herrington
CONSULTING LIMITED

Client: Dover District Council
Modelling the River Dour, Dover Mid-Town, Kent

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Canterbury Office
Unit 6 & 7
Barham Business Park
Elham Valley Road
Barham
Canterbury
Kent
CT4 6DQ

London Office
Unit D
Taper Building
Weston Street
London
SE1 3QB

Tel 01227 833855
www.herringtonconsulting.co.uk

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1. Background

1.1. Herrington Consulting has been approached by Dover District Council (DDC) to assess the potential options for improving the river corridor in Dover mid-town, for the purpose lowering flood risk and enabling the redevelopment and the regeneration of the area. As part of this work DDC have partnered with Affinity Water Ltd who are interested in opportunities to improve the habitats, water quality, biodiversity, and amenity value of the River Dour.

1.2. This document outlines the numerical flood modelling that has been completed to identify the potential options available for the improvements to the river corridor and to determine the likely improvements to flood risk in the redevelopment areas.

1.3. With respect to future redevelopment, DDC wish to include mid-town in the Local Plan to facilitate the future regeneration. Therefore, this project seeks to demonstrate the positive impact that potential redevelopment and improvements have in the mid-town area, so that agreement can be sought from the Environment Agency (EA) with respect to flood risk.

1.4. The results of the modelling have been presented to the EA during a meeting in the presence of representatives from both DDC and Affinity Water, prior to the completion of this document. The minutes of the meeting have been included in Appendix E.

1.5. Figure 1 delineates the area of interest which is centred upon the River Dour in the centre of Dover. The area is bound by Maison Dieu Road to the north, Cannon Street and Biggin Street to the south, Castle Street to the east and Park Street to the west.

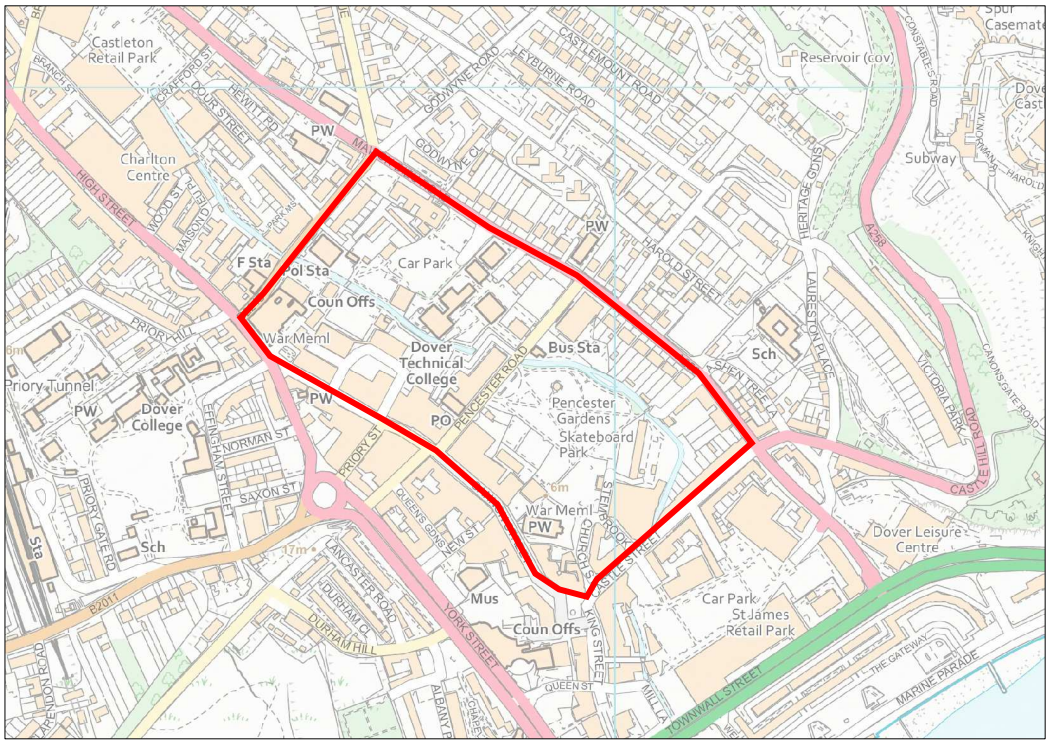


Figure 1 – Dover mid-town area.

1.6. The River Dour is approximately 5.4 km long watercourse with a head located at Temple Ewell and flowing into the sea at Dover's Wellington Dock, as shown in Figure 2 (River Dour delineated by the red line). The Alkham Bourne (purple line) joins the River Dour near Kersney.

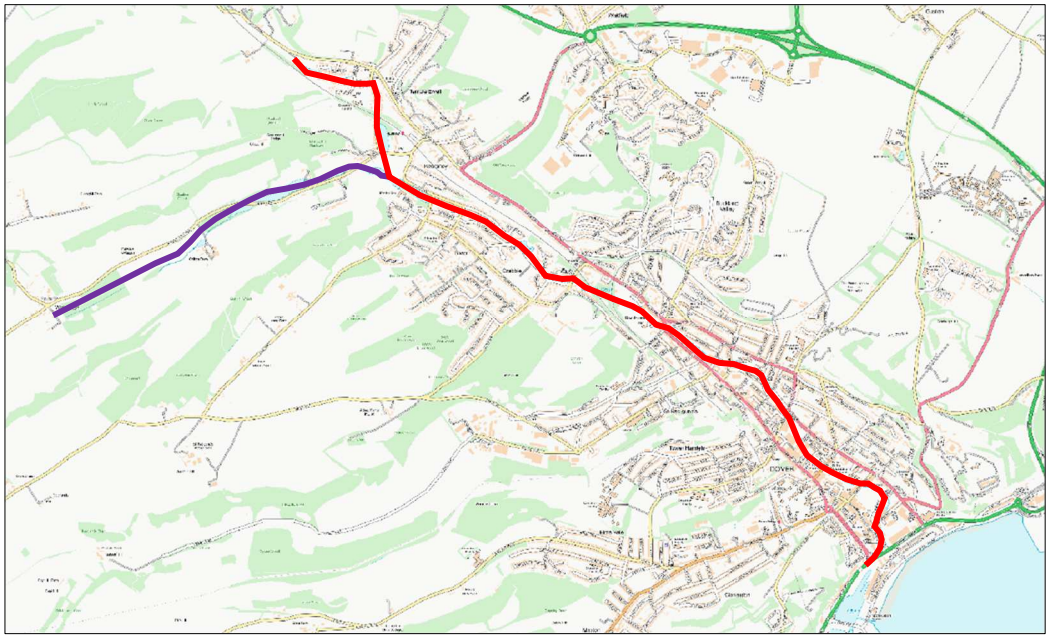


Figure 2 – Route of the River Dour.

1.7. The River Dour is classified as a chalk stream, as it is fed by groundwater originating in the chalk downs flowing towards the sea over the chalk bedrock, which is typical of the region in the south east of Kent. The steep and heavily urbanised area through which the Dour runs, the town of Dover, results in significant surface water run-off providing input to river flows/levels also. The River Dour is heavily modified throughout, with culverts and bridges at numerous road crossings, rail crossings and urban development. Numerous weirs, side channels and ponds are also present due to historic industrial (milling) activities. Although those industries are no longer present, the modifications to the watercourse remain, and influence the passage of flow through the town.

1.8. In Dover mid-town there is a road bridge at Park Street and foot bridges near the police station, Dover Technical College and at Pencester Court. A 50 m culvert conveys the river beneath Pencester Road and the mixed-used premises on the western side of Pencester Road, while a 90 m long culvert carries the river out of the mid-town area beneath Castle Street.

1.9. DDC has advised that the areas in mid-town that may be considered for redevelopment are as shown in Figure 3, and include;

- Maison Dieu carpark,
- the bowls club grounds,
- the carpark at Dover Technical College (but not Dover Technical College itself),
- Stembrook Street carpark and,
- the retail units at the corner of Stembrook Street and Castle Street.

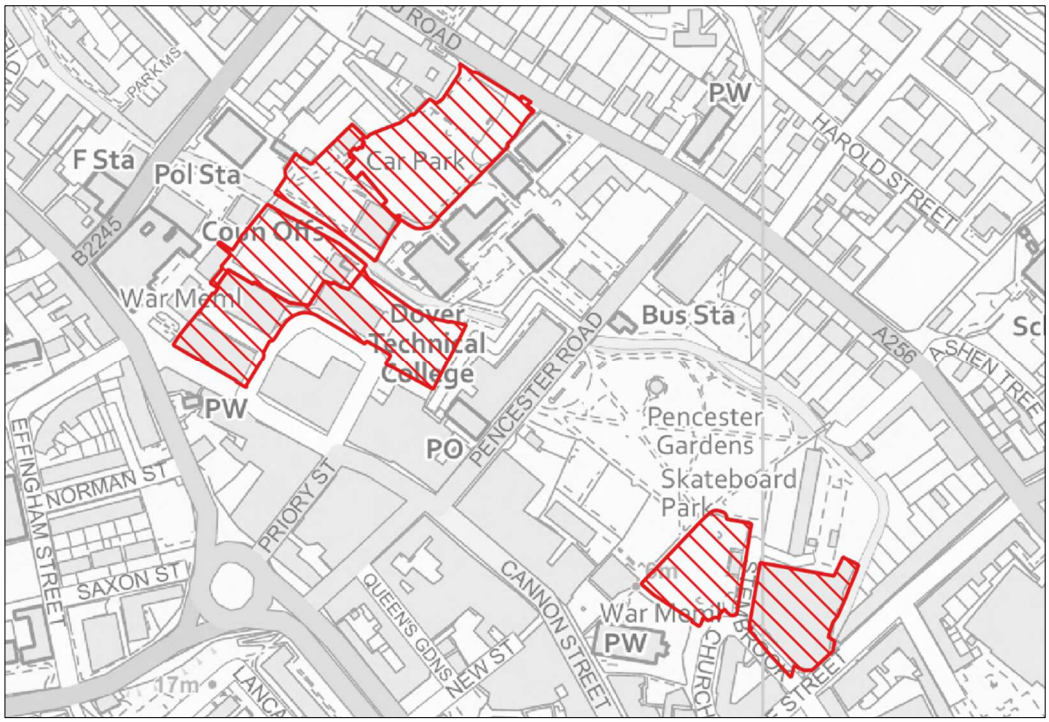


Figure 3 – Mid-town areas potentially available for redevelopment.

1.10. Alongside any potential redevelopment, Pencester Gardens is being considered as an extension of the river corridor and subject to similar improvements for amenity value and access, river habitat and river condition. Improvements may include lowering the riverbank and landscaping the park to provide flood storage.

1.11. This study seeks to determine the efficacy of potential improvements to the river corridor and the landscaping of Pencester Gardens for improving the risk of flooding throughout mid-town, particularly in the areas of potential development.

1.12. The mid-town area includes residential, retail and amenity areas and therefore, has a mixed range of vulnerability classifications (with respect to flood risk). These have been reviewed as part of this study and are shown in Figure 4. They identify much of the commercial (ground floor only in some cases) and public amenity areas as 'Less Vulnerable', and a number of community services buildings with a 'More Vulnerable' status. Where residential properties may typically attract a 'More Vulnerable' status, here, almost all of the older residential properties have basements and therefore are considered to be 'Highly Vulnerable'. Only one area of 'Essential' infrastructure is present in mid-town in the form of the electrical sub-station located next to Maison Dieu carpark. All areas identified for potential redevelopment by DDC (Figure 3) area located in areas of 'Less Vulnerable' status.

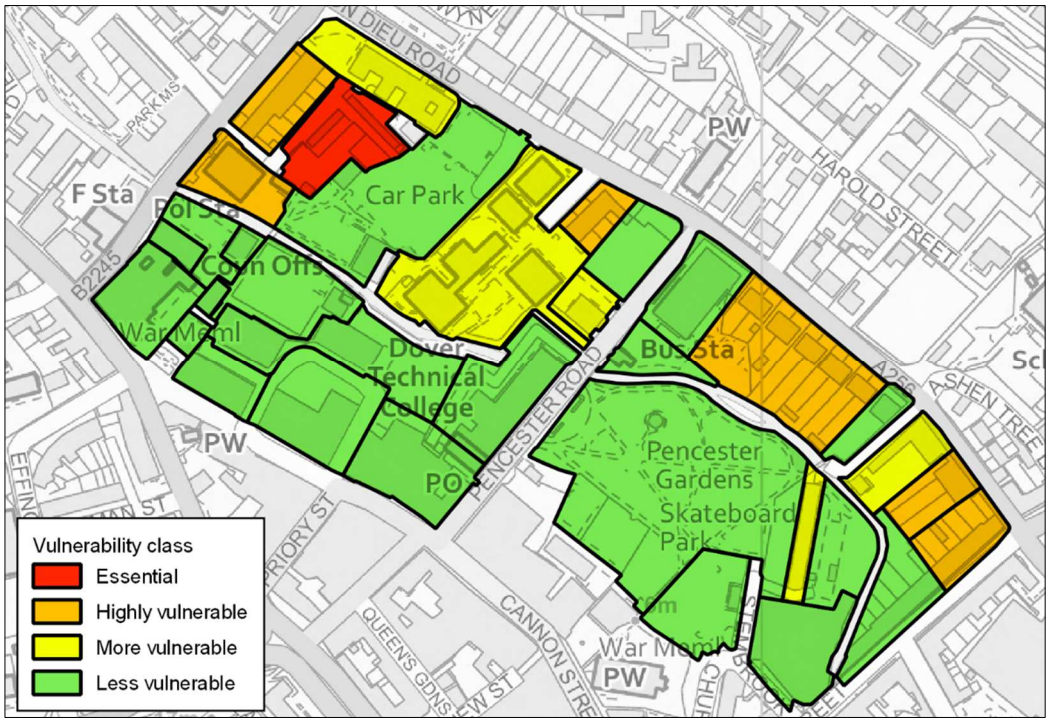


Figure 4 – Mid-town vulnerability classifications.

2. Modelling Approach

2.1. The numerical flood modelling undertaken for this study has utilised the existing EA model of the River Dour, the full details of which are available in the EA's model documentation[1]. Herrington Consulting has been using this model in various forms to support Flood Risk Assessments (FRAs) in Dover since it became available from the EA in 2016.

2.2. The modelling process has been undertaken in two distinct stages. The first stage applied the partially modernised model to the testing of a number of highly conceptual scenarios for mid-town to determine their overall efficacy, including the following:

- Widened River (ignoring ownership)
- Widened River (constrained by ownership)
- Dover Technical College landscaping
- Pencester Gardens landscaping
- Daylighting Pencester Road culvert
- Single-side (asymmetric) two-stage channel

2.3. The results of the above tests have not been included for detailed discussion in this report, but the graphical outputs have been included for completeness in Appendix A.

2.4. In summary, the two-stage channel proved to be the most practicable option to implement, while offering some benefit to flood risk in the mid-town area. On this basis, the second stage of the modelling sought to refine the detail of the two-stage channel design using a fully-modernised version of the model.

[1] River Dour Modelling and Mapping Study, Final Report, August 2016. Report for the Environment Agency by JBA Consulting

3. Modelling Technical Summary

3.1. The model was originally built for the EA to assess, at a strategic level, the risk of fluvial flooding in Dover, with the model results providing the basis for the EA's Flood Zones 2 and 3 of the Flood Maps for Planning. The original River Dour model is therefore, typical of the EA's strategy level models in that it is based on extensive topographic surveys of bank levels, channel profiles and watercourse structures only, with no account of features on the floodplain (commensurate with the 'bare earth' modelling approach) such as walls or other solid structures.

3.2. This modelling study has included a review of the structures within the floodplain and discovered a number of walls which have a significant effect on flow paths. These have been detailed later in this section.

3.3. The original model represents a fixed moment in time prior to 2016, when the model study was completed and supplied to the EA. Therefore, as part of this modelling study the model has undergone modernisation so that it includes recent developments which may affect the prediction of flood risk in the area of interest.

3.4. The changes to the model as part of this study are detailed as follows.

3.4.1. **New development at Lorne Road**. The mill pond and mill leat (left bank) at Lorne Road are still present. Historically, a long section of the leat had been culverted and built over. The outlet of the culvert exited into a section of open channel orientated at 90° to the culvert, which was just 10 m long, before another 90° bend to reconnect the flow with the original leat. The arrangement of culvert and leat channel in the original mode are shown in Figure 5.

Figure 5 – Route of the culvert in the original EA model (red) and the double 90° bends. Image from GoogleEarth dated 2006.

3.4.2. The section of culvert to the east of Lorne Road has been daylighted as part of a riverside residential development and is shown in Figure 6. The open channel with the two 90° bends has been filled in and is now part of the residence carpark, under which a large bore pipe connects the daylighted section with the old leat, replacing the two 90° bends. Also, a brick slipway now directs surface water run-off or flood water in the carpark to the river (Figure 6).

Figure 6 – Daylighted culvert at Lorne Road (left) and spillway connecting the carpark with the river (right).

3.4.3. **Buckland Mill wetland**. Since the original EA model was constructed, a wetland has been installed on the left bank of the Dour at Buckland Mill. This has been modelled using the as-designed levels from another version of the Dour model developed specifically for the FRA at Buckland Mill completed by Herrington Consulting.

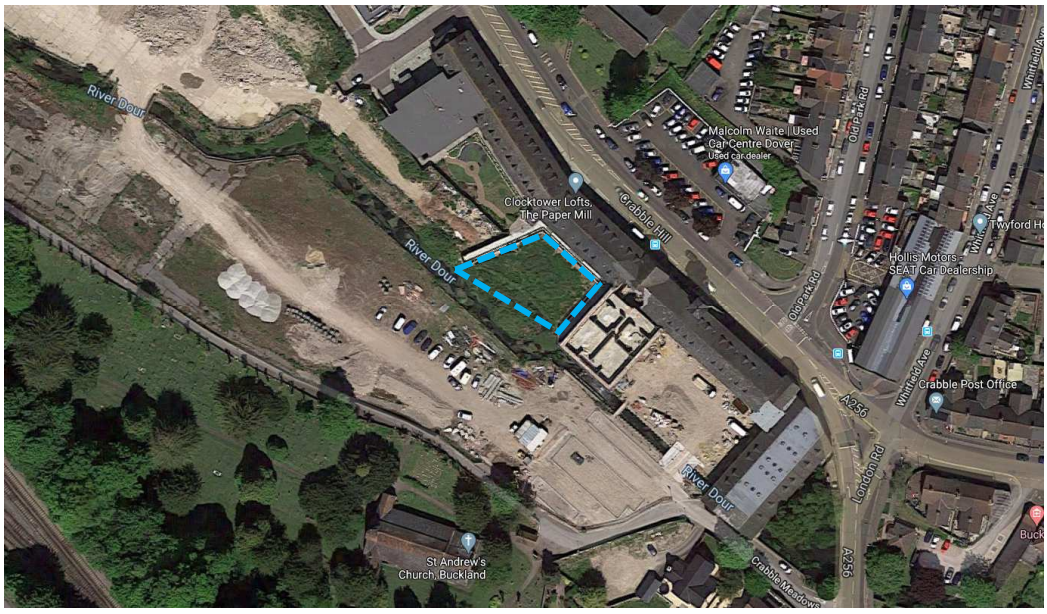


Figure 7 – Buckland Mill wetland.

3.4.4. **Halfords (store) carpark wall**. At the rear of the Halfords store on Granville Street the Dour drops over a weir, before entering a culvert that carries the river under the Halfords store carpark. The carpark backs onto a terrace of houses located on Charlton Green, whereby the terrace forms a wall running the length of the carpark and the culvert as shown in Figure 8. The original model excluded the houses and the wall, such that water exiting the river at the weir/culvert inlet ran onto Charlton Green [road], then onto Maison Dieu Road and onward to the Dover mid-town area. The carpark wall has been included in the model to better replicate actual flood conditions, whereby this flow route is prevented from occurring during smaller flood events within the new model. The wall retains flood water in the carpark and directs it back into the river.

Figure 8 – Halfords carpark wall location and view from the carpark (inset).

3.4.5. **Mid-town walls**. There are a number of solid stone walls within the mid-town area which generally delineate property boundaries. These have been added to the model following the alignment shown in Figure 9.

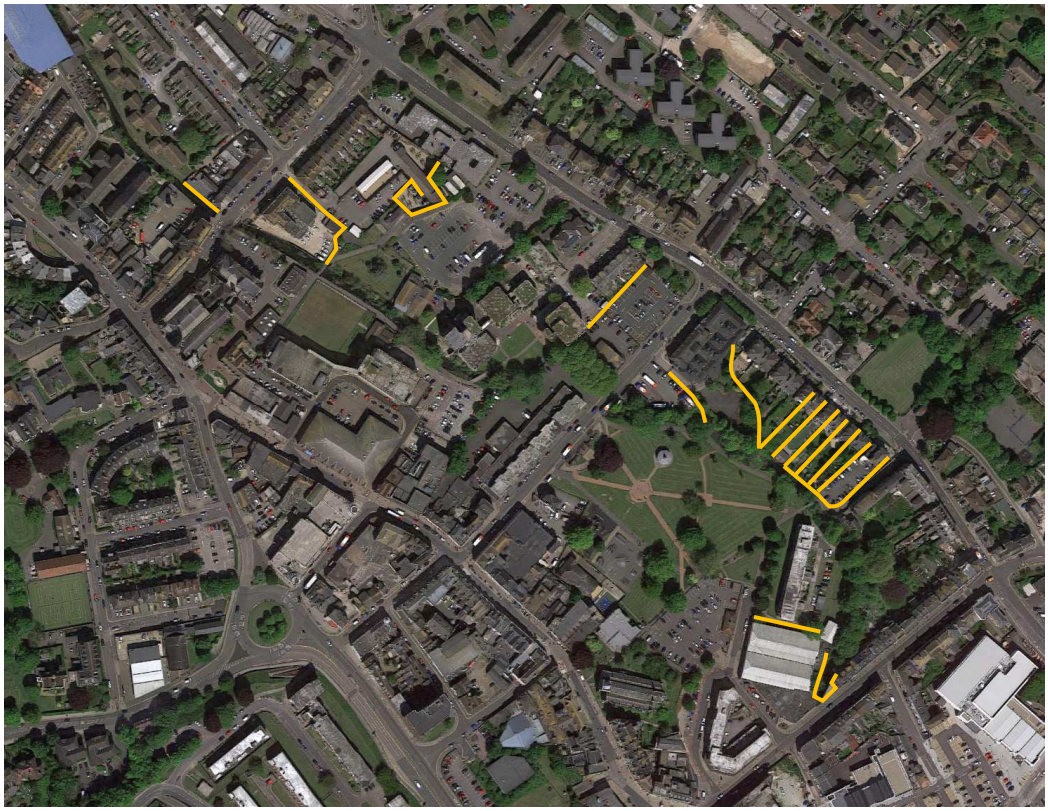


Figure 9 – Walls in the mid-town area.

3.4.6. **Culvert corrections**. During the updating of the model the culverts at two locations, Castle Street and Castleton Retail Park, were noted to have been sub-divided during the original modelling, but their inlet and outlet invert levels had not been corrected accordingly. Therefore, this has been corrected as part of the model update with some improvement to model stability and a small effect upon predicted extent of flooding.

3.5. The original model has been provided with inflow conditions ranging from a 1:2 year return period event through to a 1:1,000 year return period event. The following events have been selected from the available conditions and applied to the tested scenarios:

- 1:20 (represents the extent of the functional floodplain)
- 1:100 (represents the extent of Flood Zone 3)
- 1:100+45% climate change (represents the design condition in an FRA)
- 1:1,000 (represents the extent of Flood Zone 2)

4. Baseline Model and Results

4.1. The results of the modelling for the existing conditions (the baseline) are presented in this section of the report. The maximum depth of flooding is presented graphically, focused on the mid-town area only, for discussion purposes, while the same results are presented in Appendix B to show a wider view.

4.2. The model results presented in this report and appendices show the maximum depth of flooding. The maximum predicted value extracted from the model is calculated for each 2D grid cell at any point in time (throughout the entire model duration). Therefore, these outputs should not be interpreted as a single snapshot in time.

4.3. Figure 10 shows the extent of flooding during the 1:20 year return period event which represents the extent of Flood Zone 3b (functional floodplain). These results show that flood water exits the river channel in three specific locations, as follows:

- the Maison Dieu carpark (Less Vulnerable), almost surrounding the Age Concern building,
- at the bowls club clubhouse (Less Vulnerable), and,
- at the Dover Technical College (More Vulnerable).

Bank heights in these areas range between 5.2 mAODN and 5.4 mAODN.

