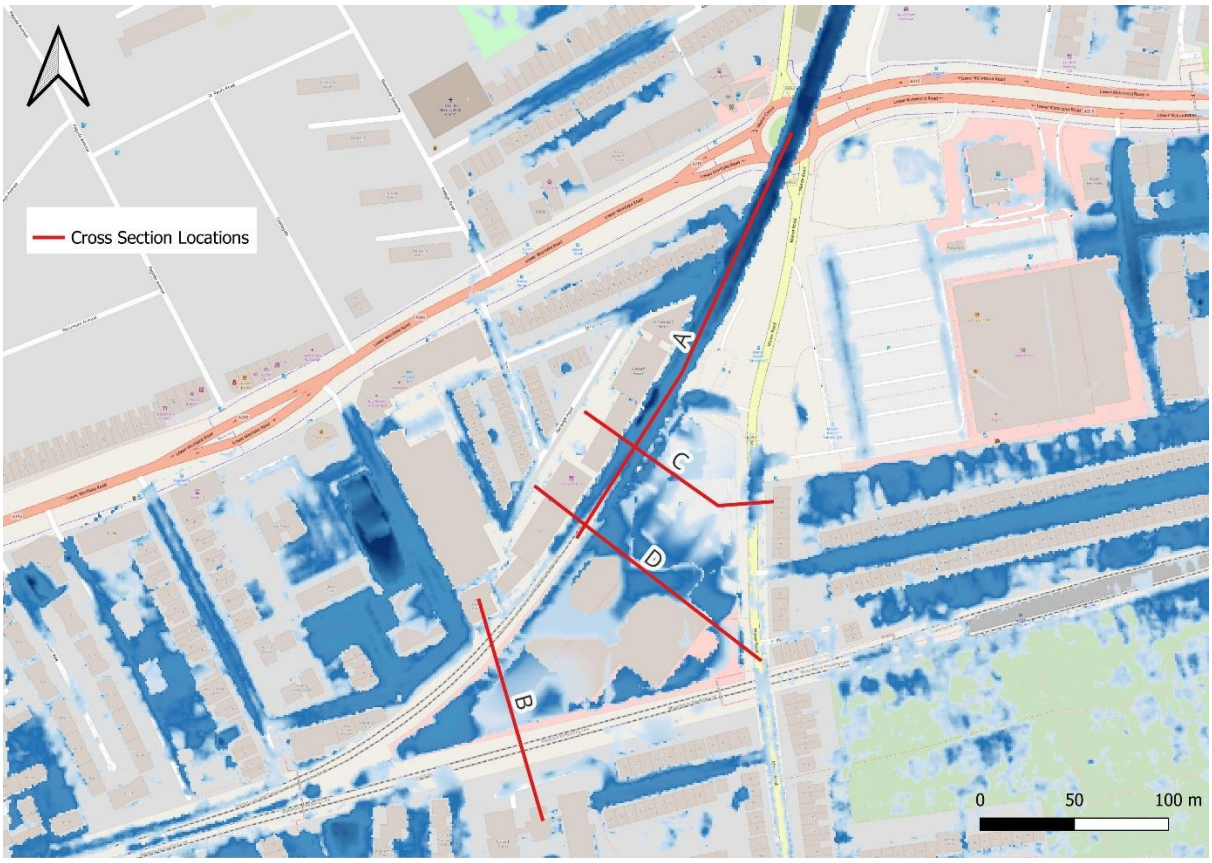
further guidance, no reference is made to an acceptable tolerance in terms of surface water modelling outputs and potential offsite increases – i.e. no set tolerance.

