3.5 Area 3 North – Cork Rd Bridge to N25

Area 3 includes Midleton Town Centre, southern side of IDL site, the Baby Walk, People's Park, areas adjacent to Dungourney River and Bailick Road. The area is at risk of fluvial flooding from the Owenacurra and the Dungourney, as well as tidal flooding.

Figure 46: Area 3 North

3.5.1 Cork Road Bridge/ Lidl Bridge

Mechanisms of Flooding in Hydraulic Model

There are a number of mechanisms of flooding in the area from the Cork Road Bridge to the Lidl Bridge on the Owenacurra. This area includes a number of large commercial properties including Lidl (Waters Edge) and businesses accessed from Riverside Way as well as residential properties (Woodlands Estate, Thomas Street). The mechanisms of flooding detailed below correspond to the arrows in Figure 47.

A. Water overtops the right bank of the Owenacurra at the Woodlands estate for the relatively lower return period events;

B. Thomas Street is inundated due to water getting out of channel on the left bank of the Owenacurra. This mechanism also inundates Riverside Way and the carparks/ commercial properties in this area.

C. Thomas Street is also at risk of flooding from overland flow from Main Street.

D. Upstream of the Lidl Bridge water gets out of bank on the right bank of the Owenacurra. Properties within the Waters Edge commercial development are at risk from this mechanism (Lidl, McDonalds, Aldi etc)

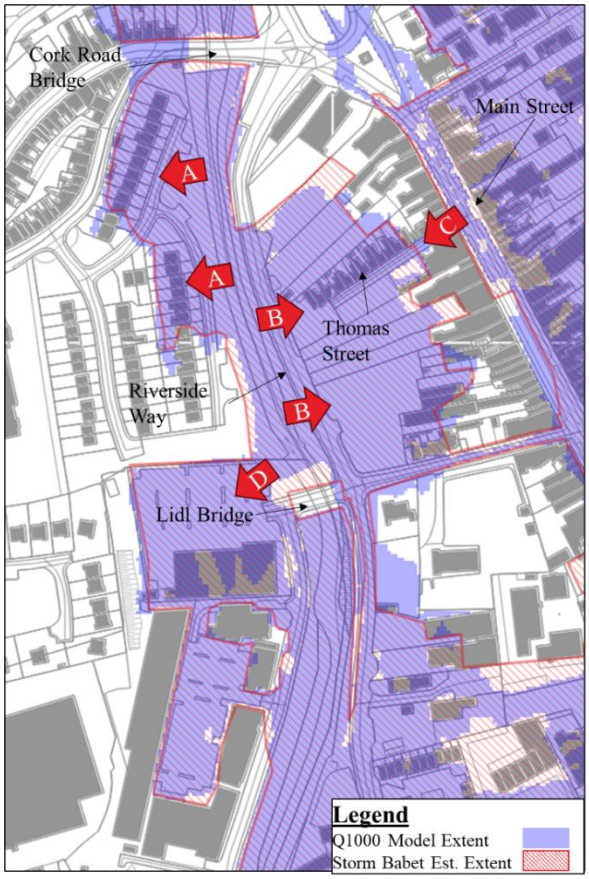

Figure 47: Cork Bridge/ Lidl Bridge: Existing Flood Mechanisms

Comparison of Modelled vs Observed Mechanisms During Storm Babet

All the mechanisms of flooding in this area as detailed in the hydraulics report and as noted above occurred during Storm Babet. We have been able to determine this by reference to the aerial imagery as supplied by the Guileen Coast Guard (Figure 48) and observations from our site visits. Wrack marks recorded in the days after the flood event were also compared against Lidar data in order to confirm the flood extents in the Woodlands Estate and Thomas Street Area. We note that there was good validation between the wrack mark data and the Q1000 model water levels in these two areas.

Figure 48: Flooding of Woodlands Estate and Riverside Way

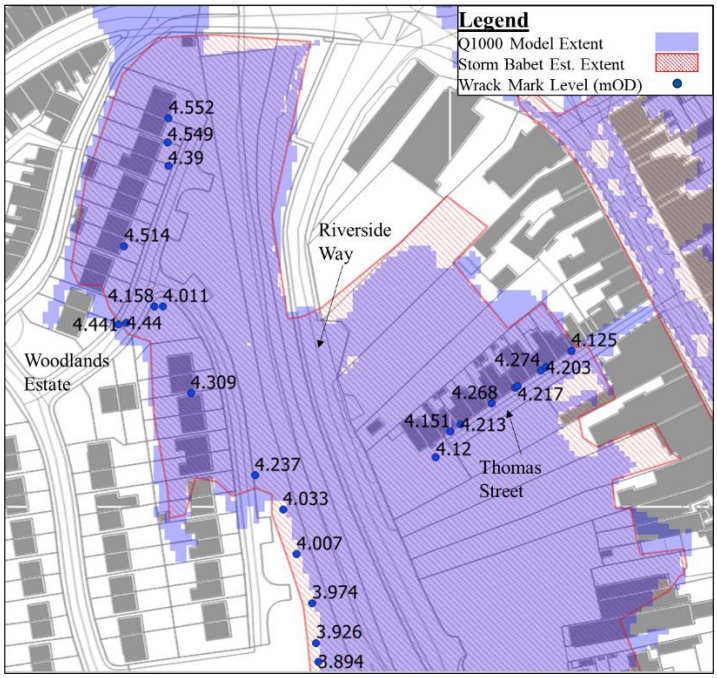

Figure 49: Woodlands and Thomas Street: Wrack Marks Levels (mOD)

Stills of CCTV footage from the AIB Carpark camera (refer to Figure 48 for the location and direction of camera) show water getting out of bank and starting to flood Riverside Way at circa 12.00pm. These stills, which are time stamped, are presented in Figure 50.

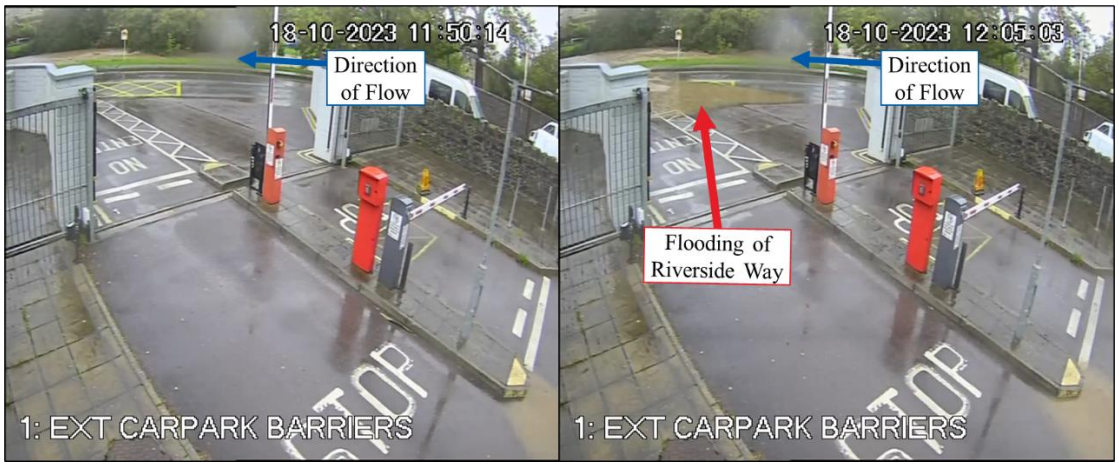

Figure 50: Flooding of Riverside Way between 11.50am and 12.05pm

From inspection of the full CCTV footage, the peak of the flood event in this area occurred at circa 2.20pm in this area. Figure 51 presents a still of the CCTV footage shows the extent of the flooding at this time. The peak of the flow on the Dungourney is discussed in Section 3.5.6.

Figure 51: Flooding of Riverside Way between at estimated peak (2.20pm)

Figure 52 presents an aerial image of Thomas Street and the Lidl development inundated after the peak of the event. It can be seen that the Lidl bridge is not surcharged in the image. Drone footage taken from earlier in the event and therefore closer to the peak, does however show that the Lidl Bridge was in fact surcharged by the event but not overtopped. It's estimated that water levels upstream of the bridge were circa 4.0mOD at the peak which is almost equivalent to the Q1000 model max water level of 3.95mOD.

Figure 52: Flooding of Riverside Way, Thomas Street and Lidl

Wrack marks recorded in the Waters Edge commercial development are presented in Figure 53. All the levels are circa 100mm higher than the modelled Q1000 maximum water levels in this area. It is noted that the model has a T5 downstream tidal boundary which coincides with the peak of the fluvial hydrograph which suggests that the Q1000 modelled water levels would in fact be lower if the model was run with a tidal boundary equivalent to the recorded tide during Storm Babet.

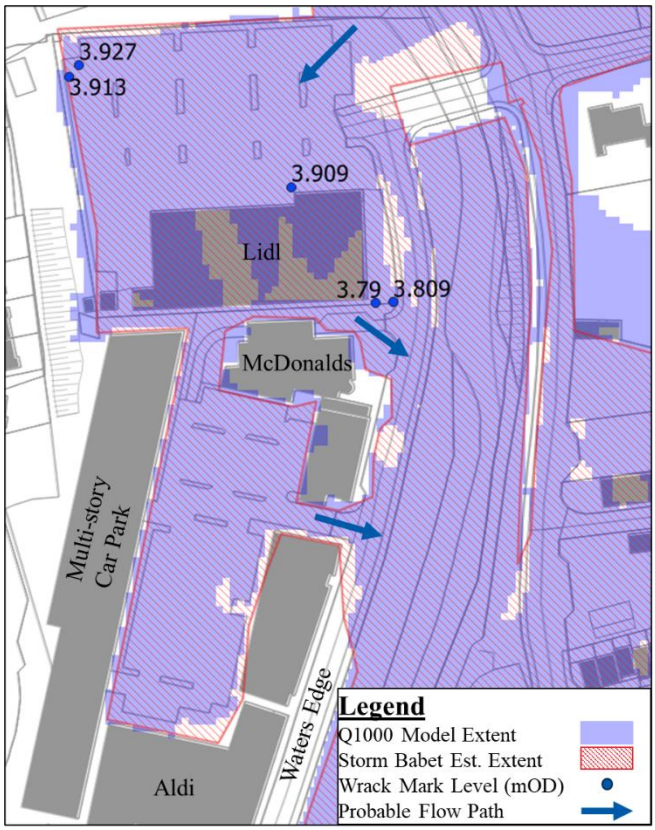

Figure 53: Waters Edge Development: Wrack Marks Levels (mOD) and estimated direction of flow

Based on an inspection of the various datasets, we do not believe that water overtopped the right bank of the Owenacurra downstream of the Lidl Bridge during Storm Babet and that the inundation of the car park between the Aldi and McDonalds was a result of overland flow which originated from upstream of the Lidl bridge. The likely flow paths in this area are also presented in Figure 53.

It is estimated that 28 residential properties and 6 commercial properties were flooded in this area during Storm Babet.

3.5.2 Lidl Bridge to Chadwicks

Mechanisms of Flooding in Hydraulic Model

There are a number of mechanisms of flooding in the area between Lidl Bridge and Chadwicks. This area includes a large number of commercial and residential properties in the vicinity of Kennedy Park. The mechanisms listed below correspond to the arrows in Figure 54.