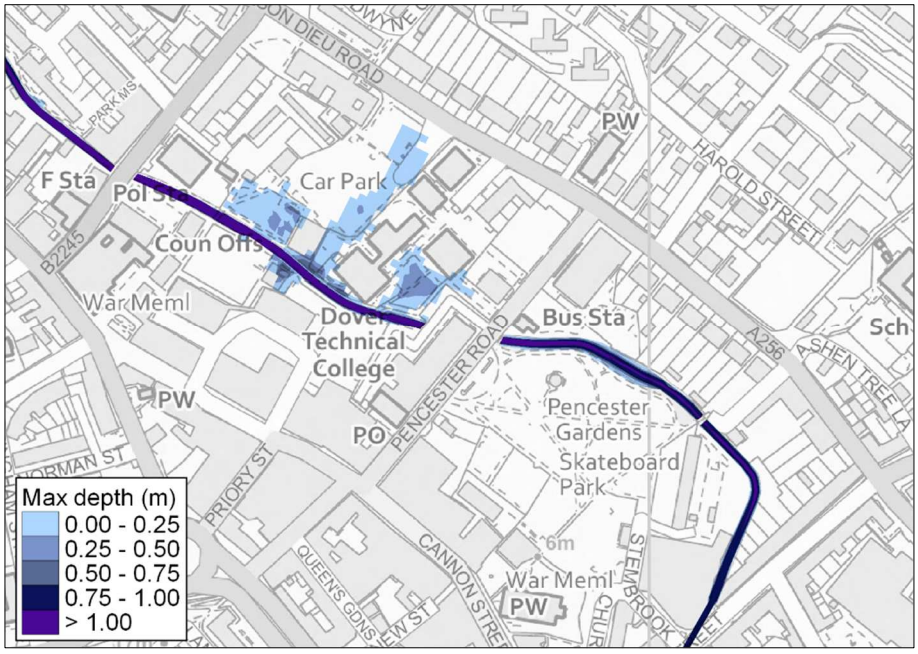


Figure 10 – Existing conditions maximum depth of flooding, 1:20 year event.

4.4. On the basis of this result, the only area of potential development located within the functional floodplain is part of Maison Dieu carpark. However, the depth of flooding is shallow, at less than

0.25 m, and the flood water does not flow onwards to affect any other areas during the 1:20 year return period event.

4.5. Figure 11 shows the extent of flooding during the 1:100 year return period event, which represents the extent of Flood Zone 3a. This extent of flooding is consistent with the EA online flood mapping of Flood Zone 3, whereby differences between the result in Figure 11 can be attributed to the presence of the walls in the updated model (see Figure 9).

Figure 11 – Existing conditions maximum depth of flooding, 1:100 year event.

4.6. During the 1:100 year event flood water exits the river channel at Maison Dieu carpark (an area of potential development) and Dover Technical College, before flowing through these areas to reach Maison Dieu Road, Pencester Road, the bus station (Less Vulnerable) and the properties on Maison Dieu Road (Highly Vulnerable) that back onto the river opposite Pencester Gardens. Flood water flowing along these routes finally returns to the river channel, mainly through the bus station located on Pencester Road.

4.7. Flood water also exits the river at the bowling green (Less Vulnerable, and an area of potential development), at Pencester Gardens near Pencester Court (More Vulnerable) and into the rear gardens of the properties (Highly Vulnerable) that back onto the river (property fronts located on Maison Dieu Road and Castle Street). It should be noted that the flood water exiting these locations during this event does not flow onwards to affect other areas. The flood water in Pencester Gardens begins to reach the Stembrook Street carpark which is an area of potential development.

4.8. Figure 12 shows the extent of flooding during the 1:100 year return period event (plus an increase of 45% allowance for future climate change), which represents the design conditions for residential development.

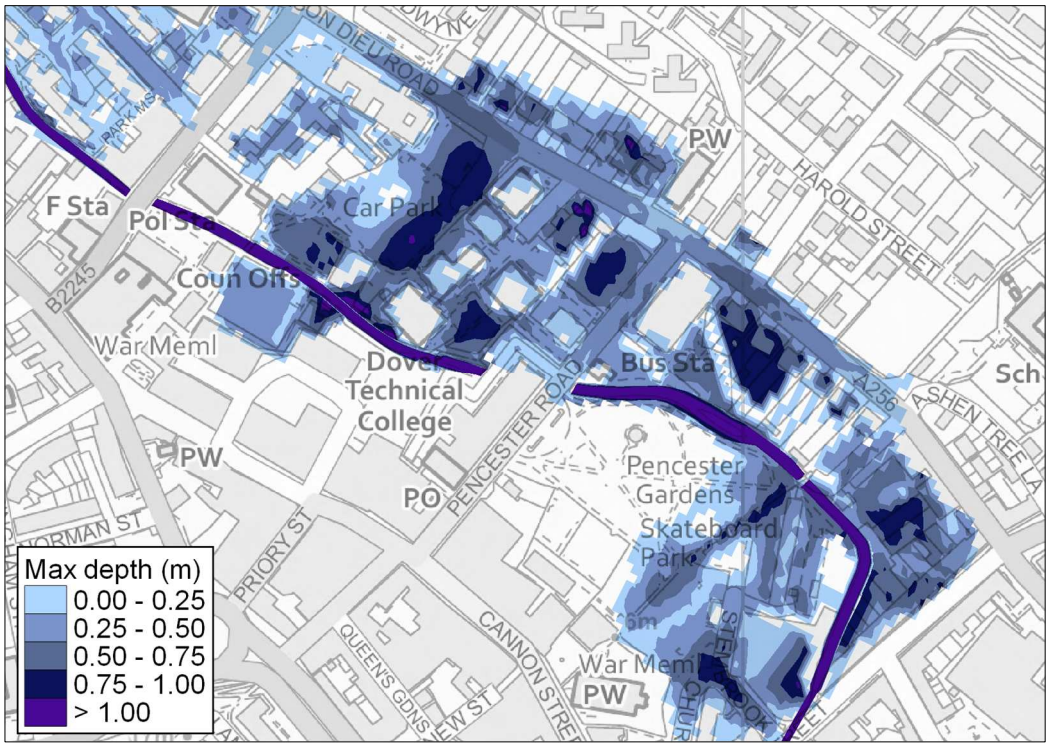


Figure 12 - Existing conditions maximum depth of flooding, 1:100(+45%) year event.

4.9. Flood water exits the river in the same locations as per the 1:100 year return period event, with additional flood water arriving in mid-town along Maison Dieu Road, having exited the river at Charlton Gardens (opposite the Castleton Retail Park), and at the rear of the properties at Goodfellow Way. Flood water in mid-town now also flows further down Maison Dieu road, exacerbating the flooding at the properties at the corner of Maison Dieu Road and Castle Street (Highly Vulnerable), before returning to the river channel opposite Pencester Court. Flood water also encroaches into the retail units at the corner of Stembrook Street and Castle Street and the Stembrook carpark (both are areas of potential development).

4.10. The depth of flooding in areas of potential development include:

- Maison Dieu carpark, which reaches up to 1.0 m deep where ground elevations are lowest,
- The bowling green, where flood water reaches depths of 0.3 m, and
- Stembrook carpark and neighbouring retail units, where the depth of flooding reaches up to 0.9 m.

4.11. Figure 13 shows the extent of flooding during the 1:1,000 year return period event which represents the extent of Flood Zone 2. The extent of flooding is largely the same as for the 1:100 year (plus climate change) event, although the depth of flooding is increased. Additionally, flood water also

leaves the river to flood the carpark belonging to Dover Technical College (Less Vulnerable), which is an area of potential development.

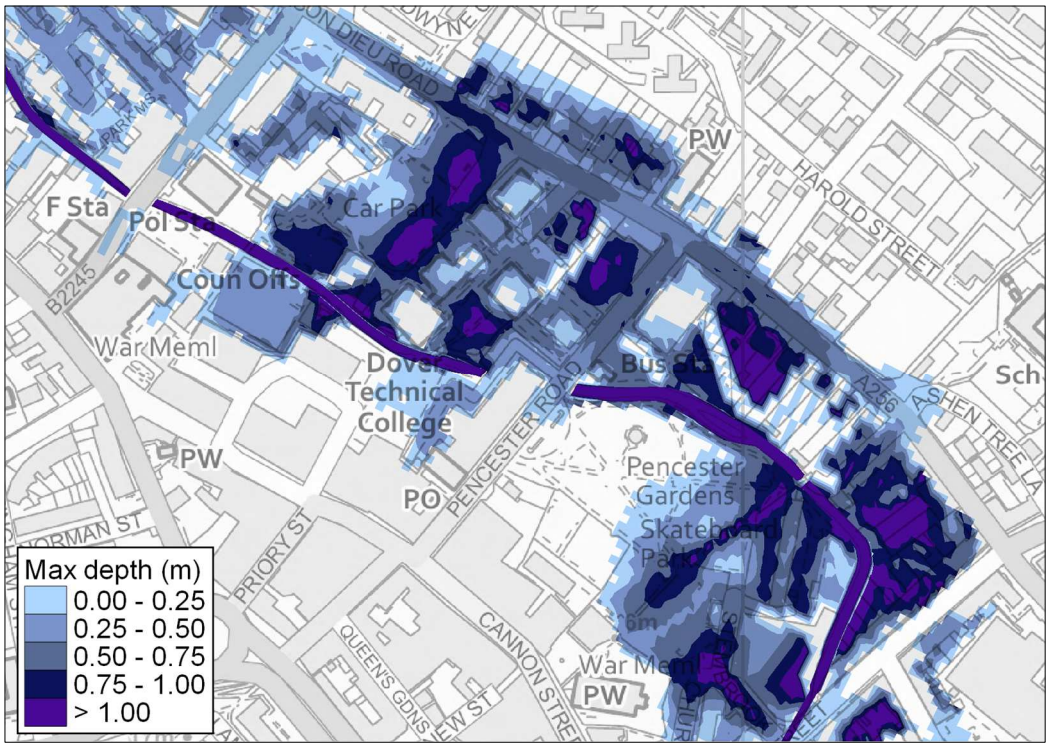


Figure 13 - Existing conditions maximum depth of flooding, 1:1,000 year event,

4.12. The results of the baseline modelling show that the areas of potential development are subject to flooding under various return period events. Most significantly, Maison Dieu carpark is partially within the functional floodplain (Flood Zone 3b), which would usually prohibit any new development. All other areas of potential development are within Flood Zone 3a or Flood Zone 2 and would typically be subject to the Sequential Test.

4.13. Assuming that the Sequential Test can be passed, on the basis of the need for regeneration of the mid-town area, there will remain a need to mitigate the risk of flooding to satisfy the Exception Test. Only appropriate types of development can be located in flood risk areas and the mitigation options are discussed in the following section.

5. Mitigation Measure 1: Two-Stage Channel

5.1. The initial modelling stages identified that the most practicable of the conceptual options tested included a two-stage channel. Therefore, a two-stage channel of a more refined design has been tested as the first mitigation option.

5.2. Implementing a two-stage channel along the River Dour would require one (asymmetric) or both (symmetric) sides of the existing riverbanks to be lowered, so that they flood during times of high flow. During low, or 'normal' flow conditions, the existing river channel would remain unmodified and continue to convey water at it does currently.

5.3. The elevation (stage) to which the existing riverbanks are lowered is determined by frequency at which they are required to flood. In the model, the riverbanks between Park Street and Pencester Road Culvert have been lowered to 5.1 mAODN, so that they would be flooded during the 1:2 year return period event. The plan alignment of the two-stage channel as modelled is shown in Figure 14, and is asymmetrical (one-sided) immediately downstream of Park Street. This is due to the presence of the high wall along the police station. Downstream of the police station the channel is symmetrical.

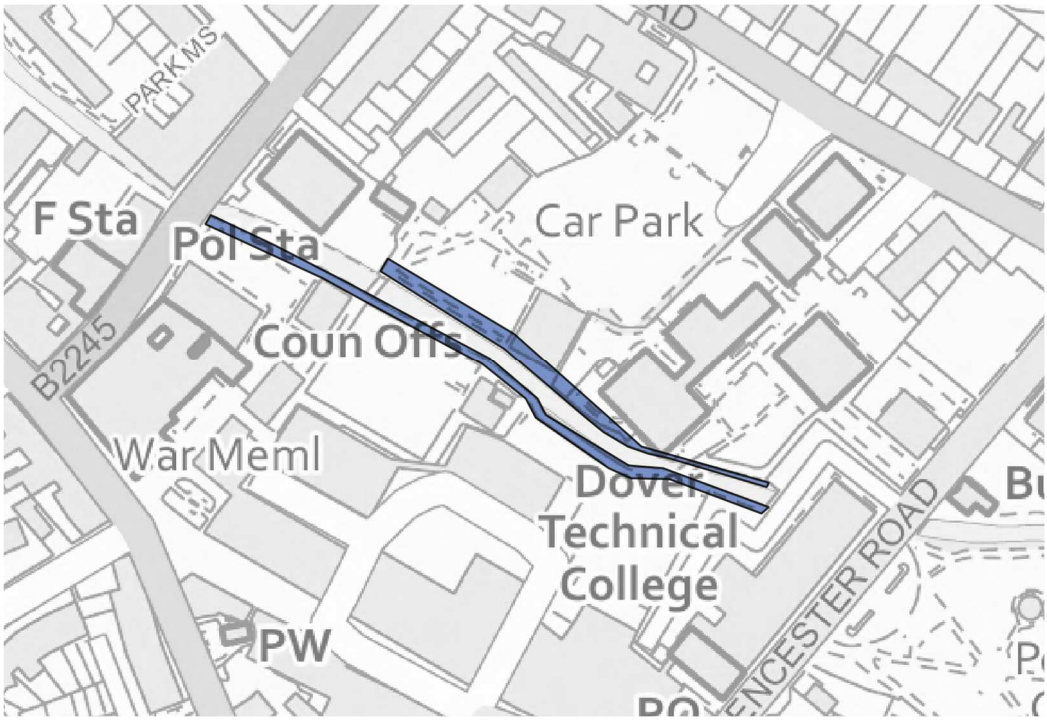


Figure 14 – As-modelled plan alignment of the two-stage channel.

5.4. The as-modelled two-stage channel is idealised in that the symmetrical section downstream of the police station is 3 m wide on the right bank (bowling green side), where the existing footpath and cycleway could be lowered to form the right-hand stage. On the left bank (Maison Dieu and Dover Technical College) it is modelled as 5 m wide. However, in reality the buildings of the Dover Technical College prevent the 5 m wide stage being implemented along the full length of the left

bank and therefore, the stage on the opposite bank may need to be widened to maintain the overall capacity of the proposed two-stage channel. This is thought to be a viable possibility on the basis that the widened stage of the right bank would encroach only into the Technical College carpark development area.

5.5. Also key to the efficacy of the two-stage design is the inclusion of a wall/bund to aid containment of high flows within the two-stage channel. This wall/bund would have a crest height of no higher than 5.7 mAODN on the left bank (Maison Dieu carpark) and no higher than 5.8 mAODN on the right bank (bowling green), making it between 0.3 m and 0.5 m high.

5.6. The modelling of the two-stage channel has also included the removal or replacement/raising of the low footbridges (Maison Dieu and College carpark) to raise these features above the water level generated under high flow conditions.

5.7. A full set of results for the tests presented in this section are included in Appendix C and show a slightly wider view than the figures included within this section of the report.

5.8. Figure 15 shows the extent of flooding during the 1:20 year return period event (functional floodplain) with the two-stage channel, where the functional floodplain has been confined to the two-stage channel. On this basis, the potential development areas in mid-town (Maison Dieu carpark) are no longer in the functional floodplain, with no detrimental effects elsewhere.

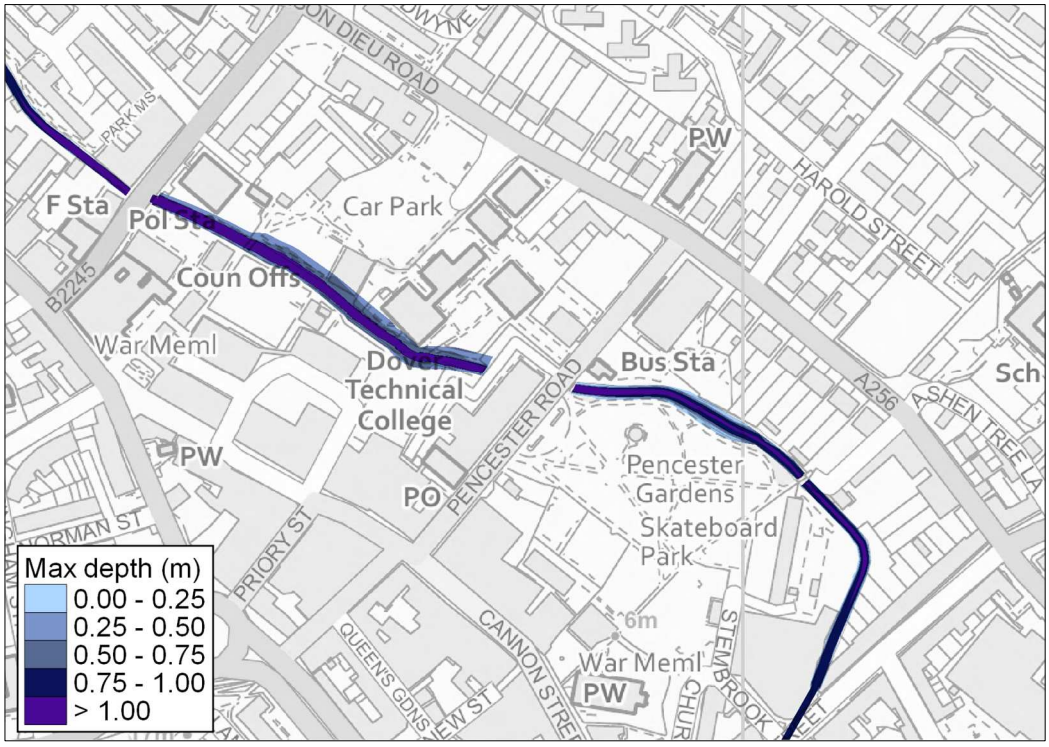


Figure 15 – Mitigation measure 1 maximum depth of flooding, 1:20 year event.

5.9. Figure 16 shows the extent of flooding during the 1:100 year return period event with mitigation measure 1 implemented. These results are very similar to those of the baseline conditions for the 1:100 year return period event.

Figure 16 – Mitigation measure 1 maximum depth of flooding, 1:100 year event.

5.10. It is difficult to easily decern the differences between this result and the baseline, and therefore, the difference between the baseline result and the two-stage channel result are best shown by subtracting the baseline result from the two-stage channel result (proposed minus baseline), so that the actual differences in the design condition can be quantified. This comparison of results yields the image shown in Figure 17, where differences in flood level are indicated with shades of green for a reduction and shades of orange/red indicate increases. Additionally, yellow shading indicates areas which have become dry as a result of the two-stage channel, while pink shading indicates areas that have become wet/flooded as a result of the two-stage channel.

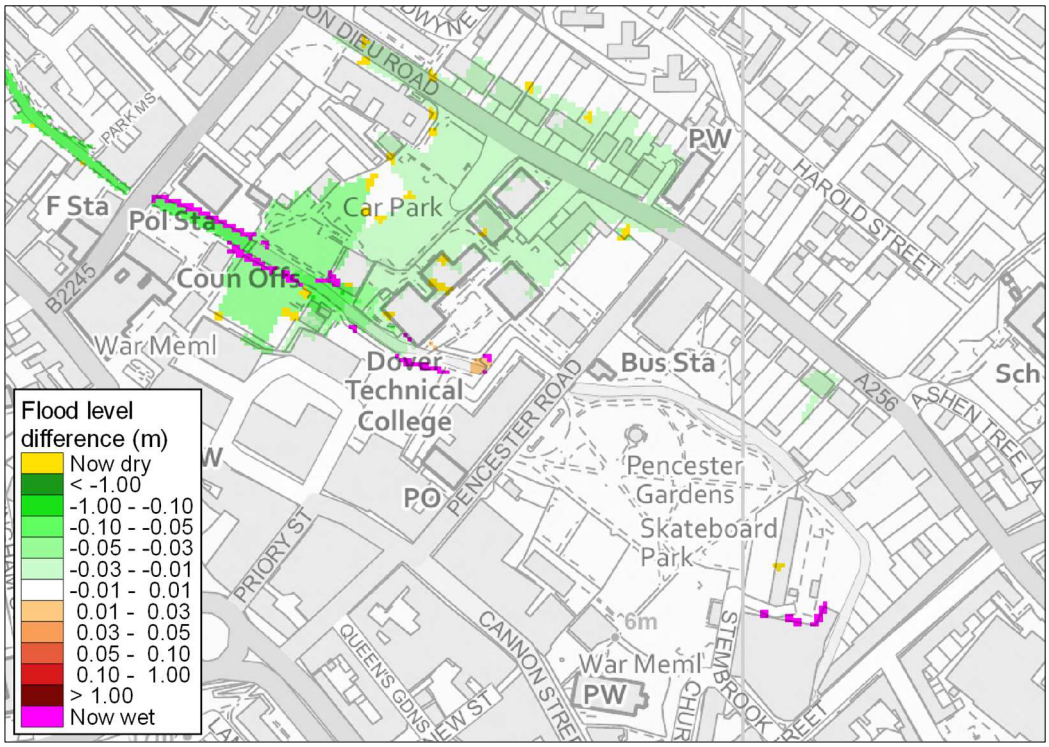


Figure 17 – Mitigation measure 1 minus existing condition maximum depth of flooding, 1:100 year event.

5.11. Broadly, the two-stage channel results in a lowering of the flood level in mid-town area. Areas of pink shading in Figure 17 are the result of the widening the existing channel to make the two-stage channel and the removal of the retail unit on the corner of Stembrook Street and Castle Street in the mitigation scenario.

5.12. Figure 18 shows the extent of flooding during the 1:100 year return period event (plus an increase of 45% allowance for future climate change). The extent of flooding is broadly unchanged compared to the baseline condition. However, reference to Figure 19 shows that the carpark to the rear of the retail units (Less Vulnerable) on Pencester Road is shaded pink, indicating that the changes to the channel have resulted in the flooding of the carpark. This result represents a slightly earlier onset of flooding (at a slightly more frequent return period event) than present. It is anticipated that this small variation in the extent of flooding could be contained with further careful design of the level of the adjacent riverbank and or the parapet wall at the inlet of the Pencester Road Culvert.

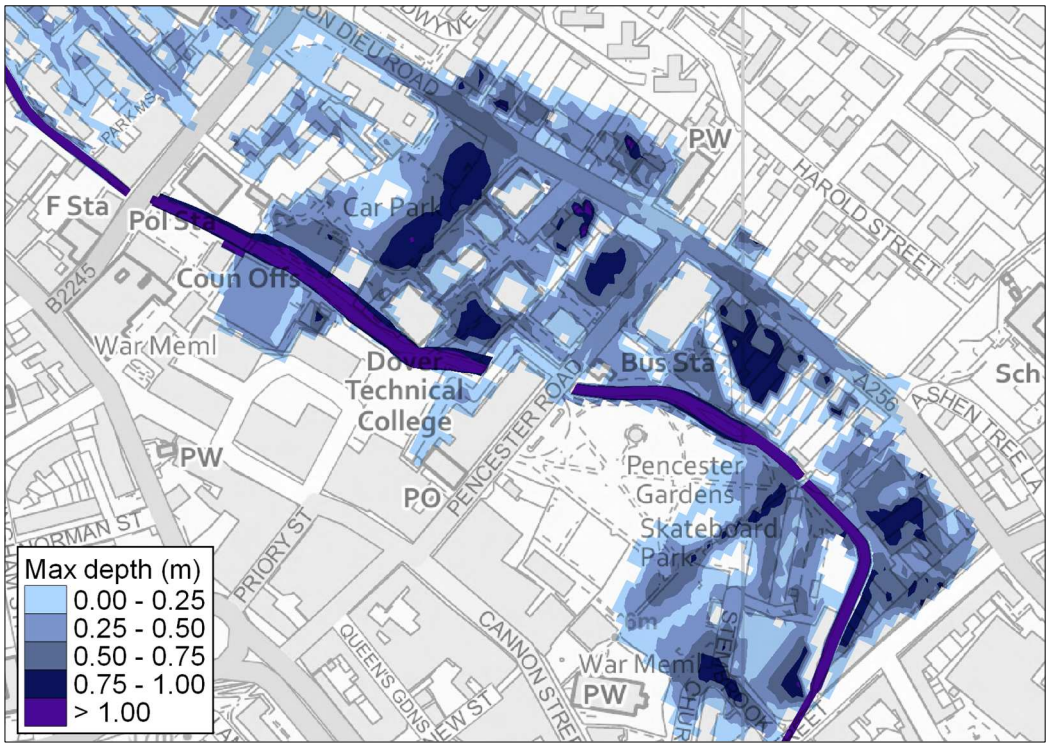


Figure 18 – Mitigation measure 1 maximum depth of flooding, 1:100(+45%) year event.