2.29 The only reference to model tolerances was found within the TUFLOW Manual (Version 2018-03). Within this document is reference to any modelling being a mathematical representation of reality and there will inevitably be some discrepancies. Whilst it states that this is a known potential issue across all models (rainfall, fluvial, coastal etc) differences are to be addressed through measures such as applying freeboard for any 'sensitive' elements. In the case of the proposed development site this has been achieved through raising finished floor levels above the predicted peak surface water flood level AND inclusion of a freeboard – therefore this is in line with wording within the TUFLOW manual as can be managed

2.30 Further to the above the TUFLOW manual refers to this tolerance being plus or minus 10mm but specifically states that this is for fluvial models. No reference in the TUFLOW manual is made to an acceptable tolerance for rainfall runoff modelling and it would be welcomed for GLA and their consultant to provide a reference (and paragraph numbers) for the requirement they have referred to. Additionally, it should also be noted that this document is not a policy or guidance document and is purely a manual for software produced by a private company. Therefore it is considered that any potential increase in flood depths is to be assessed on a site by site basis and on its own merits. For example if the increase were to result in increased depths to an existing development considered as being 'highly vulnerable' then that should be view less favourably that a small increase in flood depths toa transport network when management and alternatives are available such that users are not placed at increase harm / risk as a result when compared to existing conditions. On this basis it is considered that the previous discussions with GLA (and as referred to in the email of 13 January 2023) hold more weight based on this being a detail assessment that acknowledges model limitations (i.e. no drainage system included) and the potential impact as a result of the proposals (i.e. a 2.3% increase on an area already flooding to a depth of greater than 1000mm).

GLA Comment: Depth change figures should be provided to show the extent of the impacts.