A. As discussed in Section 3.5.1, water overtops the left bank upstream of the Lidl Bridge and travels South along Riverside Way towards Coolbawn Court

B. Water also gets out of bank along the left bank via O'Farrell's Funeral Home upstream of Pontoon Bridge

C. Downstream of Pontoon Bridge the left bank is overtopped which leads to flooding of the ESB Site

D. As discussed in further in Section 3.5.3, overland flow from Upper Main Street also leads to flooding in this area.

E. The Dungourney overtops the left bank around the Bailick Road Bridge and also results in flooding of the Bailick Road adjacent to Chadwicks Hardware store.

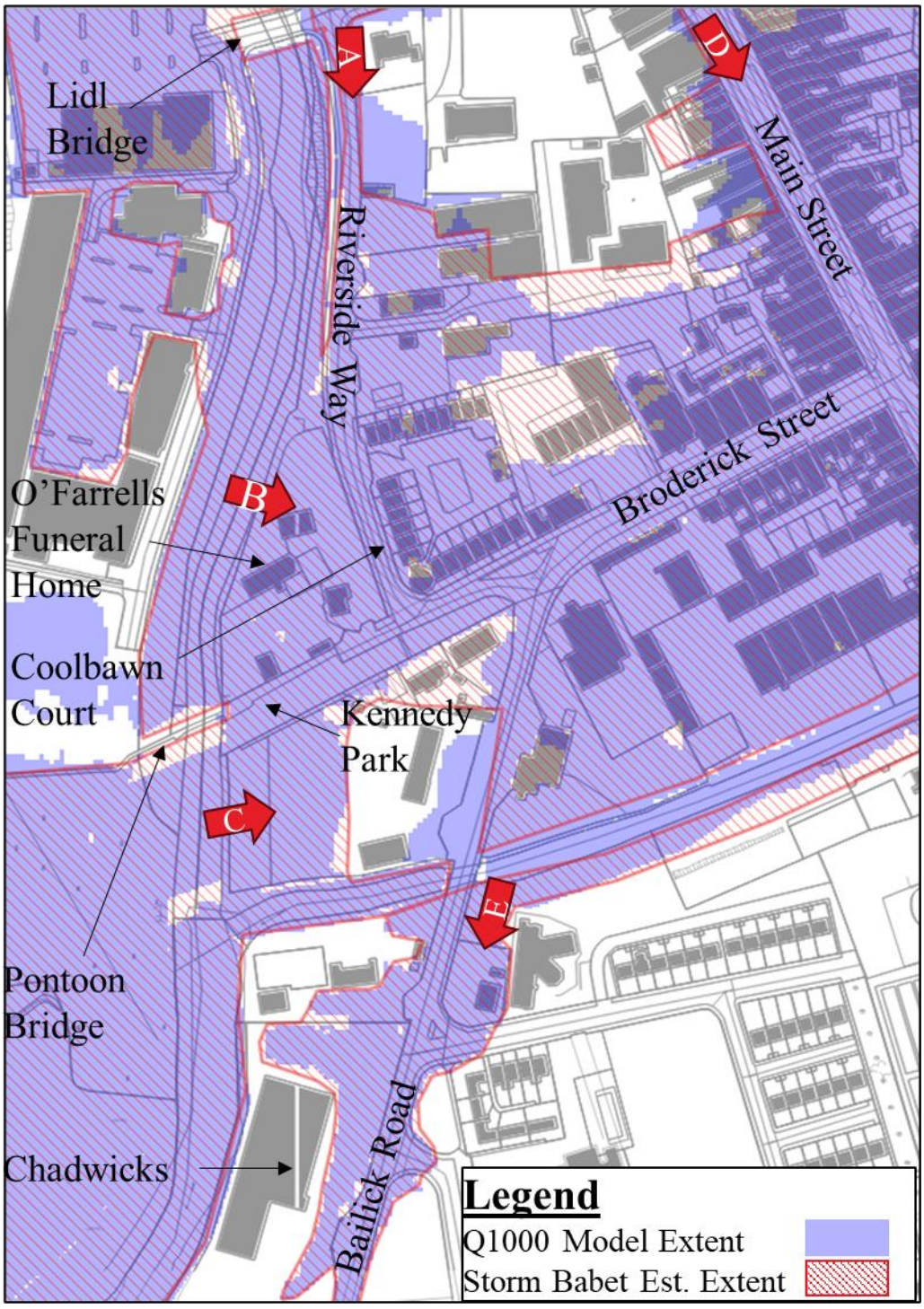

Figure 54: Lidl Bridge to Chadwick's: Existing Flood Mechanisms

Comparison of Modelled vs Observed Mechanisms During Storm Babet

All the mechanisms of flooding listed above were observed to occur during Storm Babet. The mechanisms were largely validated using aerial images taken by the Guileen Coast Guard, drone footage uploaded to social media as well as our own observations from the site visits. The owners/staff of a number of commercial properties also confirmed to Arup the extent and depth of flooding in their premises during the event.

Figure 55 presents a still image of the drone footage which was uploaded to social media and shows Riverside Way and the Coolbawn Court/ Kennedy Park area inundated by the event close to the peak.

Figure 55: Flooding of Riverside Way and the Coolbawn Court/ Kennedy Park area

Figure 56 presents an aerial image from the Guileen Coast Guard which shows extensive flooding of Main Street. The flooding to the East of Main Street was overland flow coming the Drury's Avenue direction (refer to Section 3.5.3).

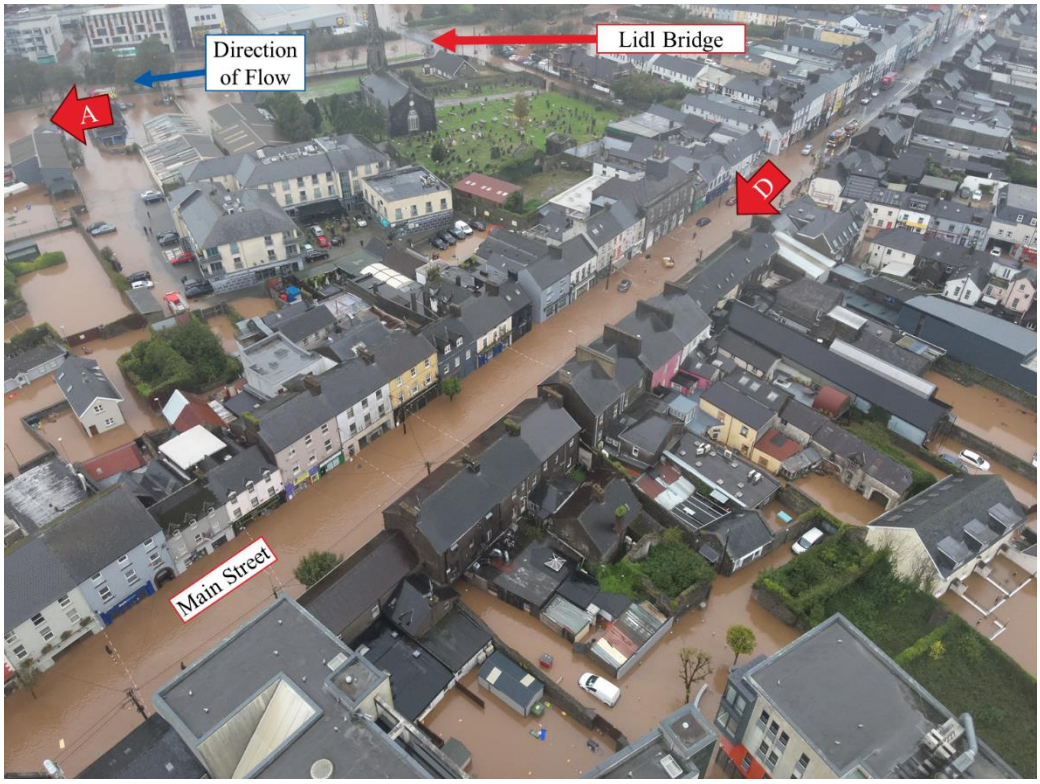

Figure 56: Flooding of Main Street

Figure 57 presents an image taken at 3.50pm on the day of the flood event and shows flooding of Bailick Road South of the Dungourney. We note that only one residential property was inundated in this area. The commercial properties on Bailick Road (i.e. Chadwicks and the Uisce Eireann sites) were not inundated but we note that entrances to the sites were, as these are at a lower elevations than the buildings.

Figure 57: Flooding of Bailick Road South of the Dungourney

Flood water travelled south along the Bailick Road until it entered the estuary via two locations. These locations were Choctaw Park immediately North of N25 bridge and the existing boat ramp South of the N25. There were no reports of any properties south of Chadwicks being inundated during the event. Figure 59 presents another photograph (taken at 3.40pm) of the flood extent along the Bailick Road adjacent to the Choctaw Park.

An estimation of flood depth from a local resident was recorded by Office of Public Work (OPW) Staff in the days after the event the residential property opposite Chadwicks. It was estimated that the water depth at this location was circa 0.72m as shown in Figure 58.

Figure 58: Estimated Depth of Flooding at the Residential Property Opposite Chadwick's

Figure 59: Flooding of Bailick Road/ Riverside Park adjacent to Choctaw Park

A wrack mark was recorded by OPW Staff in the days after the event at Nunsville, Riverside Park along the Bailick Road. It was estimated that the water depth at this location was circa 0.27m as shown in Figure 60.

Figure 60: Wrack Mark at Nunsville, Riverside Park, Bailick Road

Figure 61 presents the modelled existing scenario Q1000 maximum flood extent in blue and the Storm Babet estimated extent in red hatch for this area. The delta between the surveyed wrack marks and the modeled Q1000 max water levels is also shown. It is evident from inspection of the delta values that the wrack marks and modelled Q1000 water levels are in close agreement despite the different tidal conditions in the model and during the actual event.

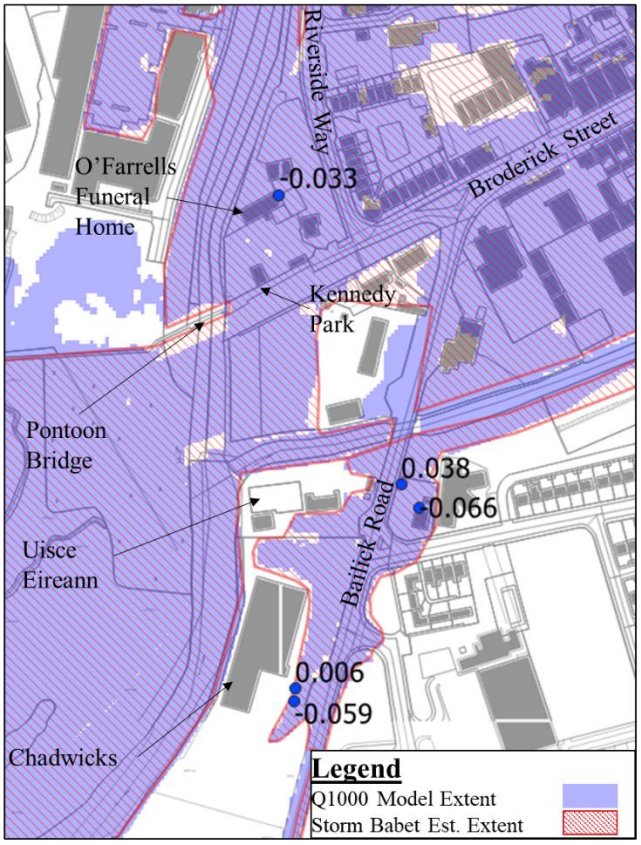

Figure 61: Riverside Way to Chadwicks: Wrack Marks vs Q1000 Modelled Levels (m)

It is estimated that 81 properties were flooded in the area between Lidl Bridge and Chadwicks during Storm Babet.

