

Loughton, Buckhurst Hill and Theydon Bois Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

The CDA is located in the eastern portion of the study area. Significant ponding of water is predicted around Chequers Road and low-lying areas within the CDA. The railway line presents a major barrier to flow, resulting in ponding to the north (upstream) of the railway line. Hazard ratings in this area are predicted to range from 'Significant' to 'Extreme.' The main flow route that feeds this area runs north to south along Deepdene Road. In this area there is some capacity within the pipe network but in areas where flood depths are deeper pipes are running at capacity.

The CDA has no fluvial or tidal Flood Zones

The southern portion of the CDA has medium (25%-50%) susceptibility to groundwater flooding.

There have been historical flood events reported within the CDA.

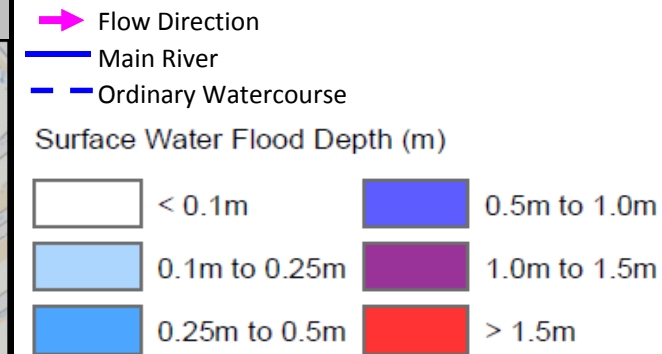
Opportunity Area

LBT_06

6

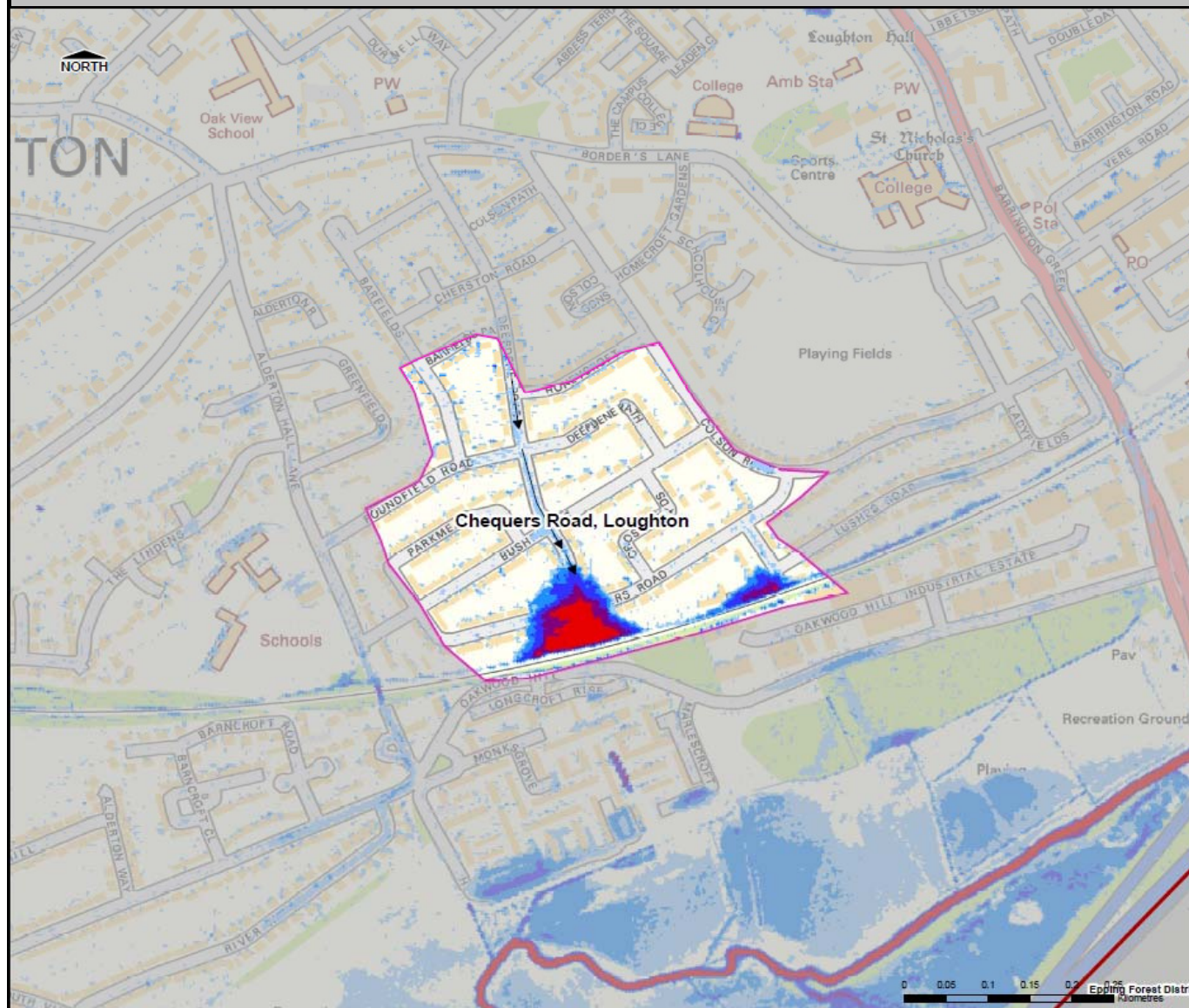
Chequers Road, Loughton

LEGEND



PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		



Flood Risk Source

Surface Water	Yes
Groundwater	Yes
Ordinary Watercourse	No
Fluvial	No
Tidal	No

Validation

Historic Events	Yes
Site Inspection	Yes



**LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX**

IDENTIFICATION OF MEASURES

CDA ID: LBT_06 6. The Meadway, Buckhurst Hill					
	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	Green Roof		Green Roofs are an excellent source control measure that can be implemented where soil / geology makes implementing infiltrating SuDS challenging. These are suitable for retrofits on council owned lands, School properties and housing society / social housing sites	High proportion of residential properties within CDA would make this difficult to implement	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Soakaways / sub-surface infiltration can be incorporated into smaller / 'tight' areas without compromising the use of the lands above (such as playing fields). Performance depends upon the infiltration rate of the underlying geology.	Could help alleviate problem in high risk areas. Underlying London Clay may prohibit effective functioning of measure.	Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Swales provide a means of managing surface water above ground - slowing and infiltrating runoff at the surface. They are generally shallower and wider than ditches.	Throughout CDA where possible. Swales can be incorporated into new development or retrofitted into open spaces like parks.	High proportion of residential properties within CDA would make this difficult to implement
	Permeable Paving		Permeable paving can be used to promote storage / infiltration when replacing aging car parks as well as be used for parking areas in roads for road reconstruction projects.	Throughout CDA, to the north west of the CDA at the eastern end of Barfields Path and also possible in the carpark to the north of Cherston Road. Would require a location for water to drain through to.	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Rainwater harvesting involves the collection of rooftop rainwater and storing it for future use (such as toilet flushing or landscape irrigation)	Majority of area is residential, therefore Rainwater Harvesting would be difficult to implement on a large scale.	High proportion of residential properties within CDA would make this difficult to implement
	Detention Basins		A strategically located detention basin could be constructed where runoff flows out of bank (or is diverted into) as a result of the OWC/main river being culverted under the downstream urban area or lost due to urban creep.	These can be located in open areas like parks and can be used to temporarily store surface water from overland flows (like roads).	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA or within the CDA.	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits. A small open area to the East could store surface water.	Review of preferred type of SuD should be considered bioretention, wetland or pond preferred over detention basin.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits.	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	Increasing Capacity in Drainage Systems		The existing drainage system capacity could be increased to accommodate storm water	This option could be coupled with SuDS through the installation of a 'perforated pipe', where water will be encouraged to infiltrate into the ground along the flow path. However, this is a costly approach and would cause disruption to local residents. Improved drainage through the railway embankment would prevent the water from backing up against it but may make the problem worse in other areas.	Review the incorporation of these measures once large SuDS attenuation and diversion measures have been implemented.
