Appendix A Folkestone Road Area

A.1 Description of Area

For the purposes of this study, the Folkestone Road area comprises Clarendon, Elms Vale, Maxton which lie adjacent to Folkestone and Elms Vale Roads to the south west of Dover. Elms Vale and Folkestone Road represent two significant dry valleys which converge in Clarendon. At this point, Folkestone Road is in a valley with Tower Hamlets on high ground to the north and Western Heights on high ground to the south. The area is predominantly residential although contains Priory Station, Government buildings (off St John's Road), the Ambulance Station, nursing homes, schools with associated playing fields and some local retail premises.

Drainage in this area is via the Southern Water surface water and combined sewer networks which convey surface water eastwards towards Mid Town, running parallel along Folkestone Road. Two combined sewer pipes of the same diameter (675mm) from Folkestone Road and Elms Vale Road combine into a single 675mm pipe under Folkestone Road at the junction with Malvern Road. The separate surface water sewer increases in size to a diameter of 1200mm by Priory Station.

Low property thresholds at junction of Folkestone Road and Elms Vale Road

Looking towards basement properties on Folkestone Road from Malvern Road

Playing field adjacent to Great Farthingloe

Harbour school playing field adjacent to Elms Vale Road

Figure A.1 Photographs of some key features in the Folkestone Road area

A.2 Preliminary Risk Assessment

Based on desk-based assessment of available information and site inspection, the Folkestone Road area was assigned a preliminary hazard rating of between

Moderate at the western extent and Severe towards Priory Station. The following were key observations:

- Flooding of basement properties along Folkestone Road, particularly near the junction with Malvern Road, was recorded in the summers of 2004 and 2007. The area also has a history of flooding from the combined sewer network.
- A number of properties have low thresholds, including many with steps down to basement properties. There are credible reports of flooding of between 3 and 4 feet deep in basement properties in 2004 and 2007.
- The junction of Folkestone Road and Elms Vale Road is a confluence of two major flowpath systems which converge and extend to the topographic depression at the junction with Malvern Road. Folkestone Road then slopes up to pass over the railway at Priory Station. The only land below this low point is the site of the Government buildings on St John's Road.
- The area is identified from the Environment Agency Flood Map for Surface Water as an area where surface water flooding in the 3.33% (1:30 year) and more extensively in the 0.5% (1:200 year) could be deep (>0.3m).
- Flowpath contributions from the steep sided valleys adjacent to Folkestone Road (e.g. from the vicinity of the new development opposite Winchelsea Road and Eaton Road) could reach high velocities.

A.3 Development Plans and Opportunities

The Site Allocations process[5] has identified sites in the Folkestone Road area for which development may be considered. Options for improved flood risk management (Section A.6) have been identified which could involve the following locations:

- Land at Farthingloe (NS10DOV): Approximately 55ha of land, aligned with the base of the dry valley, could be considered for a Mixed Use scheme
- Land at Western Heights (NS11DOV): Approximately 49ha of land, aligned with the high ground to the south of Folkestone Road, could be considered for a Mixed Use scheme
- Land to the rear of Dover Priory Railway Station (UCS004 & UCS019): Approximately 0.6ha of land which could be considered for residential housing

A.4 Environmental Designations and Other Possible Constraints

The following environmental designations are noted:

- The dry valleys adjacent to Folkestone Road and Elms Vale Road are designated as part of the Kent Downs Area of Outstanding Natural Beauty. This includes the majority of Farthingloe.
- Land surrounding the top of Western Heights is designated as a local nature reserve, with the portion to the north identified as Lowland Calcareous Grassland.
- Some areas of woodland, e.g. Elms Wood and Long Wood are designated as ancient woodland

The area to the north of Folkestone Road is designated as Source Protection Zone 1 (inner). The Folkestone Road area is also identified as a zone where groundwater levels could be close to the surface in a winter hydrologically similar to 2000/1. Selection of appropriate SuDS in this area should therefore consider the need for pollution control and the possibility that high groundwater levels may impede infiltration.

[5] Dover District Council (2010) Site Allocations Document – Interim Consultation. October 2010

A.5 Detailed Model Results

The detailed modelling predicts the following pattern of surface water flooding as summarised in Table A.3 and shown for the 0.5% (1 in 200) AEP event in Figure A.2.

A.6 Surface Water Management in the Folkestone Road Area

A.6.1 Key Concepts for the Options

In addition to a series of generic options for improved surface water management included in the Action Plan, the following concepts are particularly relevant to the Folkestone Road area:

- Basement properties should be protected from water ponding on the roads. This may include raising of thresholds or kerbs.
- Due to the topographic depression at the junction of Folkestone Road and Malvern Road and limited capacity in the combined sewer, options to convey flood water away from this location are limited and likely to be expensive. Therefore, limiting runoff from fringe areas (e.g. land at Western Heights, Farthingloe, Elms Vale) is of primary importance.
- Redevelopment should seek to safeguard and utilise natural ponding areas (e.g. site of Government Immigration Building) and respect natural flow routes (e.g. dry valley at Farthingloe).

A.6.2 Location-specific Options not Included in the Action Plan

The options for improved management of flooding listed in Table A.1 have been considered during the appraisal process but are not included in the Action Plan:

Table A.1 Folkestone Road options not included in the Action Plan

Option Considered	Reasons for Excluding from SWMP Action Plan
Detention basins in the playing fields for Astor College for the Arts (on Noah's Ark Road) and Dover Grammar School (on Astor Avenue)	• The playing fields lie on a watershed and will therefore attenuate minimal flows down Astor Avenue and Eaton Road.
Detention basin in existing playing field at Great Farthingloe adjacent to Manor Road.	• A detention basin, pond or wetland included as part of redevelopment of land at Farthingloe is more likely to be feasible and beneficial.
Detention basins formed by bunds across dry valley at Elms Farm and Elmswood Farm adjacent to Elms Vale Road	• Detention basins are likely to need the bund lining, supported by piling or grouting of the Chalk in order to support the structure and reduce leakage through the Chalk due to the additional head of water stored. Piling or grouting risks stopping and/or diverting natural groundwater flow. • The bunds may be only seldom used if groundwater floods similar to those of 2000/1 only occur with a frequency of between 1 and 0.5%. • The volumes of water generated during extreme groundwater conditions are large and will require large storage areas to be available for, potentially, many months. • Whilst grassed bunds could be blended into the landscape they may still detract from the attractive chalk valleys of the Kent Downs which are designated an AONB.

Option Considered	Reasons for Excluding from SWMP Action Plan
Attenuation tank for high flows in the combined sewer under the disused land adjacent to Priory Station	• Volume of storage required will be large (>2,000m^3 for 3.33% AEP event) and a tank expensive. • Increasing the capacity of the combined sewer network is not a sustainable option and not in the long-term interests of surface water management • The land adjacent to Priory Station is anticipated by DDC to be developed before Southern Water is able to consider implementing any scheme.

A.6.3 Location-specific Option Included in the Action Plan

The option for improved management of flooding listed in Table A.2 is included in the SWMP Action Plan. The primary reasons for inclusion are given.

Table A.2 Folkestone Road option included in the Action Plan

Option	Primary Reasons for Inclusion in the Action Plan
Attenuate upstream flows in a detention basin, pond or wetland as part of redevelopment of Great Farthingloe. Improve property resistance/ resilience for basement properties at key locations along Folkestone Road flow route. Route exceedance flows from Folkestone Road into a pond or wetland sited adjacent to the Government Immigration Buildings off St John's Road, particularly as part of any redevelopment.	• Attenuation of surface flows upstream of Folkestone Road junction with Malvern Road is of primary importance. • Land at Great Farthingloe which is proposed for redevelopment is on the natural flow path along the dry valley and could be considered for redevelopment. • Fourteen basement properties on Folkestone Road at the junction with Malvern Road could be funded for property level resistance/resilience works following a grant from Defra. • The Government Immigration Buildings site is a natural depression behind the railway line and a natural storage area for surface water from the Elms Vale and Folkestone Road catchments. Any available opportunity to return to use it as storage for surface runoff should be considered. • Routing flows from Folkestone Road into the storage areas will most likely require a piped connection due to the raised topography of St John's Road. This may be best considered during any future redevelopment of the site.
Detention basins in the playing field of Harbour School adjacent to Elms Vale Road and the Dover College cricket and hockey ground (bordered by Folkestone Road, Cow Lane and Church Road).	• Attenuation of surface flows upstream of Folkestone Road junction with Malvern Road is of primary importance and these two locations are ideally suited, even though some excavation will be required.

Table A.3 Predicted pattern of flooding in the Folkestone Road area

Rainfall Event (AEP)	Key Pattern of Flooding
50% (1 in 2)	Isolated ponding of direct rainfall, with basement properties on Folkestone Road opposite the junction with Malvern Road flooding first.
3.33% (1 in 30)	Ponding to depths of over 0.5m on Folkestone Road at the junction with Malvern Road, with depths in adjacent basement properties of over 1.5m. Depths of over 0.5m are predicted at the Government buildings off St John's Road, as well as basement properties along Folkestone Road adjacent to the junction with Belgrave Road. The combined sewer surcharges, particularly around the junction with Malvern Road.
1% (1 in 100)	Ponding of up to 2m in the basement properties opposite the junction of Malvern Road, over 0.5m in basement properties adjacent to the junction with Belgrave Road and adjacent to St John's Road and in the nearby Government buildings. Surface water is predicted to flow along Folkestone Road from the junction with Maxton Road to depths of over 0.2m and flows into the disused land adjacent to Priory Station.
0.5% (1 in 200)	Almost continuous flow of surface water is predicted along Folkestone Road from Manor Road to St John's Road, as well as along Elms Vale Road from around the junction with Kings Road. Groups of basement properties which are particularly susceptible to deep ponding are those opposite the junction with Malvern Road, adjacent to the junction with Belgrave Road, opposite the junction with Underdown Road and on the corner of Manor Road in Maxton. Velocities of over 1.0m/s are predicted along some sections of Folkestone Road.