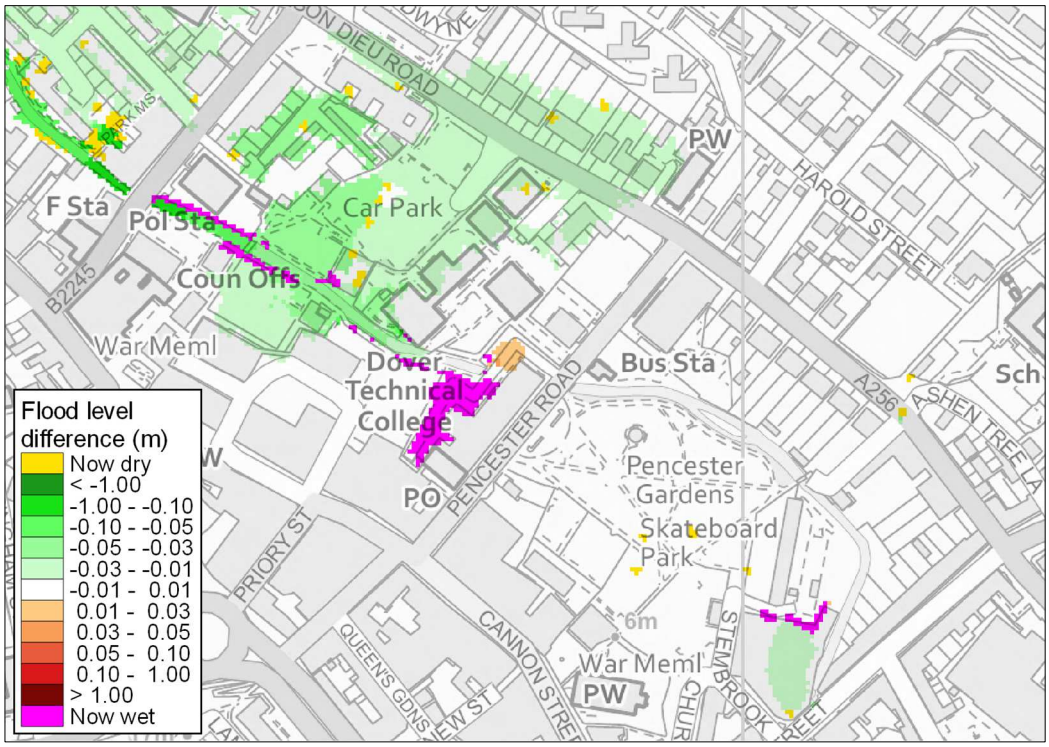


Figure 19 – Mitigation measure 1 minus existing condition maximum depth of flooding, 1:100(+45%) year event.

5.13. Figure 20 shows the extent of flooding during the 1:1,000 year return period event and the definition of Flood Zone 2 in the presence of the two-stage channel. Again, it is difficult to discern the

difference between this and the baseline result and therefore, reference to Figure 21 shows that the two-stage channel broadly results in a reduction in flood level throughout mid-town and the sider area for this event.

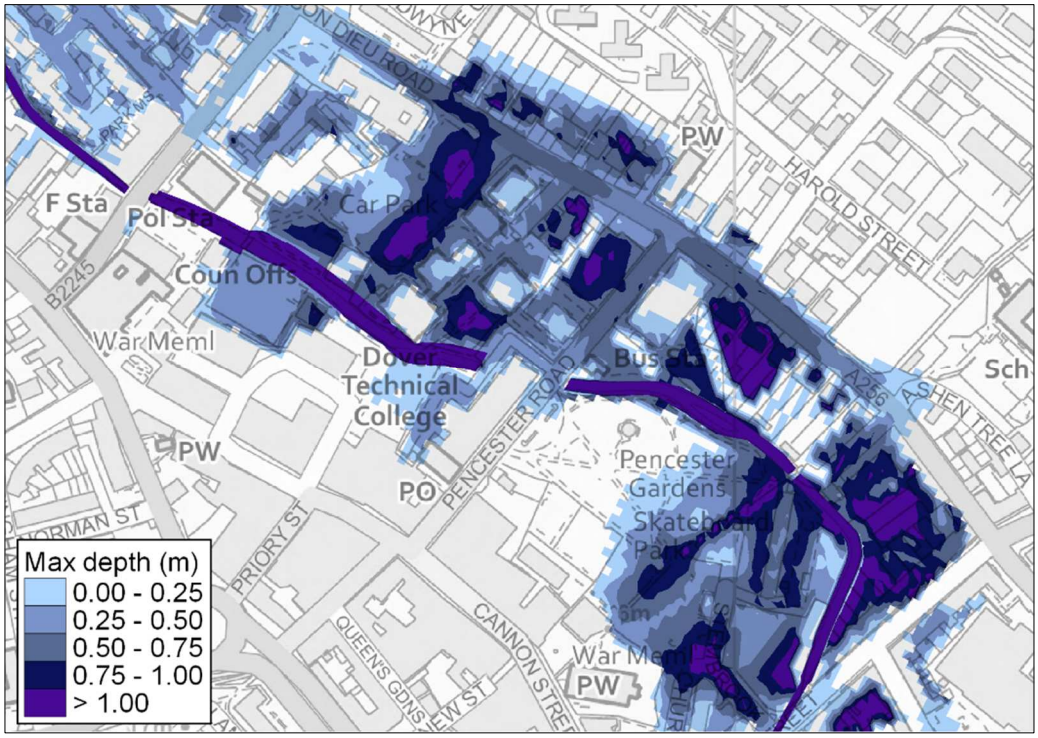


Figure 20 – Mitigation measure 1 maximum depth of flooding, 1:1,000 year event.

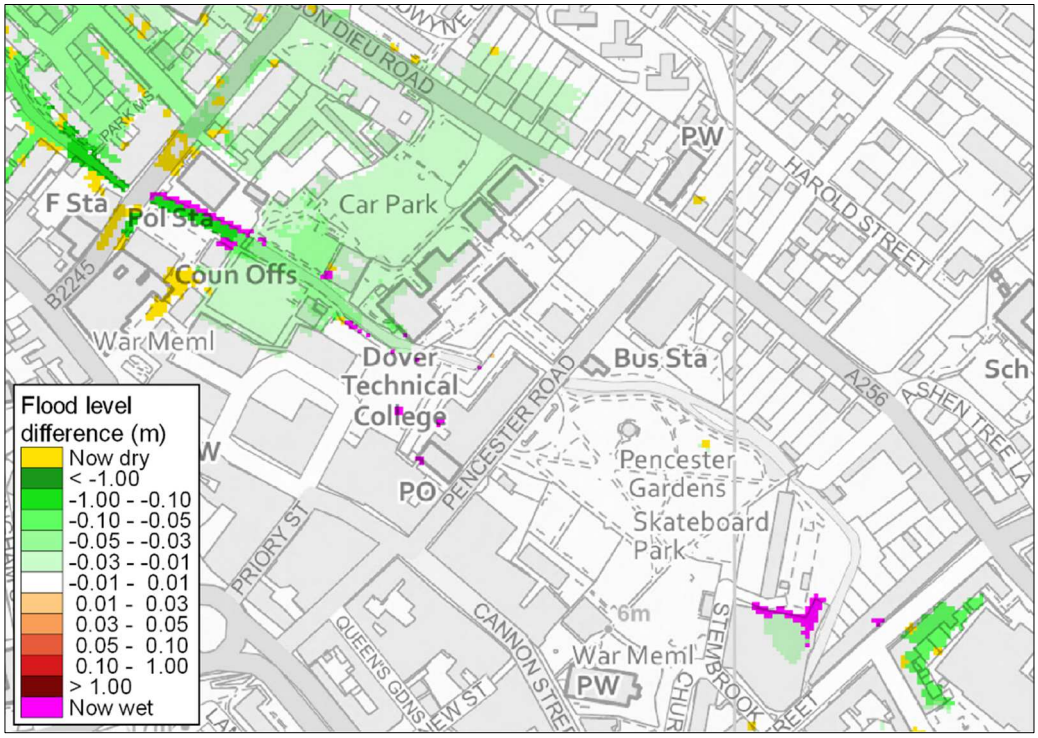


Figure 21 – Mitigation measure 1 minus existing condition maximum depth of flooding, 1:1,000 year event.

6. Mitigation Measure 2: Land Raising & Lowering

6.1. The testing of the two-stage channel, presented in the previous section, showed that while the flood level in mid-town and the wider area could be lowered with improvements to the river corridor, these reductions were insufficient to significantly lessen the depth of flooding in the areas of potential development. Additionally, the review of the baseline results showed that the areas of potential development in mid-town are located on overland flow paths.

6.2. On the basis of the above, it has been considered that the flooding in mid-town is related to the conveyance of flood water through the mid-town area, rather than the storage volume available for flood water. Therefore, land raising in the potential development areas has been tested in the model as an additional mitigation option, in combination with the two-stage channel measures.

6.3. While the improvements to the river corridor may include landscaping in Pencester Gardens, the mitigation tests also include this in combination with the land raising in the area of potential development.

6.4. The geometry of the model has been modified to represent the land raising and lowering and is shown in Figure 22, where areas of raising and lowering have been labelled with their new elevation, in mAODN, and the volume of the raising or lowering. The land raising elevations have been selected specifically to raise the development areas above the flood level of the 1:100 year return period event (plus 45% climate change), but keep it approximately 0.1 m below the flood level of the 1:1,000 year return period event.

Figure 22 – Mitigation measure 2 land raising and lowering.

6.5. The raising at the bowling green and Maison Dieu carpark represents an increase in ground elevation of between 0.3 m and up to 0.8 m, respectively. The raising in Stembrook carpark and retail units would see an increase of between 1.0 m and 2.2 m, due in part to the low bank level next to the river. The landscaping in Pencester Gardens would represent a lowering of existing ground elevations of up to 2.2m.

6.6. The result of the 1:20 year return period event has not been presented in this section on the basis that the results are the same as the two-stage channel (mitigation measure 1) in that the functional floodplain has been entirely confined to the two-stage channel and the lowering in Pencester Gardens. The full results are available in Appendix D.

6.7. Figure 23 shows the extent of flooding during the 1:100 year return period event with mitigation measure 2 (two-stage channel and land raising/lowering), which shows the potential development areas to now be dry (no longer in Flood Zone 3a) and the lowered areas in Pencester Gardens to be wet. The overland flow routes through Dover Technical College, and on to Maison Dieu Road and Pencester Road, remain unaffected by the land raising.

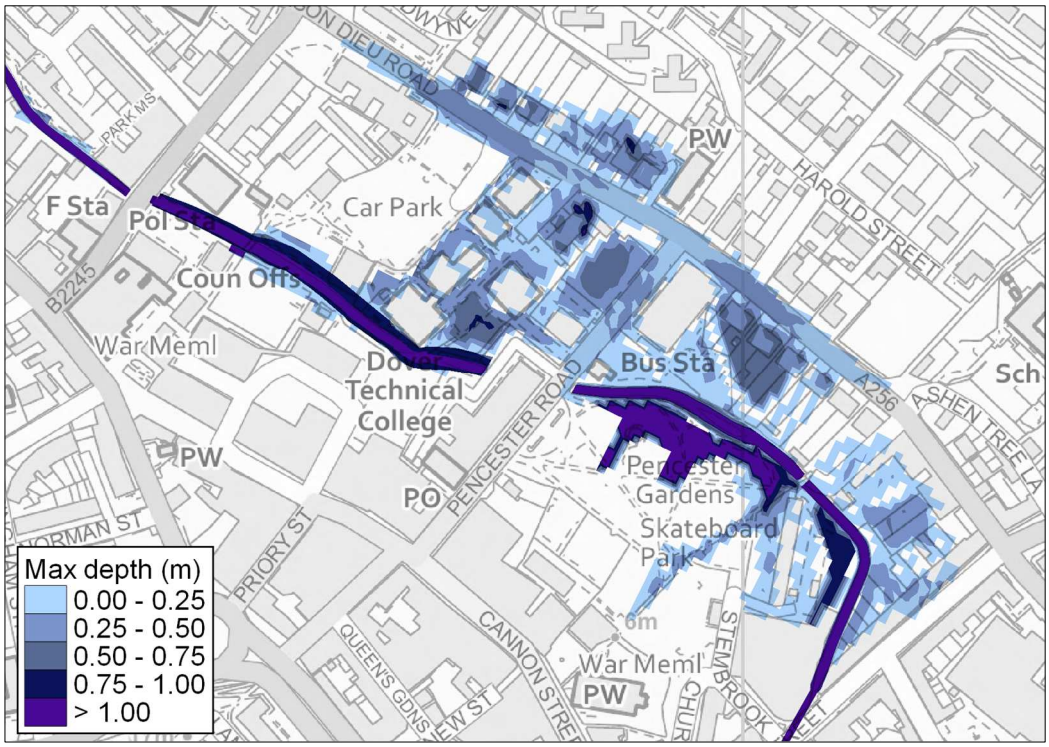


Figure 23 – Mitigation measure 2 maximum depth of flooding, 1:100 year event.

6.8. Figure 24 shows the difference plot for mitigation measure 2 versus the baseline, whereby these differences are shown clearly by the yellow and pink shaded areas. The difference plot in Figure 24 also indicates further reduction in the flood level in, and opposite, Pencester Gardens (mixed vulnerability status, including Highly Vulnerable) as a result of mitigation measure 2.

6.9. The only area experiencing a negative effect as a result of mitigation measure 2 is a small area in the grounds of Dover Technical College (More Vulnerable). In this area the flood level increases by 0.02 m where the depth of flooding is already in excess of 0.75 m.

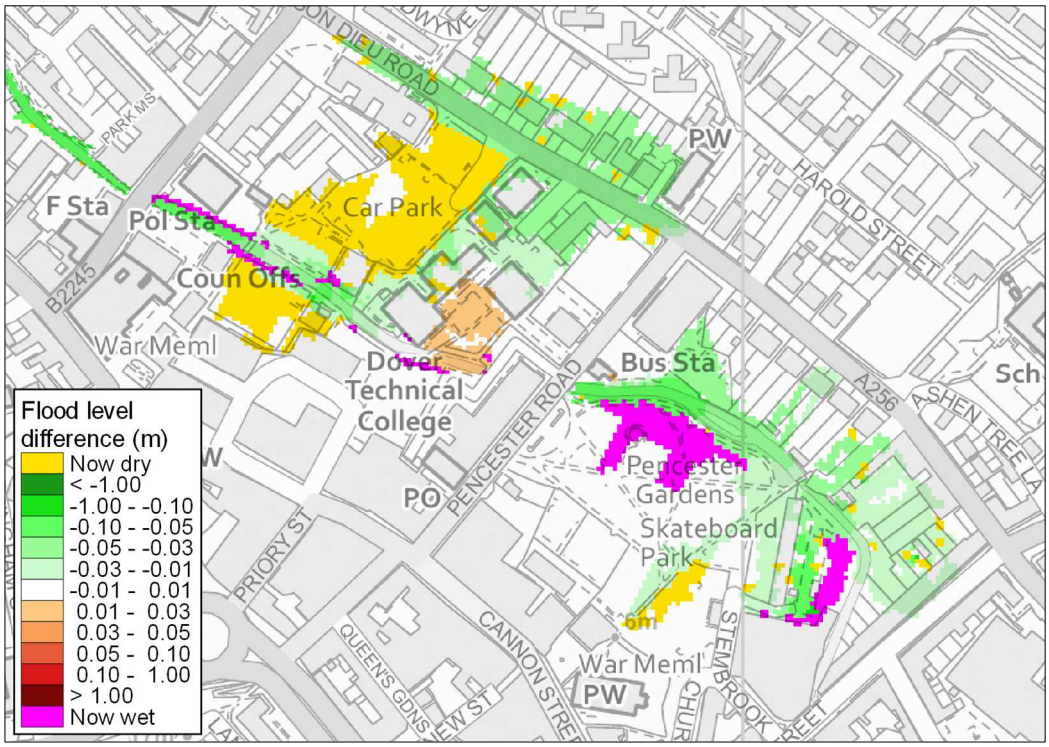


Figure 24 – Mitigation measure 2 minus existing condition maximum depth of flooding, 1:100 year event.

6.10. Figure 25 shows the extent of flooding during the 1:100 year return period event (plus an increase of 45% allowance for future climate change) with mitigation measure 2. The results are similar to those of the 1:100 year return period event whereby the potential development areas are dry. The overland flow route from Charlton Gardens down Maison Dieu Road and into mid-town remain unaffected by the land raising.

6.11. The difference plot in Figure 26 shows that the areas experiencing a reduction in flood level now extend to include a larger area of Maison Dieu Road and the properties there and on Castle Street (Highly Vulnerable), which back onto the river. The results are very similar to mitigation measure 1, where the carpark of the retail units on Pencester Road (Less Vulnerable) wet sooner as a result of the mitigation measures.

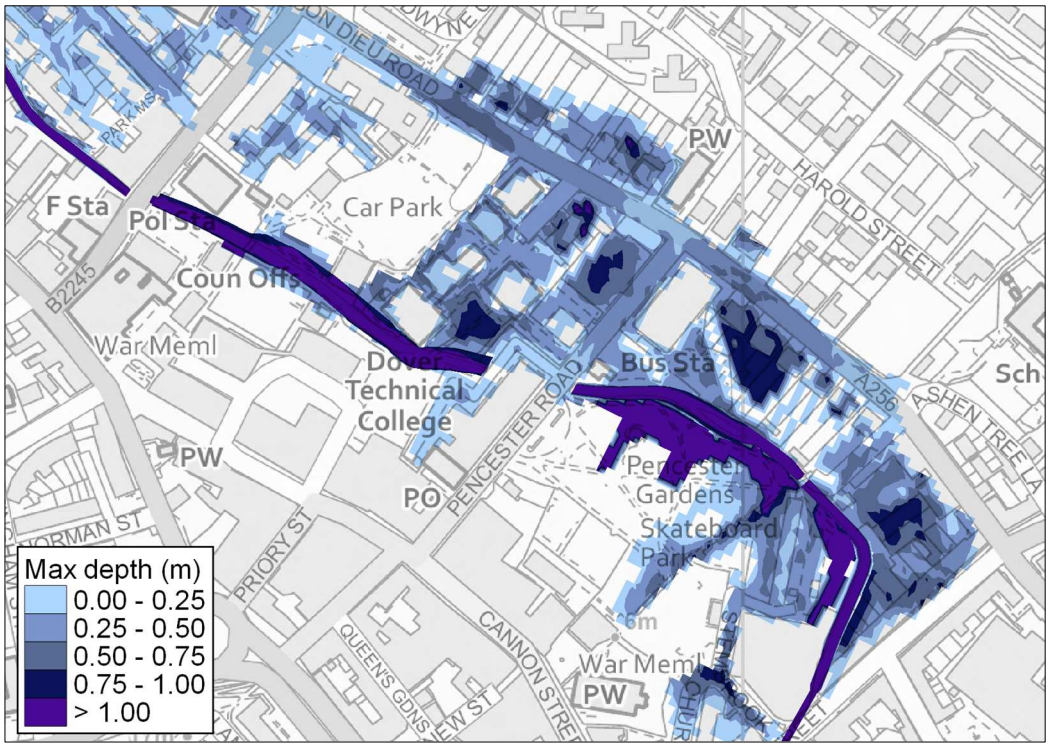


Figure 25 - Mitigation measure 2 maximum depth of flooding, 1:100(+45%) year event.

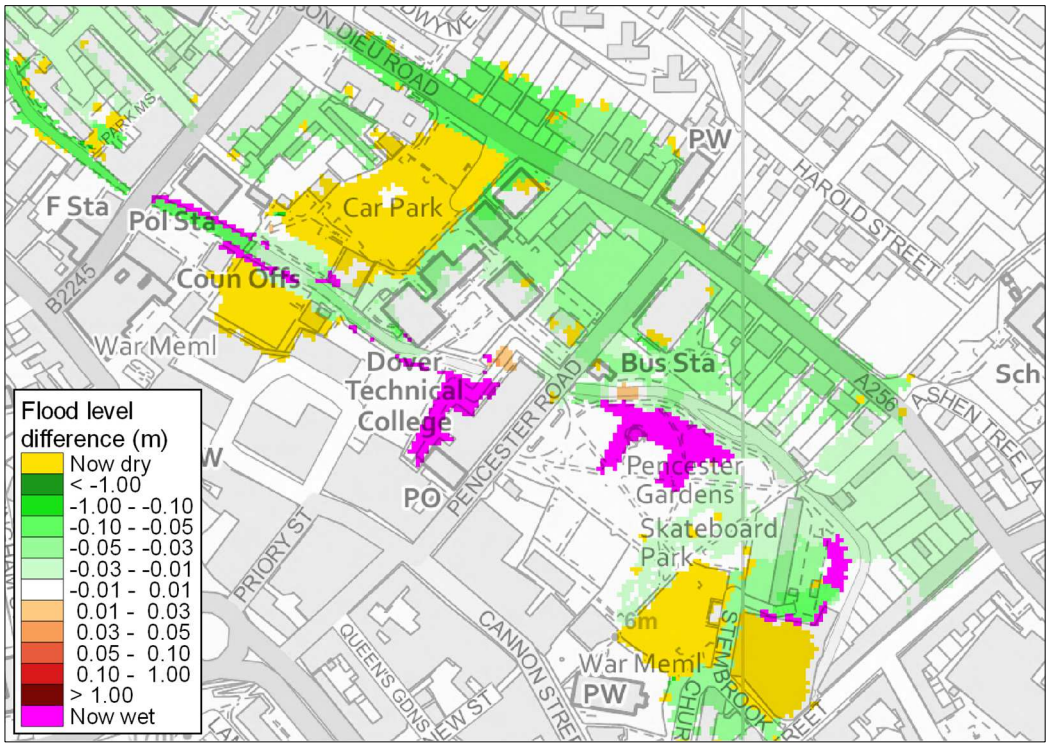


Figure 26 – Mitigation measure 2 minus existing condition maximum depth of flooding, 1:100(+45%) year event.

6.12. Figure 27 shows the extent of flooding during the 1:1,000 year return period event with mitigation measure 2, where the extent of flooding is very similar when compared to the baseline and

mitigation measure 1. However, it can be seen that the raised areas are wet, as planned, during this event and therefore are located in Flood Zone 2. The depth of flooding in the raised areas during this scenario is around 0.1 m. The overland flow routes along Maison Dieu Road and throughout mid-town remain unaffected.

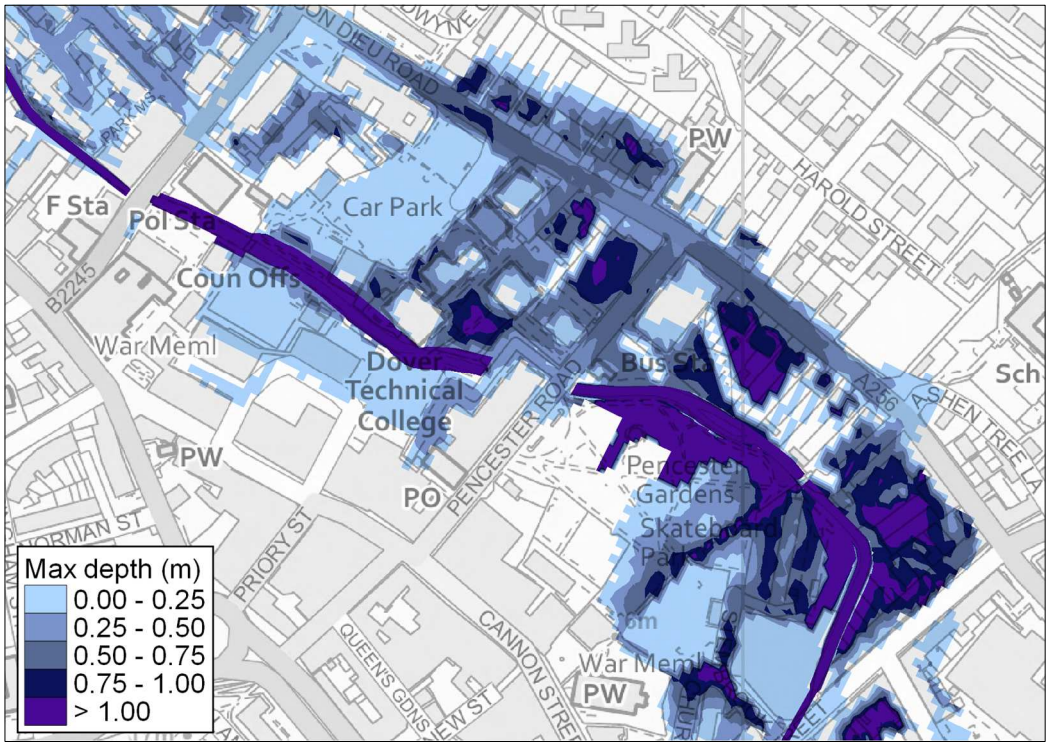


Figure 27 - Mitigation measure 2 maximum depth of flooding, 1:1,000 year event.