	Separation of Foul and Surface Water Sewers		Separation of combined drainage networks into foul and surface water systems	The combined network in this CDA could be separated. This would require a cost benefit analysis. This could be combined with other measures relating to the drainage network.	
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA. This would have substantial benefits locally to the improved maintenance.	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course.
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' and 'Ponds and Wetlands' comments above.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)		Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates.	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	N/A
	Other 'Pathway' Measures		Modify flow paths within a CDA - could include introducing culverts to reduce area of ponding with overland flow paths that are obstructed etc.	This may prevent the widespread surface water flooding found in the residential areas of the CDA from concentrating flow in one location.	N/A
RECEPTOR	Improved Weather Warning		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Policies can be adopted to specify more stringent SuDS / surface water peak runoff control / volume control requirements for new major development.	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	These can be investigated in areas where other measures are not technically or economically viable.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure.
	Improved Resilience and Resistance Measures		Commercial or property level resilience measures	Review flood risk management measures within the CDA and improve as necessary.	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CDA ID: LBT_06		LBT_06																														
Option No.	Option (Scheme Category)	Standard Measures														Short listing Options					Take Forward Option to Detailed Assessment?	Comments										
		SOURCE				PATHWAY				RECEPTOR						Appropriate Measures Available?	Technical	Economic	Social	Environmental			Objectives	Overall								
Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sowers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures						Improved Weather Warning	Planning Policies to Influence Development			Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures				
1	Do Nothing																							✓	2	-1	-2	0	-2	-3	×	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	Do Minimum																							✓	2	0	-1	0	-1	0	×	
3	Improved Maintenance																							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	Planning Policy																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on Greenfield land within the CDA.
5	Source Control, Attenuation and SUDS																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits.
6	Flood Storage / Permeability																							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated along Colston Road either side of Homecroft Gardens, either side of Border's Lane and within the playing fields east of Colson Road.
7	Separate Surface Water and Foul Water Sewer Systems																							✓	-1	-2	0	0	1	-2	×	The CDA uses a combined system. A cost benefit analysis is required to determine if this should be investigated further.
8	De-culvert / Increase Conveyance																							✓	1	1	0	1	2	5	✓	This may prevent the widespread surface water flooding found in the residential areas of the CDA from concentrating flow in one location.
9	Preferential / Designated Overland Flow Routes																							✓	2	1	0	0	2	5	✓	Modifying kerb and flow patterns along Colson Road to divert flows into SuDS measures within the open space east of the road should be investigated.
10	Community Resilience																							✓	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	Infrastructure Resilience																							✓	2	1	1	0	1	5	✓	This option could be considered for the station and industry predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	Other - Improvement to Drainage Infrastructure																							✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	Other or Combination of Above																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices and preferential overland flows could assist in 'cutting off' the overland flow routes within the CDA.