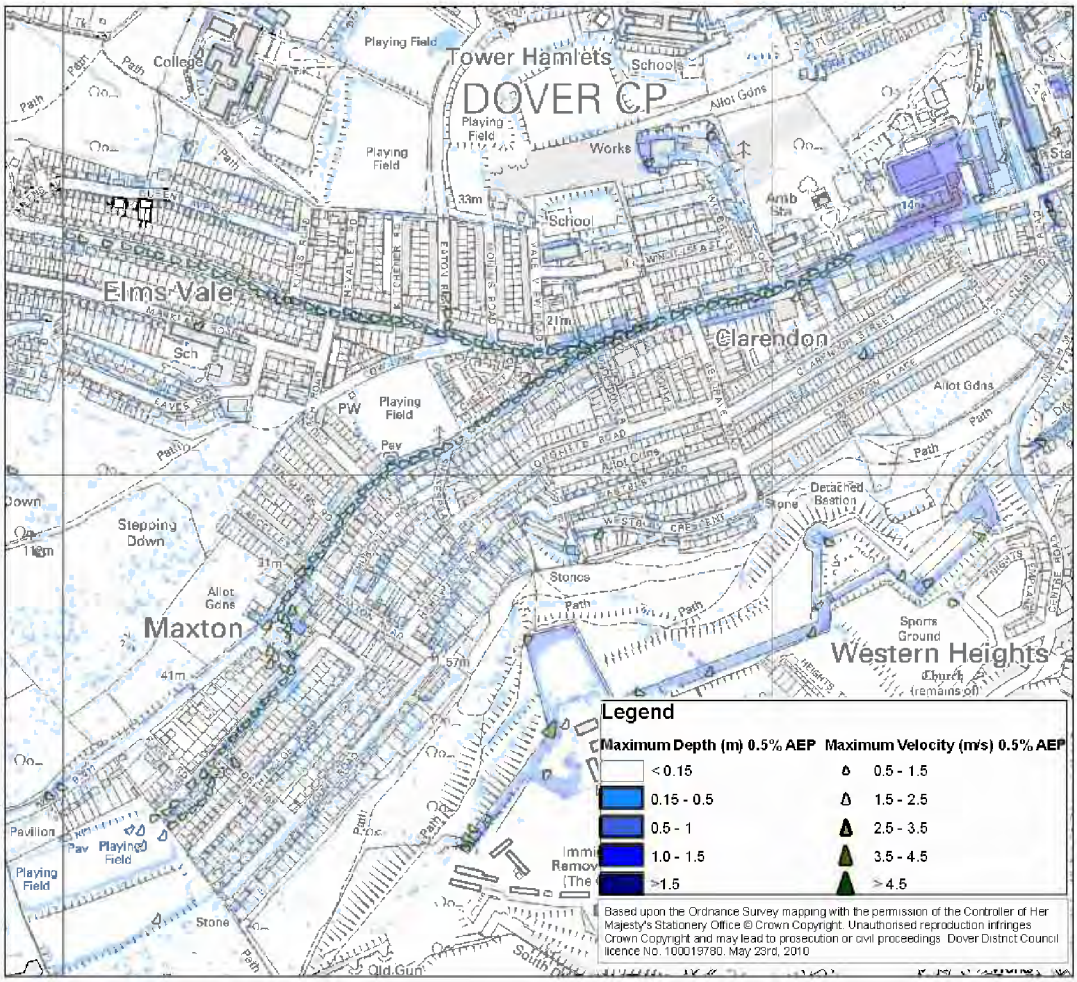


Figure A.2 Maximum depth and velocities in the 0.5% AEP rainfall event

Note: Malvern Road is shown erroneously on this OS Map as Birchwood Rise.

Appendix B Tower Hamlets Area

B.1 Description of Area

For the purposes of this study, the Tower Hamlets area comprises the area bordered by Harbour View Road to the north, Astor Avenue and Priory Hill to the south, Astor College for the Arts (on Noah's Ark Road) to the west and High Street to the east. The majority of Tower Hamlets is on relatively high ground which slopes away on its north, south and east sides into the Coombe Valley, Folkestone Road and Mid Town areas respectively. The area is predominantly residential although contains other infrastructure including a shallow cutting for the railway line, two schools with associated playing fields and some local retail premises.

Drainage in this area is predominantly via the Southern Water surface water sewer network, although a section of combined sewer starting around West Street also conveys surface water eastwards towards Mid Town. Southern Water's plans show that the surface water sewer discharges into the Dour at Bridge Street, and that the combined sewer joins the 1500mm combined sewer running south east from DeBurgh Street. The surface water sewer size increases to 675mm diameter as it passes down Tower Hamlets Road.

Basement properties in West Street ponding area

Looking down Tower Hamlets Road flow route towards West Street

Rise over railway line along Tower Hamlets Road

College playing fields at catchment watershed

Figure B.1 Photographs of key features in the Tower Hamlets area

B.2 Preliminary Risk Assessment

Based on desk-based assessment of available information and site inspection, the Tower Hamlets area was assigned a preliminary hazard rating of Severe. The following were key observations:

- The topography slopes steadily downwards from the west, north and south to a local low point at the junction of East Street, West Street, Tower Hamlets Street, Eldred Road and Ethelbert Road. Tower Hamlets Road then slopes up to pass over the railway. The only land lower than this low point is the railway which runs in a cutting.
- The railway forms a barrier to further eastwards flow at the surface from this area. Furthermore, since the line lies in a shallow cutting, it will make any culverting of surface flows under the railway extremely challenging.
- A number of properties have low thresholds, including retail premises along the High Street and many residential properties with steps down to basements.
- Flooding of basement properties in the East Street area is recorded in the summer of 2007, with previous flooding of roads, gardens and properties in 1992, 1995, 2003 and 2004. There is a credible report of flooding causing a car to float down the road in 2004. Flooding along the High Street has occurred in various years including 1994/5 and 2000/1 which could be as a result of high groundwater levels. The area has a history of flooding from the combined sewer network.
- The East Street area is a confluence of a number of flowpaths along roads and is identified from the Environment Agency Flood Map for Surface Water as an area where surface water flooding in the 3.33% (1:30 year) and more extensively in the 0.5% (1:200 year) could be deep (>0.3m).
- Flowpath contributions along the roads could reach high velocities, particularly along Tower Hamlets Street and between Templar Road and Tower Hamlets Road.

B.3 Development Plans and Opportunities

The Site Allocations process has identified two sites in the Tower Hamlets area for which development may be considered. However, neither of these parcels of land would provide significant opportunity for improved management of surface water to either the Tower Hamlets or Coombe Valley areas:

- Land at Noah's Ark Road (NS07DOV): Approximately 0.3ha of land which could be considered for residential housing
- Land to the north of Eldred Road (NS12DOV): Approximately 0.1ha of land which could be considered for residential housing

B.4 Environmental Designations and Other Possible Constraints

The following environmental designations are noted:

- The area of land to the north of Tower Hamlets is designated as High Meadow Local Nature Reserve
- Land to the west of Astor College for the Arts is designated as Lowland Calcareous Grassland.

The area to the west of the railway line is designated as Source Protection Zone 1 (inner) and 2 (outer). The Tower Hamlets Road area is also identified as a zone of where groundwater levels could be close to the surface in a winter hydrologically similar to 2000/1. Selection of appropriate SuDS in this area should therefore consider the need for pollution control and the possibility that high groundwater levels may impede infiltration.

B.5 Detailed Model Results

The detailed modelling predicts the pattern of surface water flooding as summarised in Table B.2 and shown for the 0.5% (1 in 200) AEP event in Figure B.2.

B.6 Surface Water Management in the Tower Hamlets Area

B.6.1 Key Concept for the Option

In addition to a series of generic options for improved surface water management included in the Action Plan, the following concept is particularly relevant to the Tower Hamlets area:

- Basement properties should be protected from water ponding on the roads. This may include raising of thresholds or kerbs. Due to the break line in natural drainage caused by the railway cutting, options to store or convey flood water away from the junction of East Street, West Street, Tower Hamlets Street, Eldred Road and Ethelbert Road are limited and likely to be expensive. Although limiting runoff within the catchment is important, opportunities in the dense residential area are also limited.

B.6.2 Location-specific Options not Included in the Action Plan

The options for improved management of flooding listed in Table B.2 have been considered during the appraisal process but are not included in the Action Plan:

Table B.1 Tower Hamlets options not included in the Action Plan

Option Considered	Reasons for Excluding from SWMP Action Plan
Detention basins in the playing fields for Astor College for the Arts (on Noah's Ark Road) and Dover Grammar School (on Astor Avenue)	• These grassed areas are at the watershed at the top of the catchment and will therefore receive minimal flow to attenuate.
Surface flow route connecting Tower Hamlets Street and Templar Street via a culvert under the railway line.	• The railway at this location is in a cutting. Routing a culvert under the railway will be technically difficult and expensive.
Increasing surface runoff into the combined sewer which runs in a 750mm pipe from West Street to Templar Street before joining a 1500mm pipe running south down De Burgh Street.	• Increasing flow in the combined sewer is not a sustainable option and could potentially lead to increased flooding downstream. • Increasing the number of entries to the combined sewer at the East Street junction in the detailed model suggests it will have a negligible impact on flood levels in the area.
New surface water drainage following the railway from adjacent to East Street to discharge near the Tidal Basin.	• There is minimal space adjacent to the railway tracks, especially through the tunnels and Priory Station, to site a drainage channel. • Network Rail has confirmed that a pipe under the railway track would need to be at least 2m below track level so as not to interfere with railway infrastructure and there would be no opportunity for inspection chambers. • Installing an underground pipe would be extremely expensive to construct given the need to close and remove the railway track for either surface digging or tunnelling methods.

Table B.2 Predicted pattern of flooding in the Tower Hamlets area

Rainfall Event (AEP)	Key Pattern of Flooding
50% (1 in 2)	Isolated ponding of direct rainfall, with basement properties adjacent to DeBurgh Street flooding first.
3.33% (1 in 30)	In addition to flow of up to 0.3m along Tower Hamlets Street and Ethelbert Road, ponding to depths of up to 0.5m at basement properties adjacent to East Street and of over 0.5m adjacent to DeBurgh Street is predicted. Flooding of over 1.0m is predicted for the area behind the Charlton Shopping Centre. The surface water sewer surcharges at various locations between East Street and Bridge Street.
1% (1 in 100)	Almost continual flow of over 0.2m is predicted along Wyndham Road, Tower Hamlets Street and Ethelbert Road, with ponding of over 0.5m at basement properties adjacent to East Street. Most properties between Tower Hamlets Road and Templar Street are predicted to flood.
0.5% (1 in 200)	The surface water flowpath between Wyndham Road and Bridge Street, through the East Street properties and those between Tower Hamlets Road and Templar Street is well established. Maximum flood depths approaching 1.5m are predicted for the area behind the Charlton Shopping Centre. Velocities of over 1.0m/s are predicted along the main flow route.