6.13. Figure 28 shows the difference plot for mitigation measure 2 versus the baseline for the 1:1,000 year return period event. Potential areas of development at the bowling green and the Dover Technical College carpark are shown to wet where they were once dry. However, this is a direct result of raising this area to a single level. It is anticipated that, where practicable, these areas could be raised further to prevent them being wetted during this event without any detrimental effects elsewhere.

6.14. Figure 28 shows the beneficial lowering of flood levels for the 1:1,000 year return period event throughout mid-town and the wider area. However, a small area of increased flood level occurs in the river channel at the downstream end of the Pencester Gardens, which reaches into the rear gardens of the properties along Castle Street (Less Vulnerable).This represents an increase of up to 0.05 m where the depth of flooding is already in access of 1.0 m.

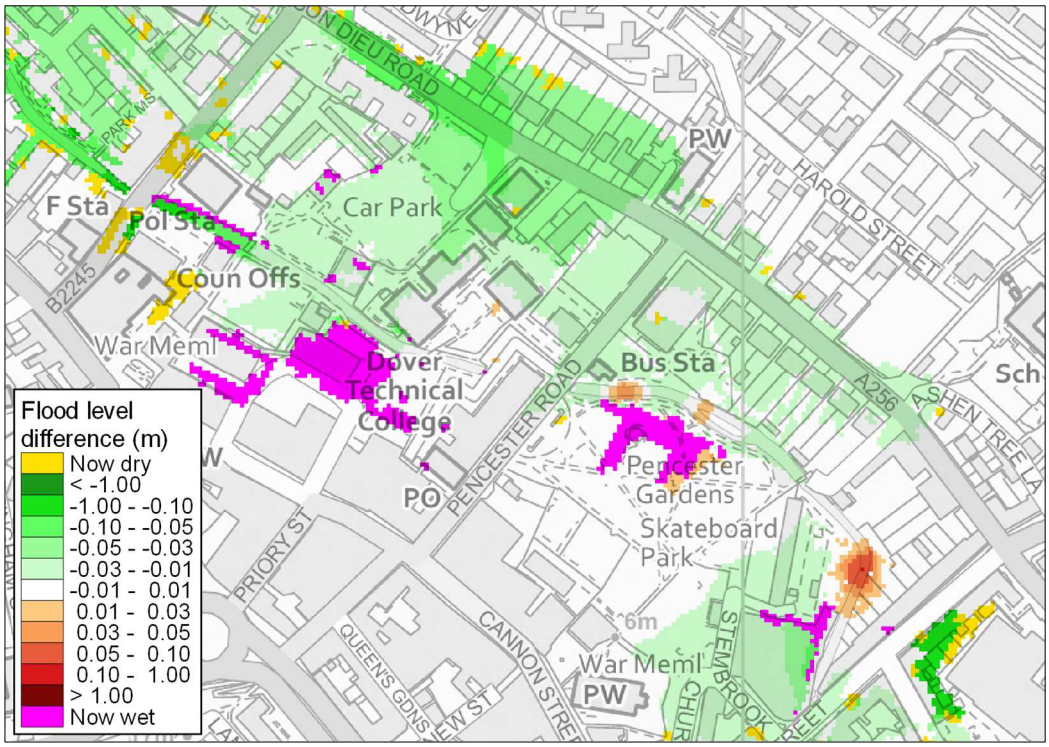


Figure 28 - Mitigation measure 2 minus existing condition maximum depth of flooding, 1:1,000 year event.

7. Conclusions

7.1. The EA's model of the River Dour has been updated to represent the current configuration of the river which flows through Dover, to determine the true flood extents in the mid-town area. A series of conceptual mitigation measures, which seek to reduce the risk of flooding, have been applied to the model, which has been re-run for a range of extreme fluvial events. The model results have been interrogated to determine what impact the mitigation measures will have in the areas of potential development available to DDC, and include detailed improvements to the river corridor in the form of a two-stage channel, and land raising and lowering in potential development areas. The modelling has identified the following:

7.1.1. Under existing conditions, the functional floodplain affects the bowls club, part of Maison Dieu carpark and part of the Dover Technical College. This is due to the very low bank levels along the river at these locations.

7.1.2. As a result of the current limited flow capacity in the river channel, during the 1:100 year return period event flood water exits the river channel at Maison Dieu and Dover Technical College and flows through mid-town, before re-entering the river channel opposite Pencester Gardens. These overland flow routes must be maintained to prevent flooding being exacerbated in mid-town.

7.1.3. During events greater than the 1:100 year return period event, flood water also enters mid-town along Maison Dieu Road, having exited the river channel near the junction between Charlton Gardens and Bridge Street.

7.1.4. The modelling has shown that widening the river to create a two-stage channel between Park Street and Pencester Road, alongside modest improvements to bank levels, can reduce the extent of flooding during the 1:20 year return period event. This has the effect of removing the development study areas from the functional floodplain.

7.1.5. The modelling also shows that the improvements to the channel between Park Street and Pencester Road, have the potential to reduce flood levels throughout mid-town and the residential areas west of Park Street during higher return period events.

7.1.6. Land raising in the study area will allow ground floor levels to be raised above the flood level of the 1:100 year return period event (plus an increase of 45% for future climate change), providing the opportunity to develop this area safely. The comparison models with the corresponding baseline return period event scenarios show that there is no detrimental impact offsite caused by raising the land in the mid-town area. This is attributed to the flooding resulting from a lack of conveyance within the river and floodplain, and as a result, raising land levels does not displace floodwater, providing the channel is made wider.

7.1.7. The current model tests have keep the maximum height on the land raising below the water level for the 1:1,000 year return period event scenario. This decision has been made on the basis that it may not be considered practicable to raise the land further, without having a detrimental impact elsewhere.

7.1.8. Whilst the modelling has shown that through mitigation the risk of flooding to the study area can be significantly reduced, when compared to the current situation, the risk is not removed entirely. As such, ground floor uses for any new development may need to be restricted to Less Vulnerable uses. It is, however, recommended that further site-specific analysis is undertaken if the ground floor vulnerability is proposed to be increased.

7.1.9. The modelling has shown that land lowering in Pencester Gardens can be beneficial, by lowering flood levels near the properties at the lower end of Maison Dieu Road and Castle Street. Land lowering in Pencester Gardens has no significant benefit with respect to reducing the risk of flooding in Maison Dieu carpark or Maison Dieu Road.

7.1.10. The ground elevations alongside the river channel in Pencester Gardens are higher than those on the opposite riverbank. Therefore, any proposed land lowering in Pencester Gardens must specify a land level which is lower than the level of the opposite bank, to ensure a positive impact for the properties fronting onto Castle Street.

7.1.11. Construction in the mid-town area that could impede the overland flow routes should be avoided, as this has the potential to direct flood water to other areas, which may otherwise be currently unaffected. Construction that should be avoided includes; raising bank levels or installing walls along the edge of the river at Dover Technical College, the bus station, or at the rear of the properties along Castle Street.

7.1.12. Small sections of wall and particular buildings located outside of the mid-town area can have a significant effect on flooding in mid-town itself, i.e. the wall along Halfords rear carpark. When these features are absent from the model it leads to an earlier onset of flooding in the residential areas to the west of Park Street.

7.1.13. Although the impact of flood alleviation works on the outskirts of Dover have not been included as part of this study, the analysis suggests that alleviation works are likely to provide the greatest reduction in flood risk in Dover mid-town as a whole. This is on the basis that the river corridor is highly constrained by existing development and as such, there are few opportunities to manage the volume of flood water that reaches the town, within mid-town itself.

8. Recommendations

8.1. This study focuses on testing the conceptual options for Dover mid-town and includes a number of assumptions, which are required to be made due to the limited information available regarding the regeneration planning. Therefore, to further refine the modelling and to determine the impacts of any final scheme, the following recommendations are made:

8.2. Detailed modelling of the two-stage channel (an 'as-designed' version) is recommended once a full understanding of the potential design constraints has been identified. This may include: wider stages at Maison Dieu, narrow left bank and wide right bank near Dover Technical College, and any constraints on the bank opposite the police station.

8.3. It is recommended that the proposed landscaping in Pencester Gardens is fully tested through further detailed modelling, to ensure a full understanding of its as-designed efficacy. Lowering land in Pencester Gardens, as tested in the model, has taken an arbitrary form purely to test the concept and effect of providing an increased volume of storage . The current model simply ensures that any land lowered in this area must be to below the level of the opposite bank (to provide any significant benefit), however, no further investigation of the impacts has been considered at this stage. Notwithstanding this, the modelling results do suggest that land lowering is most beneficial during less extreme flood events and the reduction in flood level in the nearby areas is directly proportional to the additional storage provided in Pencester Gardens. This is anticipated to hold true up to the point where the larger flood events dominate the flooding amongst the properties on the opposite bank. Therefore, it is considered that lowering Pencester Gardens will be largely insensitive to its actual form, i.e. it could include multi-stage flood storage and channels routed through the Gardens in a complementary plan form.

8.4. During a project meeting with EA, the EA requested that a model sensitivity test is undertaken for the final scheme, to simulate the closure of Wellington Dock outer dock gates. This represents a scenario during times of high tidal surge, which will trigger the closure of the dock gate. Therefore, it is recommended that the tidal surge level that triggers dock gate closure is understood prior to commencing additional model runs. It is, however, recommended that the probability of the tidal surge and fluvial flooding occurring coincidentally should be considered further, given the limited correlation between the coincidence of extreme fluvial flow events and high surge tide events[2].

8.5. The EA has also requested that any future modelling also considers the impact of a surface water (pluvial) flood event in Dover. As it stands, the model includes the lateral inputs of the urban catchments in Dover and these have been inserted into the river channel at various points along its length. However, it is understood that surface water run-off can lead to significant flooding and therefore, it is recommended that this request is addressed as part of the final modelling solution for the mid-town area.

[2] Petroliagkis, T.I., Voukouvalas, E., Disperati, J. and J. Bildot, 2016. Joint Probabilities of Storm Surge, Significant Wave Height and River Discharge Components of Coastal Flooding Events. EUR 27824 EN. doi:10.2788/677778

9. Appendices

Appendix A – Initial modelling stage: conceptual tests

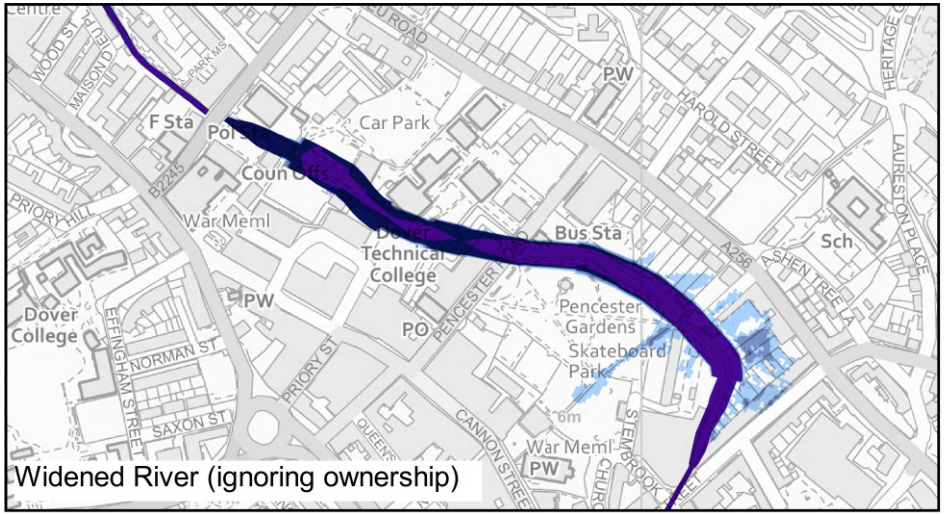
Appendix B – Baseline: model results

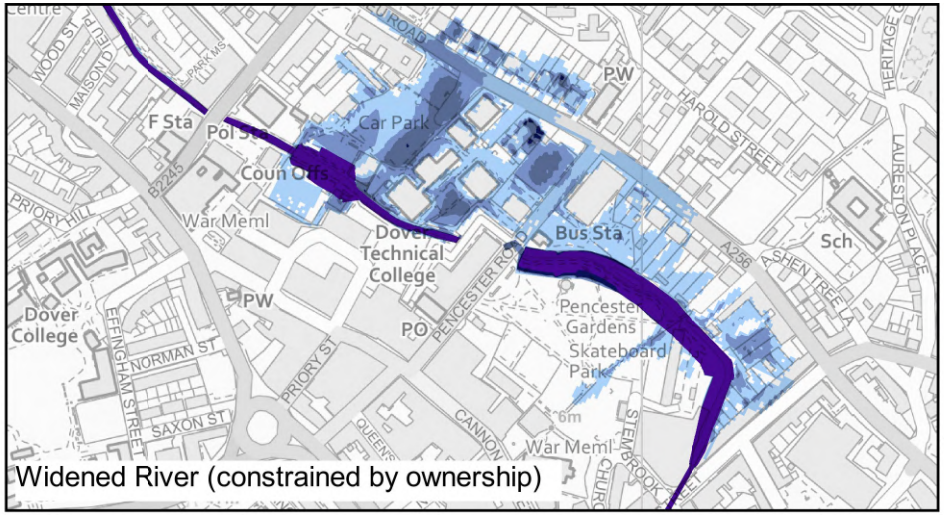
Appendix C – Mitigation measures 1: model results

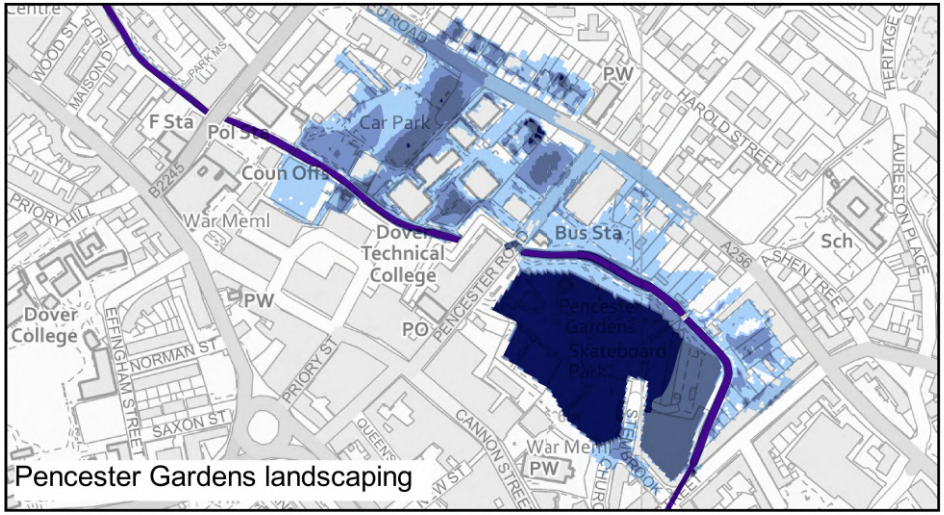
Appendix D – Mitigation measures 2: model results

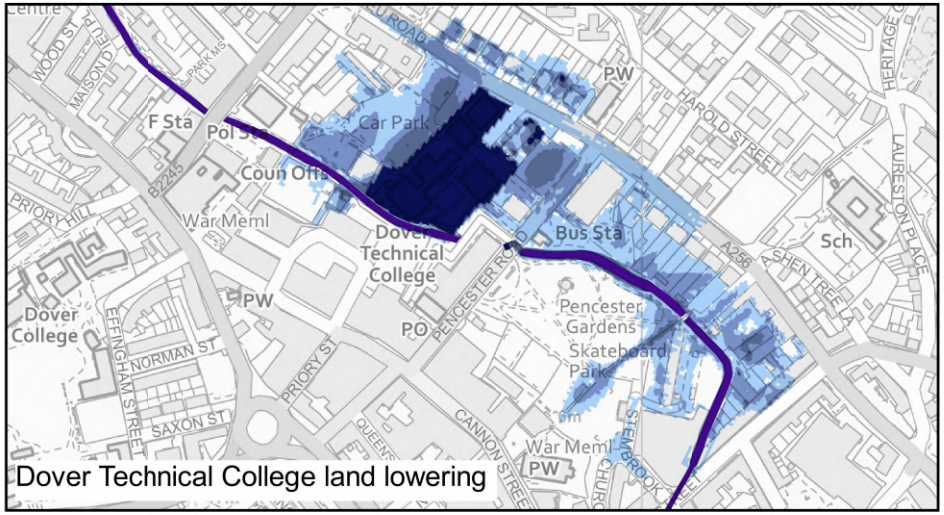
Appendix E – Meeting minutes and correspondence

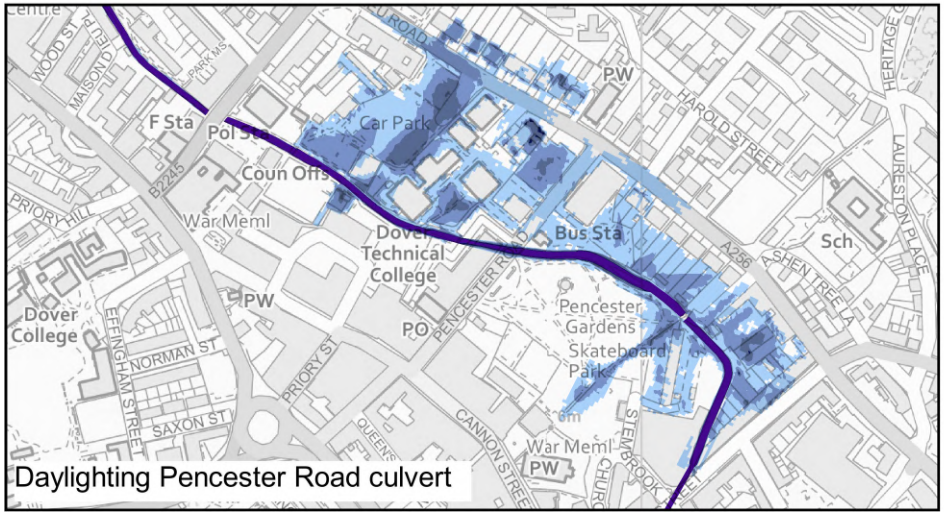
Appendix A – Initial modelling stage: conceptual tests

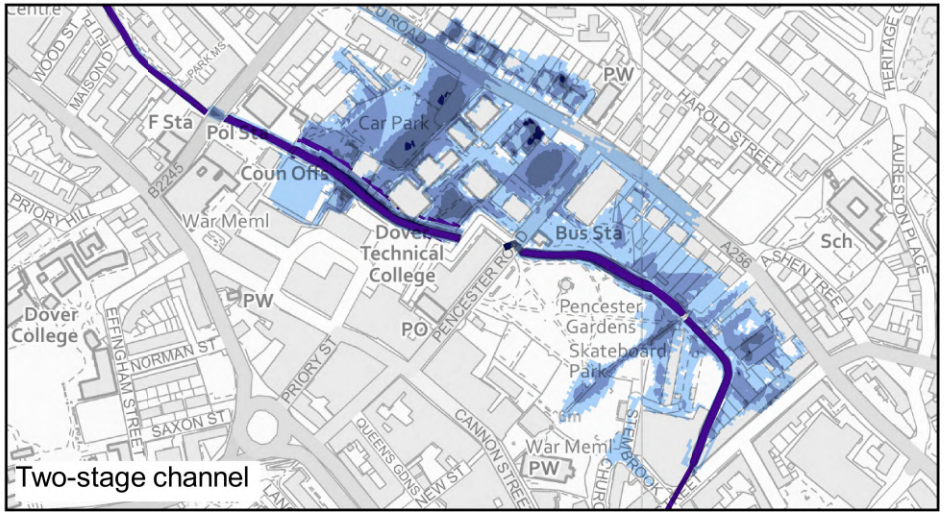












TITLE

MAXIMUM DEPTH OF FLOODING
INITIAL STAGE CONCEPTUAL TESTS
1:100 year

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 100 year return period event

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1	1st issue	30-07-2020

CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
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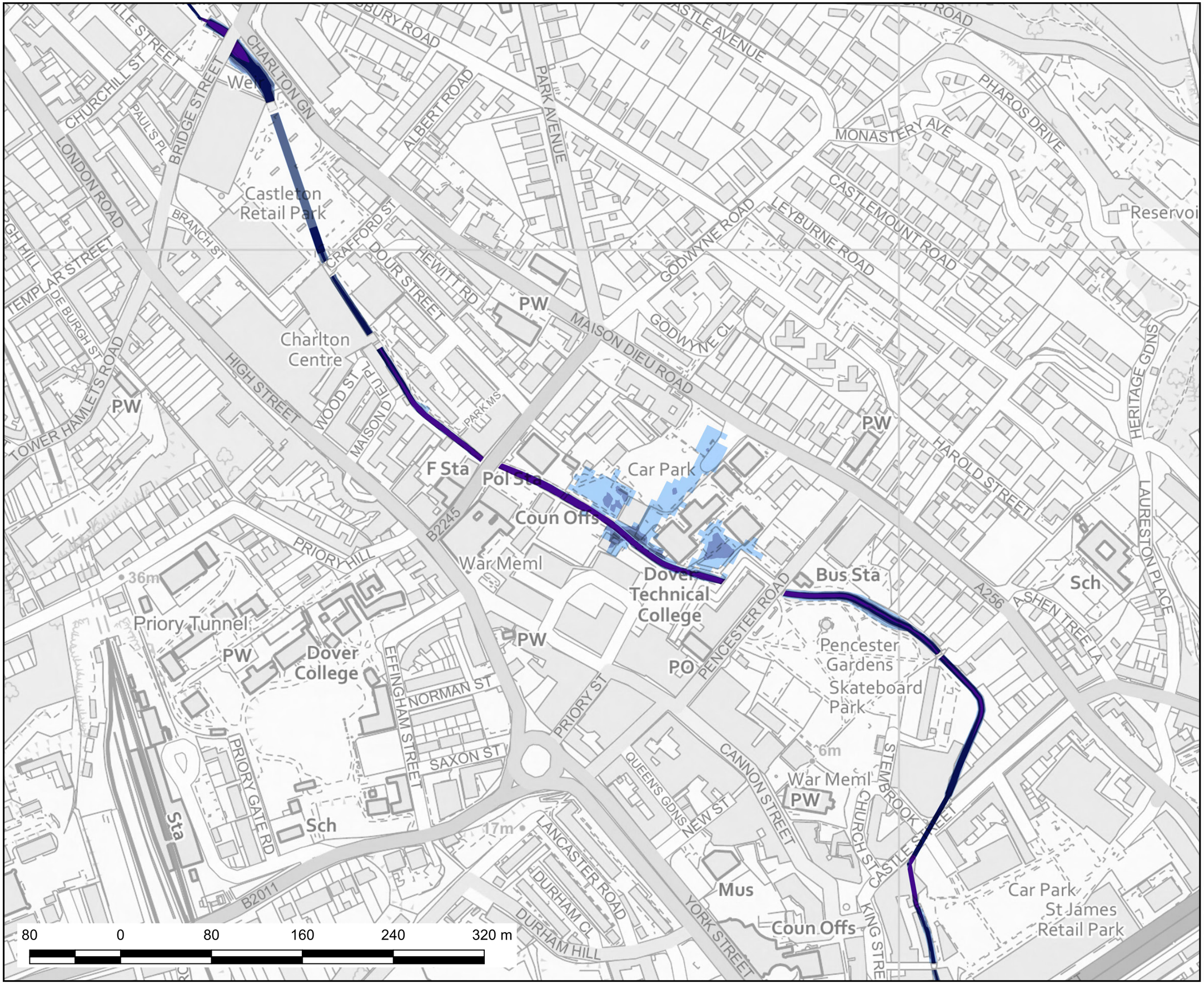
DRAWING No. **A.1**

Appendix B – Baseline: model results



TITLE

MAXIMUM DEPTH OF FLOODING
EXISTING CONDITIONS
1:20 year

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 20 year return period event.