2.31 This point has previously been discussed with GLA and it was the view that the modelling files previously provided by Hydrock allowed the reviewers to undertaken their own review of the outputs to avoid being restricted to points chosen by those producing the drawings. This is often an approach adopted to allow complete transparency for the review. However this comment indicates that depth change figures are required. As such, the below figure (as that above) provides the location of four cross sections that have been taken through the site and surrounding area along with associated graphs taken from the approved model results to show the difference in baseline and proposed flood depths. All of these graphs have been generated for the agreed design event of the 1 in 100 year plus 40% allowance for climate change event.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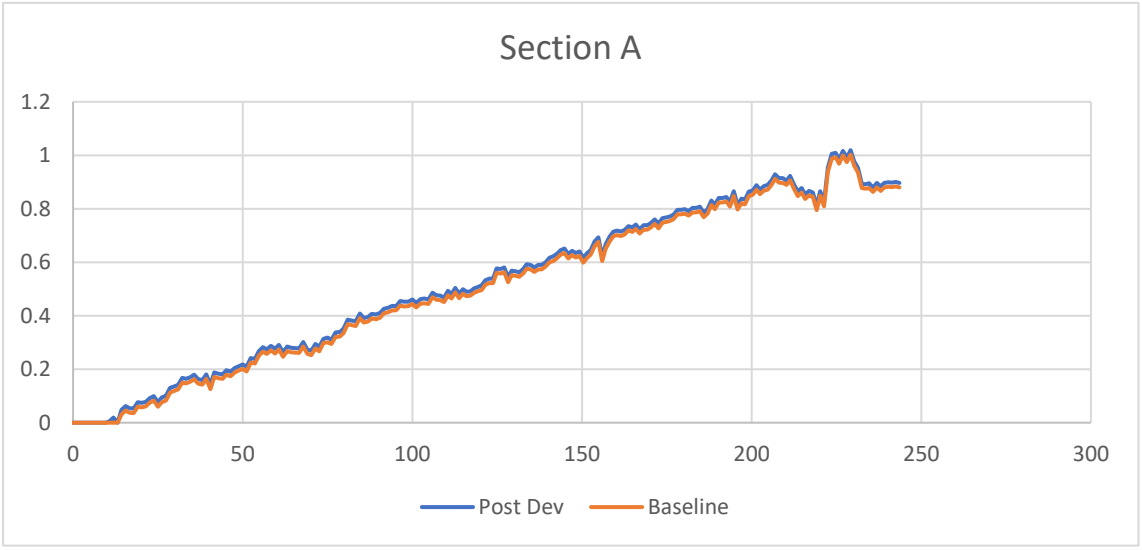
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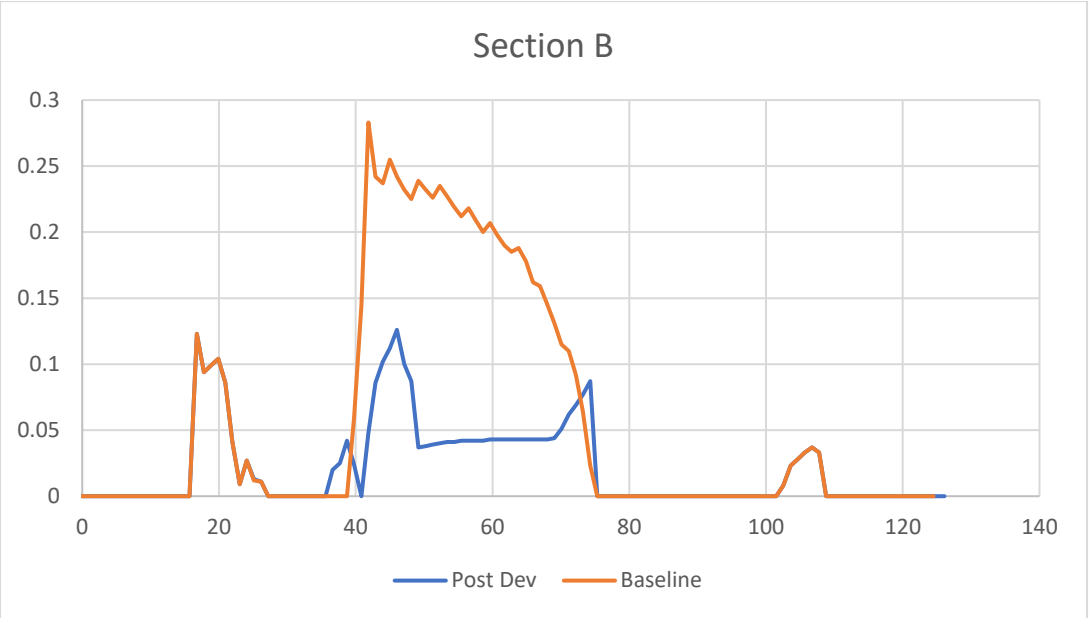
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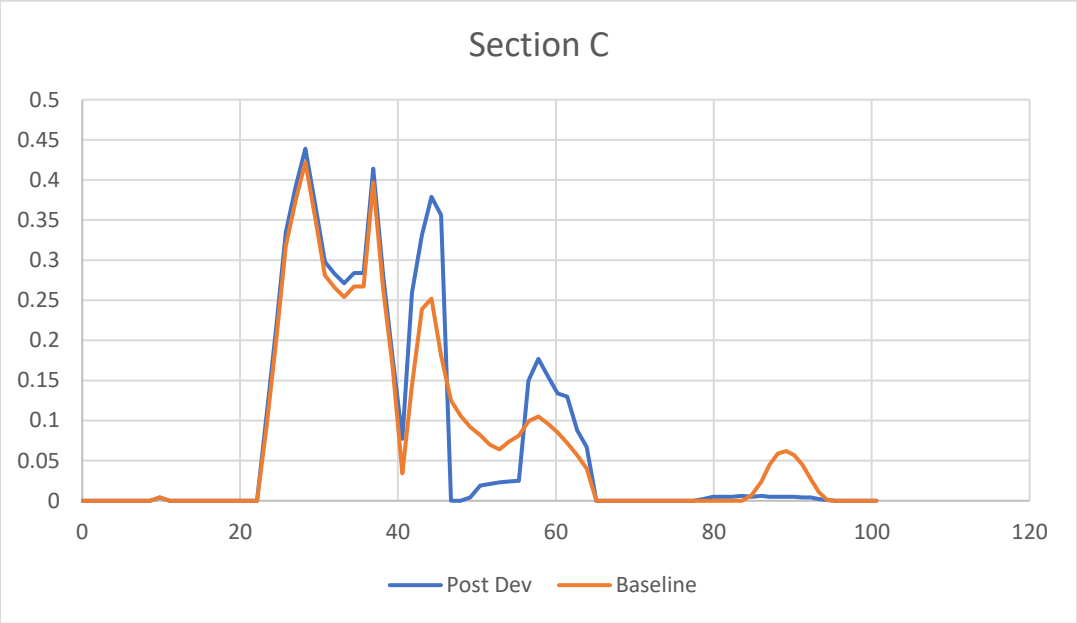
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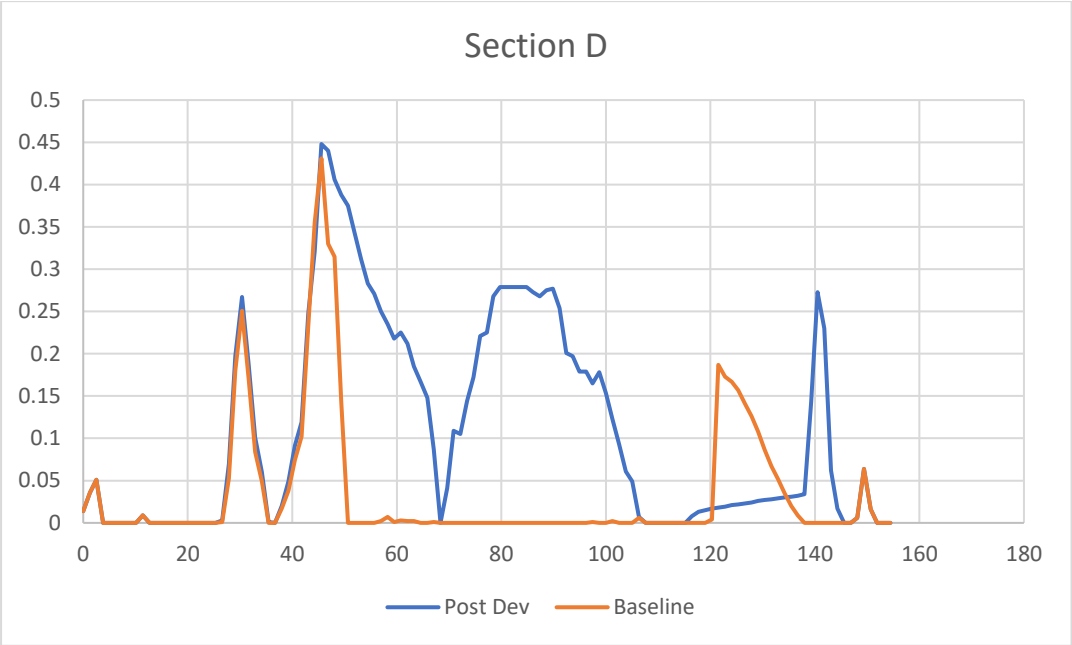