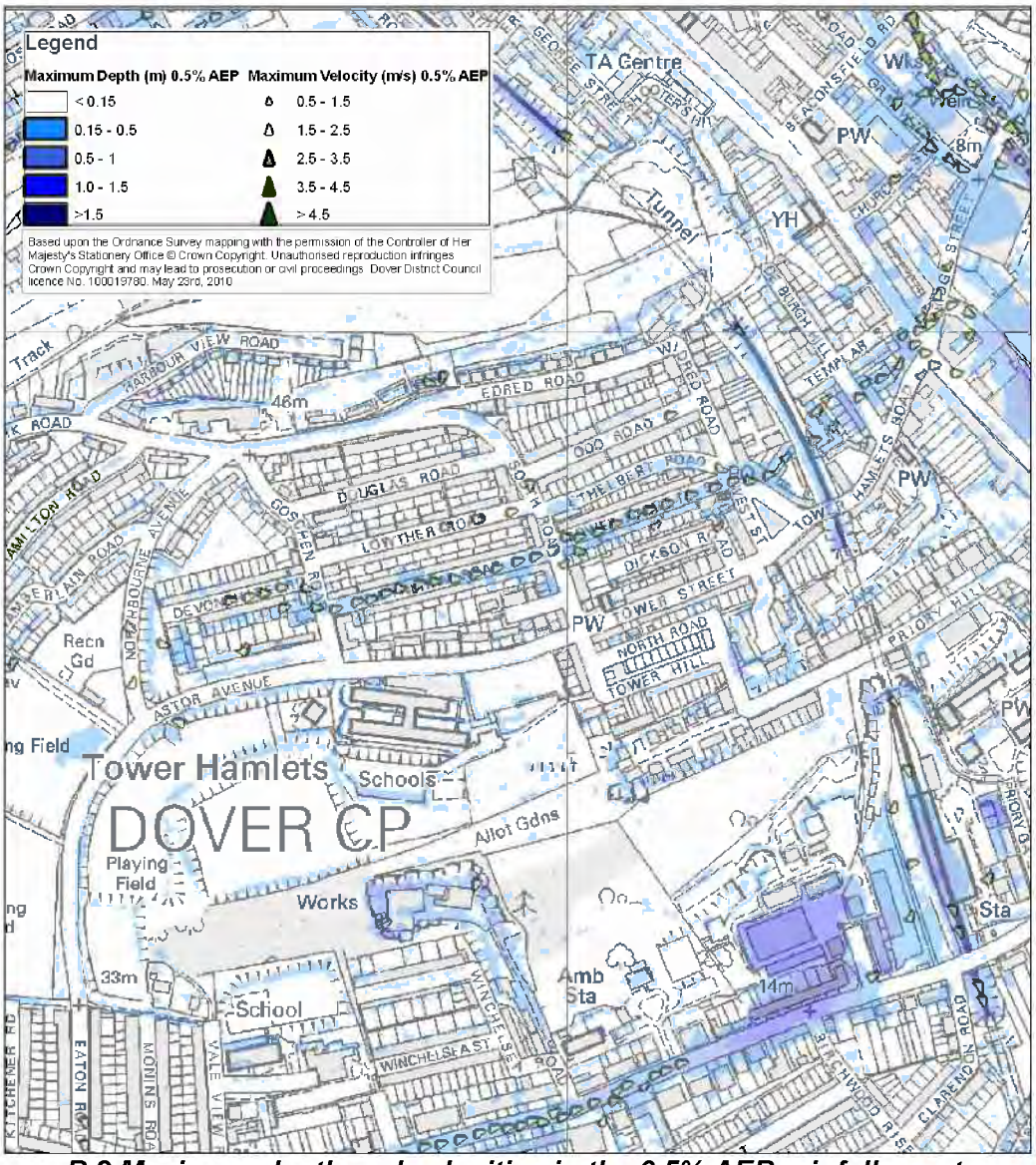


Figure B.2 Maximum depth and velocities in the 0.5% AEP rainfall event

B.6.3 Location-specific Option Included in the Action Plan

The option for improved management of flooding listed in Table B.3 is included in the SWMP Action Plan. The primary reasons for inclusion are given.

Table B.3 Tower Hamlets option included in the Action Plan

Option	Primary Reasons for Inclusion in the Action Plan
Improve property resistance and resilience measures for selected properties adjacent to Tower Hamlets Street, East Street and De Burgh Street.	• Ten basement properties on East Street could be funded for property level resistance/resilience works following a grant from Defra.

Appendix C Coombe Valley Road

C.1 Description of Area

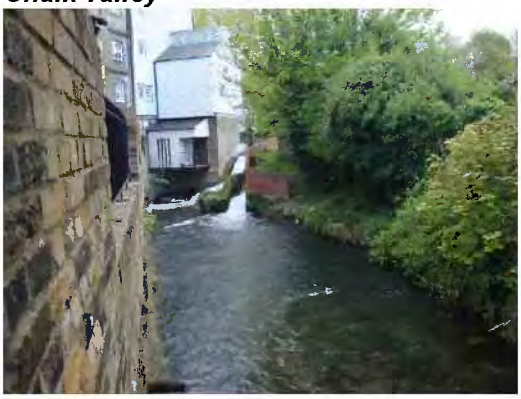
For the purposes of this study, the Coombe Valley Road area comprises the area bordered by St Radigunds Road to the north, high ground between Coombe Valley Road and Noah's Ark Road to the south, Coombe Valley Road Industrial Estate to the west and London Road to the east. The Eric Road area is also included. Coombe Valley Road runs approximately along the base of the valley from which the land slopes upwards to the north and south. Coombe Valley represents a significant dry valley which falls steadily downwards towards the London Road and the River Dour to the east. The area is a mix of residential and business use, with Buckland Hospital and industrial premises to the south and west and predominantly residential properties with a school and nursing/care homes to the north. The railway is elevated above the valley bottom as it runs northwest parallel to London Road.

Drainage in this area is via the Southern Water surface water sewer network in the predominantly residential areas, with a combined sewer running along Coombe Valley Road from the junction with Barwick Road. Southern Water's plans show the surface water sewer, which starts in Poulton Close and Barwick Road, increasing in diameter to 750mm as it approaches London Road before discharging into the Dour at Lorne Road and Cherry Tree Avenue. Both the combined sewer (450mm) along Coombe Valley Road and a branch serving Eric Road join the 600mm combined sewer running along London Road.

Low thresholds to basement properties at the bottom of Coombe Valley Road

Coombe Road climbing through the dry Chalk valley

Depression in Poulton Close before road continues to slope steadily downwards



Weir on the River Dour upstream of Lorne Road

Figure C.1 Photographs of some key features in the Coombe Valley area

C.2 Preliminary Risk Assessment

Based on desk-based assessment of available information and site inspection, the Coombe Valley area was assigned a preliminary hazard rating of Moderate at the western extent and Severe at London Road. The following were key observations:

- Flooding of properties towards the bottom of Coombe Valley Road, along London Road and Eric Road has been recorded over a number of years (e.g. 2003, 2004 and 2007) and temporary flood barriers were observed across entrances to some basement properties. The area around Eric Road and London Road has a history of flooding from the combined sewer network.
- A number of properties have low thresholds, including retail premises along London Road and residential properties with steps down to basements.
- Coombe Valley Road is a substantial flowpath from the dry valley to the west, and is identified from the Environment Agency Flood Map for Surface Water as an area where surface water flooding in the 3.33% (1:30 year) and more extensively in the 0.5% (1:200 year) could be deep (>0.3m).
- The topography slopes steadily downwards from the west to the River Dour which is on the far side of London Road. Any water at the surface must therefore cross London Road.
- In the Coombe Valley Industrial Estate there is a significant depression (approximately 2m deep) in the road which water at the surface must overtop before flowing down Poulton Close and Coombe Valley Road.
- Flow along Coombe Valley Road could reach moderately high velocities.

C.3 Development Plans and Opportunities

The Site Allocations process has identified sites in the Coombe Valley Road area for which development may be considered. Options for improved flood risk management (Section C.6) have been identified which could involve the following locations:

- Buckland Hospital site (SAD19A): Approximately 3.19ha of land which could be considered for residential housing
- Land enclosed by Coombe Valley Road, Edgar Road and Prospect Place (LDF031): Approximately 0.9ha of land which could be considered for residential housing
- Barwick Road (LDF036): Approximately 3.68ha of land which could be considered for mixed use development.

C.4 Environmental Designations and Other Possible Constraints

The following environmental designations are noted:

- Coombe Valley, including a portion of the Industrial Estate and land to the north of St Radigund's Road is designated as part of the Kent Downs Area of Outstanding Natural Beauty (AONB).
- A number of portions of land within the AONB as well as to the south of the Industrial Estate are identified as Lowland Calcareous Grassland.
- Land to the south of Coombe Valley is designated as two Local Nature Reserves: Whinless Down and High Meadow

Portions of the Coombe Valley area are designated as Source Protection Zones 1 (inner), 2 (outer) and 3 (total). The base of Coombe Valley Road is also identified as a zone of where groundwater levels could be close to the surface in a winter hydrologically similar to 2000/1. Selection of appropriate SuDS in this area should therefore consider the need for pollution control and the possibility that high groundwater levels may impede infiltration.

C.5 Detailed Model Results

The detailed modelling predicts the pattern of surface water flooding as summarised in Table C.1 and shown for the 0.5% (1 in 200) AEP event in Figure C.2.

Table C.1 Predicted pattern of flooding in the Coombe Valley Road area

Rainfall Event (AEP)	Key Pattern of Flooding
50% (1 in 2)	Ponding of direct rainfall of up to approximately 0.5m is predicted for the properties on Beaufoy Road near the junction with Coombe Valley Road, as well as isolated properties between Primrose Road and Coombe Valley Road and between Oswald Road and London Road.
3.33% (1 in 30)	Ponding of over 1m at the depression on Poulton Close and at the railway underpass on Coombe Valley Road, and up to around 0.3m on London Road adjacent to Eric Road. Ponding to around 0.5m at properties on Edgar Road, the junction of Coombe Valley Road and MacDonald Road and at the bottom of Coombe Valley Road.
1% (1 in 100)	Almost continual flow of over 0.3m is predicted along Coombe Valley Road between the junction with Primrose Road and the railway underpass, as well as deeper ponding on London Road adjacent the junction with Eric Road, the depression on Poulton Close and at properties identified above.
0.5% (1 in 200)	The surface water flowpath down Coombe Valley Road from the junction with Beaufoy Road is well established and almost continual ponding is predicted on London Road between the junctions with Coombe Valley Road and Bunker's Hill. Flood depths of over 1m are predicted at key groups of properties. Velocities of over 1.0m/s are predicted along Coombe Valley Road.