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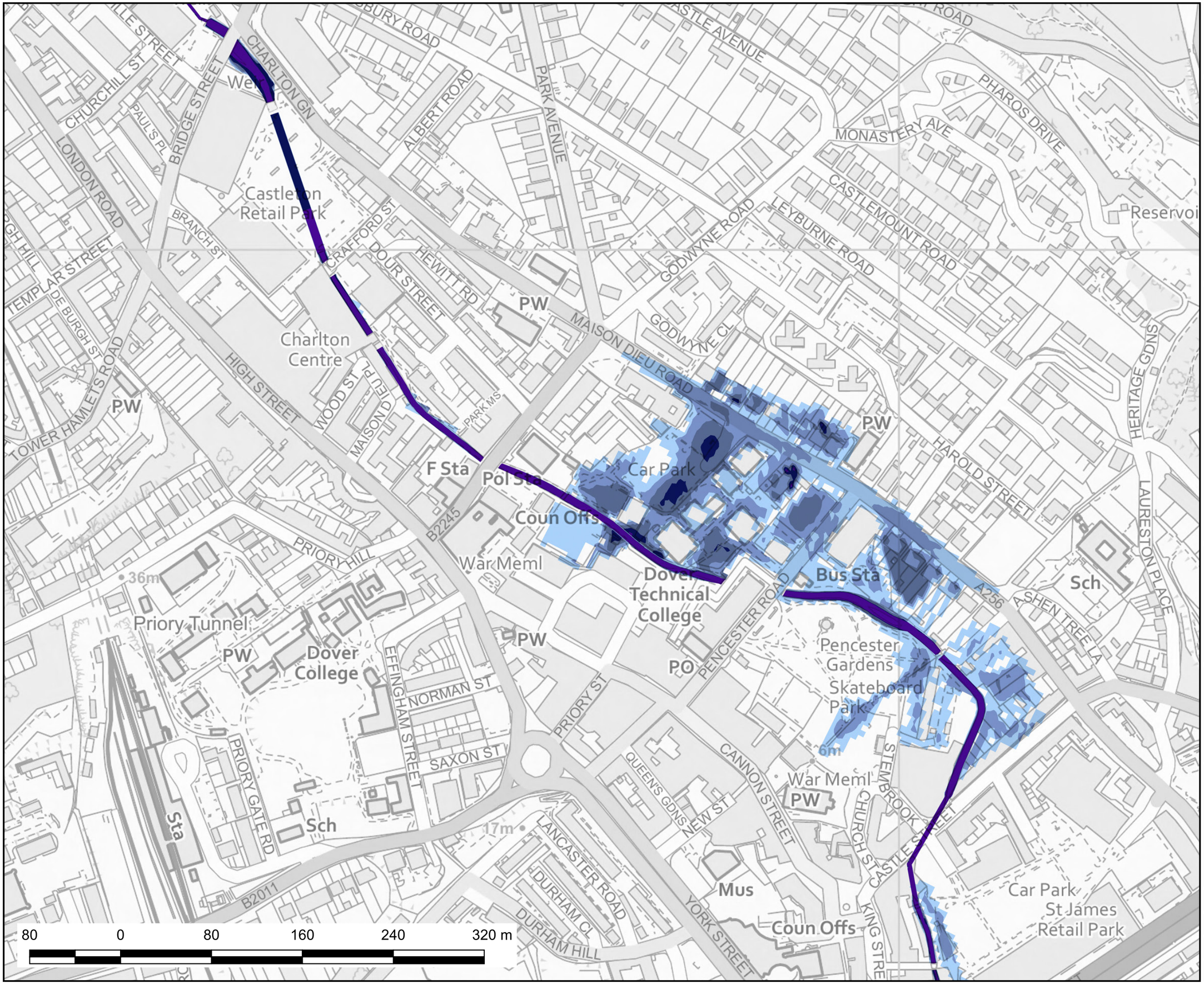

TITLE

MAXIMUM DEPTH OF FLOODING
EXISTING CONDITIONS
1:100 year

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 100 year return period event.

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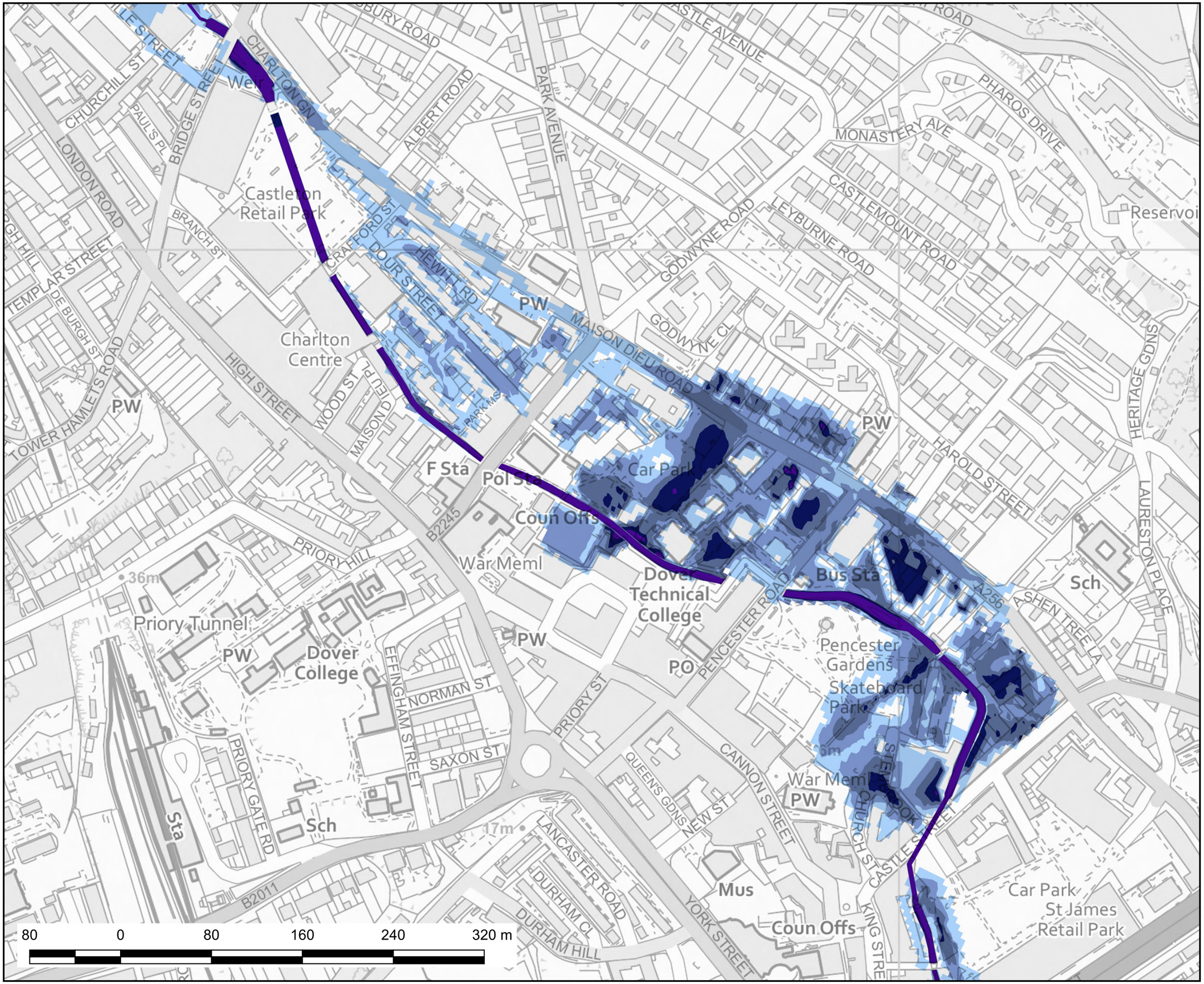

TITLE

MAXIMUM DEPTH OF FLOODING
EXISTING CONDITIONS
1:100 year +45%

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 100 year return period event, including an increase in the flows of 45% to represent climate change 100 years in the future.

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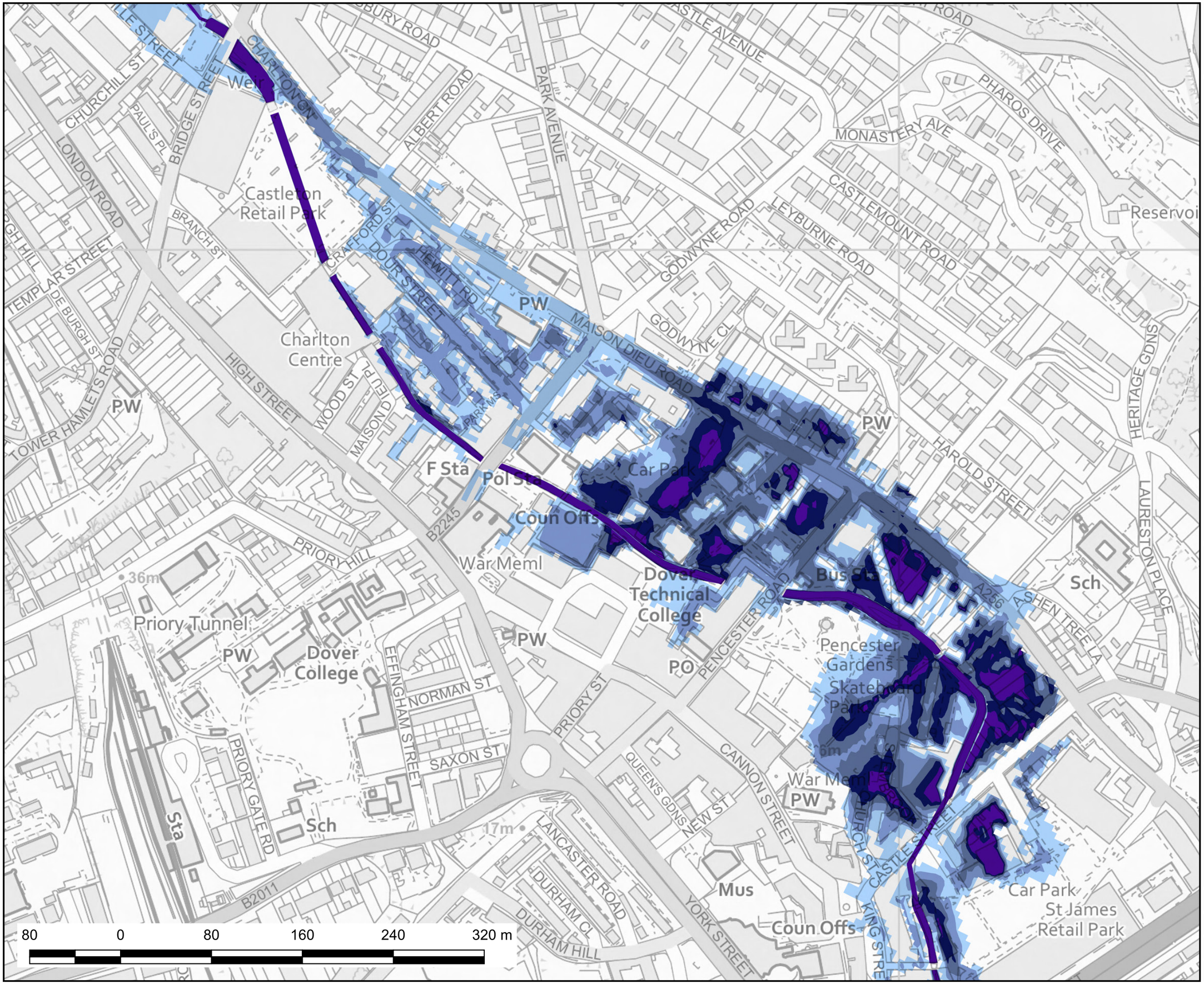

TITLE

MAXIMUM DEPTH OF FLOODING
EXISTING CONDITIONS
1:1,000 year

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 1,000 year return period event.

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PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
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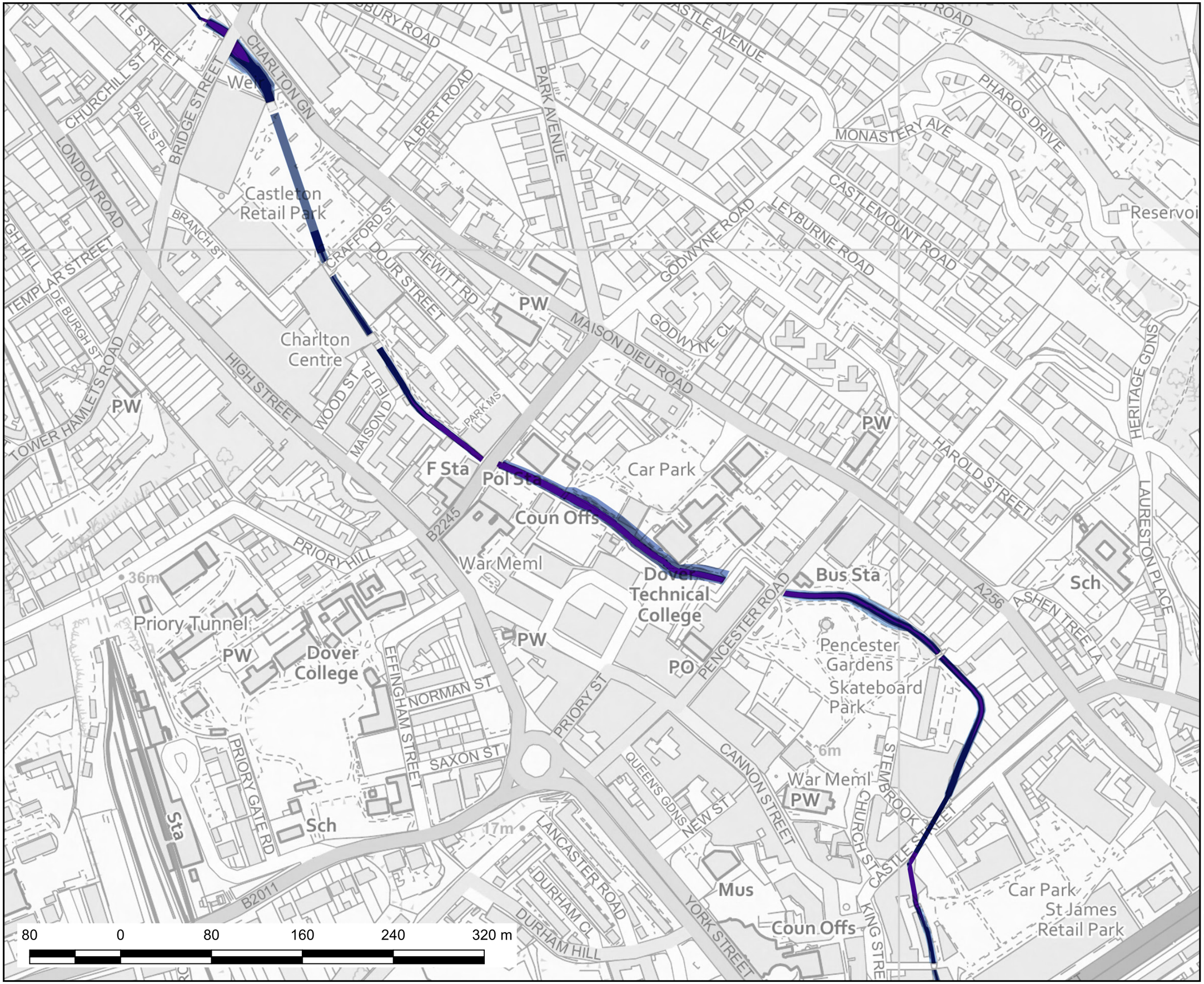
DRAWING No.: **B.4**

Appendix C – Mitigation measures 1: model results



TITLE

MAXIMUM DEPTH OF FLOODING
MITIGATION MEASURE 1
1:20 year

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 20 year return period event.

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PROJECT: MID-TOWN, DOVER

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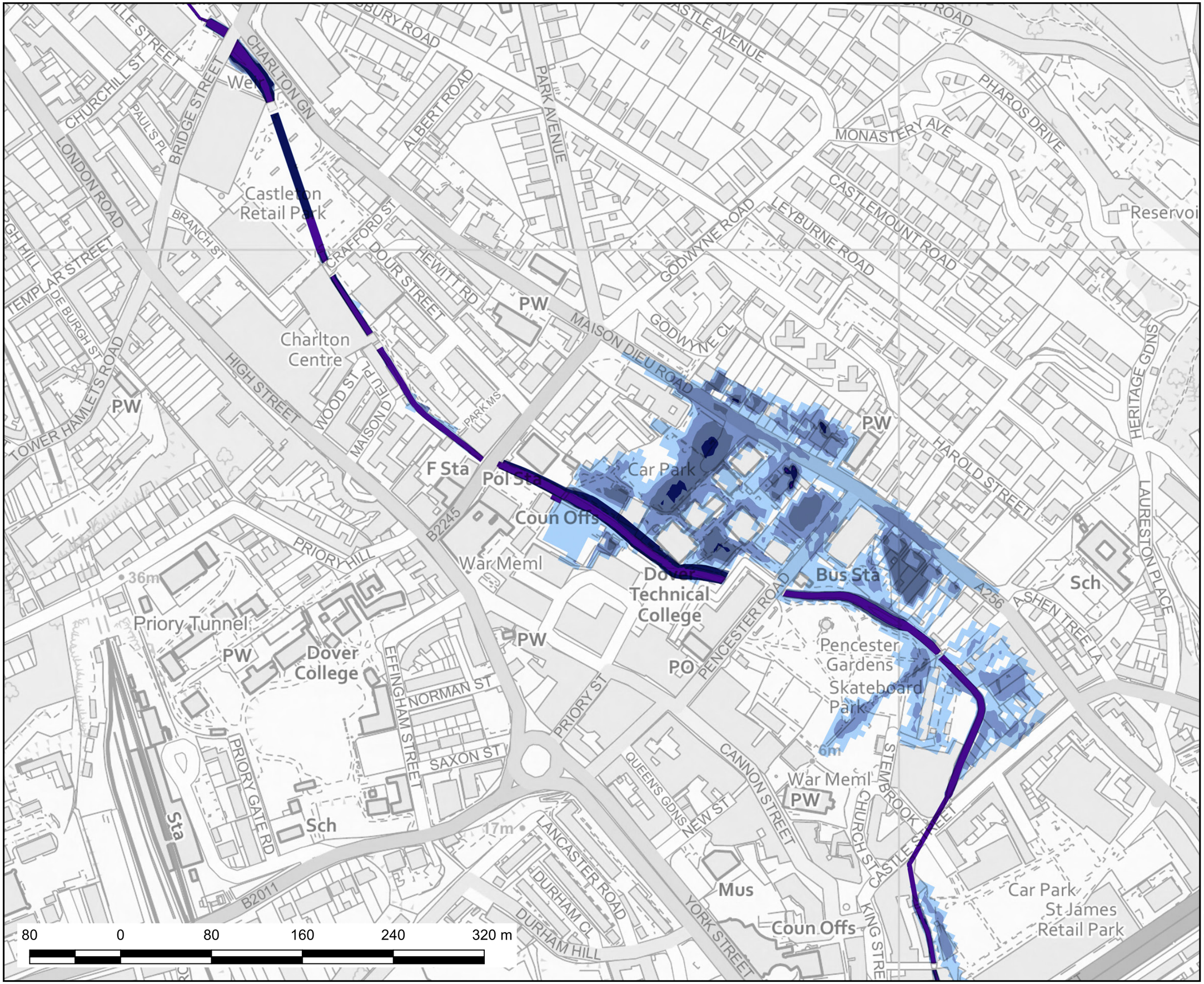

TITLE

MAXIMUM DEPTH OF FLOODING
MITIGATION MEASURE 1
1:100 year

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 100 year return period event.

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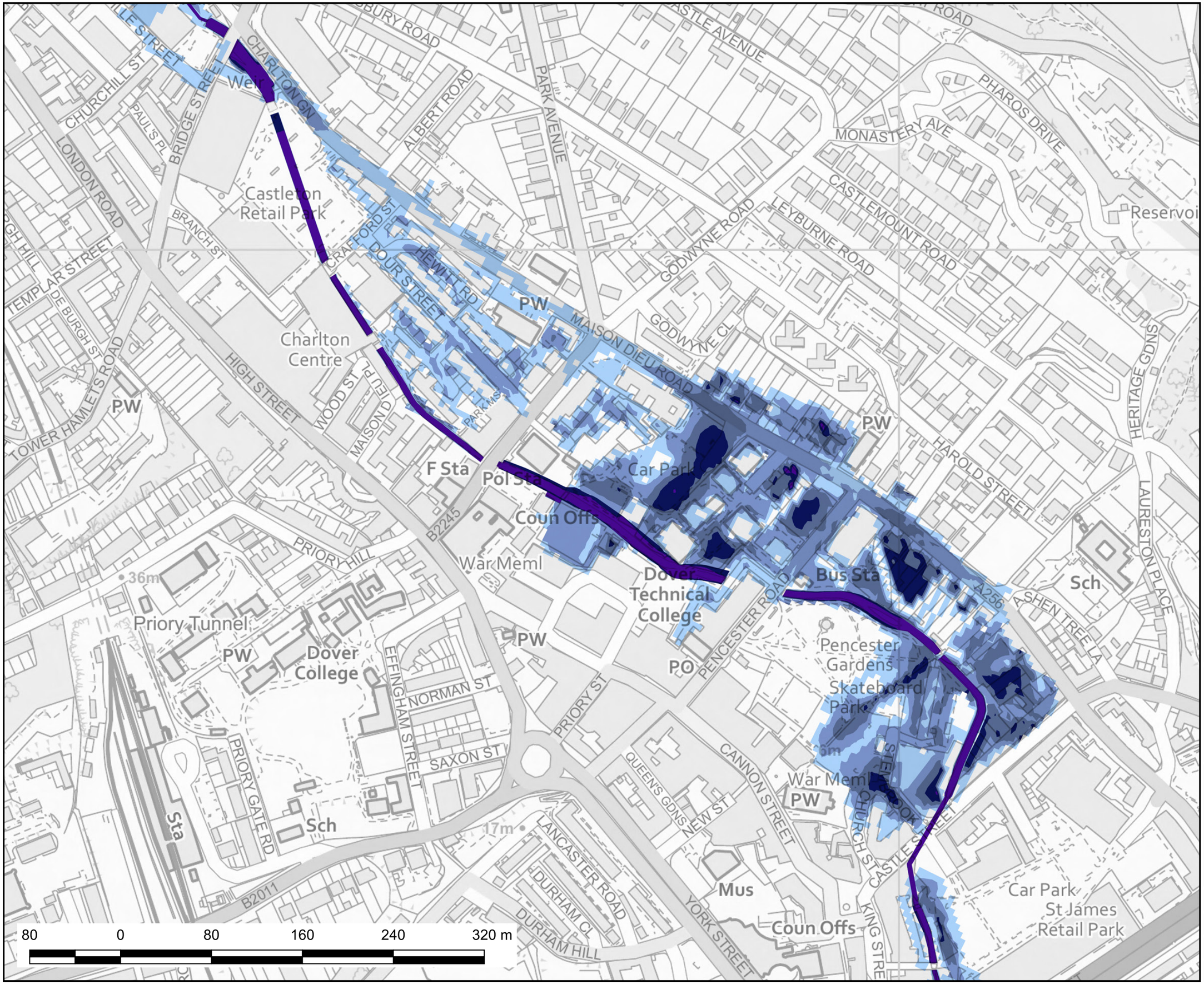

TITLE

MAXIMUM DEPTH OF FLOODING
MITIGATION MEASURE 1
1:100 year +45%

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 100 year return period event, including an increase in the flows of 45% to represent climate change 100 years in the future.