3.5.3 Upper Main Street to Connolly Street

Mechanisms of Flooding in Hydraulic Model

There are two mechanisms of flooding in this area both of which are detailed below and correspond to the arrows in Figure 62.

A. Overland flow from the area to the North via the top of Main Street (discussed in Section 3.4.7)

B. Overland flow from the area to the North via Drury's Avenue (discussed in Section 3.4.7)

Figure 62: Upper Main Street/ Drury's Avenue: Existing Flood Mechanisms

Comparison of Modelled vs Observed Mechanisms During Storm Babet

Both of the mechanisms of flooding detailed above occurred other during Storm Babet and as with the other areas in the town centre, this was validated with reference to the various aerial images, our site visits and discussion with the owners and staff of various commercial premises.

Figure 63 presents an aerial image of the upper end of Main Street from which it can be seen that the upper end of the street is flooded to shallow depths due to overland flow from the Towns Park area.

Figure 63: Flooding of Upper Main Street

Figure 64 presents aerial imagery at the lower end of Drury's Avenue/ Connolly Street from which it can be seen that the entire area is inundated.

Figure 64: Flooding of Drury's Avenue/ Connolly Street.

A picture shared on social media and which is reproduced below in Figure 65 shows that the flood depths along Drury's Avenue, adjacent to An Stor were very significant and well in excess of 1.4m. We note that flood depths of this magnitude are circa 0.5m higher than the Q1000 model maximum flood depth in this area.

Figure 65: Water depths: Drury's Avenue (adjacent to An Stor)

It is estimated that 110 properties were inundated in this area during the flood event the majority of which were commercial properties.

3.5.4 Beechwood/ Oakwood Estate

Mechanisms of Flooding in Hydraulic Model

The primary mechanism of flooding in the Beechwood and Oakwood Estate is from overland flow entering the rear of the estate. This water originates from overtopping of the left bank of the Dungourney and flows across the GAA pitches before reaching the estate. This mechanism of flooding is indicated in Figure 66.

As part of the GAA grounds redevelopment works it is understood that an informal earthen embankment was placed parallel to the rear wall of the Beechwood and Oakwood Estates. However, there is a gap of circa 15m in this embankment between the South of Beechwood Drive and the North of Oakwood Lodge. It is likely that the majority of flood water entered the estates at this location.

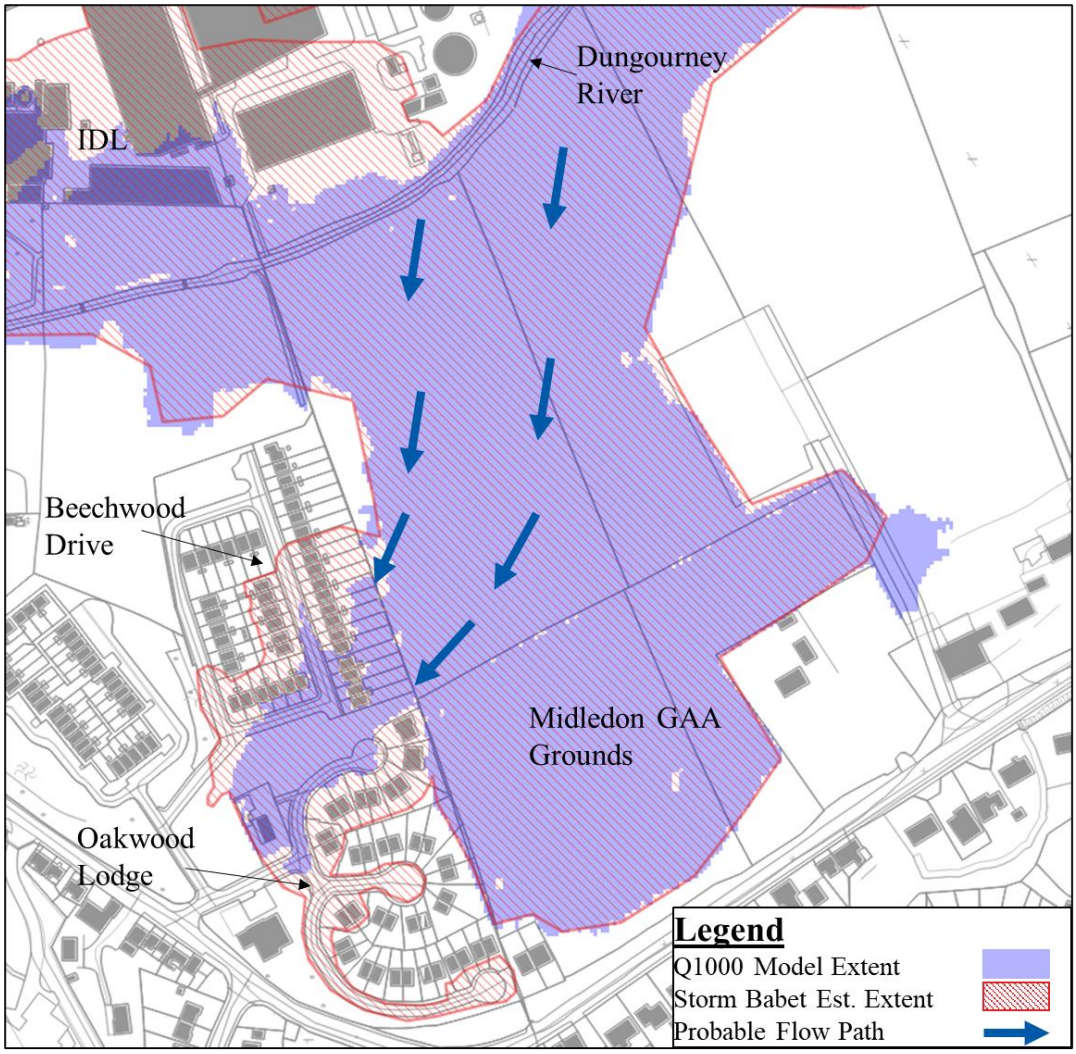

Figure 66: Beechwood/ Oakwood Estate: Existing Flood Mechanisms

Comparison of Modelled vs Observed Mechanisms During Storm Babet

A significant number of wrack marks were recorded on this area and were used to generate the maximum flood extent from the Lidar data as shown in Figure 66. This extent was then cross referenced with the anecdotal data on the flood extent and depths which were observed in the estates during the event.

From comparison of the Q1000 model extent and the Storm Babet observed extent it is clear the modelled Q1000 extent is considerably less than the observed extent of flooding within the Beechwood/ Oakwood estates. This may be due to the flow from the Dungourney catchment during the event being in excess of the Q1000 design flow, i.e. Storm Babet may have approximated to an event in excess of the Q1000 event on the Dungourney. Alternatively, the model in this area may not be representative of what is on the ground and may therefore underestimate water levels for extreme events in the area. This may be related to recent changes in the floodplain elevations associated with the development of the GAA pitches or it may be a function of the roughness in channel and on the floodplain. Further assessment of the design hydrology and hydraulic model will be carried in order to investigate the representation of Storm Babet by the model.

A still of a video taken by a Beechwood resident and shared with the Project Team is shown in Figure 67 below, it shows the GAA Grounds inundated. It is noted that the permitted GAA development required no reduction in floodplain storage, therefore if this was constructed as permitted it should not result in an increase in flood levels.

Figure 67: Flooding of the GAA Grounds to the Rear of Beechwood

It is estimated that 37 residential properties were flooded in this area during Storm Babet.

3.5.5 Irish Distillers Site

Mechanisms of Flooding in Hydraulic Model

The Irish Distillers Site (which includes The Jameson Experience) is at risk from a number of mechanisms of flooding from the Dungourney as listed below and as sketched in Figure 68:

A. Fluvial water from the Dungourney backs up the culvert under the Distillery entrance resulting in flooding around the tail race.

B. Water overtops the right bank of the Dungourney flooding the site from the South. It is noted that that the perimeter wall between the IDL Site and the People's Park has been removed from the hydraulic model for events beyond the Q50 event.

C. The main source of flooding to the IDL site is fluvial water from the Dungourney backing up the culvert and also overtopping the existing bund spill level.

D. The right bank of the Dungourney overtops resulting in fluvial flooding at the extraction pump.

E. Water overtops the left bank of the Mill Race and travels South before entering the Dungourney.

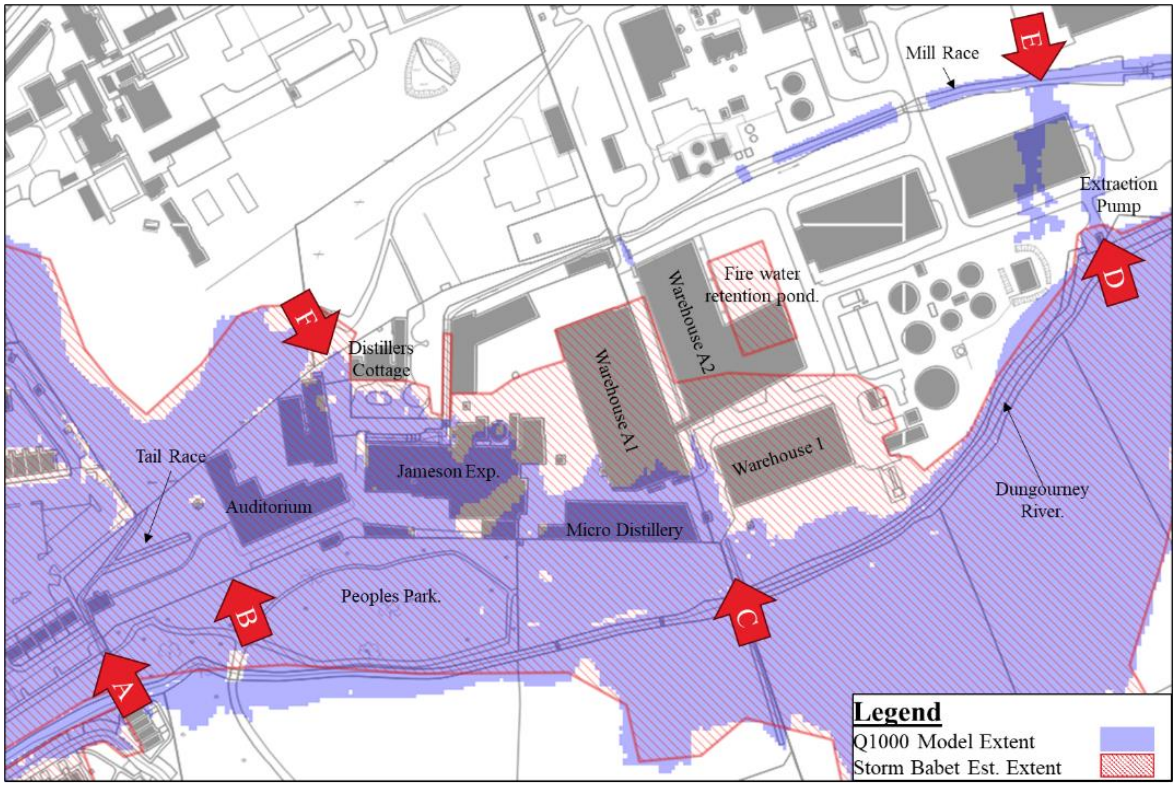

Figure 68: Irish Distillers: Existing Flood Mechanisms

An additional mechanism of groundwater flooding which was not considered by the Q1000 model but which was activated during the Storm Babet is detailed as:

F. Surcharging of the cavern water system to the west of Distillers Cottage. The cavern started to surcharge when the distillation process was shut down (circa 2pm). As this mechanism was attributed to groundwater flooding it was not included in the hydraulic model.