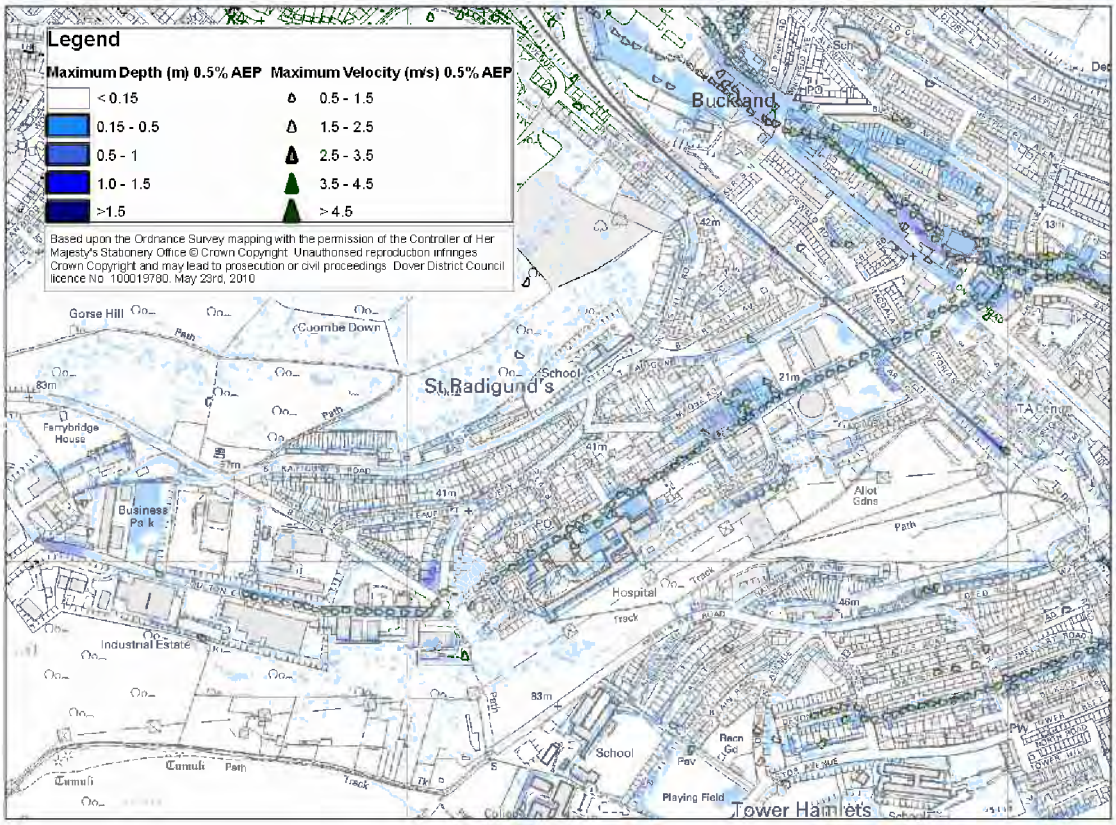


Figure C.2 Maximum depth and velocities in the 0.5% AEP rainfall event

C.6 Surface Water Management in the Coombe Valley Road Area

C.6.1 Key Concepts for the Options

In addition to a series of generic options for improved surface water management included in the Action Plan, the following concepts are particularly relevant to the Coombe Valley Road area:

- Basement properties should be protected from water ponding on the roads. This may include raising of thresholds or kerbs.
- Surface water which has exceeded the capacity of the drainage network along Coombe Valley Road must cross the key traffic route of London Road to enter the River Dour. Therefore, attenuating surface flow along Coombe Valley Road, including limiting runoff from the Coombe Valley fringe is of primary importance.
- Redevelopment of the Industrial Estate should recognise the potentially useful role of the depression in Poulton Close to limit any surface flow from Coombe Valley. Connections to the surface water sewer from the industrial estate should be limited and alternative access via Barwick Road could be considered to maintain access if Poulton Close becomes impassable.

C.6.2 Location-specific Options not Included in the Action Plan

The options for improved management of flooding listed in Table C.2 have been considered during the appraisal process but are not included in the Action Plan:

Table C.2 Coombe Valley Road options not included in the Action Plan

Option Considered	Reasons for Excluding from SWMP Action Plan
Fringe interception immediately upstream of the Coombe Valley industrial estate or at the location of Square Wood	• See the reasoning for exclusion of detention basins in the dry valleys upstream of Folkestone Road in Table A.1. • In addition, the natural depression in Poulton Close will act to limit onwards surface flow.
Swales adjacent to Coombe Valley Road	• There is limited space for construction of swales adjacent to Coombe Valley Road
Improve property resistance and resilience measures for properties adjacent to Eric Road.	• The flooding is primarily a result of insufficient sewer capacity which is being addressed by Southern Water. The surface water flow down Eric Road is not predicted to be substantial.

C.6.3 Location-specific Option Included in the Action Plan

The option for improved management of flooding listed in Table C.3 is included in the SWMP Action Plan. The primary reasons for inclusion are given.

Table C.3 Coombe Valley Road option included in the Action Plan

Option	Primary Reasons for Inclusion in the Action Plan
Route exceedance flows along Coombe Valley Road and Lorne Road and into the River Dour, with an off-line detention basin or pond at the Buckland Hospital site as part of site redevelopment. Improve property resistance/ resilience along route as required.	• Flooding at various properties along Coombe Valley Road has been recorded and basement properties are particularly susceptible to flow from the road. • DDC could use experience which will arise from property level resistance/resilience works proposed for other areas to encourage uptake of measures. • The hospital site is proposed for redevelopment. However, land enclosed by Coombe Valley Road, Edgar Road and Prospect Place is also proposed for redevelopment and could provide an alternative to attenuation in the hospital site.

Appendix D River and Crabble

D.1 Description of Area

For the purposes of this study, the areas of Crabble and River are considered together and comprise the area bordered by Kearsney Abbey lakes to the north, the River Dour to the north and east, the Crabble Athletic Ground to the south and the urban fringe to the west. The land falls downwards, often steeply, towards the River Dour in the north east. The area is predominantly residential, although it includes River Primary School, Crabble Recreation Ground and Crabble Athletic and Football Grounds. The railway line crosses the Dour valley on a high embankment as it runs northwest parallel to London Road.

Drainage in this area is predominantly via the Southern Water surface water sewer network in the residential areas, with a combined sewer running along Lower Road and Crabble Avenue before crossing the Buckland Mill site to continue down London Road. Southern Water plans indicate that the surface water sewers discharge into the Dour at various locations, with diameters up to 300mm.

Low thresholds to basement properties along Crabble Avenue

Properties in dry valley between Cowper Road and Common Lane

River Dour between Minnis Lane and Kearsney lakes

River Dour upstream of Crabble Mill weir

Figure D.1 Photographs of some key features in River and Crabble

D.2 Preliminary Risk Assessment

Based on desk-based assessment of available information and site inspection, the River and Crabble areas were assigned a preliminary hazard rating of High. The following were key observations:

- A few properties were observed to have low thresholds, including basement properties along Crabble Avenue and Hillside Road. Crabble Avenue rises towards the junction with Hillside Road such that a local depression is formed. Surface water flowing along Crabble Avenue will not be able to pass under the railway arch to Buckland Mill unless it ponds to sufficient depth (~0.5m) on Crabble Avenue.
- Flooding from the combined sewer along Lower Road has been recorded, as well as flooding to basement properties on Crabble Avenue at various times (e.g. 2001, 2003 and 2004).
- Flow down the steep valley sides (particularly Minnis Lane) could reach high velocities.
- Minnis Lane and the valley between Cowper Road and Common Lane are potentially substantial flowpaths from dry valleys to the west, and are identified from the Environment Agency Flood Map for Surface Water as an area where surface water flooding in the 0.5% (1:200 year) could be deep (>0.3m).
- The combined sewer reduces from 900mm to 450mm between Crabble Lane and Crabble Avenue.
- The River Dour passes from Kearsney Abbey land under Minnis Lane through a small culvert which could be liable to block.

D.3 Development Plans and Opportunities

The Site Allocations process has identified three sites in Crabble for which development may be considered. However, none of these parcels of land provides significant opportunity for improved management of surface water since they are elevated above major flow routes:

- Crabble Athletic Ground (SHL098): Approximately 4.13ha of land which could be considered for residential housing
- Crabble Athletic Football Ground (SAD18): Approximately 2.77ha of land which could be considered for residential housing
- Land at Crabble Lane (NS05DOV): Approximately 5.15ha of land which could be considered for residential housing

D.4 Environmental Designations and Other Possible Constraints

The following environmental designations are noted:

- The majority of land to the west of River and Crabble is designated as part of the Kent Downs Area of Outstanding Natural Beauty (AONB).
- Land to the south of Crabble Athletic Ground is identified as Lowland Calcareous Grassland.
- River Bottom Wood and Frandham Wood are designated as Ancient Woodlands, with Alkham, Lydden & Swingfield Woods additionally designated as a Site of Special Scientific Interest.

The majority of the area is designated as Source Protection Zone 1 (inner) or 2 (outer). An area adjacent to the River Dour is also identified as a zone where groundwater levels could be close to the surface in a winter hydrologically similar to 2000/1. Selection of appropriate SuDS in this area should therefore consider the need for pollution control and the possibility that high groundwater levels may impede infiltration.

D.5 Detailed Model Results

The detailed modelling predicts the pattern of surface water flooding as summarised in Table D.1 and shown for the 0.5% (1 in 200) AEP event in Figure D.2.

Table D.1 Predicted pattern of flooding in River and Crabble

Rainfall Event (AEP)	Key Pattern of Flooding
50% (1 in 2)	Ponding of direct rainfall is predicted for a small group of properties in the valley between Cowper Road and Common Lane.
3.33% (1 in 30)	Ponding at a small group of basement properties adjacent to Crabble Avenue. A flowpath down Cowper Road is established. The River Dour overtops Minnis Lane near the junction with Lower Road.
1% (1 in 100)	Ponding of around 0.3m in basement properties along Crabble Avenue. Flood depths approaching 0.5m for isolated properties adjacent to Cowper Road. Fluvial fooding of a small group of properties adjacent to the River Dour on the corner of Lower Road and Crabble Road.
0.5% (1 in 200)	Flooding in Crabble Avenue of up to 0.5m as well as flooding of up to 0.3m in adjacent basement properties. Flooding of properties at the bottom of Minnis Lane and between Cowper Road and Common Lane. Velocities of over 0.5m/s are predicted down Minnis Lane, adjacent to Cowper Road and adjacent to Crabble Lane.