NOTES

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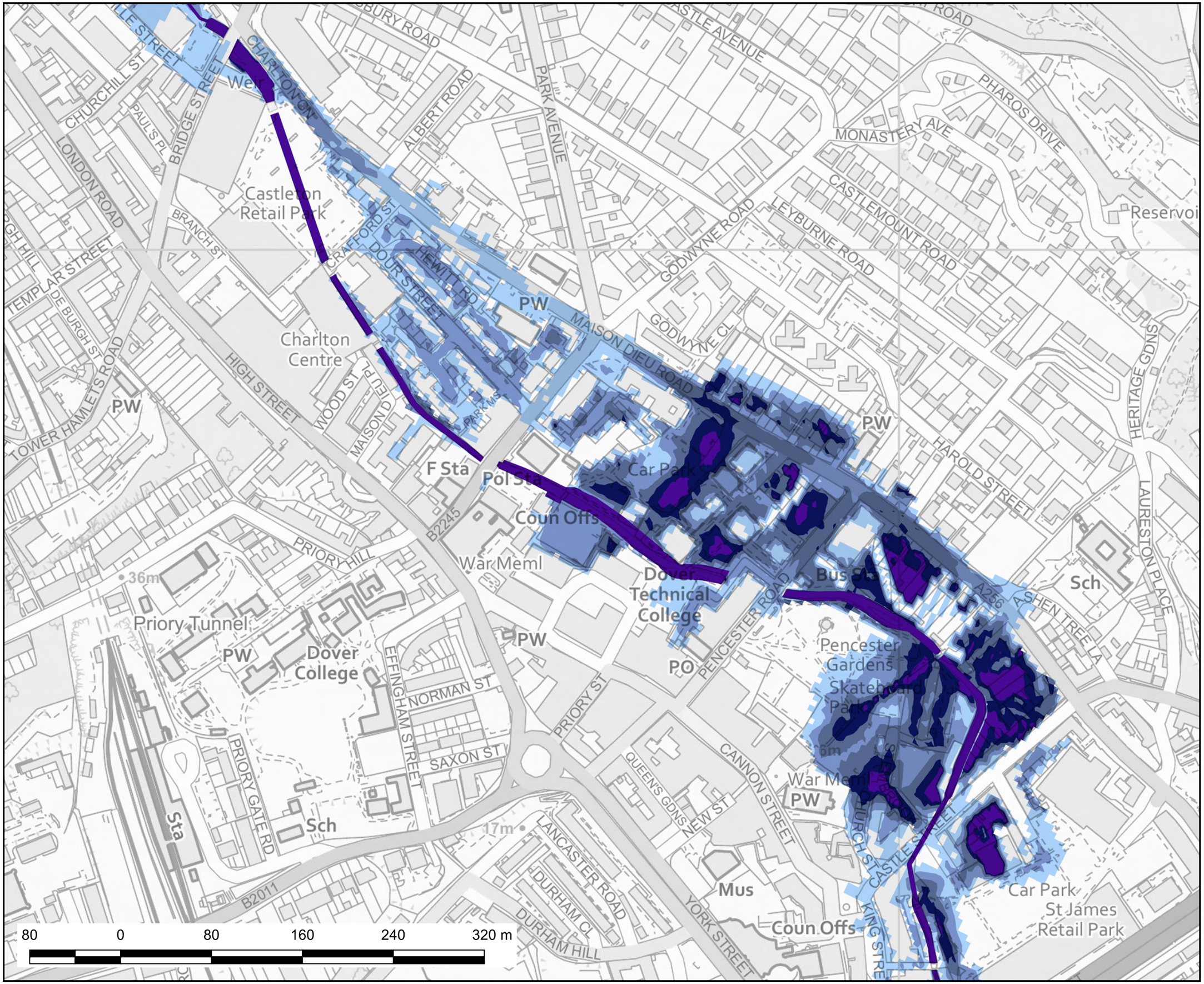
REV	DESCRIPTION	DATE
1	1st issue	30-07-2020

CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **C.3**



TITLE

MAXIMUM DEPTH OF FLOODING
MITIGATION MEASURE 1
1:1,000 year

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 1,000 year return period event.

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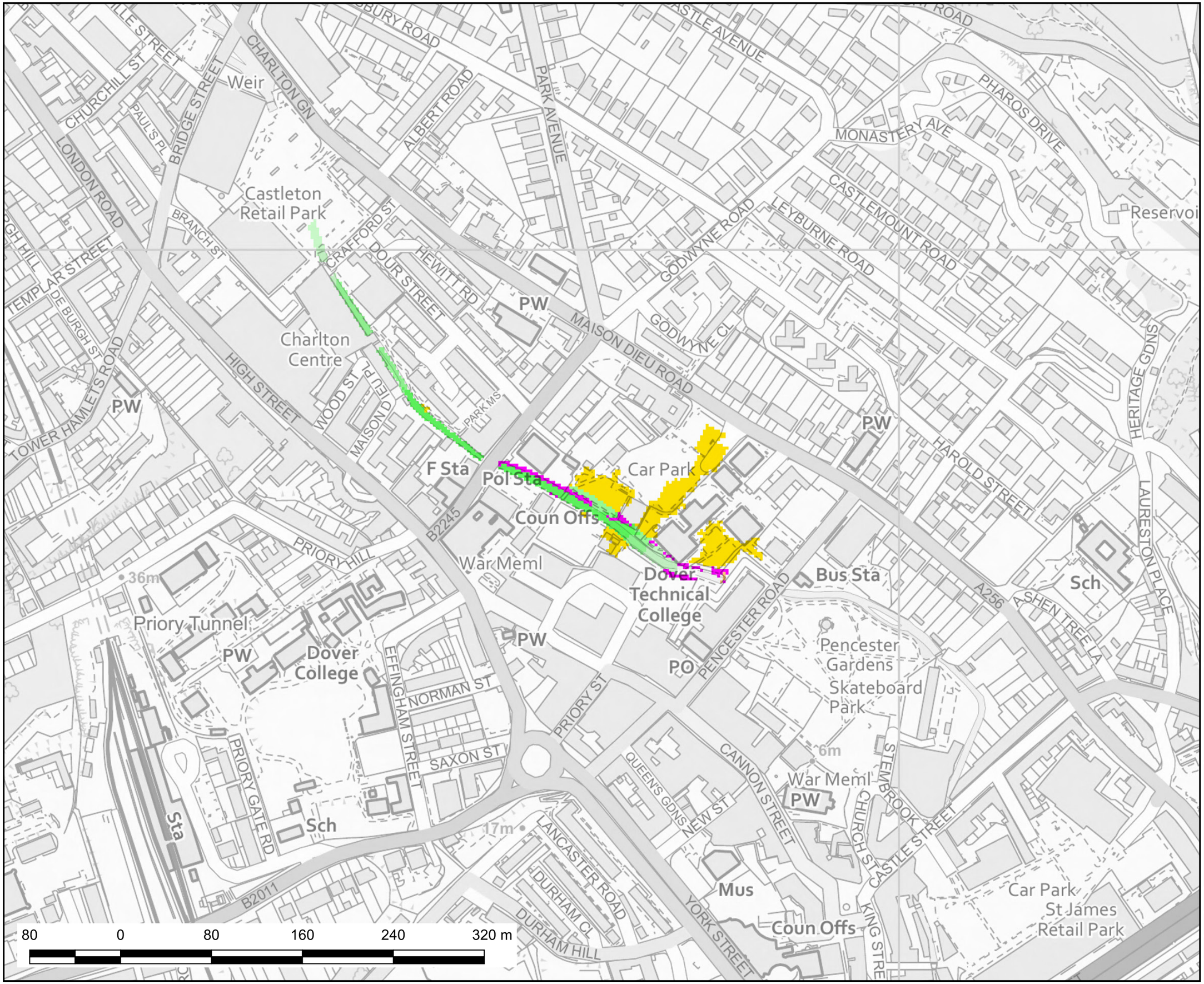
1	1st issue	30-07-2020

CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **C.4**



TITLE

DIFFERENCE IN FLOOD LEVEL
MITIGATION MEASURE 1
minus
BASELINE
1:20 year

LEGEND

Level difference (m)

- Now dry
- < -1.00
- -1.00 - -0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- 0.10 - 1.00
- > 1.00
- Now wet

DETAILS

The model results presented are the difference in the maximum flood level (proposed minus baseline). The scenario represents an extreme flood of 1 in 20 year return period event.

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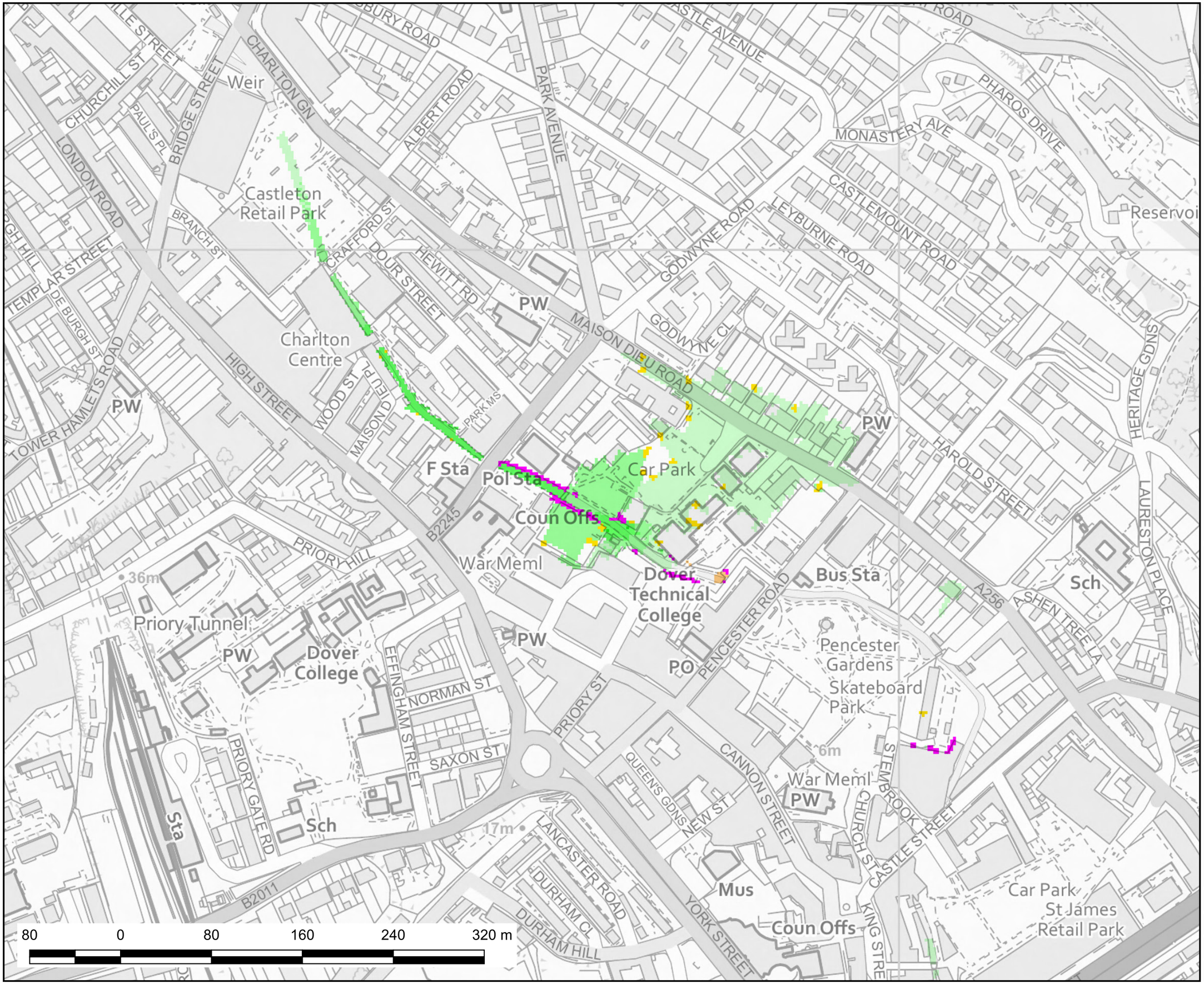
1	1st issue	30-07-2020

CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **C.5**



TITLE

DIFFERENCE IN FLOOD LEVEL
MITIGATION MEASURE 1
minus
BASELINE
1:100 year

LEGEND

Level difference (m)

- Now dry
- < -1.00
- -1.00 - -0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- 0.10 - 1.00
- > 1.00
- Now wet

DETAILS

The model results presented are the difference in the maximum flood level (proposed minus baseline).
The scenario represents an extreme flood of 1 in 100 year return period event.

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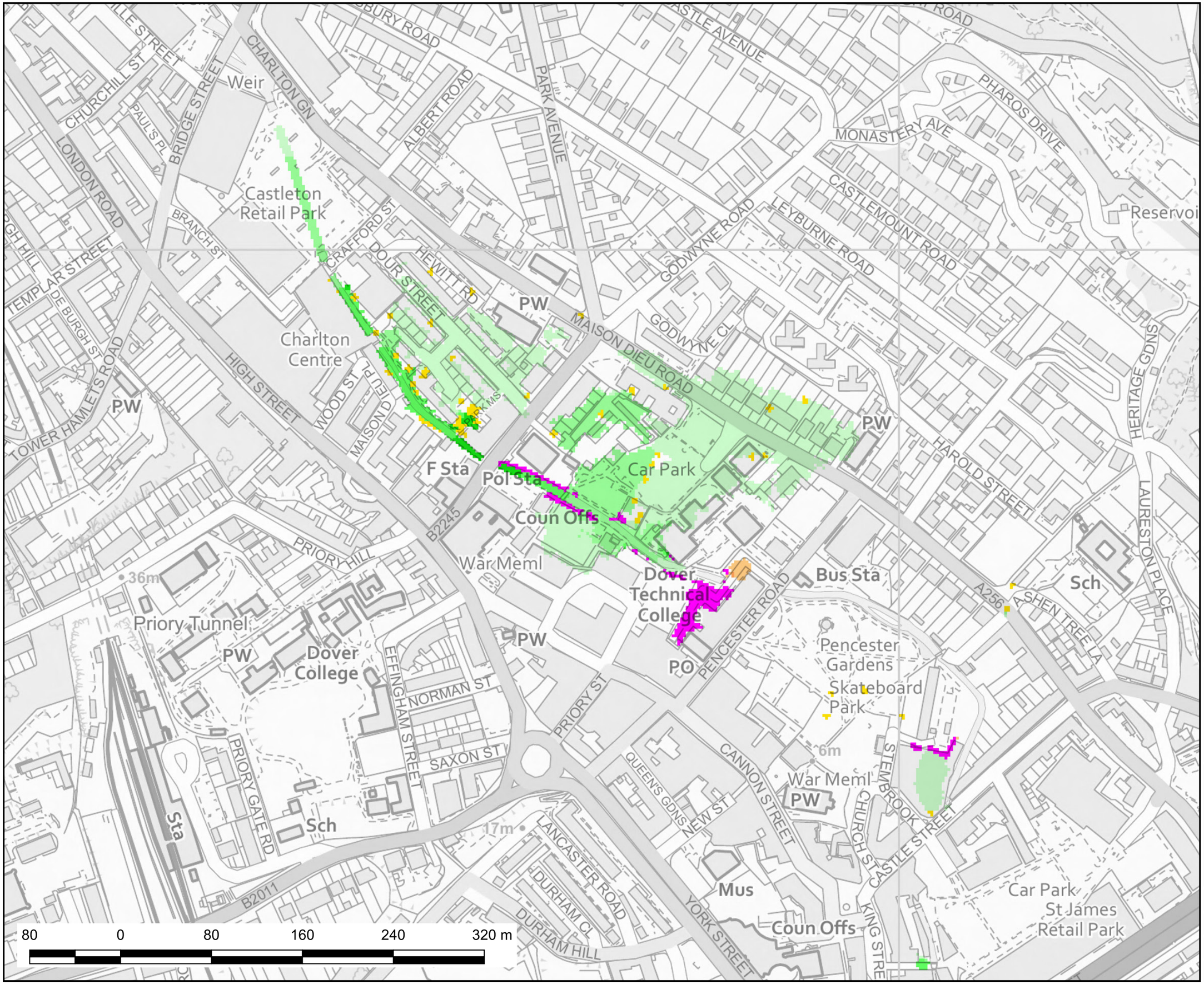
CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **C.6**



TITLE

DIFFERENCE IN FLOOD LEVEL
MITIGATION MEASURE 1
minus
BASELINE
1:100 year (+45%)

LEGEND

Level difference (m)

- Now dry
- < -1.00
- -1.00 - -0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- 0.10 - 1.00
- > 1.00
- Now wet

DETAILS

The model results presented are the difference in the maximum flood level (proposed minus baseline). The scenario represents an extreme flood of 1 in 100 year return period event, including an increase in the flows of 45% to represent climate change 100 years in the future.

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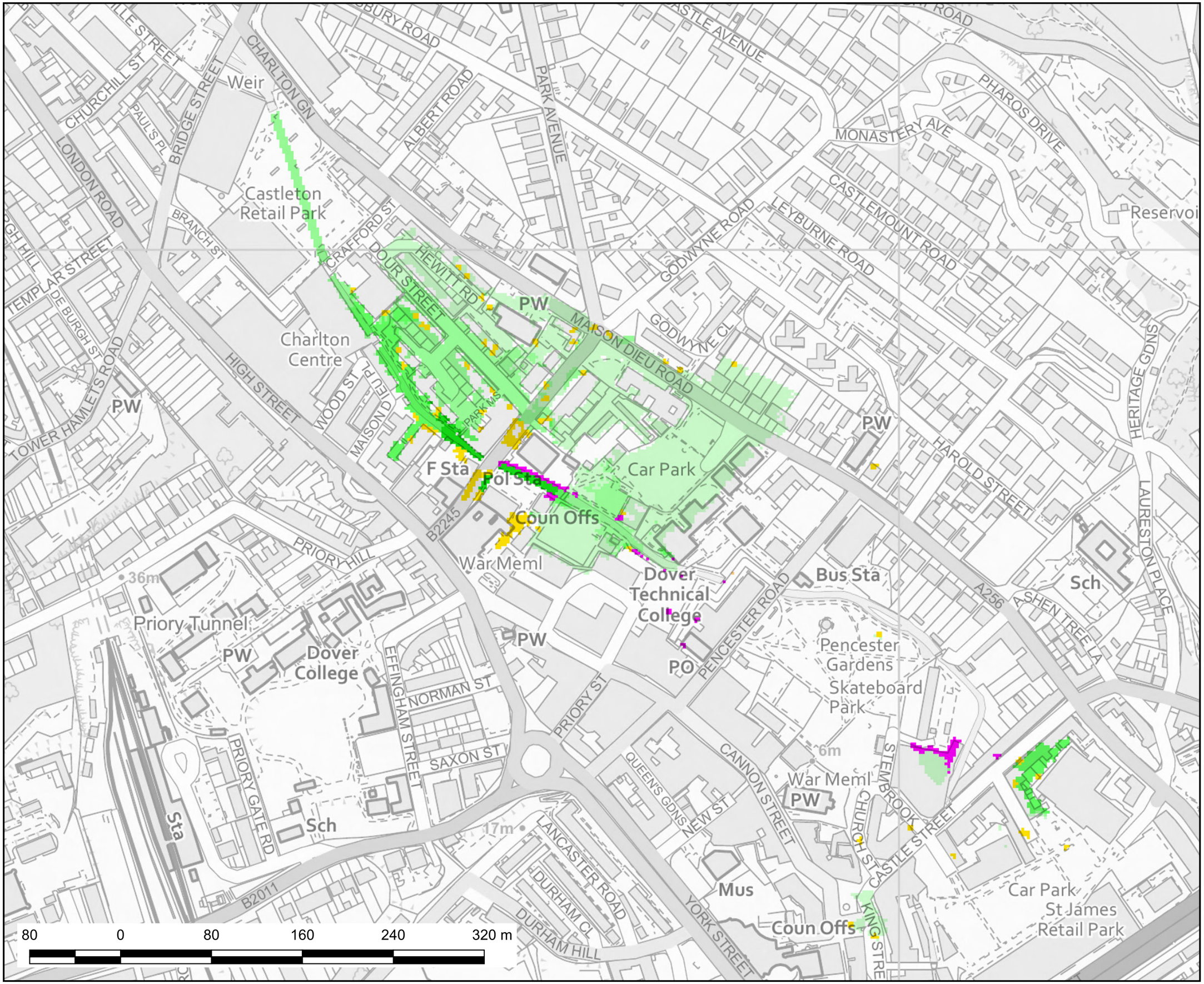
CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **C.7**



TITLE

DIFFERENCE IN FLOOD LEVEL
MITIGATION MEASURE 1
minus
BASELINE
1:1,000 year

LEGEND

Level difference (m)

- Now dry
- < -1.00
- -1.00 - -0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- 0.10 - 1.00
- > 1.00
- Now wet

DETAILS

The model results presented are the difference in the maximum flood level (proposed minus baseline). The scenario represents an extreme flood of 1 in 1,000 year return period event.

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1	1st issue	30-07-2020

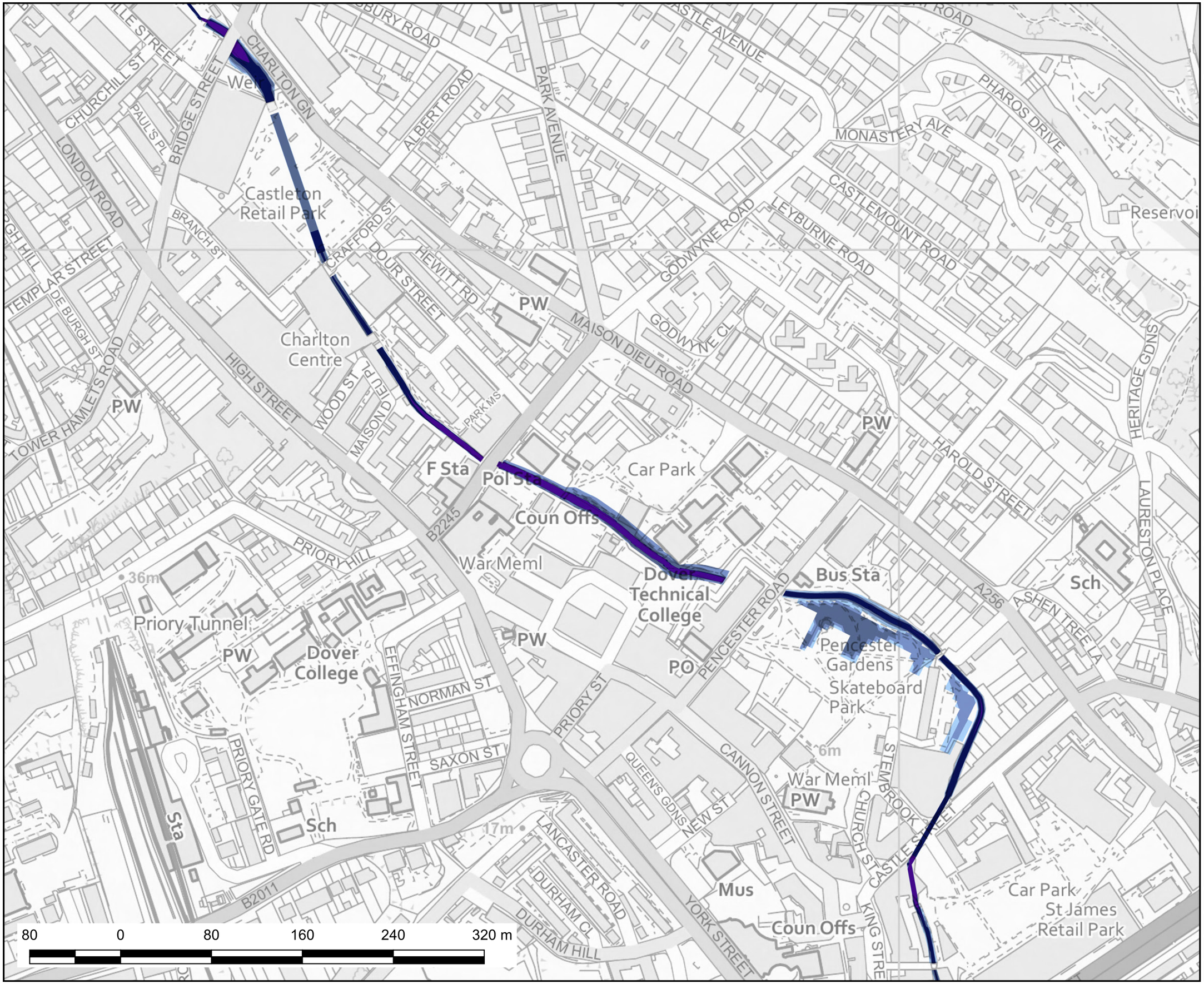
CLIENT DOVER DISTRICT COUNCIL

PROJECT MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No. **C.8**

Appendix D – Mitigation measures 2: model results



TITLE

MAXIMUM DEPTH OF FLOODING
MITIGATION MEASURE 2
1:20 year

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 20 year return period event.