Loughton, Buckhurst Hill and Theydon Bois Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in the southern portion of the study area. Depths of surface water flooding are predicted to be high (>1.5m) within the CDA. Ponding is shown in the topographic low point near the railway line just upstream of where the railway line presents a significant barrier to flow. An overland flow route is present along Forest Hill, continuing onto Station Road. Surface water also ponds against the raised car park area to the west of Loughton Station causing several residential properties on Meadow Road to be within an area of predicted surface water flooding. The pipe network is running at or near to capacity during the model simulation. The main receptors within the CDA are Loughton Station and Roding Valley School.

Fluvial Flood Zone 2 is located within the CDA. No tidal Flood Zones are found within the CDA.

The CDA has a moderate (25-50%) susceptibility to groundwater flooding.

Historic events have been identified within the CDA by Thames Water and Epping Forest District Council

Opportunity Area

LBT_04

4

Loughton Station

LEGEND

➔ Flow Direction

Surface Water Flood Depth (m)

	< 0.1m		0.5m to 1.0m
	0.1m to 0.25m		1.0m to 1.5m
	0.25m to 0.5m		> 1.5m

PREFERRED OPTIONS SUMMARY:

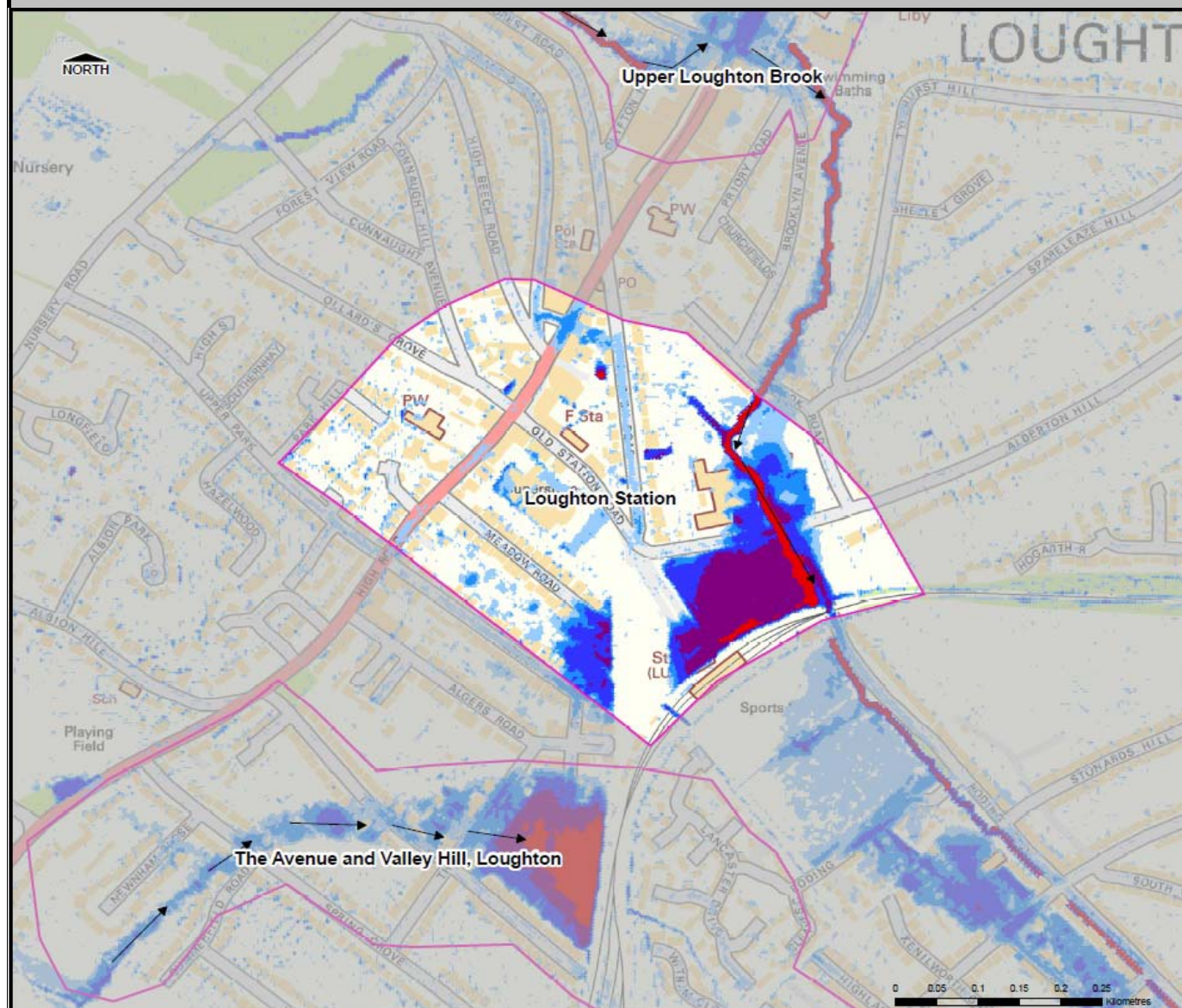
Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		

Flood Risk Source

Surface Water		Yes
Groundwater		Yes
Ordinary Watercourse		No
Fluvial		Yes
Tidal		No