A meeting was held between Arup and IDL after the flood event to discuss the mechanism of flooding/ flood extent on the site during Storm Babet. All the mechanisms detailed above, with the exception of mechanism E occurred during Storm Babet. Further detail on these mechanisms during Storm Babet is outlined in the next section.

Comparison of Modelled vs Observed Mechanisms During Storm Babet

Note: Arup are awaiting images from the event the IDL which will be included in this section in a later draft of the report.

It is noted that the extent of flooding in the Q1000 model is less than what was observed during the flood event in the IDL Site. This may be due to the flow in the channel being greater than the Q1000 design flow and/or the setup of the model in this area not being representative of what is on the ground. Further assessment of the model will be carried out to better represent the mechanism of flooding during Storm Babet.

Although the wall between the People's Park and the IDL did not fail during the event, seepage through cracks/ grouting caused by a large head of flood water on the river side of the wall (People's Park) was observed during the flood event. It is noted that this mechanism was not a significant source of flooding on the IDL site.

The main volume of water entering the site was from fluvial water backing up the culvert and over topping of the bund spill level close to the micro distillery. An image of the outfall and spill is shown in Figure 69.

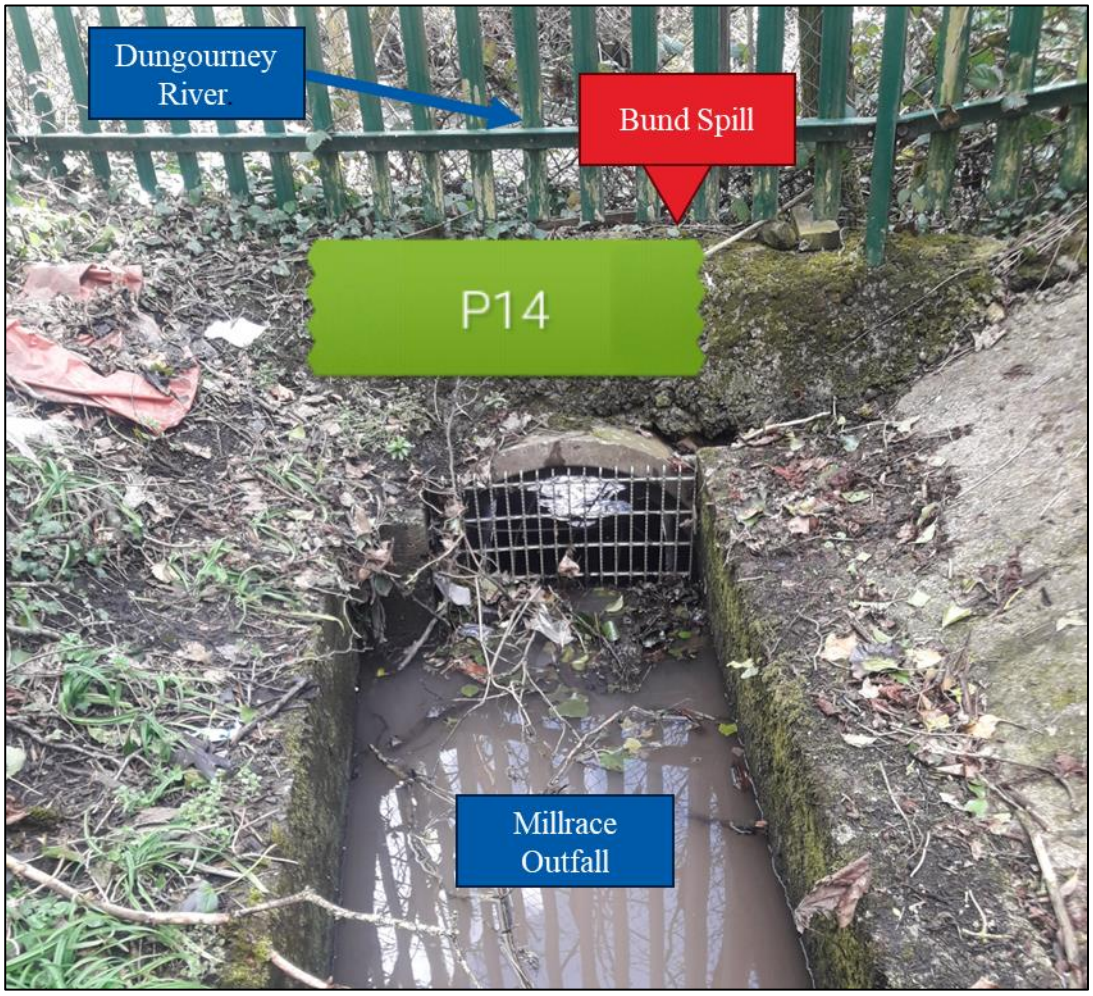

Figure 69: Millrace outlet to Dungourney

There were reports that the area around the extraction pump flooded during Storm Babet due to over topping of the Dungourney right bank.

The model assumes the existing sluice gate upstream on the millrace fails and therefore the millrace takes water from the Dungourney and is active. During the Q1000 model scenario the left bank overtops but this mechanism was not observed during Storm Babet as the millrace was only wet with direct rainfall.

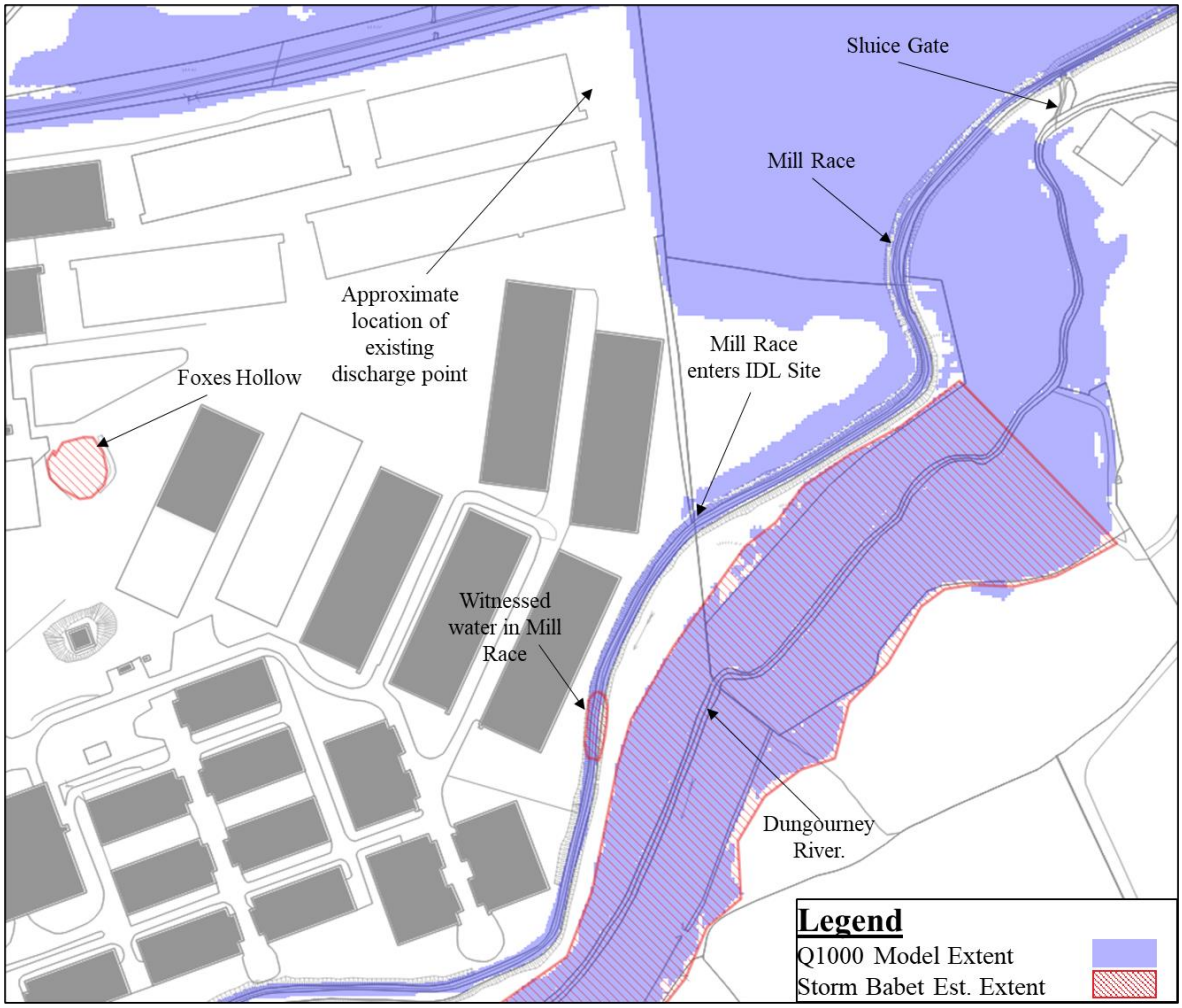

Figure 70: Irish Distillers Upstream: Modelled vs Observed Storm Babet Flood Extent

A number of mechanisms which resulted in flooding on site during the 2016 flood event are not believed to have reoccurred during Storm Babet. These included significant flooding at Foxes Hollow, although there was some localised flooding of the vegetated area (as shown in Figure 70), it was not a major concern during Storm Babet. Groundwater flooding to the northeast corner of the site did not reoccur as the discharge point has been blocked up since 2016. A repeat of localised flooding close to the culvert (which discharges to Foxes Hollow) through the northern embankment in 2016 was also not reported.

Based on the meeting held with the IDL after the flood event, it was noted that 7 buildings flooded on site, these included;

- The Auditorium (circa 1m lower FFL than the rest of the building)
- The Jameson Experience - circa 900mm of flooding
- The Micro Distillery - circa 900mm of flooding
- Warehouse A1
- Southern portion of Warehouse A2
- The Pump Station offtake

Water got within a few centimetres of the Distillers Cottage and the Warehouse 1 FFL which had been raised in recent years.

3.5.6 The Baby's Walk/ Lower Main Street

Mechanisms of Flooding in Hydraulic Model

The main area of the town in the vicinity of The Baby's Walk and Lower Main Street is at risk from a number of mechanisms of flooding from the Dungourney and the Owenacurra. The mechanisms of flooding in the hydraulic model detailed below correspond to the arrows in Figure 71.

A. For the large return period events, flood risk in the vicinity of Main Street is partly due to overland flow from the Owenacurra River as detailed in Section 3.5.3. The threshold of flooding of this flow path is the Q1000 event in the hydraulic model;

B. There is also a risk of overland flow from Drury's Avenue which travels South and inundates Connolly Street/ Dickinson's Lane as detailed in Section 3.5.3. The threshold of flooding of flooding of this flow path in the hydraulic model is the Q100 event.

C. Overland flow from the Owenacurra via Kennedy Park and Broderick Street travels East as detailed in Section 3.5.2.

D. The Baby's Walk is flooded from the East due to overland flow from the IDL/ People's Park as discussed in Section 3.5.5.

E. The Baby's Walk area is directly flooded from the Dungourney due to over topping of the right bank of the river. The threshold of flooding for fluvial flooding is the Q5 event.