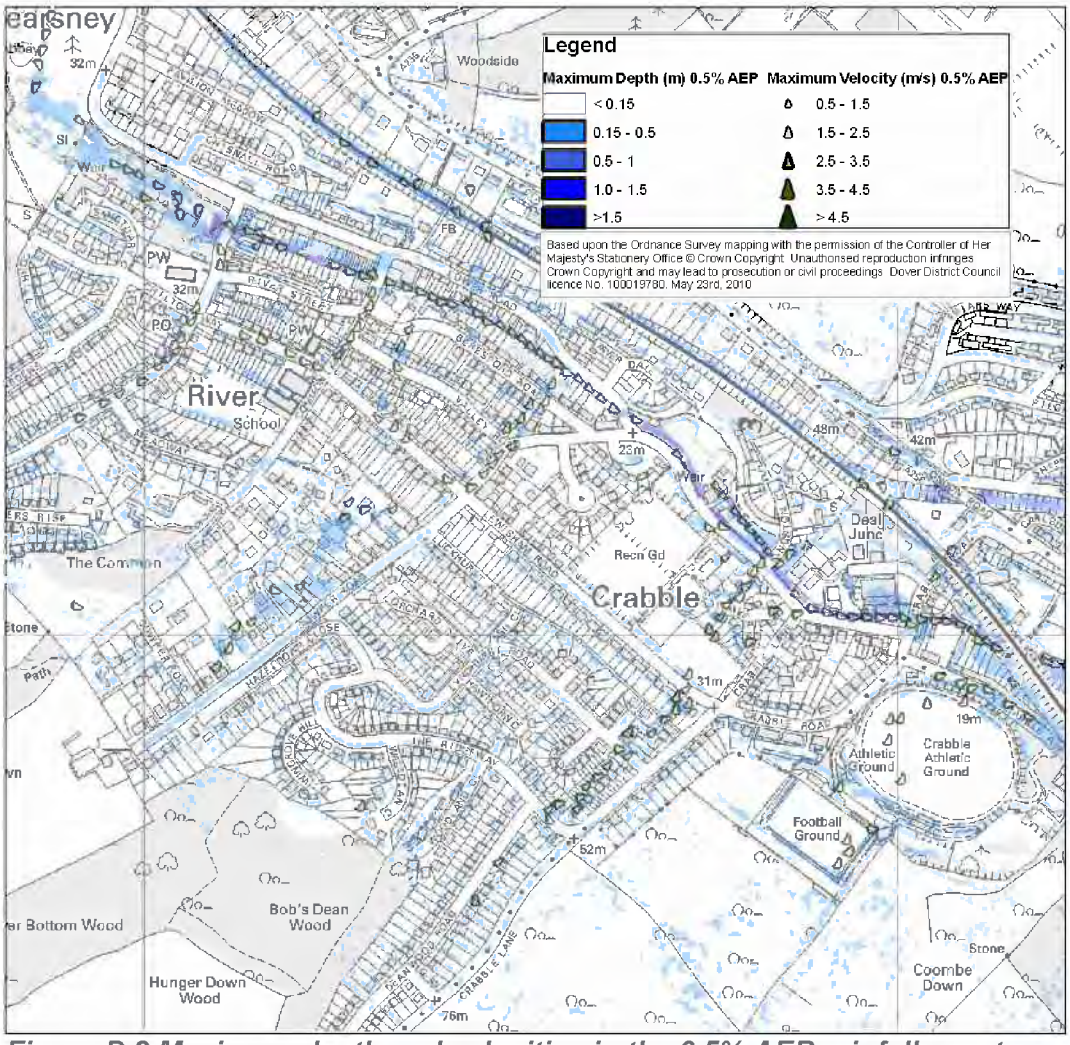


Figure D.2 Maximum depth and velocities in the 0.5% AEP rainfall event

D.6 Surface Water Management in River and Crabble

D.6.1 Key Concepts for the Options

In addition to a series of generic options for improved surface water management included in the Action Plan, the following concepts are particularly relevant to River and Crabble:

- Basement properties should be protected from water ponding on the roads, as well as from high groundwater levels. This may include raising of thresholds or kerbs, as well as tanking of basements and fitting of other resistance/resilience measures.
- Although limiting runoff from the dry valleys to the west of these areas is of primary importance, surface water which has exceeded the capacity of the drainage network along Minnis Lane, Cowper Road or Crabble Lane must be routed towards the River Dour as safely as possible.

D.6.2 Location-specific Options not Included in the Action Plan

The options for improved management of flooding listed in Table D.2 have been considered during the appraisal process but are not included in the Action Plan:

Table D.2 River and Crabble options not included in the Action Plan

Option Considered	Reasons for Excluding from SWMP Action Plan
Fringe interception in the dry valleys discharging at Minnis Lane and Cowper Road.	• See the reasoning for exclusion of detention basins in the dry valleys upstream of Folkestone Road in Table A.1. • Flow along Minnis Lane is not likely to be significant. • A detention basin at the top of the valley between Cowper Road and Common Lane does not appear feasible since any outflow would continue to be through the properties at risk.
Detention basin in the grounds of River Primary School	• There is no natural flow route between Minnis Lane and the grounds of River Primary School and additional drainage infrastructure is likely to be expensive. • Flow down Minnis Lane predicted by the modelling is not likely to be significant.
Route exceedance flows down Crabble Lane and into a detention basin in Crabble Recreation Ground. Consider sewer interruption into detention basin.	• Flow down Crabble Lane predicted by the modelling is not likely to be significant. • There is a substantial rise in the topography between the low point on the The Ridgeway at the junction with Deanwood Road and Crabble Lane which makes rerouting surface flow down Crabble Lane impractical. • There is no history of flooding from the surface water sewer in this area to justify a sewer interruption scheme.

D.6.3 Location-specific Option Included in the Action Plan

The option for improved management of flooding listed in Table D.3 is included in the SWMP Action Plan. The primary reasons for inclusion are given.

Table D.3 River and Crabble options included in the Action Plan

Option	Primary Reasons for Inclusion in the Action Plan
Improve property resistance/resilience measures for selected properties in the valley between Cowper Road and Common Lane	• Although there are no records of flooding at this location, modelling indicates that some properties may be at risk.
Improve property resistance and resilience measures for selected properties adjacent to Crabble Avenue.	• There is a history of basement flooding at certain properties along Crabble Avenue which could be used as evidence to support a funding application to the EA/Defra. Experience from proposed works on Folkestone Road, East Street and Maison Dieu Road could be usefully applied.
Route exceedance flows down Minnis Lane and into the River Dour on the upstream side of Minnis Lane. Improve property resistance/resilience along route as required.	• KHS may be planning works along Minnis Lane. Consider reprofiling of Minnis Lane to direct exceedance flow into the River Dour.

Appendix E Temple Ewell and Kearsney

E.1 Description of Area

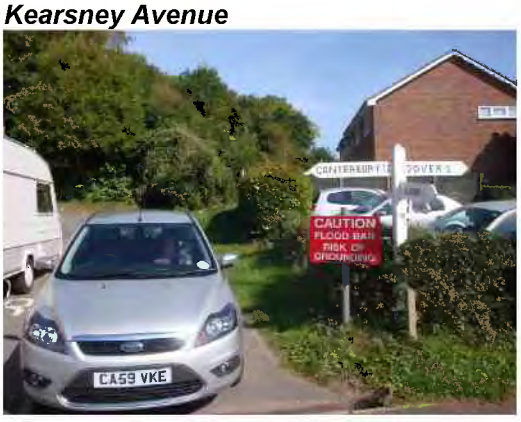
For the purposes of this study, the areas of Temple Ewell and Kearsney are considered together and comprise the area bounded by the A2 to the north, Kearsney lakes and the River Dour to the south, Great Watersend Farm to the west and the A256 (Whitfield Hill) to the east. The land falls downwards to the south west towards the River Dour. The area is a mix of rural Chalk landscape, parkland and residential development, with a number of nursing and care homes, a local hospital and a railway station. The railway line is elevated above the valley bottom in the vicinity of Kearsney Station by an embankment as it runs north west parallel to London Road.

Drainage in this area is via the Southern Water surface water and combined sewer networks. The combined sewer commences in Temple Ewell as a 300mm diameter pipe and runs along Lower Road, increasing in size to 600mm. The surface water sewers appear to discharge into the Dour at various locations, with diameters up to 300mm.

Alkham valley below Alkham

Playing fields in Whitfield Valley above Kearsney Avenue

Abbey Lake in the grounds of Kearsney Abbey



Flood bar at the junction of Temple Side and London Road in Temple Ewell

Figure E.1 Photographs of some key features in Temple Ewell and Kearsney

E.2 Preliminary Risk Assessment

Based on desk-based assessment of available information and site inspection, the Temple Ewell and Kearsney areas were assigned preliminary hazard ratings of High and Low, respectively. The following were key observations:

- Although no basement properties were observed, a few properties were observed to have low thresholds, particularly those on High Street in Temple Ewell.
- Runoff from the surrounding Chalk hills could contribute to surface water flooding. Indeed, some flooding has been reported, specifically from flow along Kearsney Avenue which crosses London Road and passes down Alkham Road.
- Temple Side/High Street and Kearsney Avenue/Alkham Road are potentially substantial flowpaths and are identified from the Environment Agency Flood Map for Surface Water as an area where surface water flooding in the 0.5% (1:200 year) could be deep (>0.3m).
- Flow down the steep valley sides (particularly Temple Side) could reach high velocities.

E.3 Development Plans and Opportunities

The Site Allocations process has identified two sites in the Temple Ewell and Kearsney areas where development may be considered. Although neither of these areas presents opportunities for improved management of existing surface water flooding issues, it is important that runoff from any development is kept to a minimum.

- Land south of A2 and Herald Wood, Whitfield (SHL077): Approximately 20.33ha of land which could be considered for residential housing.
- Manor Farmyard, Egerton Road, Temple Ewell (SHL045): Approximately 0.74ha of land which could be considered for residential housing.

E.4 Environmental Designations and Other Possible Constraints

The following environmental designations are noted:

- The majority of open land to the west of Kearsney is designated as part of the Kent Downs Area of Outstanding Natural Beauty (AONB).
- Land to the north of Temple Ewell is designated as Lydden Temple Ewell national nature reserve, which includes the Lydden and Temple Ewell Downs Special Area of Conservation and Site of Special Scientific Interest and areas of Lowland Calcareous Grassland

The majority of the area is designated as Source Protection Zone 1 (inner), 2 (outer) or 3 (total). An area adjacent to the River Dour is also identified as a zone where groundwater levels could be close to the surface in a winter hydrologically similar to 2000/1. Selection of appropriate SuDS in this area should therefore consider the need for pollution control and the possibility that high groundwater levels may impede infiltration.

E.5 Detailed Model Results

Only the south eastern portion of the area is covered by the detailed model which predicts the pattern of surface water flooding as summarised in Table E.1 and shown for the 0.5% (1 in 200) AEP event in Figure E.2.

Table E.1 Predicted pattern of flooding in the modelled portion of Temple Ewell and Kearsney

Rainfall Event (AEP)	Key Pattern of Flooding
50% (1 in 2)	Ponding of direct rainfall is predicted on Alkham Road as it passes under the railway, as well as along the approach road to the station and the bowling green.
3.33% (1 in 30)	Deeper flooding at these same locations
1% (1 in 100)	Deeper flooding at these same locations
0.5% (1 in 200)	Deeper flooding at these same locations with ponding of over 1.0m predicted on Alkham Road under the railway underpass and approaching 0.5m on the approach to the station. Velocities of over 0.5m/s are predicted from Kearsney Avenue across London Road and along Alkham Road between the railway underpass and Lower Road.