Validation

Historic Events		Yes
Site Inspection		Yes



**LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX**

IDENTIFICATION OF MEASURES

CDA ID: LBT_04 4. Loughton Station					
	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	Green Roof		Green Roofs are an excellent source control measure that can be implemented where soil / geology makes implementing infiltrating SuDS challenging. These are suitable for retrofits on council owned lands, School properties and housing society / social housing sites	High proportion of residential properties within CDA would make this difficult to implement	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Soakaways / sub-surface infiltration can be incorporated into smaller / 'tight' areas without compromising the use of the lands above (such as playing fields). Performance depends upon the infiltration rate of the underlying geology.	Could help alleviate problem in high risk areas to the North of Loughton Station. High density residential dwellings to the west of the CDA limit opportunities for sub-surface storage schemes.	Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Swales provide a means of managing surface water above ground - slowing and infiltrating runoff at the surface. They are generally shallower and wider than ditches.	Throughout CDA where possible. Swales can be incorporated into new development or retrofitted into open spaces like parks.	High proportion of residential properties within CDA would make this difficult to implement
	Permeable Paving		Permeable paving can be used to promote storage / infiltration when replacing aging car parks as well as be used for parking areas in roads for road reconstruction projects.	Throughout CDA. May help to prevent water following road network. Would require a location for water to drain through to.	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Rainwater harvesting involves the collection of rooftop rainwater and storing it for future use (such as toilet flushing or landscape irrigation)	Majority of area is residential, therefore rainwater harvesting would be difficult to implement in these areas.	Difficult to implement in this CDA
	Detention Basins		A strategically located detention basin could be constructed where runoff flows out of bank (or is diverted into) as a result of the OWC/main river being culverted under the downstream urban area or lost due to urban creep.	These can be located in open areas like parks and can be used to temporarily store surface water from overland flows (like roads). Lack of open space in areas showing surface water flooding would make this measure hard to implement.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA or within the CDA.	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits, especially to the north of Loughton Station. Lack of open spaces in the West of the CDA limit potential for storage measures.	Review of preferred type of SuD should be considered bioretention, wetland or pond preferred over detention basin.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated in less dense portions of the the CDA, particularly towards the north eastern portion of the CDA. Opportunities to intercept surface water flowpaths in the western portion of the CDA are more limited given the high density of residential development.	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits.	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	Increasing Capacity in Drainage Systems		The existing drainage system capacity could be increased to accommodate storm water	This option could be coupled with SuDS through the installation of a 'perforated pipe', where water will be encouraged to infiltrate into the ground along the flow path. However, this is a costly approach and would cause disruption to local residents. Increased capacity for flow to bypass the railway embankment would help to alleviate the deep surface water flooding found within this CDA.	Review the incorporation of these measures once large SuDS attenuation and diversion measures have been implemented.
	Separation of Foul and Surface Water Sewers		Separation of combined drainage networks into foul and surface water systems	The combined network in this CDA could be separated. This would require a cost benefit analysis. This could be combined with other measures relating to the drainage network.	
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA. Improved conveyance of Loughton Brook may help to convey surface water away from the CDA.	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course.
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' and 'Ponds and Wetlands' comments above.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)	This could be used in combination with storage measures to direct flow into areas of temporary or permanent storage.	Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates.	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	N/A
	Other 'Pathway' Measures		Modify flow paths within a CDA - could include introducing culverts to reduce area of ponding with overland flow paths that are obstructed etc.	Surface water flow routes are present due to Loughton Brook and would be difficult to modify.	N/A
RECEPTOR	Improved Weather Warning		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Policies can be adopted to specify more stringent SuDS / surface water peak runoff control / volume control requirements for new major development.	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	These can be investigated in areas where other measures are not technically or economically viable. Due to the lack of open space upstream of Meadow Road temporary defence schemes may be the most appropriate form of mitigation.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure.
	Improved Resilience and Resistance Measures		Commercial or property level resilience measures	Review flood risk management measures within the CDA and improve as necessary. The properties on the western end of Meadow Road may benefit from property level protection schemes due to the lack of feasible alternative measures in this area.	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

**LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX**

OPTIONS IDENTIFICATION AND SHORTLISTING

CDA ID: LBT_04		LBT_04																														
Option No.	Option (Scheme Category)	Standard Measures														Short listing Options					Take Forward Option to Detailed Assessment?	Comments										
		SOURCE				PATHWAY				RECEPTOR						Appropriate Measures Available?	Technical	Economic	Social	Environmental			Objectives	Overall								
Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sowers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures						Improved Weather Warning	Planning Policies to Influence Development			Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures				
1	Do Nothing																							✓	2	-1	-2	0	-2	-3	×	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	Do Minimum																							✓	2	0	-1	0	-1	0	×	
3	Improved Maintenance																							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	Planning Policy																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on Greenfield land within the CDA.
5	Source Control, Attenuation and SUDS																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer social and flood risk benefits.
6	Flood Storage / Permeability																							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated to the north of Roding Valley High School (Sub surface Storage).
7	Separate Surface Water and Foul Water Sewer Systems																							✓	-1	-2	0	0	1	-2	×	The CDA uses a combined system. A cost benefit analysis is required to determine if this should be investigated further.
8	De-culvert / Increase Conveyance																							✓	1	1	0	1	2	5	✓	Surface water flow routes are present due to Loughton Brook and would be difficult to modify.
9	Preferential / Designated Overland Flow Routes																							✓	2	1	0	0	2	5	✓	Modifying kerb and flow patterns along Brook Road to divert flows into SuDS measures within the open space west of the road should be investigated.
10	Community Resilience																							✓	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	Infrastructure Resilience																							✓	2	1	1	0	1	5	✓	This option could be considered for the station and industry predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	Other - Improvement to Drainage Infrastructure																							✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	Other or Combination of Above																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices and preferential overland flows could assist in 'cutting off' the overland flow routes within the CDA.

Loughton, Buckhurst Hill and Theydon Bois Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in the central portion of the study area. There are four main flow routes that convey surface water towards Loughton Brook within the CDA. Flooding patterns follow the road network at depths between 0.25m-0.50m. A topographic low near to Loughton Brook along the North Eastern boundary of the CDA means there is a high risk of surface water flooding and depths of up to 1.00m in the 100 year event.