F. The Distillery Walk / Cuddigan's Yard area downstream of Lewis Bridge is also directly flooded from the Dungourney due to over topping of the right bank during the Q1000 event.

G. Water overtops the Dungourney left bank upstream of Lewis Bridge and floods the Roxboro Close Area in the modelled Q1000 event.

H. On the left bank downstream of Lewis Bridge water gets out of channel in the Q1000 model event.

I. Broderick Street is also flooded from flow coming down Main Street

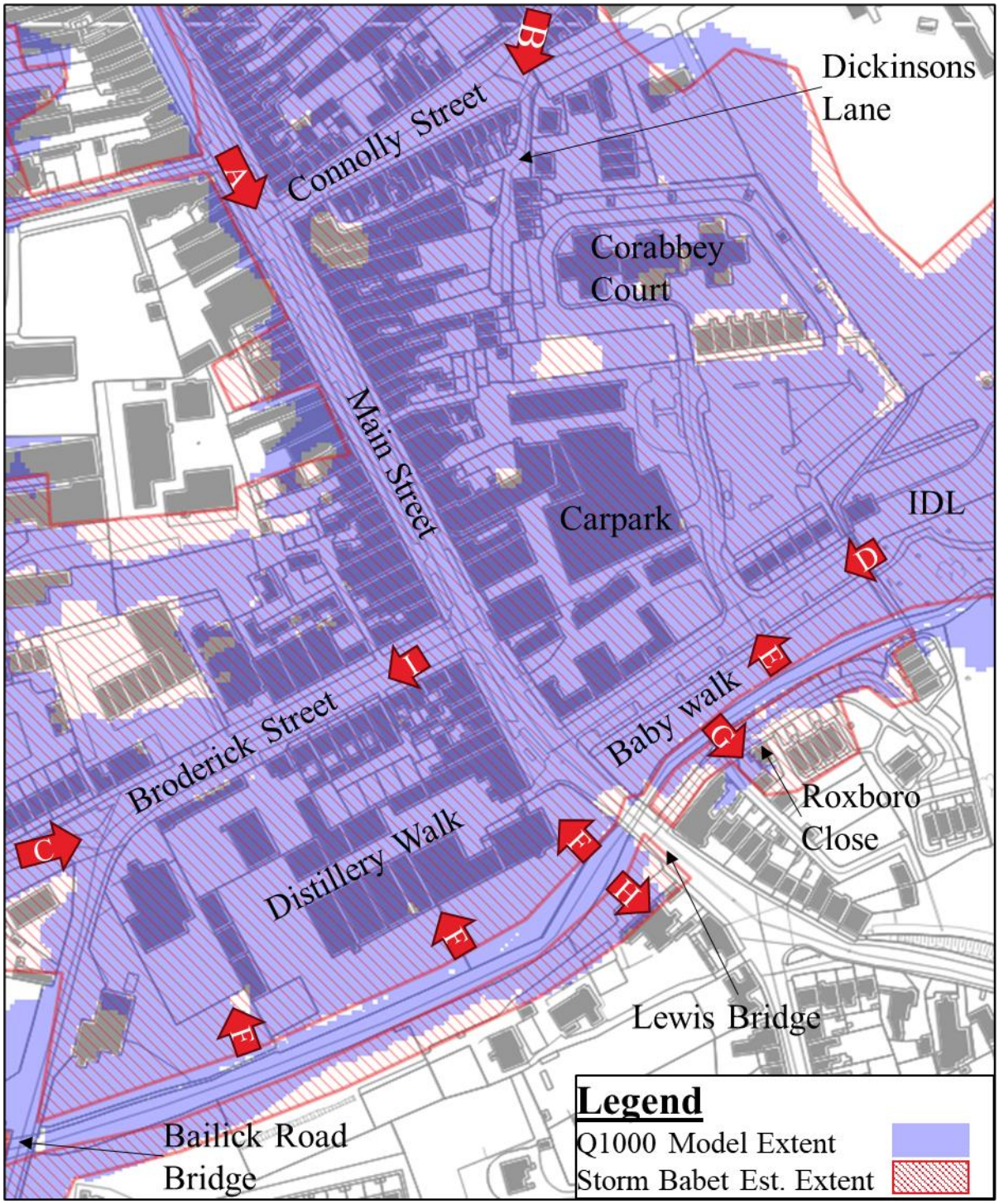

Figure 71: Lower Main Street/ The Babys Walk: Existing Flood Mechanisms

Comparison of Modelled vs Observed Mechanisms During Storm Babet

All the mechanisms of flooding in the hydraulic model detailed above occurred during Storm Babet. The mechanisms were largely validated using aerial images taken by the Guileen Coast Guard, drone footage uploaded to social media or images taken by the public and steering group members.

Figure 72 shows flooding of Lower Main Street at 2.11pm on the day of the event. Wracks marks taken at the Three shop at the end of Main Street were circa 3.8mOD which is 300mm above the modelled Q1000 modelled water level at this location (i.e. 3.5mOD).

Figure 72: Flooding of Lower Main Street

A wrack mark was also recorded by Arup at the front door of the Three shop, the maximum depth of flooding at this location was circa 1.18m as shown in Figure 73.

Figure 73: Wrack Mark at Three Shop

Figure 74 was provided by the Guileen Coast Guard shows the extent and active mechanisms of flooding in the IDL, People's Park and The Babys Walk area. Water flooded the rear of the Distillery Walk Cottages via the Corabbey Court development (Mechanism B), through the IDL entrance and the gap in the wall connecting People's Part to Distillery Walk (Mechanism D) and directly from the Dungourney (Mechanism E). The flood mechanism resulting in inundation of Roxboro Close can also been seen in Figure 74 (Mechanism G).

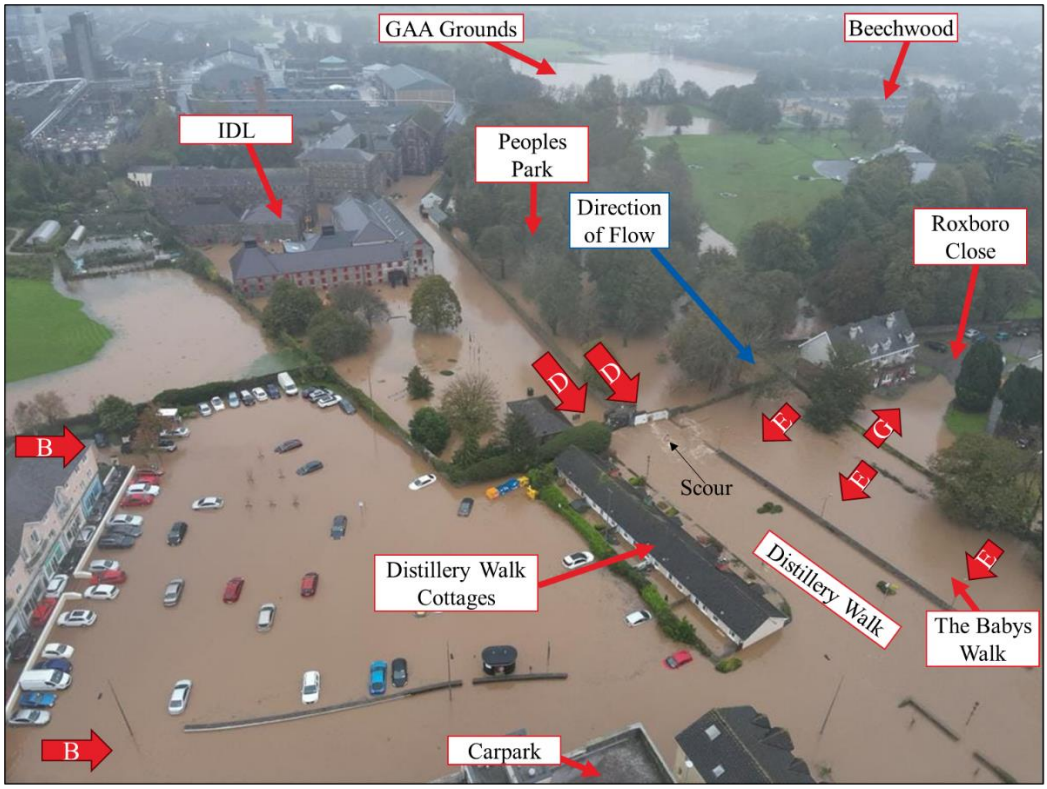

Figure 74: Flooding of IDL, Peoples Park and The Babys Walk

The gap in the wall connecting People's Park and Distillery Walk squeezed the flow and resulted in very high velocities which led to significant scouring of a section of footpath as shown in Figure 75.

Figure 75: Scour Damage at Distillery Walk

A wrack mark was also recorded by Arup at the Distillery Walk Cottages, the maximum depth of flooding at this location was circa 0.99m as shown in Figure 76.

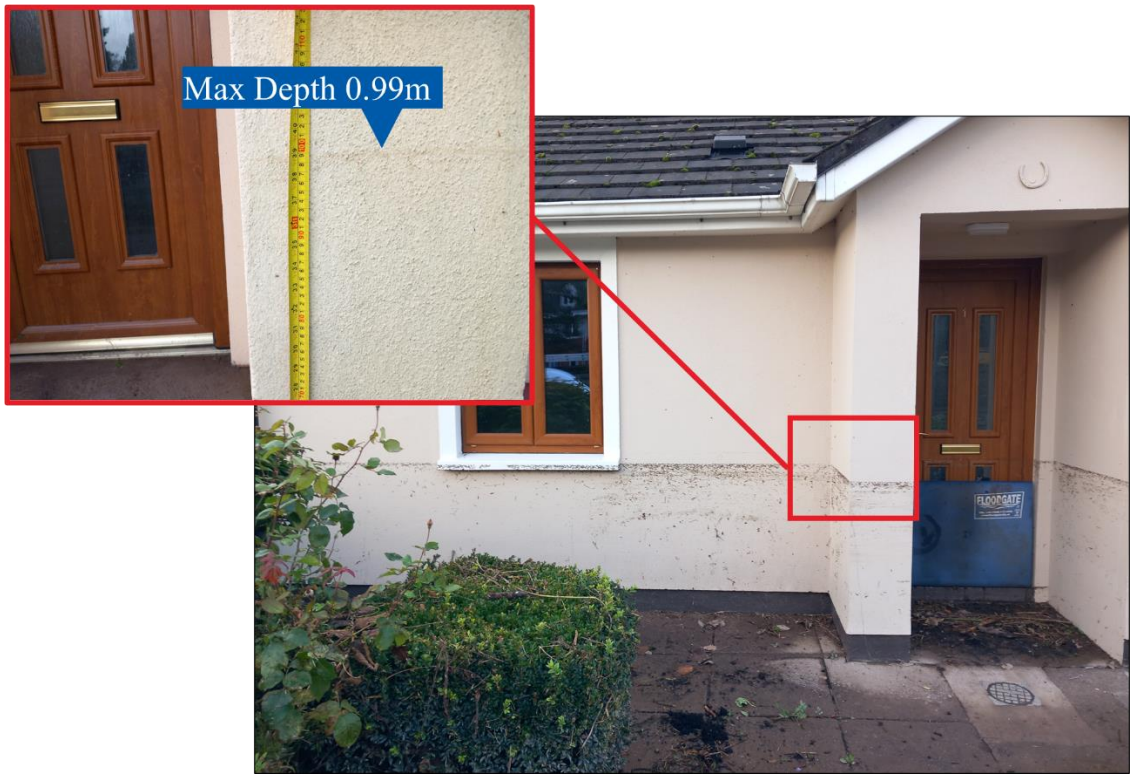

Figure 76: Wrack Mark at Distillery Walk Cottages

Figure 77 presents a still of drone footage taken just after the peak of the flood event and uploaded to social media. It shows flooding of Lower Main Street, The Baby's Walk and Roxboro Close as discussed above. It also shows the flood extent of the right and left bank downstream of Lewis Bridge (Mechanism F and H respectively). Figure 76 illustrates the flooding Broaderick Street, the source of which is believed to be from Kennedy Park in the direction of Main Street (Mechanism C) initially and then later in the event from Lower Main Street in the direction of Kennedy Park (Mechanism I). It is noted that the Owenacurra was also overtopped in this location such that water on Broderick Street was in effect a meeting point of two separate overland flow routes.