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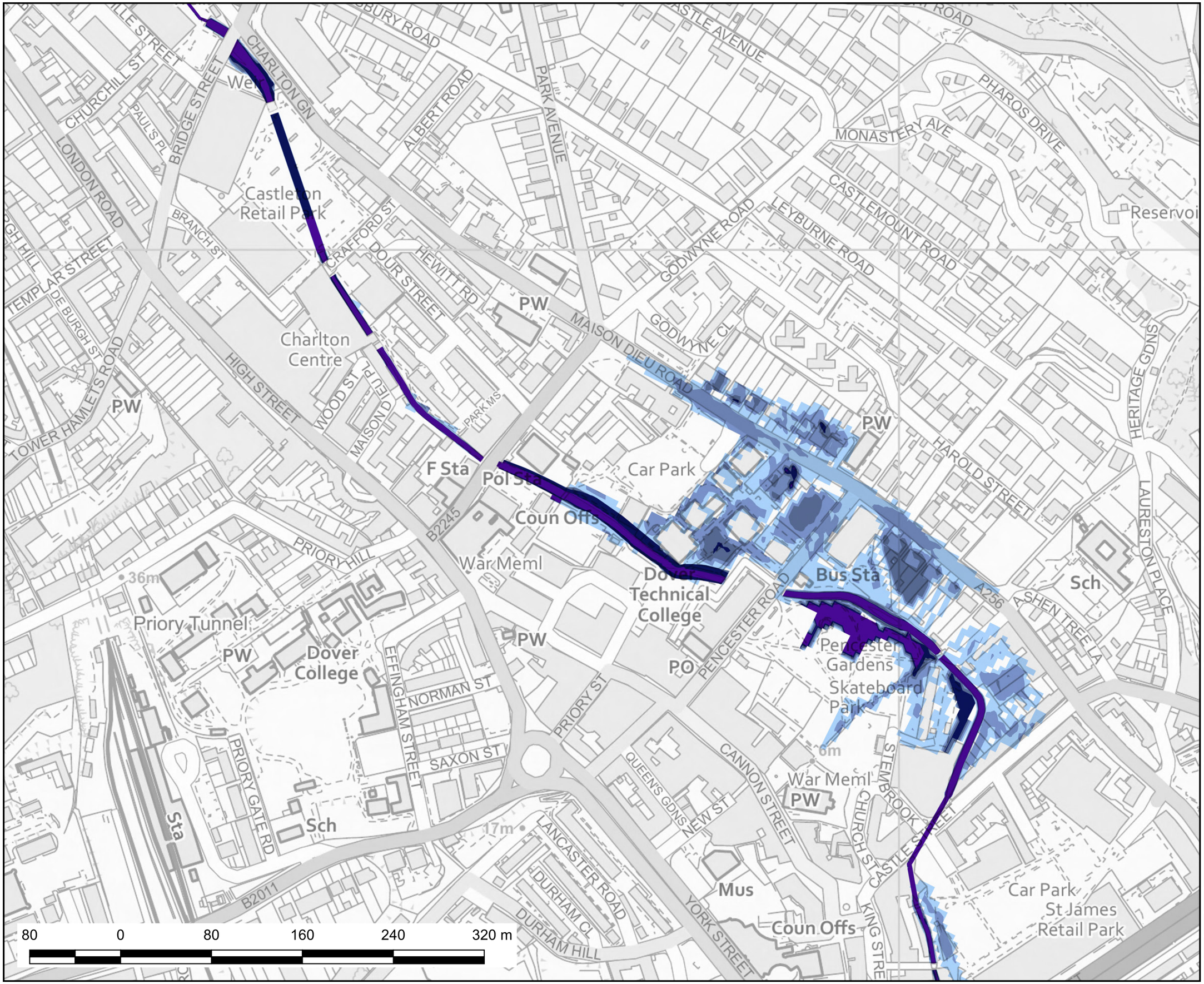
1	1st issue	30-07-2020

CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **D.1**



TITLE

MAXIMUM DEPTH OF FLOODING
MITIGATION MEASURE 2
1:100 year

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 100 year return period event.

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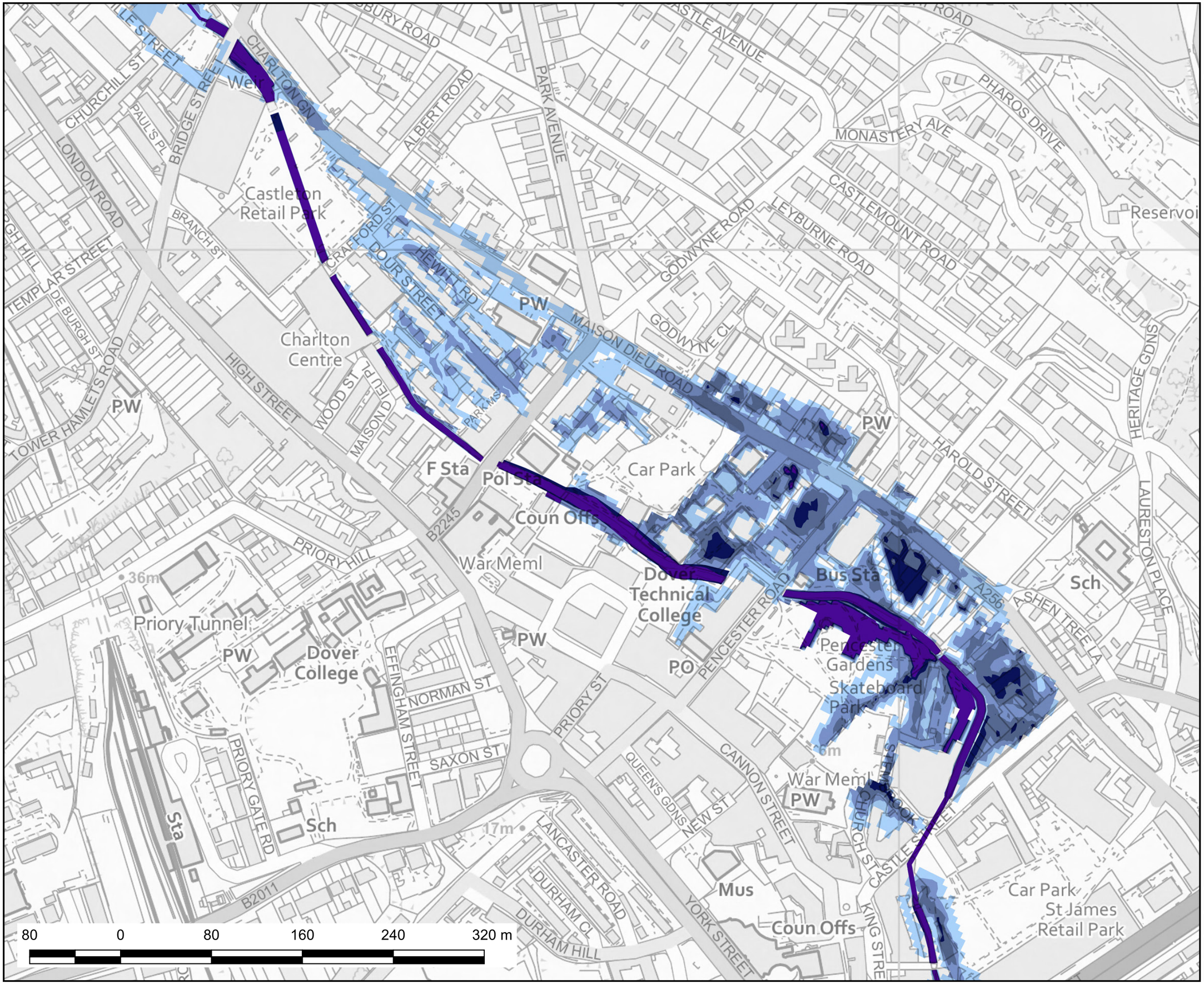
PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **D.2**



TITLE

MAXIMUM DEPTH OF FLOODING
MITIGATION MEASURE 2
1:100 year +45%

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 100 year return period event, including an increase in the flows of 45% to represent climate change 100 years in the future.

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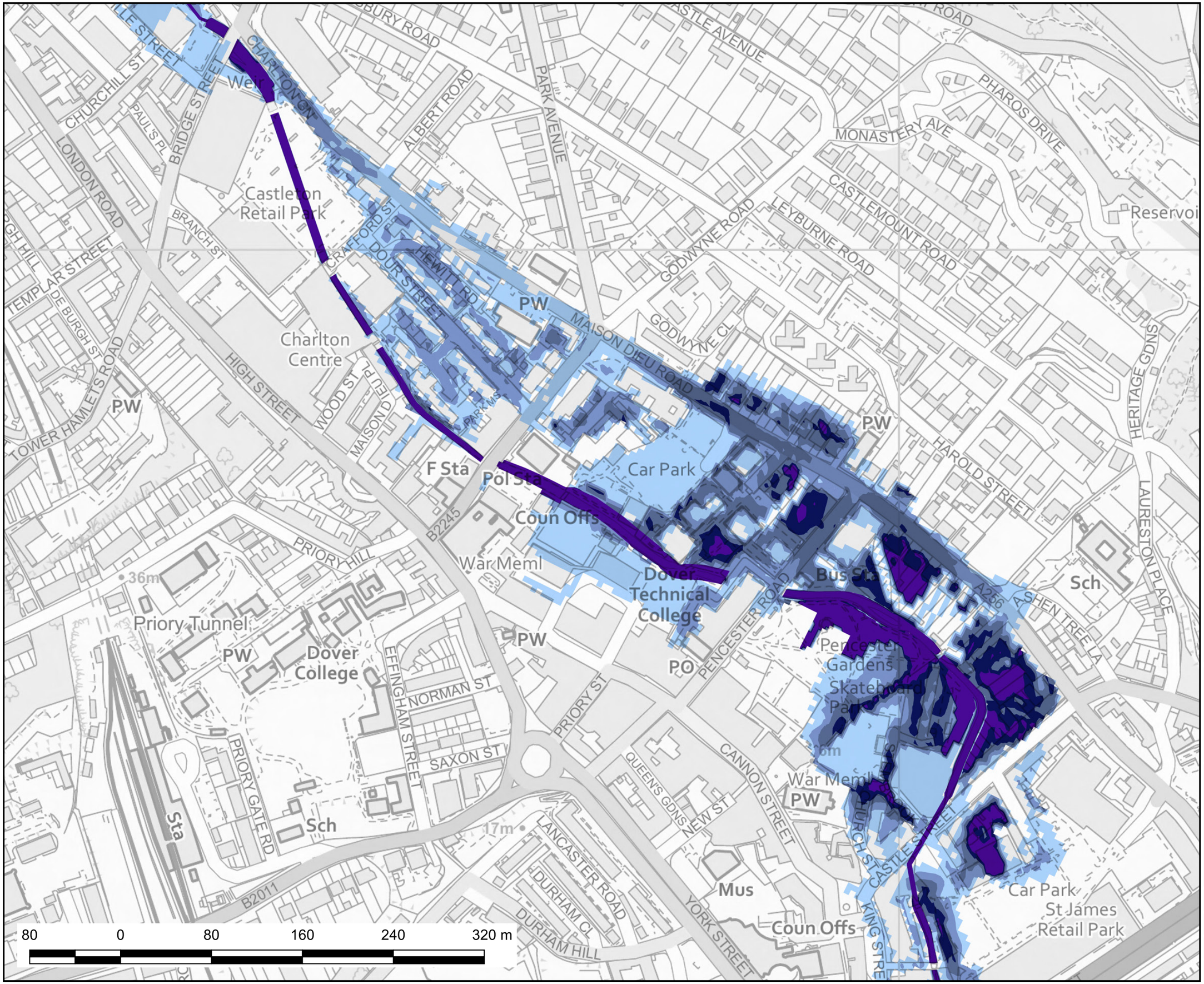
1	1st issue	30-07-2020

CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **D.3**



TITLE

MAXIMUM DEPTH OF FLOODING
MITIGATION MEASURE 2
1:1,000 year

LEGEND

Maximum Depth (m)
- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- > 1.00

DETAILS

The model results presented are the maximum depth of flooding.
The scenario represents an extreme flood of 1 in 1,000 year return period event.

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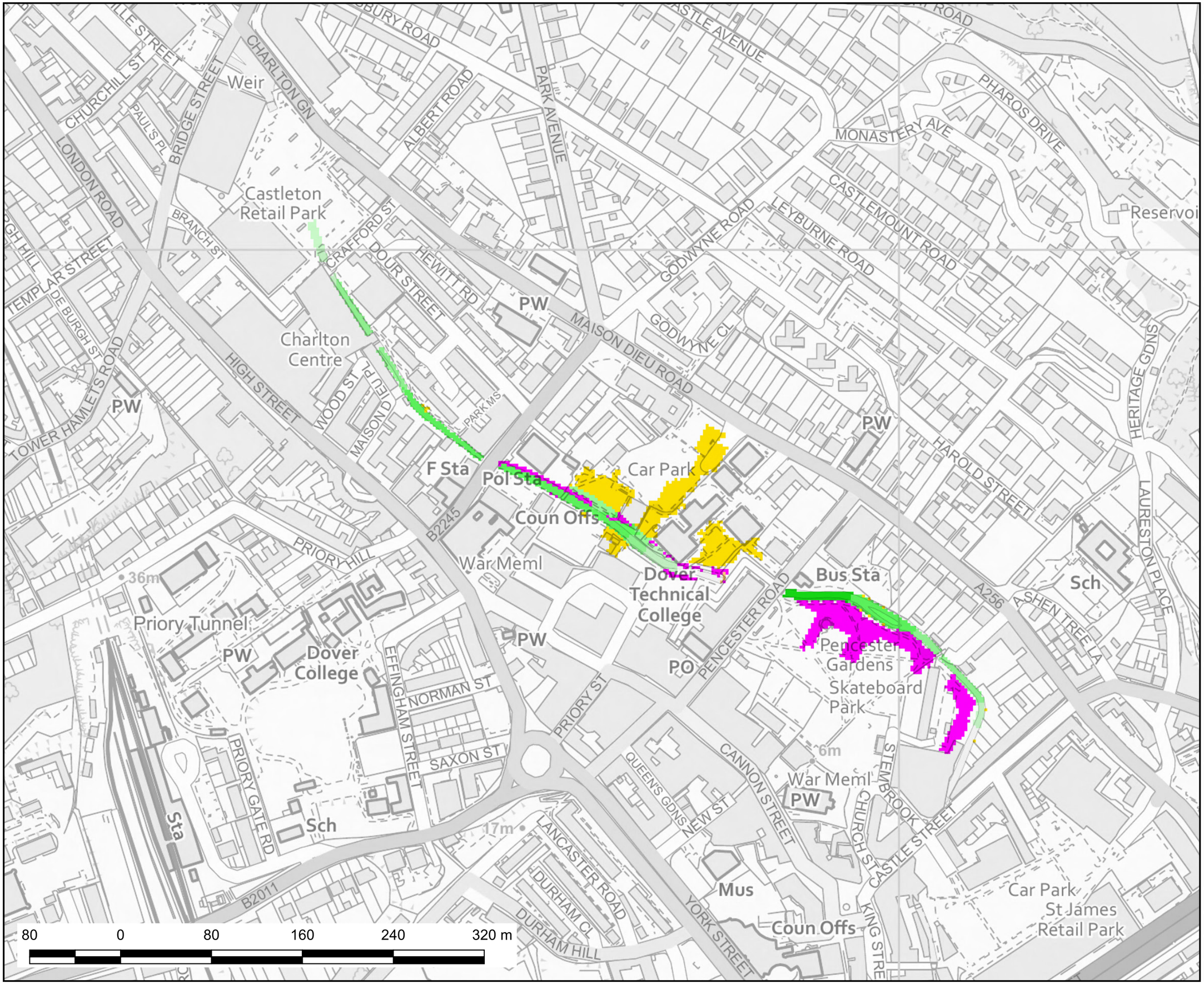
1	1st issue	30-07-2020

CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **D.4**



TITLE

DIFFERENCE IN FLOOD LEVEL
MITIGATION MEASURE 2
minus
BASELINE
1:20 year

LEGEND

Level difference (m)

- Now dry
- < -1.00
- -1.00 - -0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- 0.10 - 1.00
- > 1.00
- Now wet

DETAILS

The model results presented are the difference in the maximum flood level (proposed minus baseline). The scenario represents an extreme flood of 1 in 20 year return period event.

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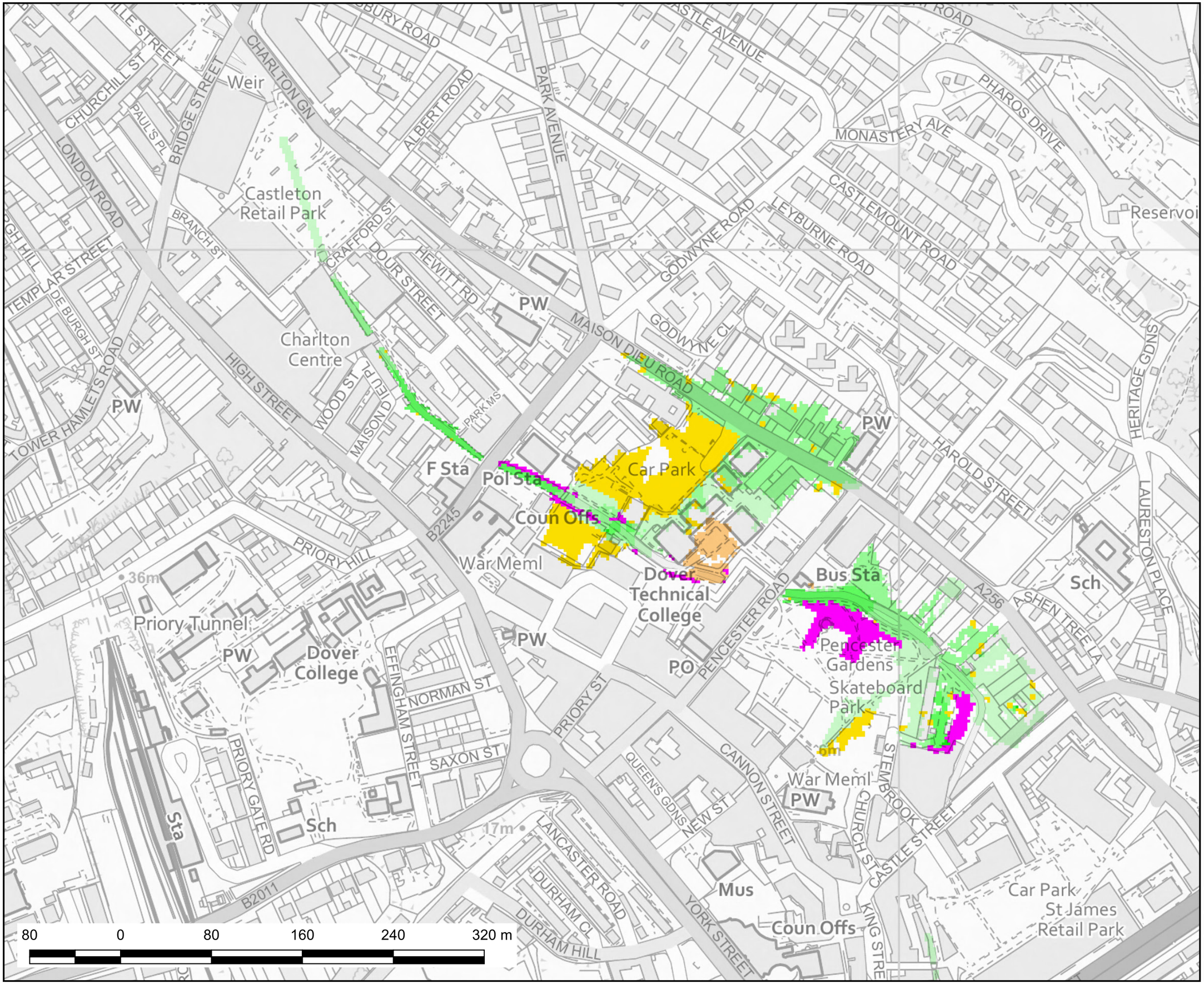
1	1st issue	30-07-2020

CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **D.5**



TITLE

DIFFERENCE IN FLOOD LEVEL
MITIGATION MEASURE 1
minus
BASELINE
1:100 year

LEGEND

Level difference (m)

- Now dry
- < -1.00
- -1.00 - -0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- 0.10 - 1.00
- > 1.00
- Now wet

DETAILS

The model results presented are the difference in the maximum flood level (proposed minus baseline). The scenario represents an extreme flood of 1 in 100 year return period event.

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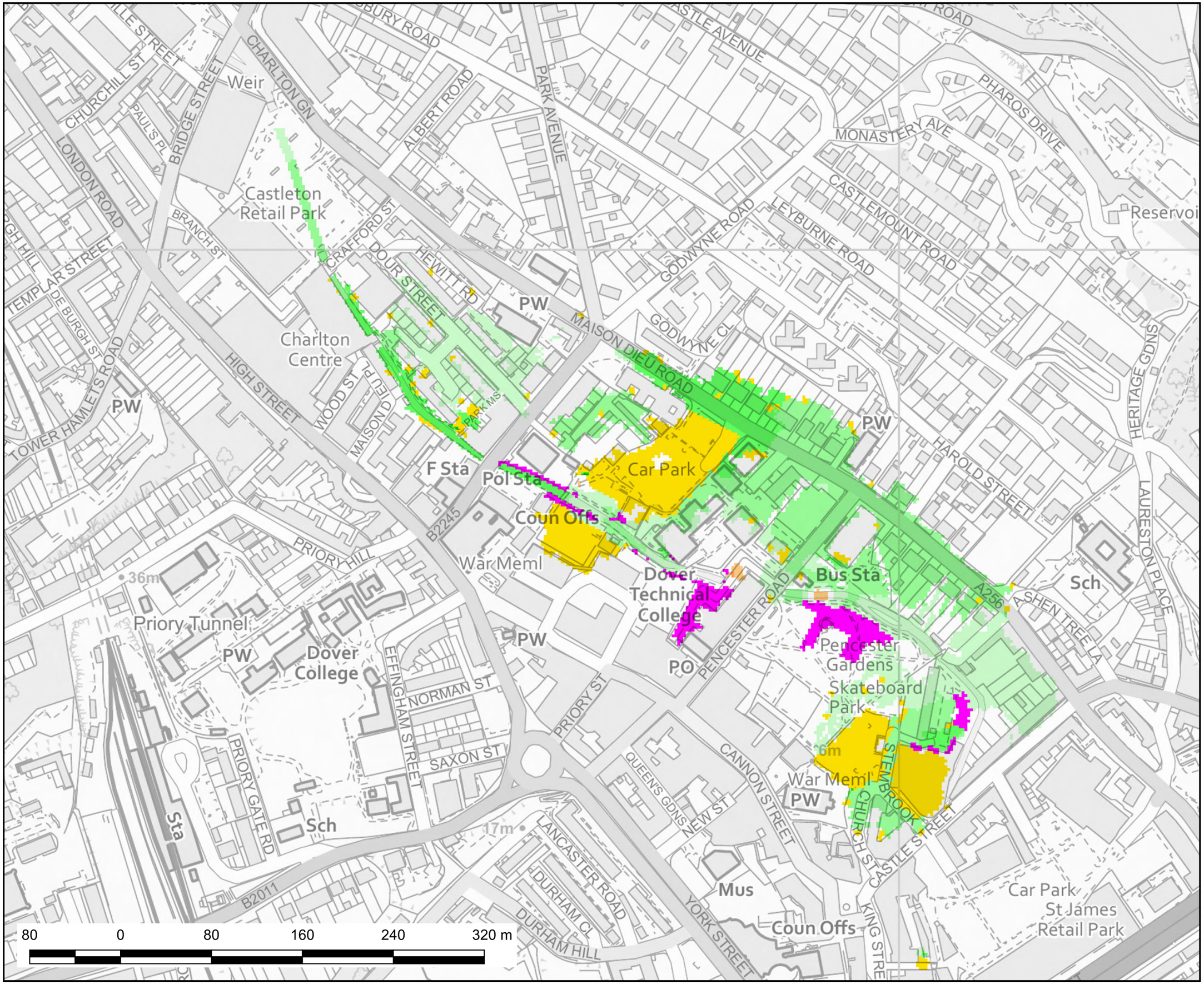
1	1st issue	30-07-2020

CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **D.6**



TITLE

DIFFERENCE IN FLOOD LEVEL
MITIGATION MEASURE 2
minus
BASELINE
1:100 year (+45%)

LEGEND

Level difference (m)

- Now dry
- < -1.00
- -1.00 - -0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- 0.10 - 1.00
- > 1.00
- Now wet

DETAILS

The model results presented are the difference in the maximum flood level (proposed minus baseline). The scenario represents an extreme flood of 1 in 100 year return period event, including an increase in the flows of 45% to represent climate change 100 years in the future.