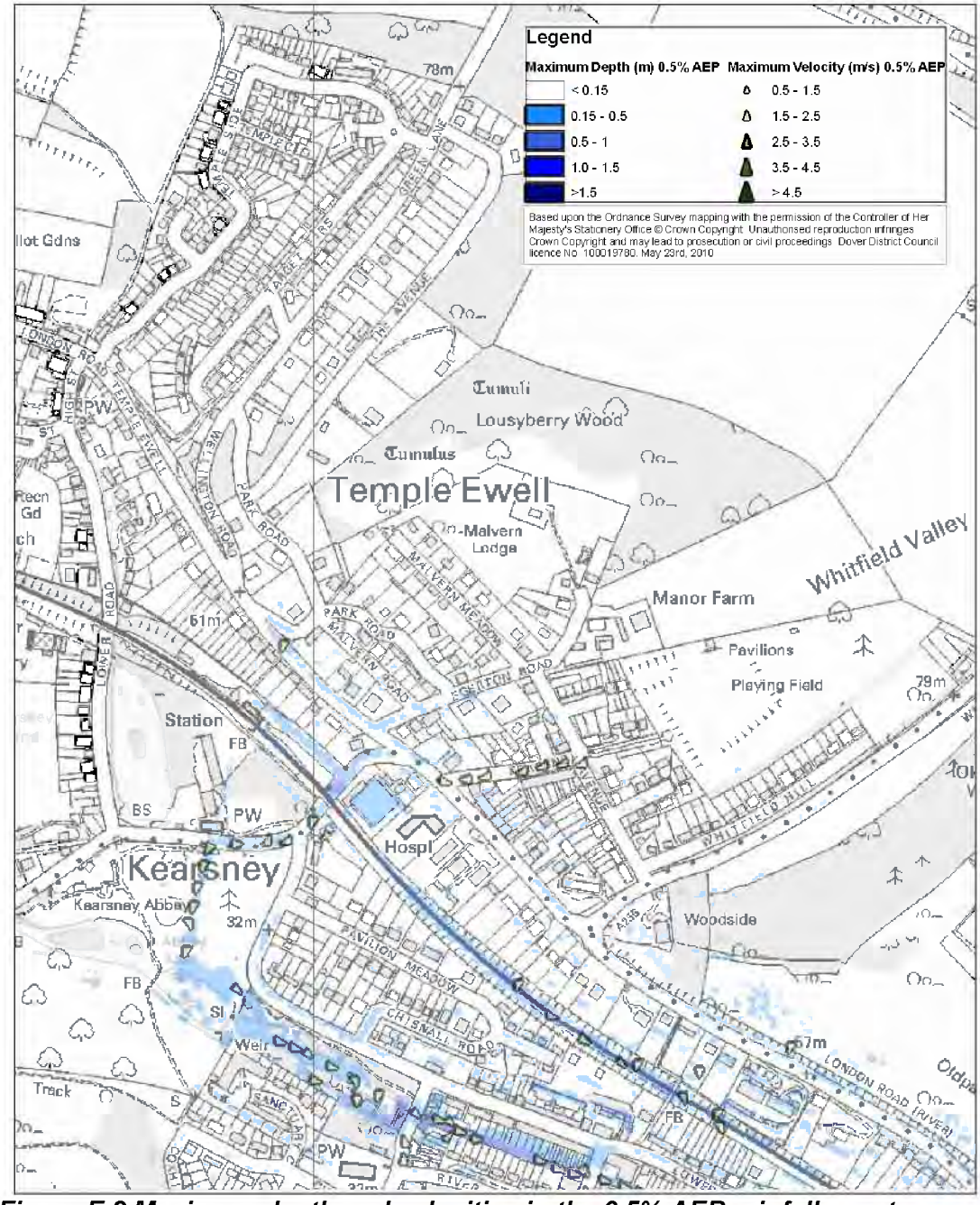


Figure E.2 Maximum depth and velocities in the 0.5% AEP rainfall event

E.6 Surface Water Management in Temple Ewell and Kearsney

E.6.1 Key Concepts for the Options

In addition to a series of generic options for improved surface water management included in the Action Plan, the following concept is particularly relevant to Temple Ewell and Kearsney:

- Runoff from the chalk hills and from any future development should be minimised.

E.6.2 Location-specific Options not Included in the Action Plan

The options for improved management of flooding listed in Table E.2 have been considered during the appraisal process but are not included in the Action Plan:

Table E.2 Temple Ewell and Kearsney options not included in the Action Plan

Option Considered	Reasons for Excluding from SWMP Action Plan
Fringe interception in the dry Alkham valley discharging at the lakes in Keasney.	• See the reasoning for exclusion of detention basins in the dry valleys upstream of Folkestone Road in Table A.1. • Control of the levels in Kearsney lakes is likely to be a more feasible alternative, although will provide significantly less storage.

E.6.3 Location-specific Option Included in the Action Plan

The options for improved management of flooding listed in Table E.3 are included in the SWMP Action Plan. The primary reasons for inclusion are given.

Table E.3 Temple Ewell and Kearsney options included in the Action Plan

Option	Primary Reasons for Inclusion in the Action Plan
Check footpath/flood barrier will protect Temple Side properties. Improve property resistance/ resilience for low threshold properties along High Street.	• Although there are no records of flooding at this location, national mapping and flow path modelling indicates that some properties may be at risk.
Kerb raising along London Road between junction with Kearsney Avenue and Alkham Road to protect properties adjacent to the hospital.	• Although a substantial attenuation option such as a detention basin above Kearsney Avenue and routing of exceedance flows to Alkham Road does not appear to be justified, there is some evidence of flooding along this route and protection of the properties adjacent to the hospital could be a quick win.
Increase storage of flows in the River Dour in the existing ponds at Kearsney.	• Levels in the lakes at Kearsney can be controlled by DDC and have been done so to limit high flows in the past.

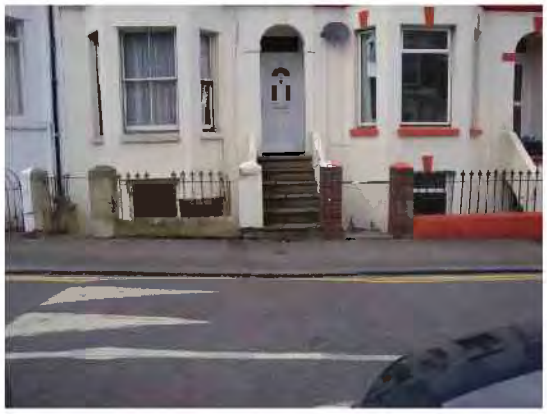
Appendix F Buckland

F.1 Description of Area

For the purposes of this study, the areas of Buckland and Buckland Valley are considered together and comprise the area from the north end of the Buckland Valley residential development to the River Dour to the south. , The open space of Old Park Hill forms the boundary to the north west and Beaconsfield Avenue and Stanhope Road to the east. The land falls generally to the south towards the River Dour. The area is predominantly residential although contains some industrial premises, nursing homes, schools with associated playing fields, allotments, and some local retail premises.

Drainage in this area is predominantly via the Southern Water surface water sewer network, although a combined sewer runs along London Road, having come across Buckland Mill estate from Crabble. The combined sewer increases from 450mm diameter pipe to 900mm along London Road adjacent to Buckland Avenue. An additional and parallel 300mm combined sewer runs under London Road from this point. The surface water sewer appears to discharge into the Dour at various locations, with diameters up to 750mm at the junction of London Road and Buckland Avenue.

Steep slopes could lead to high flow velocities along roads



Basement properties with low thresholds

Flooding of major traffic intersections and properties has occurred

Open spaces could be used for attenuation of runoff

Figure F.1 Photographs of some key features in the Buckland area

F.2 Preliminary Risk Assessment

Based on desk-based assessment of available information and site inspection, the Buckland and Buckland Valley areas were assigned a preliminary hazard rating of Severe. The following were key observations:

- A number of properties have low thresholds, including a number with steps down to basement properties.
- Surface flow from Buckland Valley is constrained by topography and the railway embankment to pass through the underpass at the top of Glenfield Road. Flowpath contributions from the steep sided valleys of Buckland Avenue (e.g. Glenfield Road) could reach high velocities which pose a risk to life (e.g. NHS establishment off Brookfield Avenue at the bottom of Glenfield Road)
- Flooding of properties (e.g. low threshold properties along London Road) and roads (e.g. junction of London Road and Buckland Avenue) is recorded as having occurred throughout the area, including a number of sewer flooding incidents from the surface water and combined networks around Brookfield Place.
- The junction of London Road and Buckland Avenue is a confluence of two major flowpath systems (the River Dour and overland flow down Buckland Valley) and is identified from the EA FMfSW as an area where surface water flooding in the 3.33% (1:30 year) and more extensively in the 0.5% (1:200 year) could be deep (>0.3m).

F.3 Development Plans and Opportunities

The Site Allocations process has identified sites in the Buckland area for which development may be considered. Although none of these areas presents opportunities for improved management of existing surface water flooding issues, it is important that runoff from any development is kept to a minimum.

- Land at Old Park Hill (SHL070): Approximately 3.1ha of land which could be considered for residential housing
- Land at Wycherley Crescent and Milton Road (NS08DOV): Approximately 0.56ha of land which could be considered for residential housing
- Land to the north of Melbourne Avenue (SAD15): Approximately 0.5ha of land which could be considered for residential housing
- Land adjacent to Former Melbourne County Primary School (SHL062): Approximately 0.35ha of land which could be considered for residential housing

Note that consideration was given in the early stages of this study to use of the Buckland Paper Mill site (LDF030) for surface water attenuation. However, planning permission has been granted for a Mixed Use development for which plans are advanced.

F.4 Environmental Designations and Other Possible Constraints

No environmental designations have been identified in this area.

The majority of the Buckland Valley area is designated as Source Protection Zone (SPZ) 2 (outer), with land towards Connaught Barracks being in zone 1 (inner). Although Buckland adjacent to the River Dour is not in an SPZ, it is identified as a zone where groundwater levels could be close to the surface in a winter hydrologically similar to 2000/1. Selection of appropriate SuDS in these areas should therefore consider the need for pollution control in SPZs and the possibility that high groundwater levels may impede infiltration near the Dour.

F.5 Detailed Model Results

The detailed modelling predicts the pattern of surface water flooding as summarised in Table F.1 and shown for the 0.5% (1 in 200) AEP event in Figure F.2.

F.6 Surface Water Management in the Buckland Area

F.6.1 Key Concepts for the Option

In addition to a series of generic options for improved surface water management included in the Action Plan, the following concepts are particularly relevant to the Buckland area:

- Basement properties and those with low thresholds should be protected from water ponding on the roads. This may include raising of thresholds or kerbs.
- Development of fringe areas should limit potential runoff into the Buckland area.