A small area of fluvial Flood Zone 2 is located within the CDA.

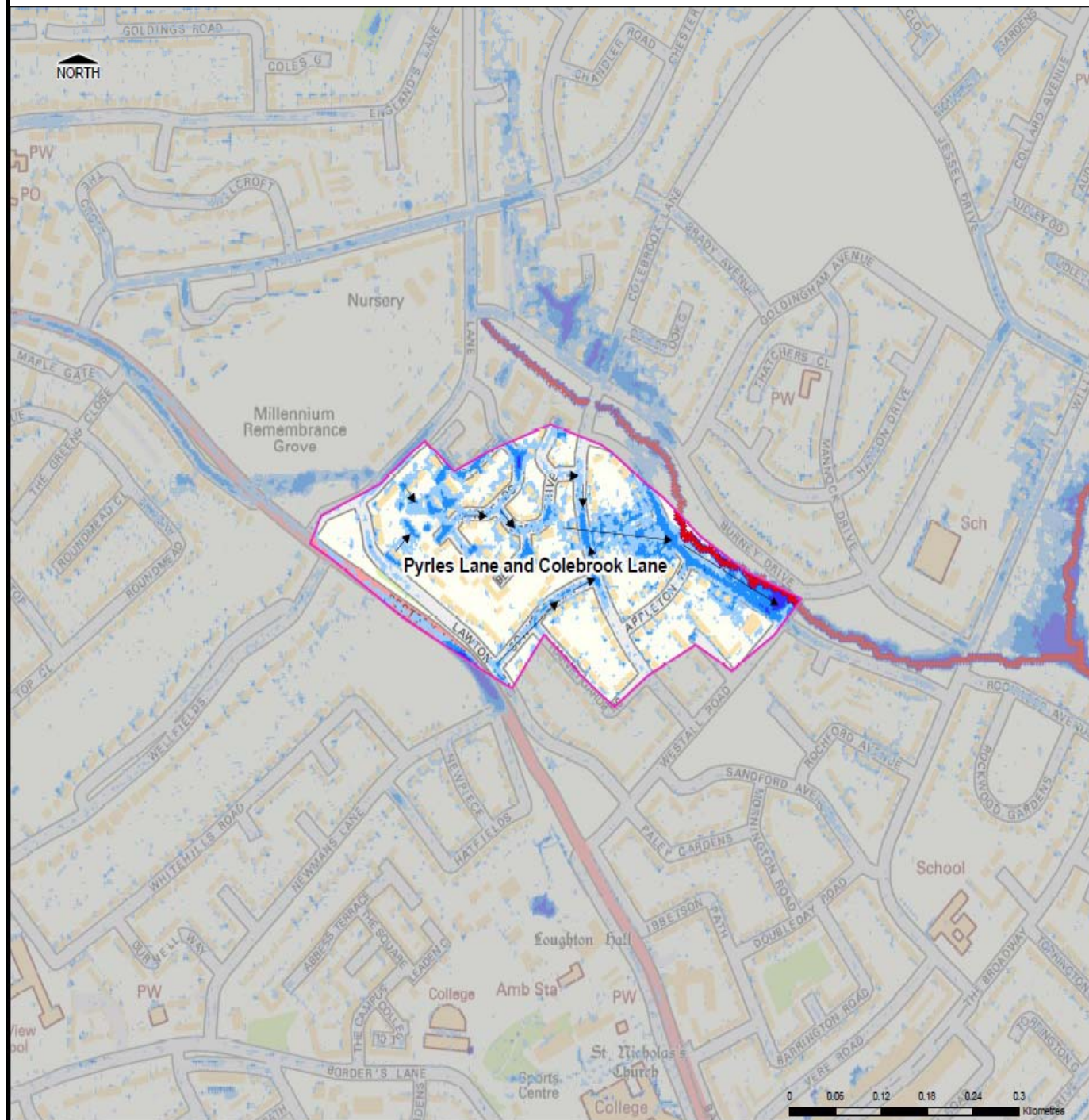
The South of the CDA has low susceptibility to groundwater flooding.

Opportunity Area

LBT_02

2

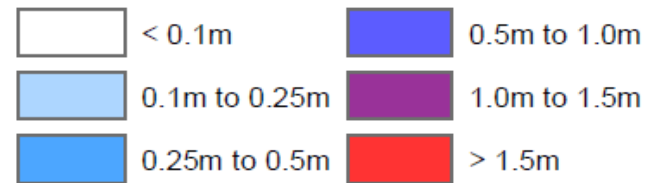
Pyrls Lane and Colebrook Lane



LEGEND

➔ Flow Direction

Surface Water Flood Depth (m)



PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		

Flood Risk Source

Surface Water		Yes
Groundwater		No
Ordinary Watercourse		No
Fluvial		Yes
Tidal		No