2.32 As can be seen from the above figure and associated graphs, flood levels throughout the application boundary are shown to increase in areas with most being within the site boundary – Section B, C and D. These have been purposefully designed to mitigate / reduce any off-site impact of the development. These areas are therefore shown as functioning correctly by providing more storage than the existing scenario.

2.33 The above figures and graphs also confirms that with the exception of a small area of the railway no other increases in flood depth are predicted section on the railway where a maximum increase of 23mm is shown. It should again be noted that the existing depth is 'significant' and a maximum of 1000mm in depth.

GLA Comments With-scheme model results predict internal flooding to Blocks C, D, and at entrance of Block A with maximum depths of 80mm (in Block C). The report states that FFLs have been raised as high as practically possible whilst ensuring level access and minimising offsite increase in flood risk. Flood resilience measures are proposed. A plan should be provided to show what the proposed uses and vulnerability classifications are at the exact locations where internal flooding is predicted. Flooding of communal lobbies/entrances may be acceptable.

2.34 On review of the provided modelling this does not result in any flooding entering the buildings with all floor levels being, with freeboard, above the flood level for the 1 in 100 year plus 40% allowance for climate change event. This results in All blocks of the development being above the flood depths. Therefore any flood resilience measures proposed (which are limited flood boards at entrance points) are not explicitly required but are being proposed so as to adopt a design for exceedance approach.

2.35 To confirm the above, the post development flood extent within the site is 6.35m AOD compared to a proposed finished floor level of 6.45m AOD for Block C and 6.75m AOD for Block D. This confirms that no internal flooding is predicted and, at minimum, a freeboard of 100mm above the flood level has been provided.

GLA Comment: The Flood Warning & Evacuation plan mentions seeking refuge on upper floors. A plan to demonstrate that there are communal areas available for this with stair access from all affected ground floor areas should be provided.

2.36 The Flood Evacuation Plan that was undertaken by Hydrock (ref: 25608-HYD-XX-XX-RP-FR-0004 P03 - FWEP, dated March 2023)) has stated that the reasons for the plan being required are in relation to the proposed failure / breach of reservoirs. These being located to the west of Heathrow Airport, including the Queen Mary Reservoir. In the event these were to fail available mapping from the .gov.uk website has confirmed that the site would experience inundation. Within the Hydrock report no details have been provided as to the predicted maximum depth or rate of inundation (i.e. how long from a breach until the site experiences flooding).

2.37 Whilst this date has not been included it is noted the proposed approach is for residents to evacuate if safe to do so and failing that safe refuge is to be sought via using the roof space of each block. However it should be noted that the closest source of reservoir flooding (as shown on the EA's mapping) is around 6km to the west of the site and therefore even in the event of a breach, and in the absence of data being available, it is considered that significant lead in time for evacuation and suitable measures would be possible.

2.38 Given the potential lead in time prior to inundation this is considered suitable to move welfare facilities (first aid kits, food, water etc) from a store room within the lower levels of the building (all above worst case surface water flooding) along with erecting temporary shelter structure on the roof of the building if required. This would all be undertaken by trained personnel either who reside in the buildings or via a management company.

2.39 Within the response the GLA have noted that whilst internal access to the roof spaces of all blocks is possible for the majority of apartments there is a small number of units which would be unable to access this via internal routes. However owing to the design and viability of the proposed development it is not possible to alter this but as outlined above; through implementation of the proposed plan, the warning times from first breach, and the presence of trained personnel it is considered that suitable management for occupants of these units is available so as either to ensure quick evacuation or alternatively being moved to areas of safe refuge on the roof space.

2.40 It should be noted, and as has previously been discussed and agreed with GLA in meetings, the risk associated within a breach / failure of the reservoirs is considered extremely low and referred to in strategic documents (including the Richmond Borough Strategic Flood Risk Assessment (SFRA)) as being more of a 'residual' risk owing to the managed nature of the reservoirs. In line with The Flood and Water Management Act (2010) and The Reservoirs Act (1975) all impounded bodies of water that are designated as a reservoir are subject to stringent management requirements. Whilst evidence of these ongoing reviews and conditions of the reservoirs are not made publicly available it is acceptable that the regularity of these reviews means suitable management and mitigation can be implement such that the breach risk is significantly reduced (often seen as being 1 in 10,000 chance in any one year) and therefore these risks are unlikely and residual. Whilst the GLA have agreed that any such risk is 'residual' confirmation the above further justification is considered suitable to meet policy requirements on this matter whilst noting more specific elements (such as personnel and detail plans) would be secured via condition.