F.6.2 Location-specific Options not Included in the Action Plan

The options for improved management of flooding listed in Table F.2 have been considered during the appraisal process but are not included in the Action Plan:

Table F.2 Buckland options not included in the Action Plan

Option Considered	Reasons for Excluding from SWMP Action Plan
Detention basin upstream of Green Park Primary School.	• A detention basin in the adjacent sports ground is more feasible.
Attenuation of surface water from Buckland Valley and of high flows in the Dour in a detention basin, ponds or a wetland sited in the disused Buckland Paper Mill site.	• Plans to develop the Buckland Mill industrial site have been approved and are already advanced. • Use of the Buckland Mill site for improving flood management in the wider area is unlikely to be a feasible constraint to impose on developers.
A detention basin in the allotment gardens between Green Lane and Glenfield Road.	• The allotment gardens slope steeply from Green Lane to Glenfield Road. Attenuating the majority of the runoff, which is likely to be down Glenfield Road, would require major excavation.

F.6.3 Location-specific Option Included in the Action Plan

The option for improved management of flooding listed in Table F.3 is included in the SWMP Action Plan. The primary reasons for inclusion are given.

Table F.3 Buckland option included in the Action Plan

Option	Primary Reasons for Inclusion in the Action Plan
Attenuate upstream flows in a detention basin in Buckland Valley Sports Ground. Route exceedance flows along Sheridan Road and across Roosevelt Road into a detention basin upstream of Winant Way. Route exceedance flows along Glenfield Road, Brookfield Avenue and Old Park Road. Raise pedestrian crossing at junction of Crabble Hill and Buckland Avenue to direct flow into the River Dour. Improve property resistance/ resilience along route as required.	• There is a history of flooding in the area, including at the junction of Buckland Avenue and Crabble Hill • Flows down the steep sided Buckland Valley may reach high velocities which could pose a risk to life • Sports ground and land amongst properties adjacent to Winant Way may be DDC land.

Table F.1 Pattern of flooding in Buckland as predicted by the detailed model

Rainfall Event (AEP)	Key Pattern of Flooding
50% (1 in 2)	Isolated ponding of direct rainfall
3.33% (1 in 30)	A flowpath down Glenfield Road is established and there is ponding of approximately 0.3m predicted at the junction of Buckland Avenue and Crabble Hill which extends into Brookfield Place, as well as the Buckland Paper Mill site.
1% (1 in 100)	Almost continuous flow is predicted between Roosevelt Road and the junction of Buckland Avenue/Crabble Hill. Flooding of some properties along Buckland Avenue and Lorne Road is predicted, with ponding along Alfred Road. Maximum depths are generally greater than 0.3m.
0.5% (1 in 200)	Deeper flooding of roads and properties is predicted along the flowpath between Roosevelt Road and the junction of Buckland Avenue/Crabble Hill, as well as between Brookfield Place/Buckland Avenue and Cherry Tree Avenue. Maximum depths generally approach 0.5m. Maximum velocities along the major flow routes are generally greater than 1.0m/s.

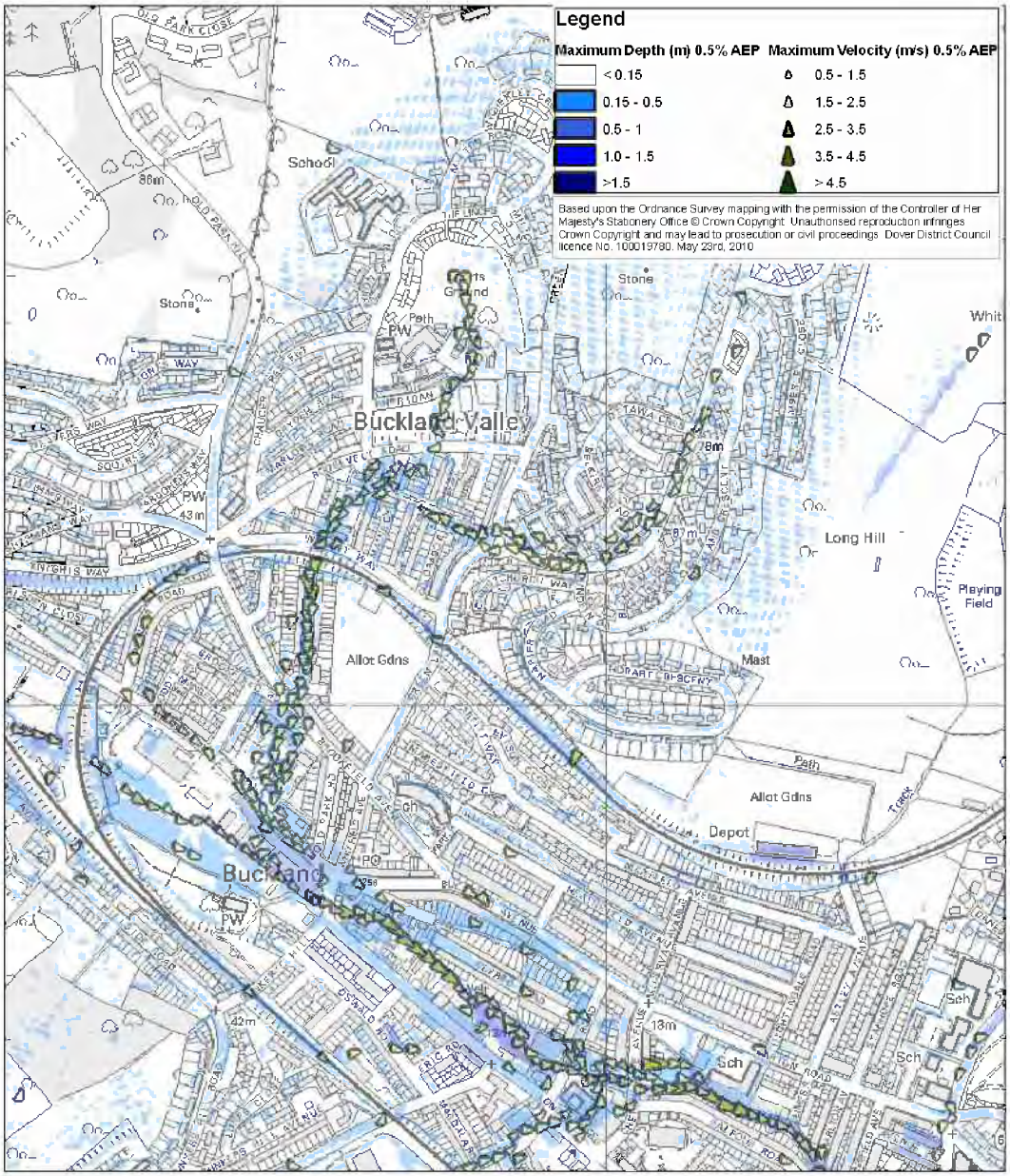


Figure F.2 Maximum depth and velocities of flooding in the 0.5% (1 in 200) AEP rainfall event

Appendix G Mid Town

G.1 Description of Area

For the purposes of this study, the Mid Town area of Dover comprises the area bounded by Beaconsfield Road and the railway to the west, Connaught Park and Barracks to the north and the sea to the south and east. The land falls to the south and to the east towards the River Dour and the sea. The area is mixed use with predominantly residential developments on the often steep sided hills to the north and commercial development along the River Dour corridor. The area contains key infrastructure (including emergency services), the main retail centre of Dover, some industrial premises, nursing homes, schools with associated playing fields and parkland.

Drainage is via the Southern Water surface water and combined sewer networks. Combined sewers of diameters up to 1500mm run down Maison Dieu Road, High Street and Effingham Street before converging at the junction of York Street and Townwall Street. From Bulwark Street, the combined sewer operates via a pump to transfer the contents to Broomfield Bank Waste Water Treatment Works. Surface water networks discharge into the River Dour at various points from pipes ranging in size up to 450mm diameter. The River Dour discharges into the sea via Wellington Dock where minimum water levels are maintained. Levels in the Dock and up the River Dour vary freely with rising tides.

Low property thresholds and basement properties

Maison Dieu road car park and other low lying areas are at risk of flooding

Weir and culverts constrict the River Dour

Dour outfalls into Wellington Dock which does not exclude high tides

Figure G.1 Photographs of some key features in the Mid Town area

G.2 Preliminary Risk Assessment

Based on desk-based assessment of available information and site inspection, the Mid Town area was assigned hazard ratings of High in the north, Severe in central Mid Town and Moderate towards the coast. The following were key observations:

- Flowpath contributions from the steep sided valleys from Connaught Barracks (e.g. Old Charlton Road, Castle Hill Road) and Tower Hamlets (e.g. Tower Hamlets Road) could reach high velocities
- A large number of properties have low thresholds, including many with steps down to basement properties and many retail premises.
- Flooding of properties (e.g. basement properties along Maison Dieu Road and the High Street) and roads (e.g. Maison Dieu Road) is recorded as having occurred throughout the area over many years, including a number of sewer flooding incidents from the combined sewer network.
- Mid Town is a confluence of major natural flowpath systems from Folkestone Road, Tower Hamlets, the River Dour through Buckland and Connaught Barracks. It is identified from the EA FMfSW as an area where surface water flooding in the 3.33% (1:30 year) and more extensively in the 0.5% (1:200 year) could be deep (>0.3m).
- The River Dour channel is complex with numerous culverted sections. It is severely constrained and includes potential obstructions to high flows. The capacity of the River Dour to receive surface runoff from the surface water drains is a key constraint during periods of high flow. Areas between Park Street and Pencester Road have been identified as the functional floodplain of the River Dour (i.e. likely to flood in a 5% AEP event).
- The shallow topography and gradient for drainage in the area is likely to result in ponding of surface water falling directly on Mid Town or running off from the surrounding land.

G.3 Development Plans and Opportunities

The Site Allocations process has identified sites in the Mid Town area for which development may be considered. Options for improved flood risk management (Section G.6) have been identified which could involve the following locations:

- Mid Town (CP9): Strategic Allocation site of 5.9 hectares which is proposed for mixed development of public sector uses, retail and residential. Integral to the development will be improvement of public areas centred on river frontages.
- Charlton Green Sorting Office (LDF06): 0.69ha of land which could be considered for residential housing
- Charlton Shopping Centre (SHL006): 0.63ha of land which could be considered for residential housing
- St James's (LDF024): 3.6ha of land which could be considered for mixed use development
- Dover Waterfront (CP8): Strategic Allocation site of 12.2 hectares which is proposed for mixed use development including residential homes, a hotel, offices and retail centres.
- Former Connaught Barracks (CP10): Strategic Allocation site of 12.5ha which is proposed for residential development.

G.4 Environmental Designations and Other Possible Constraints

The land to the east of Castle Hill Road is designated as part of the Kent Downs Area of Outstanding Natural Beauty (AONB). Dour Street is a conservation area and the area is archaeologically important.