Validation

Historic Events		Yes
Site Inspection		Yes



**LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX**

IDENTIFICATION OF MEASURES

CDA ID: LBT_02 2. Pyrles Lane and Colebrook Lane					
	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	Green Roof		Green Roofs are an excellent source control measure that can be implemented where soil / geology makes implementing infiltrating SuDS challenging. These are suitable for retrofits on council owned lands, School properties and housing society / social housing sites	High proportion of residential properties within CDA would make this difficult to implement	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Soakaways / sub-surface infiltration can be incorporated into smaller / 'tight' areas without compromising the use of the lands above (such as playing fields). Performance depends upon the infiltration rate of the underlying geology.	Could help alleviate problem in high risk areas. Underlying London Clay may prohibit effective functioning of measure.	Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Swales provide a means of managing surface water above ground - slowing and infiltrating runoff at the surface. They are generally shallower and wider than ditches.	Throughout CDA where possible. Swales can be incorporated into new development or retrofitted into open spaces like parks.	Possible location to the western part of the CDA along Lawton Road.
	Permeable Paving		Permeable paving can be used to promote storage / infiltration when replacing aging car parks as well as be used for parking areas in roads for road reconstruction projects.	Throughout CDA. May help to prevent water following road network. Would require a location for water to drain through to.	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Rainwater harvesting involves the collection of rooftop rainwater and storing it for future use (such as toilet flushing or landscape irrigation)	Majority of area is residential, therefore Rainwater Harvesting would be difficult to implement.	Further investigation is needed to assess possible locations.
	Detention Basins		A strategically located detention basin could be constructed where runoff flows out of bank (or is diverted into) as a result of the OWC/main river being culverted under the downstream urban area or lost due to urban creep.	These can be located in open areas like parks and can be used to temporarily store surface water from overland flows (like roads). Could prevent flooding of Rectory Lane if situated to the West of the CDA	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA or within the CDA.	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits. This could alleviate the main surface water flow route if located just upstream of the CDA within Remembrance Grove.	Review of preferred type of SuD should be considered bioretention, wetland or pond preferred over detention basin.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits. Bioretention can be located along Westfields	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	Increasing Capacity in Drainage Systems		The existing drainage system capacity could be increased to accommodate storm water	This option could be coupled with SuDS through the installation of a 'perforated pipe', where water will be encouraged to infiltrate into the ground along the flow path. However, this is a costly approach and would cause disruption to local residents. This could be implemented in combination with many other measures.	Review the incorporation of these measures once large SuDS attenuation and diversion measures have been implemented.
	Separation of Foul and Surface Water Sewers		Separation of combined drainage networks into foul and surface water systems	The combined network in this CDA could be separated. This would require a cost benefit analysis. This could be combined with other measures relating to the drainage network.	
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA. Improved conveyance of Loughton Brook may help to convey surface water away from the CDA, this would require consultation with the EA.	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course.
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' and 'Ponds and Wetlands' comments above.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)		Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates.	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	No watercourses impact the CDA.
	Other 'Pathway' Measures		Modify flow paths within a CDA - could include introducing culverts to reduce area of ponding with overland flow paths that are obstructed etc.	This may prevent the widespread surface water flooding found in the residential areas of the CDA from concentrating flow in one location.	N/A
RECEPTOR	Improved Weather Warning		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Policies can be adopted to specify more stringent SuDS / surface water peak runoff control / volume control requirements for new major development.	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	These can be investigated in areas where other measures are not technically or economically viable.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure.
	Improved Resilience and Resistance Measures		Commercial or property level resilience measures	Review flood risk management measures within the CDA and improve as necessary.	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

**LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX**

OPTIONS IDENTIFICATION AND SHORTLISTING

CDA ID: LBT_02		LBT_02																														
Option No.	Option (Scheme Category)	Standard Measures														Short listing Options					Take Forward Option to Detailed Assessment?	Comments										
		SOURCE				PATHWAY				RECEPTOR						Appropriate Measures Available?	Technical	Economic	Social	Environmental			Objectives	Overall								
Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sowers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures						Improved Weather Warning	Planning Policies to Influence Development			Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures				
1	Do Nothing																						✓	2	-1	-2	0	-2	-3	✗	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.	
2	Do Minimum																						✓	2	0	-1	0	-1	0	✗		
3	Improved Maintenance																						✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.	
4	Planning Policy																						✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on Greenfield land within the CDA.	
5	Source Control, Attenuation and SUDS																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer social and flood risk benefits.
6	Flood Storage / Permeability																						✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated within the area of open space in Millennium Remembrance Grove and in the western corner of the CDA.	
7	Separate Surface Water and Foul Water Sewer Systems																						✓	-1	-2	0	0	1	-2	✗	The CDA uses a combined system. A cost benefit analysis is required to determine if this should be investigated further.	
8	De-culvert / Increase Conveyance																						✓	1	1	0	1	2	5	✓	This may prevent the widespread surface water flooding found in the residential areas of the CDA from concentrating flow in one location.	
9	Preferential / Designated Overland Flow Routes																						✓	2	1	0	0	2	5	✓	Modifying kerb and flow patterns along Rectory Lane to divert flows into SuDS measures within the open space east of the road should be investigated.	
10	Community Resilience																						N/A	✓	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	Infrastructure Resilience																						✓	2	1	1	0	1	5	✓	This option could be considered for the station and industry predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.	
12	Other - Improvement to Drainage Infrastructure																						✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.	
13	Other or Combination of Above																						✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices and preferential overland flows could assist in 'cutting off' the overland flow routes within the CDA.	

Loughton, Buckhurst Hill and Theydon Bois Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

The CDA is located in the centre of the study area. Significant ponding of water occurs to the East of the railway embankment, depths are >1.5m and the hazared rating is significant to extreme. There are flow routes conveying flow from the West of the CDA through the residential area via Summerfield Road and The Crescent. There is also a flow route along the ordinary watercourse to the west of the railway embankment through The White Bridge junior school. There is generally some capacity in the pipe network, but the pipe through the railway embankment is areas where flood depths are deeper pipes are running at capacity.