Figure 77: Flooding of Lower Main Street, The Baby's Walk and Broderick Street

Figure 78 was taken at 3.06pm on the day of the event from Lewis Bridge in the direction of The Babys Walk. Based on water levels from other images it is estimated that this was the time of the peak of the flood in this area. It is estimated that the peak water level in The Baby's Walk was circa 3.6mOD which is circa 100mm higher than the modelled Q1000 model water level (i.e. 3.5mOD).

Figure 78: Flooding of The Babys Walk

Figure 79 was taken at 3.26pm from Lewis Bridge on the day of the event in the direction of Roxboro Close. Water has clearly overtopped the left bank where the metal fencing has been installed. Based on our inspection of the wrack marks, it is estimated that the peak water level in Roxboro Close was circa 4.05mOD.

This is notably higher than the Q1000 model water level in this area was circa which is 3.7mOD, i.e. the maximum water level during Storm Babet is circa 350mm higher than the modelled Q1000 water level.

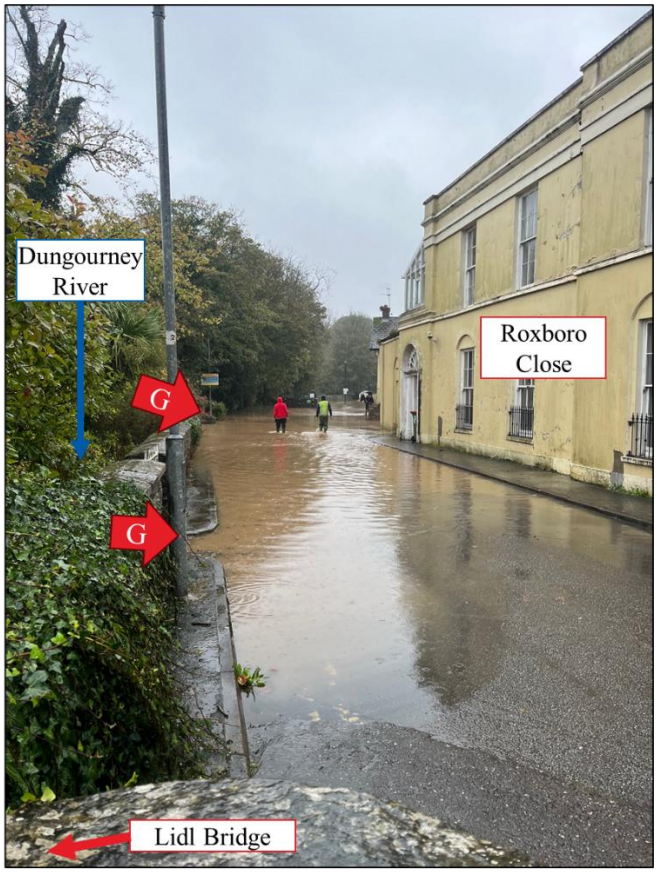

Figure 79: Flooding of Roxboro Close

Figure 80 is a still of a video and shows the mechanism of flooding on the right bank downstream of the Lewis Bridge (Mechanism F). No wrack marks were recorded after the event at this location however based on topographical survey data it is estimated that the flood level in this area was circa 3.6mOD which is 300mm higher than the Q1000 modelled level of 3.3mOD.

Figure 80: Flooding of Right Bank Downstream of Lewis Bridge

Figure 81 was taken at 3.02pm on the day of the event and shows the mechanism of flooding on the left bank downstream of the Lewis Bridge (Mechanism H). Based on topographical survey data, it is estimated the flood level in this area was circa 3.6mOD which is also 300mm above the modelled Q1000 water level of circa 3.3/3.35mOD in this area. A wrack mark was also recorded by Arup at this location, the maximum depth of flooding was circa 0.50m as shown in Figure 81.

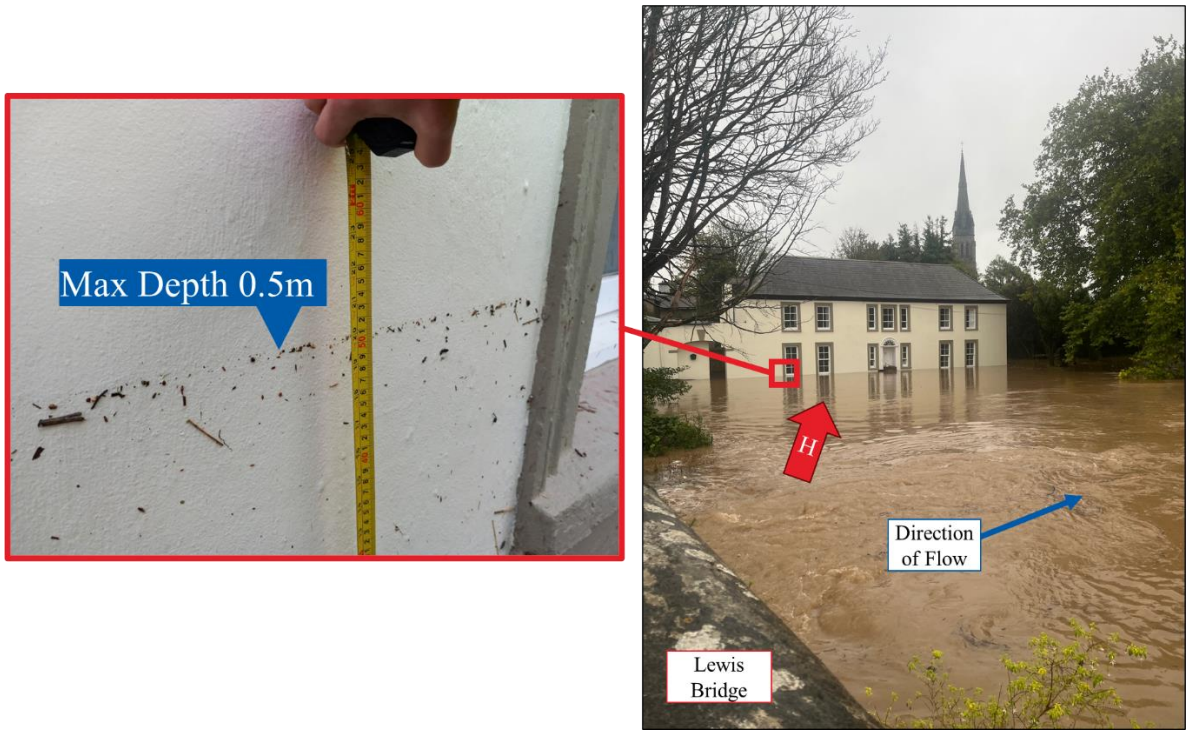

Figure 81: Flooding of Left Bank Downstream of Lewis Bridge

Reports from CCC note that the water levels at Lewis Bridge were significantly higher at 18.53 compared to water levels recorded at 14.15. A further observation shortly after high tide at 20:43 confirmed that the level

had dropped from the level observed at 18:53. Based on these observations it can be concluded that the peak of the Owenacurra passed before the peak of the Dungourney.

It is estimated that 151 properties were flooded in this area during Storm Babet, the majority of which were commercial.

3.6 Area 3 South – N25 to Bailick Rd

Area 3 South includes the estuary and Bailick Road South of the N25 as shown in Figure 82.

Figure 82: Area 3 South

As discussed in Section 3.5.2, there were reports of shallow overland flow flooding on the Bailick Road coming from North of the N25. There were no reports of any flooded properties during the event. Flow travelled South along the Bailick Road and entered the estuary at the exiting boat slip on the Bailick Road.

3.7 Area 4 – Lauriston, Rugby Club, East of IDL

Area 4 includes the IDL site, Midleton Rugby Club, Lauriston Estate, Townspark Industrial Estate and the land to the east of the Irish Distillers Limited (IDL) site adjacent to the Dungourney.

Figure 83: Area 4

There were no reports of properties flooding from groundwater/ fluvial sources in this area during Storm Babet. The Green Way, Midleton Rugby Club and agricultural lands to the East of the IDL Site were flooded. The estimated flood extent from Storm Babet is presented in Figure 84.

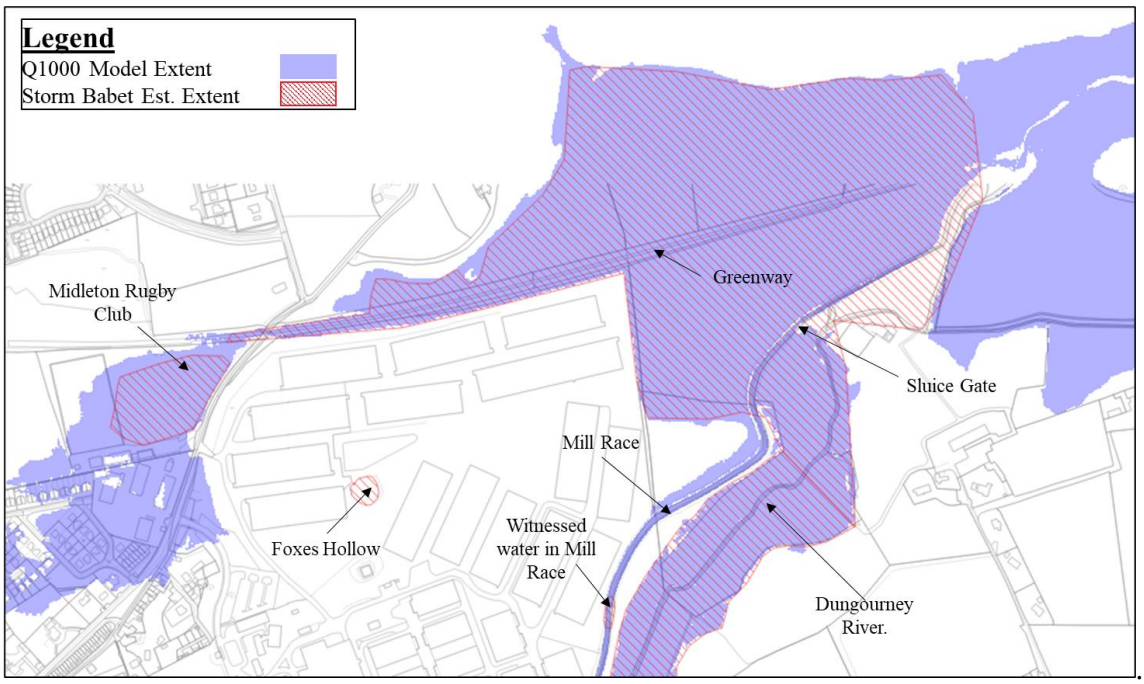

Figure 84: Area 4: Modelled vs Observed Storm Babet Flood Extent

3.8 Area 5 – Ballinacurra

On the morning of the Storm Event the high tide was recorded at 7.20am. The hightide resulted in tide locking of the culvert to the estuary, this compounded with heavy rainfall resulted in a channel full event. The Ballinacurra Stream did not break its banks as water stayed in channel upstream of the culvert inlet and at Kearney's Cross. There was some surface water flooding in the Main Street but properties had Individual Property Protection in place. There were no reports of properties flooding in this area.