The majority of the area to the north of the River Dour is designated as Source Protection Zone 1 (inner), 2 (outer) or 3 (total). An area adjacent to the River Dour is also identified as a zone where groundwater levels could be close the surface in a winter hydrologically similar to 2000/1. Selection of appropriate SuDS in this area should therefore consider the need for pollution control and the possibility that high groundwater levels may impede infiltration.

G.5 Detailed Model Results

The detailed modelling predicts the pattern of surface water flooding as summarised in Table G.1 and shown for the 0.5% (1 in 200) AEP event in Figure G.2.

Table G.1 Pattern of flooding in Mid Town as predicted by the detailed model

Rainfall Event (AEP)	Key Pattern of Flooding
50% (1 in 2)	Isolated ponding of direct rainfall including in some basement properties and the car park on Maison Dieu Road
3.33% (1 in 30)	Ponding up to depths of ~0.3m on roads and properties around Maison Dieu Road (including out-of-bank flow from the Dour across the car park), Dour Street (flow from Maison Dieu Road via Crafford Street) and Pencester Road (from Maison Dieu Road and the Dour across the College site). Depths of over ~0.5m predicted in the Maison Dieu Road car park.
1% (1 in 100)	Widespread flooding of over ~0.5m at roads and properties between the Dour and Maison Dieu Road from Beaconsfield Road to Townwall Street, and between Pencester Gardens and Castle Street on the opposite bank. As well as ponding of direct rainfall, flooding is caused by out-of-bank flow from the Dour along Granville Street and Charlton Green (due in part to the weir and culvert adjacent to Halford's superstore), Maison Dieu Road (due to the low left hand bank downstream of Park Street), Pencester Road and Stembrook/Church Street).
0.5% (1 in 200)	Widespread flooding across Mid Town with depths of over ~1m at some basement properties and the car parks on Maison Dieu and Pencester roads. Flow routes as for 1% event, with velocities of over 0.5m/s along Frith Road, Maison Dieu Road and Dour Street.

G.6 Surface Water Management in Mid Town

G.6.1 Key Concepts for the Options

In addition to a series of generic options for improved surface water management included in the Action Plan, the following are particularly relevant to Mid Town:

- Basement properties should be protected from water ponding on the roads, as well as from high groundwater levels. This may include raising of thresholds or kerbs, as well as tanking of basements and fitting of other resistance/resilience measures.
- Passage of high flows in the River Dour should be safeguarded and improved where possible. This may include removal of weirs and culverts, channel regarding and, with climate change, management of high tidal levels.
- Redevelopment should seek to safeguard and utilise natural ponding areas and respect natural flow routes. Wherever possible, source control measures should be included, particularly green street planters, green roofs and shallow storage in car parks.
- Development of fringe areas (e.g. former Connaught Barracks) should limit potential runoff into the Mid Town area.

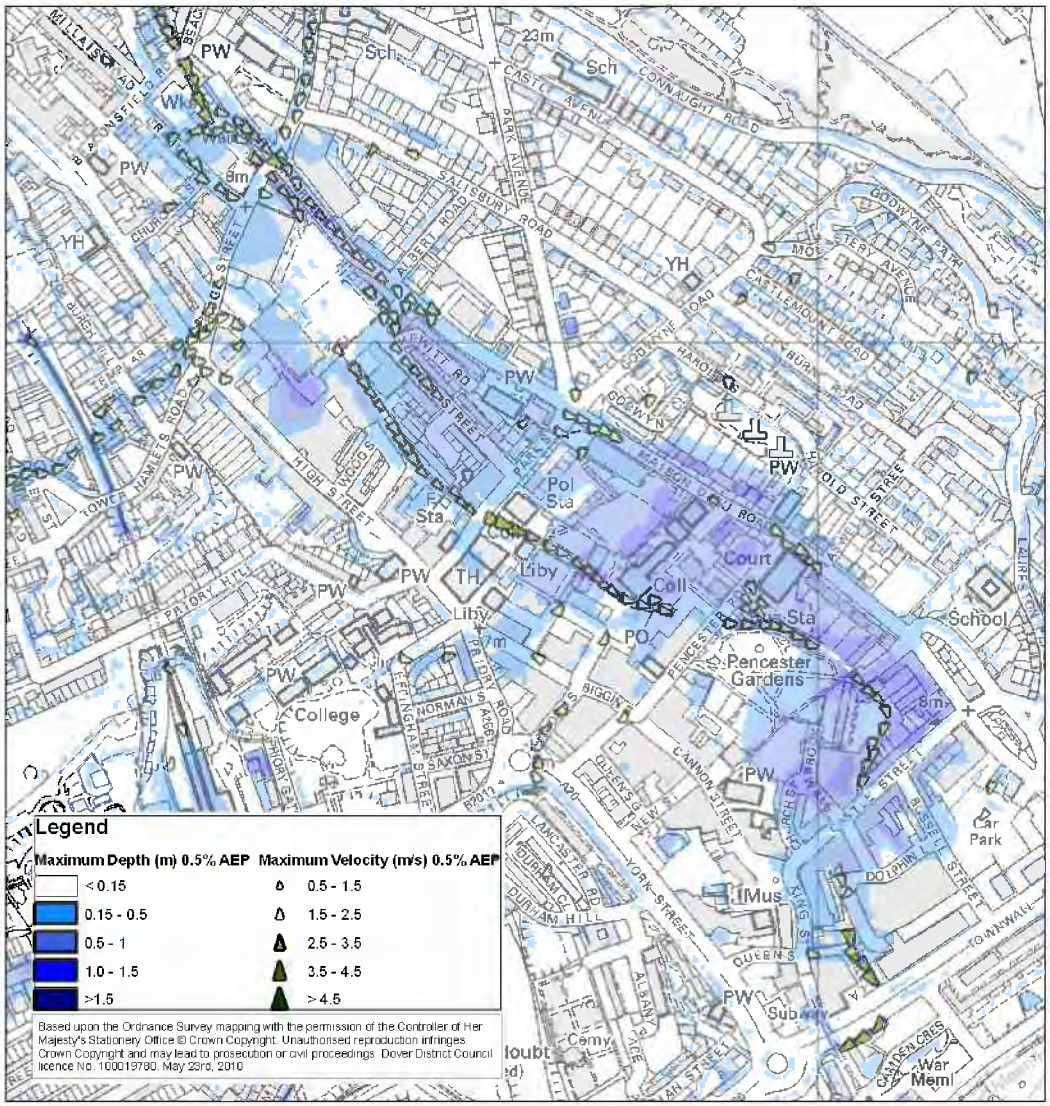


Figure G.2 Maximum depth and velocities of flooding in the 0.5% (1 in 200) AEP rainfall event

G.6.2 Location-specific Options not Included in the Action Plan

The options for improved management of flooding listed in Table G.2 have been considered during the appraisal process but are not included in the Action Plan:

Table G.2 Mid Town options not included in the Action Plan

Option Considered	Reasons for Excluding from SWMP Action Plan
Detention basins at The Danes recreation ground and sports ground at Long Hill	• Limited flows are anticipated at both locations. • Outflow from a detention basin at The Danes would be down a steep slope through which retained water will most naturally seep. Furthermore, outflow is into the cemetery which may be difficult to justify.
Route exceedance flows along Old Charlton Road and Frith Road and improve property resistance/ resilience along route as required.	• Contributions from Old Charlton Road and Frith Road are likely to be small • Reducing continuation flows down Maison Dieu Road could be achieved as part of the wider option included in the Action Plan
Dour bypass channel linking online storage/detention basins/ponds at current sites of Morrison's car park,	• Dour Street is unlikely to be redeveloped and is not wide enough for a channel and parking • Bypass channel to eliminate fluvial flooding in

Option Considered	Reasons for Excluding from SWMP Action Plan
Maison Dieu Road car park, Pencester Road car park, Pencester Gardens and Russell Street car park as part of Mid Town strategic redevelopment.	the 1% AEP event plus climate change would be up to 6m wide requiring substantial land take • Costs are likely to be prohibitive • Low flow issues in existing Dour channel would mean that bypass channel would often be dry and therefore social and environmental benefits would be limited
Removal of weir adjacent to Halford's store and regrading of the channel between Beaconsfield Road and Bridge Street.	• Regarding of the ~150m section between Beaconsfield Road and Bridge Street provides a minimal reduction in flood risk in the 3.33% AEP and 1% AEP rainfall events. This is likely to be due in part to increased flow velocities which are unable to pass through the existing culvert under Bridge Street. • It is recognised that removal of such obsolete structures is likely to lead to improvements in fish passage and the potential for local narrowing which are objectives of the Water Framework Directive. However, this option is unlikely to be motivated by improvements to surface water flood risk management. Any regrading should consider a longer length of channel and measures to reduce flow velocities.
Regrading of the channel between Park Street and Wellington Dock.	• Regrading over the ~1km length could result in an over-deep channel which suffers from poor light penetration and requires extensive reinforcement of the banks. • Regrading through Pencester Road and Castle Street culverts is likely to be highly problematic. • Costs are likely to be prohibitive • Changed bed profile could mean tidal influence extends further into Mid Town, particularly with sea level rise, and change the character of the river

G.6.3 Location-specific Options Included in the Action Plan

The options for improved management of flooding listed in Table G.3 are included in the SWMP Action Plan. The primary reasons for inclusion are given

Table G.3 Mid Town options included in the Action Plan

Option	Primary Reasons for Inclusion in the Action Plan
Route exceedance flows from Frith Road into the River Dour adjacent to Morrison's supermarket, and route exceedance flows from Maison Dieu Road into (i) the River Dour via Crafford Street and (ii) a pond or wetland sited in the existing Maison Dieu Road car park. Improve property resistance/ resilience along route as required.	• Six basement properties on Maison Dieu Road could be funded for property level resistance/resilience works following a grant from Defra. • There is a natural flow route from Maison Dieu Road into the topographic depression along Dour Street which could be redirected via kerb raising and use of traffic calming along Crafford Street. • Maison Dieu Road is a natural ponding area for high flows from the River Dour and should be used as such whilst improving the social environment as part of strategic redevelopment.
Fit tide-excluding gates at outlet of Wellington Dock Manage tide levels in the dock during periods of high river flow to maintain low	• As part of the strategic redevelopment of Wellington Dock, Dover Harbour Board (DHB) has agreed in principle to funding and fitting tide-excluding gates to the new proposed outlet of

Option	Primary Reasons for Inclusion in the Action Plan
tide levels and improve conveyance in the Dour channel.	Wellington Dock. • Consideration is also being given by DHB to allowing the gates to be closed in the event of a storm surge to improve flood management. There may, therefore, be a precedent for operating the gates for management of levels in the River Dour. • Although current MHWS tidal levels do not appear to impound high flows in the Dour channel through Mid Town, rise in sea level with climate change could make this option more beneficial.