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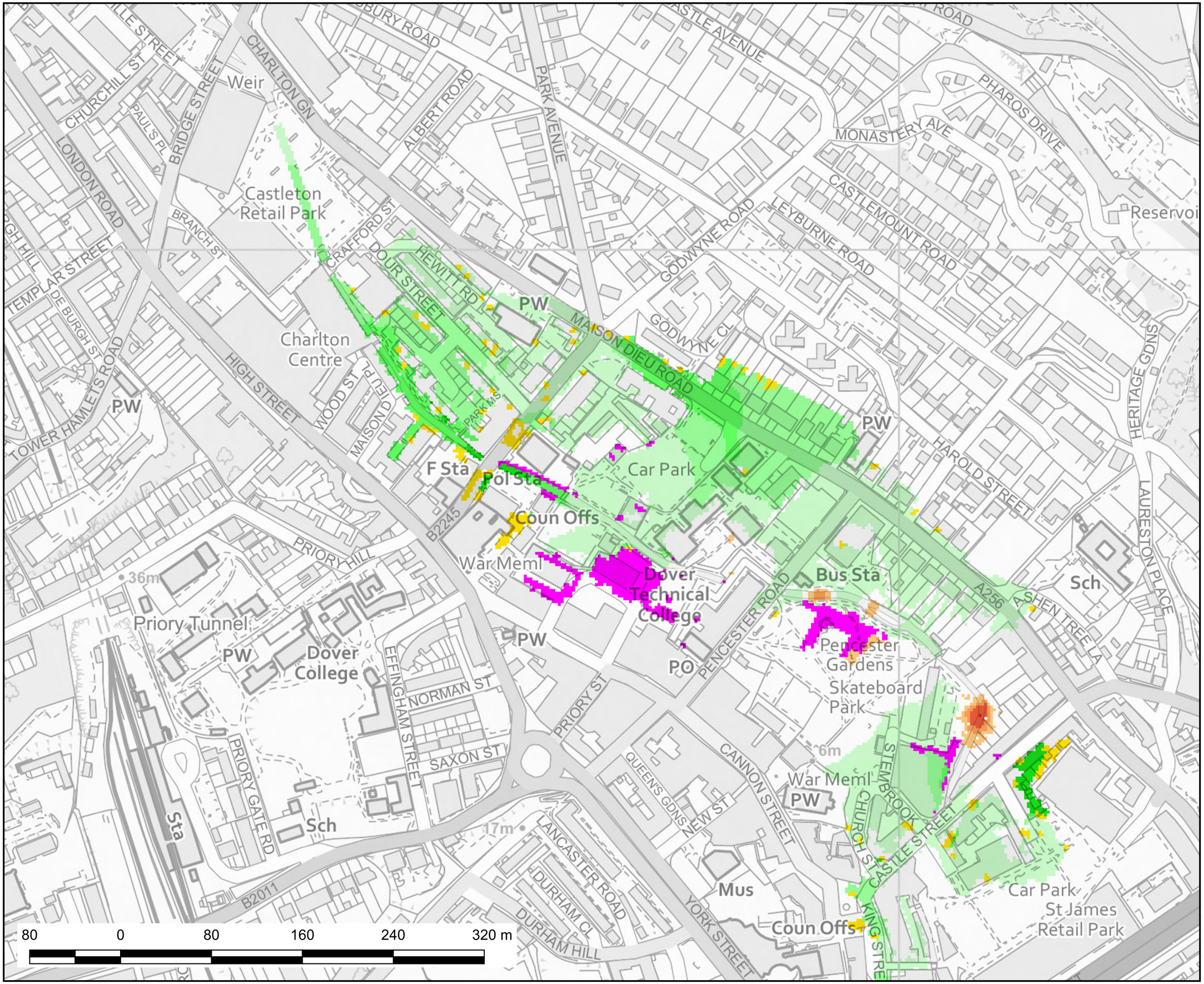
CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **D.7**



TITLE

DIFFERENCE IN FLOOD LEVEL
MITIGATION MEASURE 2
minus
BASELINE
1:1,000 year

LEGEND

Level difference (m)
- Now dry
- < -1.00
- -1.00 - -0.10
- -0.10 - -0.05
- -0.05 - -0.03
- -0.03 - -0.01
- -0.01 - 0.01
- 0.01 - 0.03
- 0.03 - 0.05
- 0.05 - 0.10
- 0.10 - 1.00
- > 1.00
- Now wet

DETAILS

The model results presented are the difference in the maximum flood level (proposed minus baseline). The scenario represents an extreme flood of 1 in 1,000 year return period event.

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1	1st issue	30-07-2020

CLIENT: DOVER DISTRICT COUNCIL

PROJECT: MID-TOWN, DOVER

SCALE	PROJECT No.	INITIALS	CHECKED
1:3000 @ A3	2607	NW	--

DRAWING No.: **D.8**

Appendix E – Meeting minutes and correspondence

Minutes

Meeting Date: Tuesday 23rd June 2020

Meeting Location: Microsoft Teams

Project: Dover Midtown Masterplan

Attendance:

Sara Gomes (SG) – Environment Agency
Tom Reid (TR) – Environment Agency
Joseph Williamson (JoeW) – Environment Agency
Jennifer Wilson (JenW) – Environment Agency
Rebecca Burden (RB) – Dover District Council
Ashley Taylor (AT) – Dover District Council
Sophie Mortimer (SM) – Affinity Water
Simon Maiden-Brooks (SMB) – Herrington Consulting
Nigel West (NW) – Herrington Consulting
Toby Vaughan (TV) – Herrington Consulting

Introductions:

SMB asks everyone to introduce themselves

SMB asks RB and SM to provide a background on DDC and Affinity Water's involvement with the project

SMB introduces the location and key areas of the modelling work. SMB highlighted that the model is an adaption of the EA's baseline model, with added detail from work undertaken previously by HC. NW discussed the work undertaken by HC at Lorne Road, Buckland Mill and Halfords, and how it would improve the model

SMB discussed the work that had been undertaken to test how to the river could be manipulated to reduce the flood risk. 6 initial scenarios were tested but led to dead ends. SMB and NW discussed how these test scenarios have led to 2 options which are the subject of this meeting.

Modelling Discussion:

SMB and NW presented mapping of the subject sites on Google Maps and QGIS to provide further context. This included the DDC potential development areas, areas within DDC ownership and vulnerability classification map. SMB highlighted the limitations associated with land outside of DDC's ownership and how it restricted the modelling options.

SMB introduced the aim of the meeting – to ask the EA if they agreed in principal to the modelling process and development in the area (pending detailed review of modelling and reports)

NW presented the baseline results, showing the existing 1 in 20 year return period event extent (functional floodplain) and 1 in 100 year event with 45% climate change allowance. NW and SMB highlighted areas that are at greatest risk of flooding.

EA (JoeW) asked if the model would be a combined sources model. NW stated fluvial only. EA asked if it was intended to include pluvial within the model at later stage. SMB answered that pluvial could be added a later stage if requested by the EA, the idea of the modelling at this stage was to modify the existing model to investigate areas that could be improved to reduce the risk of flooding.

EA (TR) expressed concern about using fluvial only when much of Dover is vulnerable to pluvial flooding. TR also asked if modelling had considered Dover Harbour Board shutting the lock gate. SMB answered that model has considered being hydraulically locked, however, not as a result of gate being shut. SMB asked JoeW if he had any information on the lock being shut. JoeW answered that it pre-dates his EA involvement, however, in the event of significant flows in the Dour he would expect Dover Harbour Board to contact the EA prior to shutting the lock gate. TR suggested it is worth checking

SMB introduced the two-stage channel and the aim of proposing a two stage channel – 1. To improve the channel (to hold more water) and , 2. To allow regeneration of the surrounding area

NW presented a cross section of the modelled two-stage channel and discussed how the channel would increase conveyance within this section of the Dour. NW highlighted that the two-stage channel is within DDC ownership. SMB commented that the channel is not as ‘concrete’ as it appears.

TR mentioned he would like to see a low flow channel to which the river would recede. SMB said this could be considered further downstream near Pencester Gardens, however, highlighted that this is constrained by the level of the culvert running beneath the road. SMB linked to further mitigation measures to be discussed shortly. NW reiterated that at this stage the aim of the modelling is to gain an overall understanding of what can be done and that 1D models cannot represent a meandering low-flow channel.

NW discussed where the two-stage channel is constrained – land outside of DDC ownership along the river banks led to only a one sided stage in some areas. JoeW highlighted cycle path adjacent to the river. NW suggested this could be lowered and partly included within the two stage channel. TR asked if the bowling clubhouse was moveable. DDC confirmed it was within their ownership and is possible to be relocated.

NW stated in addition to the two stage channel there is a small wall/bund on the edges of the channel of between 0.3 to 0.5m high.

NW presented the Function Floodplain extent based on the two-stage channel. Highlighted that the channel reduced the extent of flooding in this scenario. Water can be contained within the river during this event.

SMB mentioned that there is the option to move some DDC owned buildings which, in principle, could assist with reducing the flood risk. SMB asked JoeW for the EA stance on this. JoeW confirmed this would be acceptable,

assuming that the material removed is taken out the floodplain and there would be no increase downstream. SMB highlighted the issues within the river are due to conveyance not a lack of volume. The aim of the modelling is to reduce the Functional Floodplain extent, but have to accept flooding from higher events.

SMB introduce the raising of Maison Dieu car park. SMB and NW discussed how it was possible to raise the car park above the 1in100 +45CC without increasing flooding elsewhere. SMB stated how this shows the issue is conveyance, not volume.

NW presented difference plots. These showed the impact of lowering Pencester Gardens to increase storage. NW admitted to needing to correct an area which shows the police station bank to be wet. This should be on the other bank.

SMB discussed that due to the topography it is not possible to prevent flooding in Maison Dieu Road, although this could be reduced. JoeW highlighted that this is where pluvial should be considered as raising Maison Dieu car park could reduce conveyance to the river. NW answered that Maison Dieu Road is lower than the river bank in places and as a result, water would be directed towards these areas within the road rather than towards the river. JoeW stated that this will need to be demonstrated at a later stage. SMB agreed, and also mentioned that SuDS are yet to be considered.

SMB provided a summary of the options. 1. To reduce the Functional Floodplain. Then assuming the Sequential Test can be passed, consider raising land. 2. To provided biodiversity and amenity enhancements by lowering land in Pencester Gardens.

SMB mentioned that safe access/egress off Maison Dieu road would not be available, although the car park would be raised.

SMB accepted that there is detail to add, however, there is no point to add the detail at this stage if the EA would not accept the principle. SMB asked the EA if they would agree to the principle of the modelling and development

JoeW answered that in principle it is feasible, and the EA do not have any major concerns. JoeW asked that it would be less vulnerable uses at ground floor level within Maison Dieu car park. SMB directed the question to RB for confirmation. RB stated that at this stage the purpose is to have reassurance that any risk can be mitigated and to gain confidence that development could be put forward for inclusion within the local plan. JoeW concluded that, pending model review and design, the EA are happy in principle.

SMB proposed that once the modelling has been written up, the documents can be forward to the EA for a formal comment. RB and JoeW agreed that this would be helpful.

SMB asked TR for this thoughts on what the EA would like to see included in the landscaping of Pencester Gardens. TR answered EA would not expect large scale landscaping – would need to keep the river cool and replicate chalk stream conditions.

TR asked SM for Affinity Water's opinion. SM asked NW if it was proposed the cycle path would be included within the channel. NW answered that the cycle path would not be part of the channel. NW discussed that the cycle path could be lowered between 0.1-1m and would remain dry except during approximately 1in2 year event.

SM commented that it would be preferable to soften the bank of the river. TR also mentioned that it would be useful to tackle an infestation of Japanese Knott Weed. SMB answered that it would not be possible to plant up the entire bank, but could plant on top of the bank.

SMB also highlighted the opportunity to redirect the cycle path in times of flood risk. RB agreed, but also suggested that this level of technical detail is not required at this stage. SM explained she wanted to make sure that any proposals are in keeping with Affinity Water objectives.

RB put forward the idea of a policy for the River Dour. Could include considerations of how all elements relate to each other. SMB commented how the modelling has assisted with separating elements. RB highlighted that Pencester Gardens is a key area for development.

AT asked for the EA response to Reg 18. EA (JenW) discussed that Reg 18 is very principle based, so the EA would be providing an in principle argument for any proposal.

SMB concluding remarks summarising the actions to come from the meeting (see below).

Summary:

SMB and NW discussed in detail the modelling proposals and implications for development within the Dover Midtown area. The aim of the development is to regenerate the area (for inclusion within the DDC draft Local Plan) whilst providing improvements to the river channel and floodplain (to meet Affinity Water's objectives). The EA stated that they in principle would accept the development proposal (pending a detailed model review and design).

Actions:

HC are to formalise modelling and write a document summarising the modelling to forward to the EA for formal comment. SMB indicated that HC would get documents to the EA for approximately the start of August.

EA to review documents sent by HC. The EA indicated that to provide comments would take 2-3 weeks. A response to a detailed model review would be around 12 weeks.

DDC aiming to produce the Draft Local Plan for the end of October.

HC will consider the modelling of a 'dock gates closed' scenario as part of the final modelling package.

HC will consider the inclusion of surface water modelling in the final modelling package

It should be noted that the video conference was recorded (with consent from the group) and a copy of the recording can be provided for review if required.

Nigel West

From: Williamson, Joseph <Joseph.Williamson@environment-agency.gov.uk>
Sent: 12 August 2020 14:38
To: Simon Maiden-Brooks; KSLPlanning
Cc: Rebecca Burden; Nigel West; 'Ashley Taylor'; Wilson, Jennifer; Mortimer, Meriel; Gomes, Sara; Reid, Tom; Toby Vaughan
Subject: RE: Dover Mid-town meeting minutes and additional query.

Follow Up Flag: Follow up
Flag Status: Flagged

Good afternoon Simon.

Thank you for your e-mail and sorry for any misunderstanding that my comments may have caused (I provided the response for our Sustainable Places team to forward).

The paragraph oh concern states:

"*We would like to reiterate that land raising in the fluvial floodplain should usually be accompanied by a scheme for compensatory storage, such that the same volume/flow capacity is available during any stage of a flood even, by providing level-for-level, volume-for-volume capacity in the vicinity of any development. Modelling alone is not usually sufficient to demonstrate that the risks can be managed. We will be happy to discuss this aspect further if required."*

This is standard language that we have to provide for any response that involves the potential loss of floodplain capacity or conveyance.

I agree that the point of the meeting was to discuss this principle and I would like to clarify that we were largely in agreement with your approach to the modelling of the landraising proposed.

The key phrase from the above is "…not ***usually*** sufficient…". As a matter of course, the first presumption would be for no loss of floodplain capacity. However, in this instance we are satisfied that the modelling will be undertaken to our specification, and will be scrutinised by our Evidence and Risk team at an appropriate later date. That doesn't mean to say that this should be used to set a precedent within Dover or elsewhere in the area; our national policy for preservation of floodplain capacity should still be followed. The work and approach proposed would be by way of exception, as discussed in the meeting.

The raising of this site will only be permissible if it can be clearly shown that there will be no exacerbation of flood risk away from the site, taking into account flooding from all sources and the predicted effects of climate change, and only if our E&R team are content with the model and how it has been produced.

Please do contact me if any of the above requires clarification?

Kind regards, and sorry again for and concern caused.

Kind regards,

Joe Williamson

Joseph Williamson
Technical Advisor I Partnership & Strategic Overview – East Kent I Flood & Coastal Risk Management
Environment Agency | Orchard House, Endeavour Park, London Road, West Malling, Kent, ME19 5SH

Internal: **45711** External: (**+44) 0208 474 5711**

Email: joseph.williamson@environment-agency.gov.uk

For general enquiries please call +442084746848
Incident Reporting | 0800 80 70 60
Floodine | 0345 988 1188
@EnvAgencySE

From: Simon Maiden-Brooks [mailto:simon.mb@herringtonconsulting.co.uk]
Sent: 05 August 2020 06:44
To: KSLPlanning <KSLPLANNING@environment-agency.gov.uk>
Cc: sophie.mortimer@affinitywater.co.uk; Rebecca Burden <Rebecca.Burden@DOVER.GOV.UK>; Nigel West <nigel@herringtonconsulting.co.uk>; 'Ashley Taylor' <Ashley.Taylor@DOVER.GOV.UK>; Williamson, Joseph <Joseph.Williamson@environment-agency.gov.uk>; Wilson, Jennifer <jennifer.wilson@environment-agency.gov.uk>; Mortimer, Meriel <meriel.mortimer@environment-agency.gov.uk>; Gomes, Sara <Sara.Gomes@environment-agency.gov.uk>; Reid, Tom <Tom.Reid@environment-agency.gov.uk>; Toby Vaughan <toby@herringtonconsulting.co.uk>
Subject: RE: Dover Mid-town meeting minutes and additional query.
Importance: High

Dear Jennifer,

Thank you for your e-mail response to my colleague Nigel and for attending the meeting regarding the future proposals for Dover mid-town.

The draft model report is now complete and has been circulated to the immediate project team for approval and comment, however, on review of your latest e-mail I note a *critical* point that we will require clarification on from the EA, to avoid the risk of the entire project being undermined.

Whilst the majority of the comments in your e-mail are acknowledged and can be acted upon as the modelling is refined (going forwards), my concern is in relation to the last paragraph, which states:

We would like to reiterate that land raising in the fluvial floodplain should usually be accompanied by a scheme for compensatory storage, such that the same volume/flow capacity is available during any stage of a flood even, by providing level-for-level, volume-for-volume capacity in the vicinity of any development. Modelling alone is not usually sufficient to demonstrate that the risks can be managed. We will be happy to discuss this aspect further if required.

The very purpose of the meeting and discussion with the EA present was to gain an agreement in principle from the EA that development of the mid-town would be acceptable based on the results of the modelling presented.

It was highlighted by the EA, and not disputed by DDC, that further refined modelling would be required and that the EA modelling specialists would need to review the finalised (refined) model in detail before any development could be formally approved. Notwithstanding this, the purpose of the discussion and demonstration of the model results (as outlined in the meeting minutes) was to show how the risk of flooding to the mid-town area is attributed to the conveyance of floodwater, not the storage of floodwater on the floodplain.

In other words, the model results presented to the EA show that by incorporating a 2-stage widened river channel and raising the land in the mid-town area within DDC's control, it is possible to reduce the risk of flooding to an acceptable level to enable development in this area. Furthermore, the model results also demonstrate (through the difference plots discussed) that there will be no detrimental impact offsite, rather the opposite, the proposals could reduce flooding offsite and allow much needed regeneration within this area.

On this basis, level-for-level, volume-for-volume compensatory flood storage is neither applicable, nor required in this instance. It is also disappointing to read the EA's comment stating "…*Modelling alone is not usually sufficient to demonstrate that the risks can be managed…."*, when on numerous occasions, on projects we have worked on throughout the country, the EA has accepted this approach. Furthermore, it was on this very basis that the meeting was held and this point was not raised for discussion at any time during the meeting. Without agreement from the EA that the principle of the channel and land alterations are acceptable, this site cannot be recommended for inclusion within the emerging Local Plan as an area which is suitable for development.

Given the impact of the last paragraph, I would very much welcome a further discussion on this point and if after discussion the EA is in agreement, the removal of this final paragraph from your formal response. On agreement with DDC, I am of course happy to circulate the model report to enable you to reconsider the model outputs we discussed in more detail to revise your current position on this important issue.

Time is very much critical now, to enable the Local Plan to be keep to programme and as such, I would appreciate if this matter could be resolved within the next 2 weeks.

Kind regards

Simon (M-B)

Simon Maiden-Brooks *BSc. (Hons) MSc. C.Eng C.WEM MCIWEM*
Technical Director & Partner
Tel: 01227 833855

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Canterbury Office
A: Units 6 & 7 - Barham Business Park - Elham Valley Road - Canterbury CT4 6DQ
T: 01227 833855

London Office
Unit D, Taper Building, Weston Street – London SE1 3QB

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From: KSLPlanning <KSLPLANNING@environment-agency.gov.uk>
Sent: 15 July 2020 15:39
To: Nigel West <nigel@herringtonconsulting.co.uk>
Cc: sophie.mortimer@affinitywater.co.uk; Rebecca Burden <Rebecca.Burden@DOVER.GOV.UK>; 'Ashley Taylor' <Ashley.Taylor@DOVER.GOV.UK>; Williamson, Joseph <Joseph.Williamson@environment-agency.gov.uk>; Wilson, Jennifer <jennifer.wilson@environment-agency.gov.uk>; Mortimer, Meriel <meriel.mortimer@environment-agency.gov.uk>; Gomes, Sara <Sara.Gomes@environment-agency.gov.uk>; Reid, Tom <Tom.Reid@environment-agency.gov.uk>; Simon Maiden-Brooks <simon.mb@herringtonconsulting.co.uk>; Toby Vaughan <toby@herringtonconsulting.co.uk>
Subject: FW: Dover Mid-town meeting minutes and additional query.

Dear Nigel

Thank you for circulating the minutes of the meeting. We have reviewed them and they appear accurate from our perspective.

In answer to Ashley's question of 30 June 2020 (*black below*) we have the following response.

"You commented that it should be less vulnerable uses at ground floor within the Maison Dieu car park. What is your rationale behind that given that with the proposed 2 stage channel the site would no longer be within the functional flood plain? Would it not be for us to demonstrate that the exceptions test can be passed in order to justify more vulnerable uses on the ground floor in that location? Particularly when there are also options to raise the car park above the 1in100 +45CC without increasing flooding elsewhere?

If you were more comfortable considering this once you have HCs summary document for comment that would be fine."

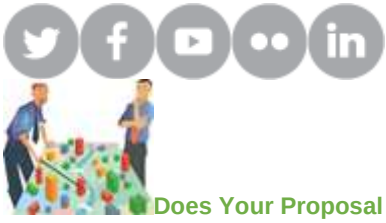
As for ground-floor 'more-vulnerable' uses, we will be happy to provide additional comment once the results of the modelling have refined the level of risk that would be present if the land raising proposed is shown to have no detrimental impact. If the risk to the area in question can be appropriately managed, we may be able to consider a 'more vulnerable' ground floor use.

We would like to reiterate that land raising in the fluvial floodplain should usually be accompanied by a scheme for compensatory storage, such that the same volume/flow capacity is available during any stage of a flood even, by providing level-for-level, volume-for-volume capacity in the vicinity of any development. Modelling alone is not usually sufficient to demonstrate that the risks can be managed. We will be happy to discuss this aspect further if required.

Kind Regards,

Jennifer Wilson
Planning Specialist
Sustainable Places – Kent and South London

kslplanning@environment-agency.gov.uk
External: 020 8474 6711



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Please note – Our hourly charge is now £100 per hour plus VAT from 1st April 2018.

From: Nigel West [mailto:nigel@herringtonconsulting.co.uk]
Sent: 29 June 2020 08:49
To: sophie.mortimer@affinitywater.co.uk; Rebecca Burden <Rebecca.Burden@DOVER.GOV.UK>; 'Ashley Taylor' <Ashley.Taylor@DOVER.GOV.UK>; Williamson, Joseph

<Joseph.Williamson@environment-agency.gov.uk>; Wilson, Jennifer <jennifer.wilson@environment-agency.gov.uk>; Mortimer, Meriel <meriel.mortimer@environment-agency.gov.uk>; Gomes, Sara <Sara.Gomes@environment-agency.gov.uk>; Reid, Tom <Tom.Reid@environment-agency.gov.uk>
Cc: Simon Maiden-Brooks <simon.mb@herringtonconsulting.co.uk>; Toby Vaughan <toby@herringtonconsulting.co.uk>
Subject: Dover Mid-town meeting minutes

Dear All,

Thank you for a productive and insightful meeting last Tuesday!
Please find attached our meeting minutes attached.
Please feel free to add any comments you think relevant to the PDF and return to us for inclusion and final distribution.

Kind regards,

Nigel West BSc MCIWEM
Senior Numerical Modeller

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Nigel West

From: Reid, Tom <Tom.Reid@environment-agency.gov.uk>
Sent: 29 June 2020 10:09
To: Nigel West; sophie.mortimer@affinitywater.co.uk; Rebecca Burden; 'Ashley Taylor'; Williamson, Joseph; Wilson, Jennifer; Mortimer, Meriel; Gomes, Sara
Cc: Simon Maiden-Brooks; Toby Vaughan
Subject: RE: Dover Mid-town meeting minutes

Follow Up Flag: Follow up
Flag Status: Flagged

All

No comments about the minutes except to add that my reference to keeping rivers cool was in the context of work such as this:
https://catchmentbasedapproach.org/learn/keeping-rivers-cool/

and

https://www.woodlandtrust.org.uk/publications/2016/02/keeping-rivers-cool/

Best wishes

Tom

Tom Reid
Biodiversity Technical Specialist, Fisheries, Biodiversity and Geomorphology, Kent South London and East Sussex
Environment Agency | Rivers House, Sturry Road, Canterbury, Kent CT2 0AA
tom.reid@environment-agency.gov.uk
External: +44 (0)20 8474 7445 | Mobile: +44(0)7876 478753

STEM Ambassador

From: Nigel West [mailto:nigel@herringtonconsulting.co.uk]
Sent: 29 June 2020 08:49

To: sophie.mortimer@affinitywater.co.uk; Rebecca Burden <Rebecca.Burden@DOVER.GOV.UK>; 'Ashley Taylor' <Ashley.Taylor@DOVER.GOV.UK>; Williamson, Joseph <Joseph.Williamson@environment-agency.gov.uk>; Wilson, Jennifer <jennifer.wilson@environment-agency.gov.uk>; Mortimer, Meriel <meriel.mortimer@environment-agency.gov.uk>; Gomes, Sara <Sara.Gomes@environment-agency.gov.uk>; Reid, Tom <Tom.Reid@environment-agency.gov.uk>
Cc: Simon Maiden-Brooks <simon.mb@herringtonconsulting.co.uk>; Toby Vaughan <toby@herringtonconsulting.co.uk>
Subject: Dover Mid-town meeting minutes

Dear All,

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Please feel free to add any comments you think relevant to the PDF and return to us for inclusion and final distribution.

Kind regards,

Nigel West BSc MCIWEM
Senior Numerical Modeller

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Canterbury Office
Units 6 & 7 - Barham Business Park - Elham Valley Road - Canterbury CT4 6DQ
tel 01227 833855

London Office
Unit D, Taper Building, Weston Street, London, SE1 3QB

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