3.9 Area 6 – Waterrock

Area 6 covers the Water Rock watercourse area to the estuary. This area includes Water Rock House, North Point Business Park, Castle Rock Estate, the proposed LIHAF Development site, Baneshane and the Wastewater Treatment Plant (WwTP) to the south.

There is a live rail-line passing east west through this area. There are a number of proposed infrastructure projects interacting with the scheme in this area including the Water Rock LIHAF Development, the Irish Water Wastewater Load Diversion project, the Irish Rail dual tracking project and the Ballinacurra to Midleton Cycleway scheme.

This area also includes a cave system, where the Water Rock watercourse goes underground and re-emerges south of the N25 road. The predominant risk of flooding in this area is fluvial, which can be exacerbated by the groundwater levels. The extent of Area 6 is shown in Figure 85 below.

Figure 85: Area 6

Mechanisms of Flooding in Hydraulic Model

Water levels upstream of the cave system are dominated by the significant head loss associated with the narrow entrance into the cave system. Groundwater levels within the cave system can also increase water levels upstream by restricting flow through the system and in effect acting as a blockage to the watercourse.

The Q100 event inundates Water Rock House and overtops the local access road. A number of residential properties adjacent to the road are inundated as a consequence. There is a sufficient head of water over the road to cause a significant volume of water to flow east beyond the residential properties and fall towards the Owenacurra, this mechanism of flooding is presented in Figure 86 using the “A” arrow.

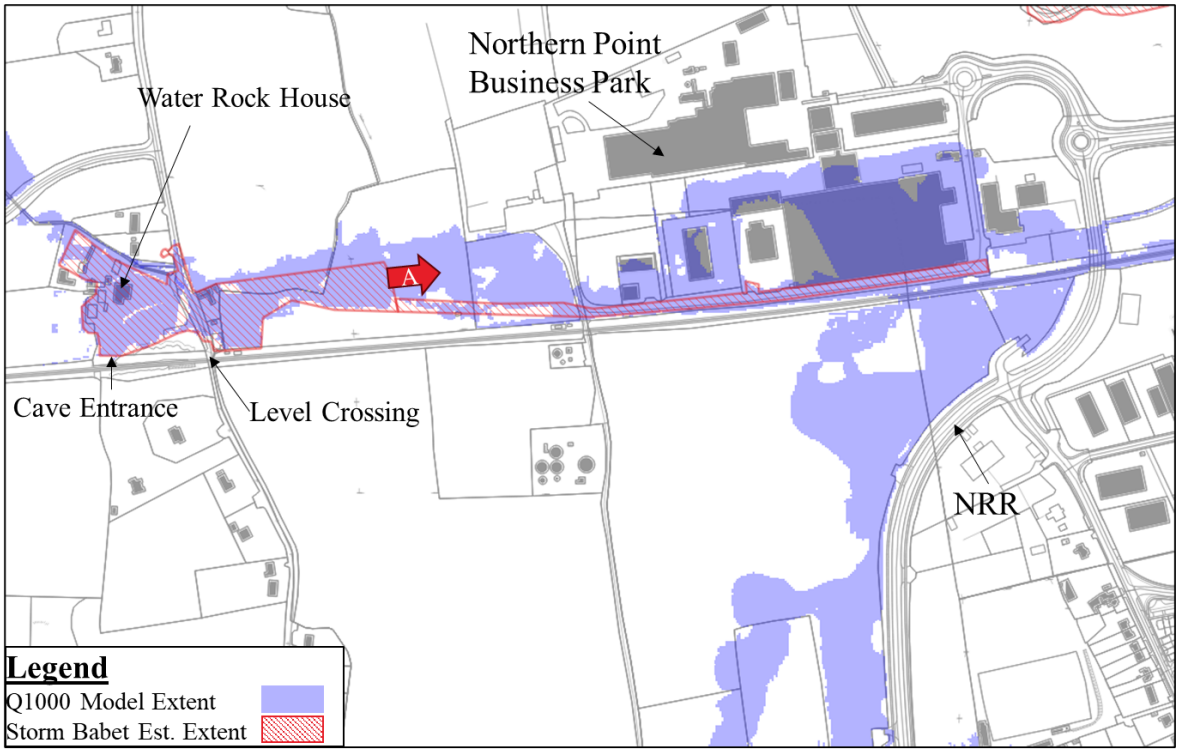

Figure 86: Water Rock Upstream of Cave System: Existing Flood Mechanism

A number of properties downstream of the cave system are also at risk from fluvial flooding. The WwTP is also at risk.

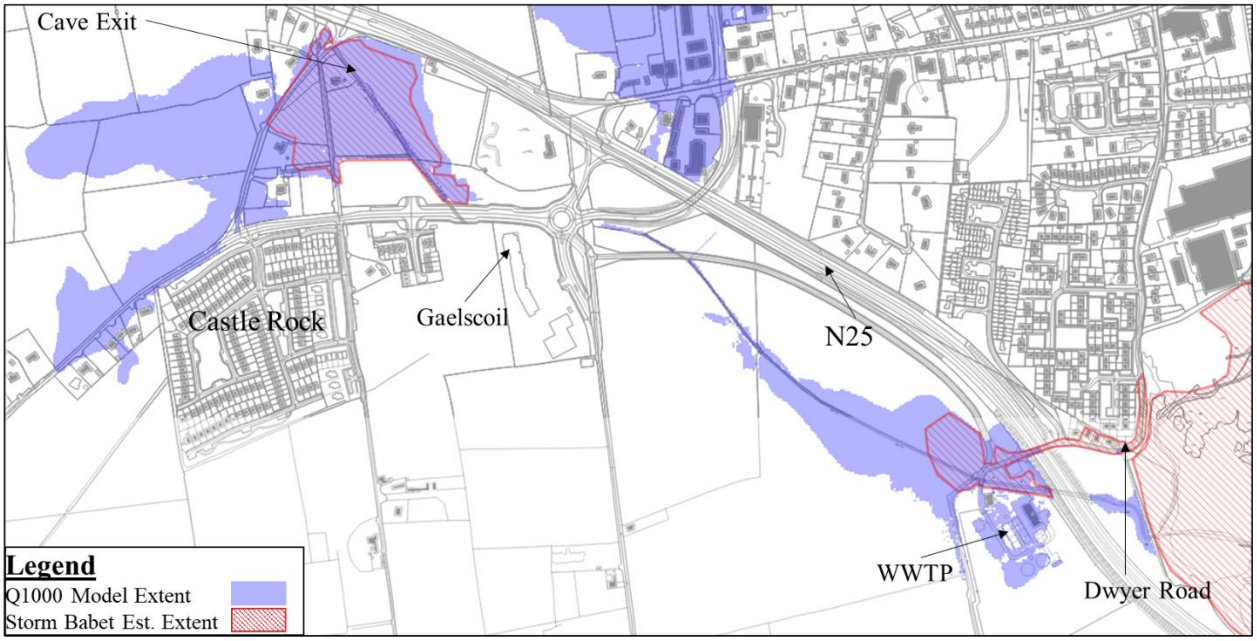

Figure 87: Water Rock Downstream of Cave System: Existing Flood Mechanism

Comparison of Modelled vs Observed Mechanisms During Storm Babet – Upstream of Cave System

The area upstream of the cave system around Water Rock House was significantly inundated with flood water. The cave system surcharged resulting in water backing up and flooding Water Rock House, the auto services and the two bungalows to the East. Locals reported that flood waters reached the new internal road on the LIHAF site. Based on information/ images gather by CCC from LIHAF Contractors a number of

recently constructed flood culverts to facilitate the new internal road network were activated. From here water continued to travel east. Arup contacted a number of businesses located on the Northern Point Business Park, there was no reports of flooding of any of the properties here however overland flow did pass along the internal road between the Business Park and the rail line at an estimated depth of 2-3ft. There are no wrack marks or images available to validate this reported depth.

Wrack marks recorded at Water Rock House by Arup following the event suggest the depth of flooding in the property was 1.06m (Figure 88), the finished floor level of this property is 10.19mOD therefore the estimated max flood level is circa 11.25mOD. The modelled Q1000 water level at this location is 11.15mOD, i.e. 100mm lower than the observed level.

Figure 88: Wrack Mark at Water Rock House

Wrack marks recorded at the bungalow opposite Water Rock House by Arup following the event suggest the depth of flooding in the property was 0.7m (Figure 89). As the finished floor level of this property is 10.66mOD the estimated maximum flood level is circa 11.36mOD which is circa 200mm above the modelled Q1000 water level at this location (11.13mOD).

Figure 89: Wrack Mark at Bungalow opposite Water Rock House

The probable flow path and the boundary walls are outlined in Figure 90. Furthermore, during the flood event the channel banks directly upstream of the culvert passing under the Water Rock House access road collapsed. (Figure 91)