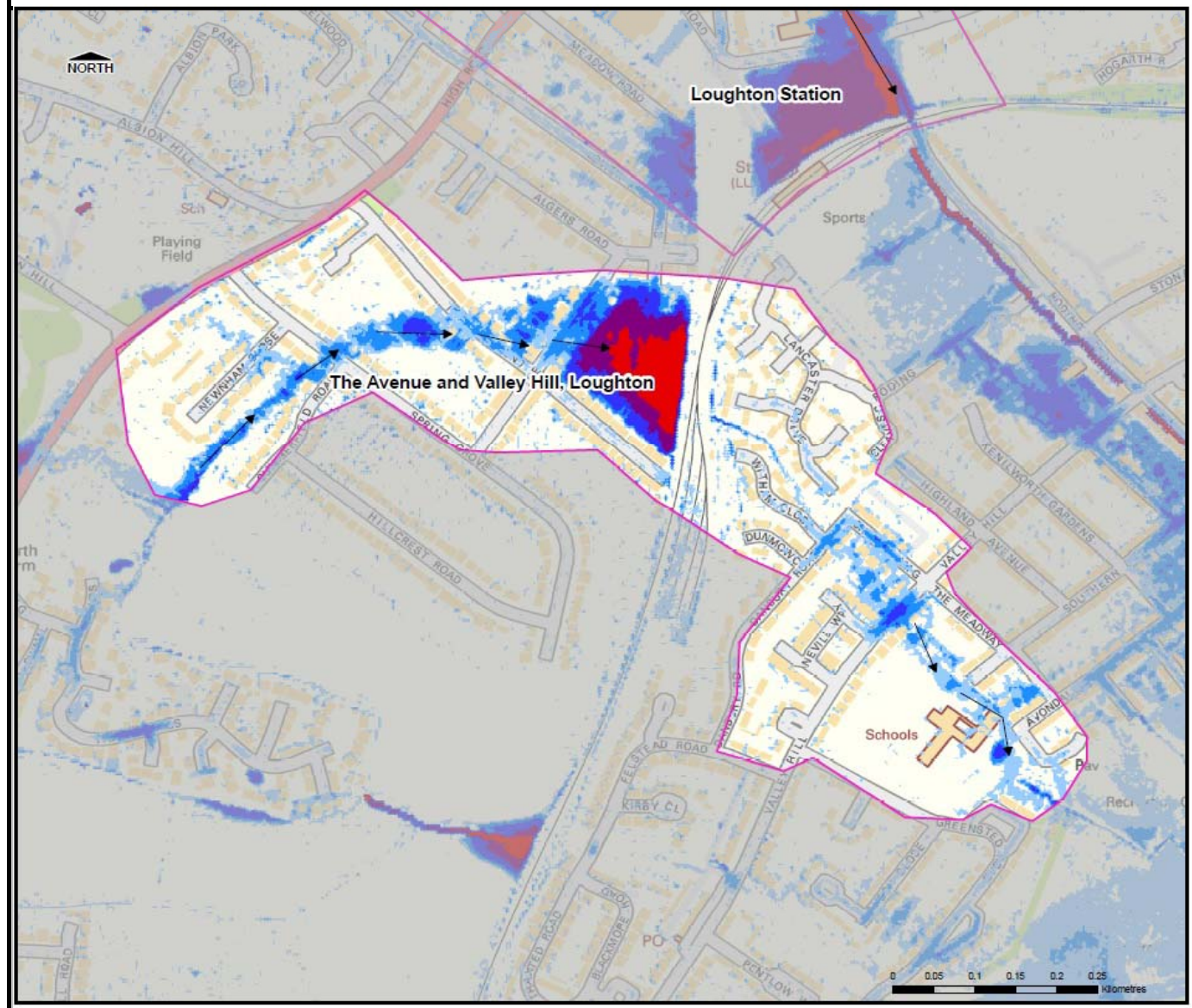
The CDA has no fluvial/tidal flood zones

The East of the CDA has medium (25%-50%) susceptibility to groundwater flooding, and the West of the CDA has low(>25%) susceptibility to groundwater flooding

There have been historical flood events reported with the CDA.

Opportunity Area

LBT_07



LEGEND

➔ Flow Direction

Surface Water Flood Depth (m)

	< 0.1m		0.5m to 1.0m
	0.1m to 0.25m		1.0m to 1.5m
	0.25m to 0.5m		> 1.5m

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		

7

The Avenue and Valley Hill, Loughton

Flood Risk Source

Surface Water		Yes
Groundwater		Yes
Ordinary Watercourse		No
Fluvial		No
Tidal		No