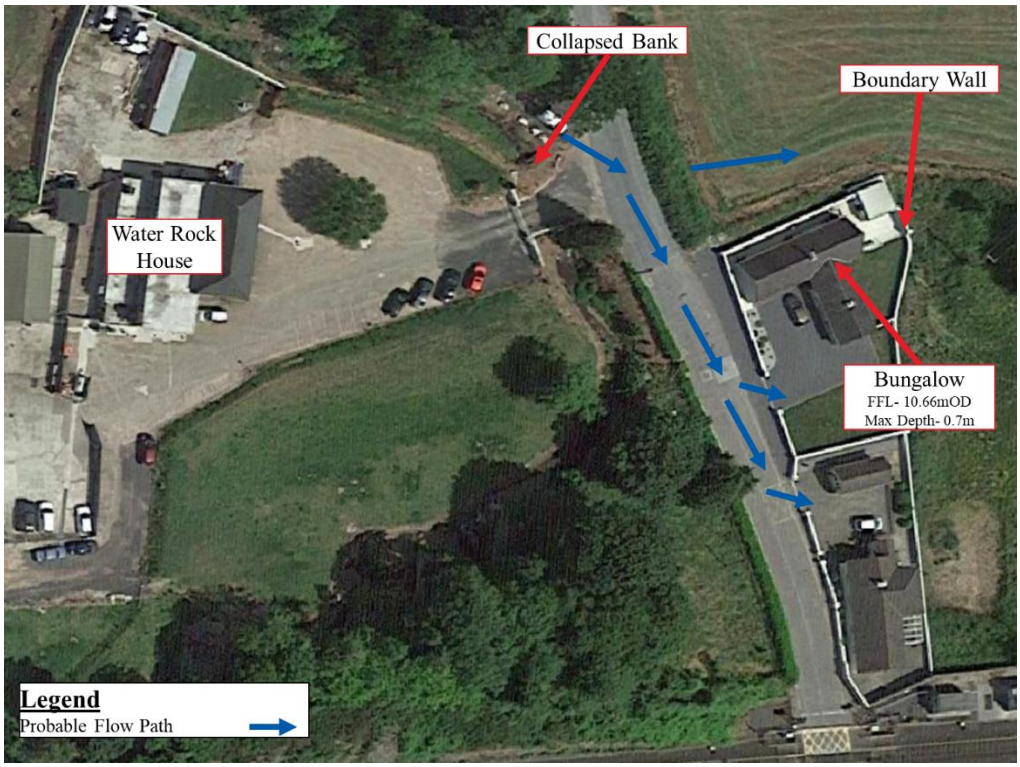

Figure 90: Probable flow path leading to flooding of Water Rock Bungalows

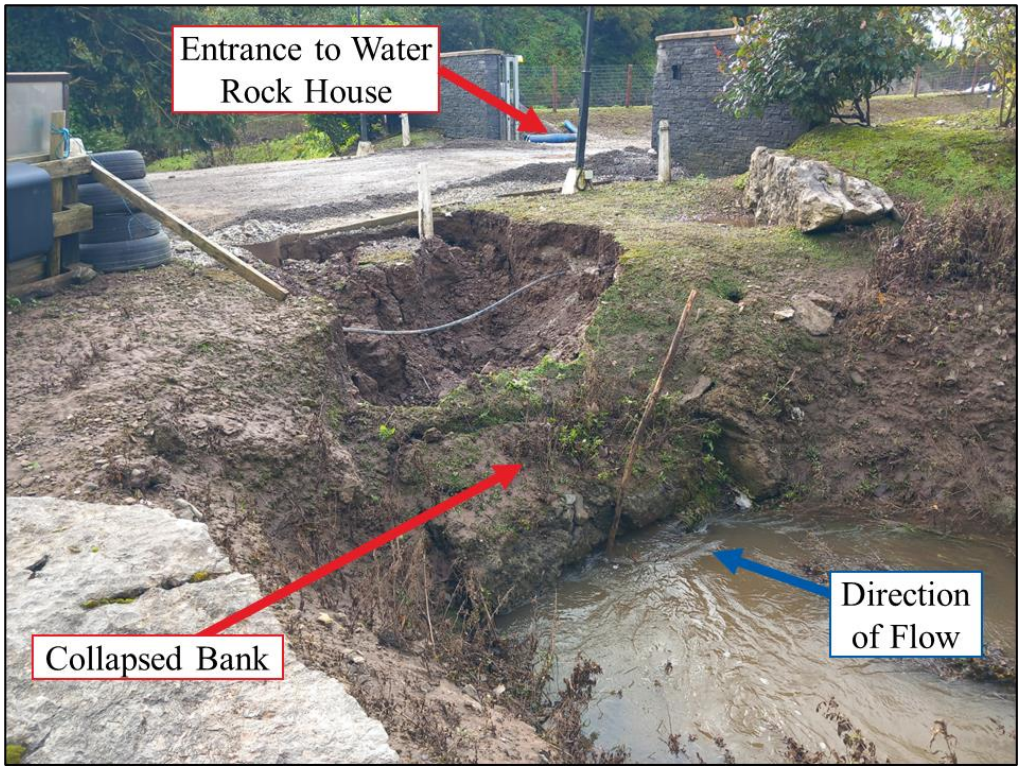

Figure 91: Bank Collapse Upstream of Culvert

Conditions in the Waterrock area during the event were exceptionally dangerous and a resident told Arup of the extreme danger that they faced in trying to exit their properties during the event by having to wade through waist high flood water to higher ground.

Comparison of Modelled vs Observed Mechanisms During Storm Babet – Downstream of Cave System

There were reports of flooding at Dwyer's Road/ Riversfield Estate on the 18th October and again on the evening of the 19th October. The probable flow path resulting in flooding of Riversfield Estate is shown in Figure 92. It is believed the source of the flooding on the 19th was due to tide locking of the Water Rock Stream outfall. The water levels in the stream were still elevated due to discharge from the cave system upstream hence there was little additional capacity in the channel available to store water which could not be discharged at high tide. It is noted that the same mechanism of flooding was witnessed circa 10 days later, over the last weekend in October.

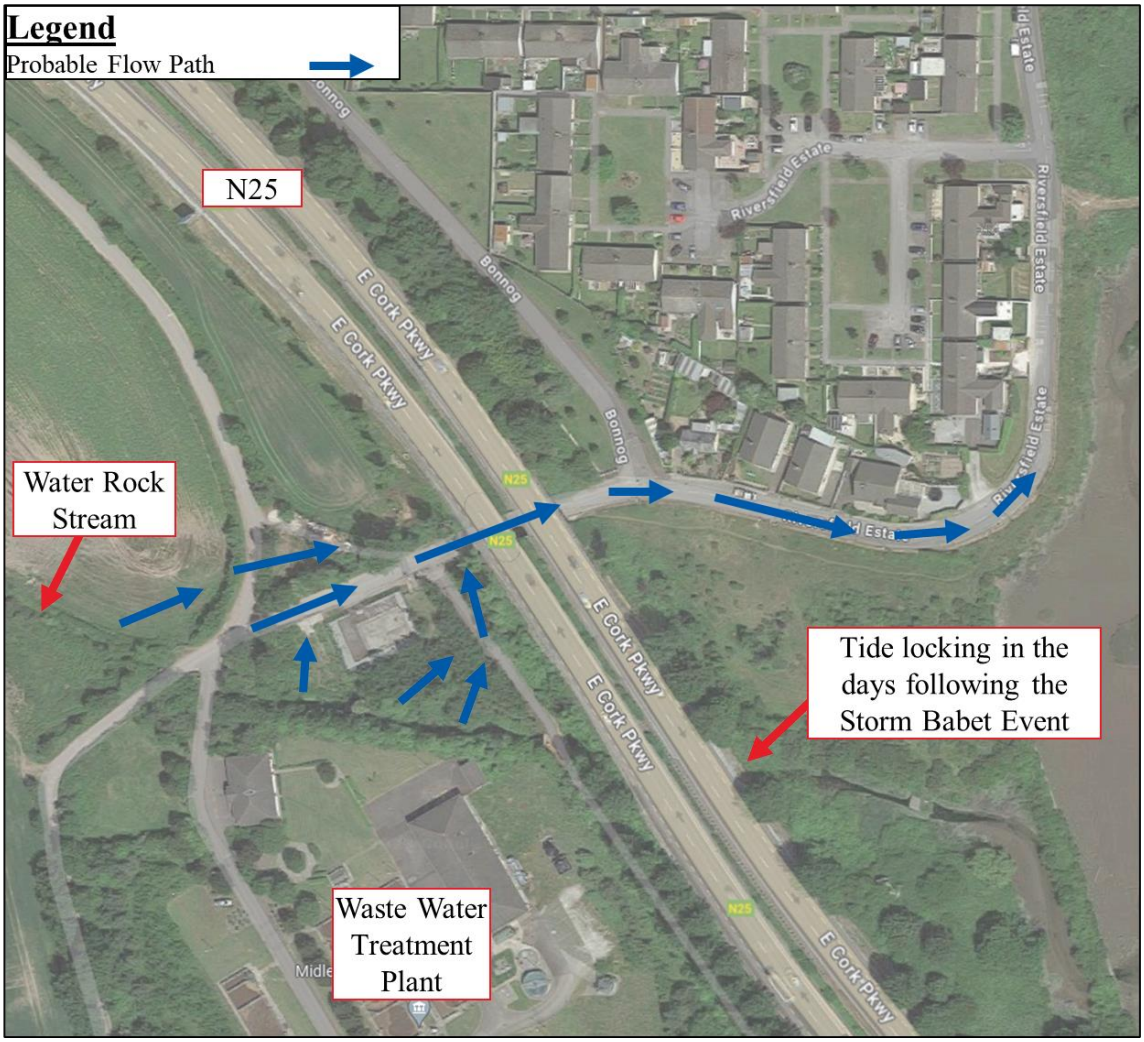

Figure 92: Probable Flow Path Flooding Riversfield Estate

Images shared on social media for this area are presented in Figure 93 below. Based on inspection of water levels and available topographical survey data it is believed that 3 residential properties flooded in the Riversfield Estate area.

Figure 93: Flooding of Dwyer's Road/ Riversfield Estate Area

Based on reports from Uisce Éireann, the WWTP site was partially flooded as a result of surcharging of the discharge. It is noted this is an ongoing issue and due for upgrade although the flood extent which occurred during Storm Babet was greater that what is normally experienced. There was no direct surface flooding of the WWTP due to the Water Roack Stream overtopping.

It is estimated that a total of 7 properties flooded in the Water Rock Area during Storm Babet.

3.10 Ballyedmond Gauge

The area in the vicinity of the gauge at Ballyedmond was very significantly flooded during Storm Babet. There was also significant damage to the local infrastructure: a number of local roads and the parking area in front of the site were all damaged during the event (Figure 94). The boundary wall in front the site was also knocked during the event (Figure 95).

The impact of the event at the gauge will be considered in detail as part of the reassessment of the scheme hydrology. Given that the gauge was bypassed during the event, a detailed appraisal of the hydraulics of during the event at the gauge will be undertaken. This work will be detailed in the follow on study assessing the preferred scheme in light of hydrology and flood levels associated with Storm Babet.

Figure 94: Damage to Road at Ballyedmond Gauge

Figure 95: Boundary wall in front of gauge site knocked

4. Overview of Flood Extents and number of impacted properties

Table 4 below summarises the estimated number of properties flooded per area, as outlined in Section 3 of this report, during Storm Babet.

Table 4: Estimated Number of Properties Flooded During Storm Babet by Area

Report Section	Area	No. of Residential Properties Flooded	No. of Commercial Properties Flooded	Total
3.4.1	Tir Cluain	66	1	67
3.4.2	Carrigogna Bridge / Clohessy's Yard	2	1	3
3.4.3	Moore's Bridge / Mill Road Upper	11	0	11
3.4.4	Willowbank	24	0	24
3.4.5	Northern Relief Road / Rail Line Level Crossing	2	0	2
3.4.6	Millbrook / Mill Road Lower	66	18	84
3.4.7	Millrace Apartments / Market Square Area	53	10	63
3.5.1	Cork Road Bridge / Lidl Bridge	27	7	34
3.5.2	Lidl Bridge to Chadwicks	28	53	81
3.5.3	Upper Main Street to Connolly Street	23	87	110
3.5.4	Beechwood/ Oakwood Estate	37	0	37
3.5.5	Irish Distillers Site	0	7	7
3.5.6	The Baby's Walk / Lower Main Street	50	101	151
3.9	Waterrock	6	1	7
	Total	**395**	**286**	**681**

Appendix A includes the flood extent maps.

5. Recommendations and Next Steps

Following submission of this draft report to CCC, it has been agreed that Arup will undertake a follow-on study that:

(a) considers the suitability of implementing any interim measures that may help mitigate flood risk in the immediate future in Midleton,

(b) reconsiders the design hydrology and preferred scheme in light of hydrology and flood levels associated with Storm Babet.

As agreed with CCC and OPW, the scope of work of the follow-on study will include the following:

- Assessment and update of the design hydrology of the scheme in light of Storm Babet, this will involve detailed hydraulic modelling at the Ballyedmund Gauge.
- An estimate of the likely return period of Storm Babet.
- Assessment of the design water levels considering any significant change to the scheme hydrology.
- Following agreement of the revised hydrology and design water levels, an assessment and update as necessary will be undertaken of the preferred scheme which has been detailed in length in the Options Report for the project. It is likely that some defence extents and heights may increase, and some new defences may be required.
- Assessment of the performance on the updated preferred scheme if an event with magnitude of Storm Babet were to occur again.
- Assessment of any suitable interim measures that could be implemented in both the short and medium term in order to mitigate flood risk in the scheme area.