Validation

Historic Events		Yes
Site Inspection		Yes



**LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX**

IDENTIFICATION OF MEASURES

CDA ID: LBT_07 7. The Avenue and Valley Hill, Loughton					
	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	Green Roof	Orange	Green Roofs are an excellent source control measure that can be implemented where soil / geology makes implementing infiltrating SuDS challenging. These are suitable for retrofits on council owned lands, School properties and housing society / social housing sites	High proportion of residential properties within CDA limit areas where installation would be feasible	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the OA.
	Soakaways	Green	Soakaways / sub-surface infiltration can be incorporated into smaller / 'tight' areas without compromising the use of the lands above (such as playing fields). Performance depends upon the infiltration rate of the underlying geology.	Could help alleviate problem in high risk areas. An area upstream of the railway embankment has been located as a possible area for underground storage, this may help to reduce the depth of flooding predicted in this location.	Further investigation is needed to assess the infiltration potential due to geology.
	Swales	Orange	Swales provide a means of managing surface water above ground - slowing and infiltrating runoff at the surface. They are generally shallower and wider than ditches.	Throughout CDA where possible. Swales can be incorporated into new development or retrofitted into open spaces like parks.	Site identified to the south west of the CDA between Wellfields.
	Permeable Paving	Green	Permeable paving can be used to promote storage / infiltration when replacing aging car parks as well as be used for parking areas in roads for road reconstruction projects.	Throughout CDA. May help to prevent water flowing along Deedean Road. Would require a location for water to drain through to. Areas of permeable paving may alleviate the surface water flow routes leading from Oakland school and across Valley Hill.	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting	Orange	Rainwater harvesting involves the collection of rooftop rainwater and storing it for future use (such as toilet flushing or landscape irrigation)	Majority of area is residential, therefore Rainwater Harvesting would be difficult to implement on a large scale.	High proportion of residential properties within CDA limit areas where installation would be feasible
	Detention Basins	Green	A strategically located detention basin could be constructed where runoff flows out of bank (or is diverted into) as a result of the OWC/main river being culverted under the downstream urban area or lost due to urban creep.	These can be located in open areas like parks and can be used to temporarily store surface water from overland flows (like roads). A small detention basin just downstream of the watercourse being culverted would help prevent the surface water flow route forming.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands	Green	A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA or within the CDA.	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits. A small open area to the North-East could store surface water. A pond at the West of the CDA may help to alleviate the flow route between High Road (A121) and Spring Grove.	Review of preferred type of SuD should be considered bioretention, wetland or pond preferred over detention basin.
	Other 'Source' Measures	Green	Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits.	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	Increasing Capacity in Drainage Systems	Green	The existing drainage system capacity could be increased to accommodate storm water	This option could be coupled with SuDS through the installation of a 'perforated pipe', where water will be encouraged to infiltrate into the ground along the flow path. However, this is a costly approach and would cause disruption to local residents. Improved drainage through the railway embankment may prevent the water from backing up against it but may make the problem worse downstream of the embankment.	Review the incorporation of these measures once large SuDS attenuation and diversion measures have been implemented.
	Separation of Foul and Surface Water Sewers	Orange	Separation of combined drainage networks into foul and surface water systems	The combined network in this CDA could be separated. This would require a cost benefit analysis. This could be combined with other measures relating to the drainage network.	
	Improved Maintenance Regimes	Orange	Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA. This would have substantial benefits locally to the improved maintenance.	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course.
	Managing Overland Flows (Online Storage)	Orange	Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' and 'Ponds and Wetlands' comments above.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)	Green	Modifying street and kerb levels to create a formal flow path (blue corridor)		Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices	Orange	Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates.	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)	Orange	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	This may reduce the overland flow route through Oaklands School. Considerable work would be required.	
	Other 'Pathway' Measures	Orange	Modify flow paths within a CDA - could include introducing culverts to reduce area of ponding with overland flow paths that are obstructed etc.	This may prevent the widespread surface water flooding found in the residential areas of the CDA from concentrating flow in one location.	N/A
RECEPTOR	Improved Weather Warning	Orange	Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development	Green	Generic Measure	Policies can be adopted to specify more stringent SuDS / surface water peak runoff control / volume control requirements for new major development.	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences	Green	Household / building level demountable flood barriers.	These can be investigated in areas where other measures are not technically or economically viable.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness	Green	Generic Measure	Throughout CDA	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure.
	Improved Resilience and Resistance Measures	Green	Commercial or property level resilience measures	Review flood risk management measures within the CDA and improve as necessary.	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

**LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX**

OPTIONS IDENTIFICATION AND SHORTLISTING

CDA ID: LBT_07		LBT_07																														
Option No.	Option (Scheme Category)	Standard Measures														Short listing Options					Take Forward Option to Detailed Assessment?	Comments										
		SOURCE				PATHWAY				RECEPTOR						Appropriate Measures Available?	Technical	Economic	Social	Environmental			Objectives	Overall								
Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sowers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures						Improved Weather Warning	Planning Policies to Influence Development			Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures				
1	Do Nothing																						✓	2	-1	-2	0	-2	-3	✗	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.	
2	Do Minimum																						✓	2	0	-1	0	-1	0	✗		
3	Improved Maintenance																						✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.	
4	Planning Policy																						✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on Greenfield land within the CDA.	
5	Source Control, Attenuation and SUDS																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits.
6	Flood Storage / Permeability																						✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users.	
7	Separate Surface Water and Foul Water Sewer Systems																						✓	-1	-2	0	0	1	-2	✗	The CDA uses a combined system. A cost benefit analysis is required to determine if this should be investigated further.	
8	De-culvert / Increase Conveyance																						✓	1	1	0	1	2	5	✓	This may prevent the widespread surface water flooding found in the residential areas of the CDA from concentrating flow in one location.	
9	Preferential / Designated Overland Flow Routes																						✓	2	1	0	0	2	5	✓	Modifying kerb and flow patterns along The Crescent and The Avenue to divert flows into SuDS measures south of these roads should be investigated.	
10	Community Resilience																						N/A	✓	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	Infrastructure Resilience																						✓	2	1	1	0	1	5	✓	This option could be considered for the station and industry predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.	
12	Other - Improvement to Drainage Infrastructure																						✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.	
13	Other or Combination of Above																						✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices and preferential overland flows could assist in 'cutting off' the overland flow routes within the CDA.	

Loughton, Buckhurst Hill and Theydon Bois Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

The CDA is located in the southern portion of the study area. There is a large area predicted to be at risk of surface water flooding caused by flow 'backing up' against the railway embankment. There is also a large surface water flow path carrying water along the Meadway from West to East.

The CDA has no fluvial or tidal Flood Zones

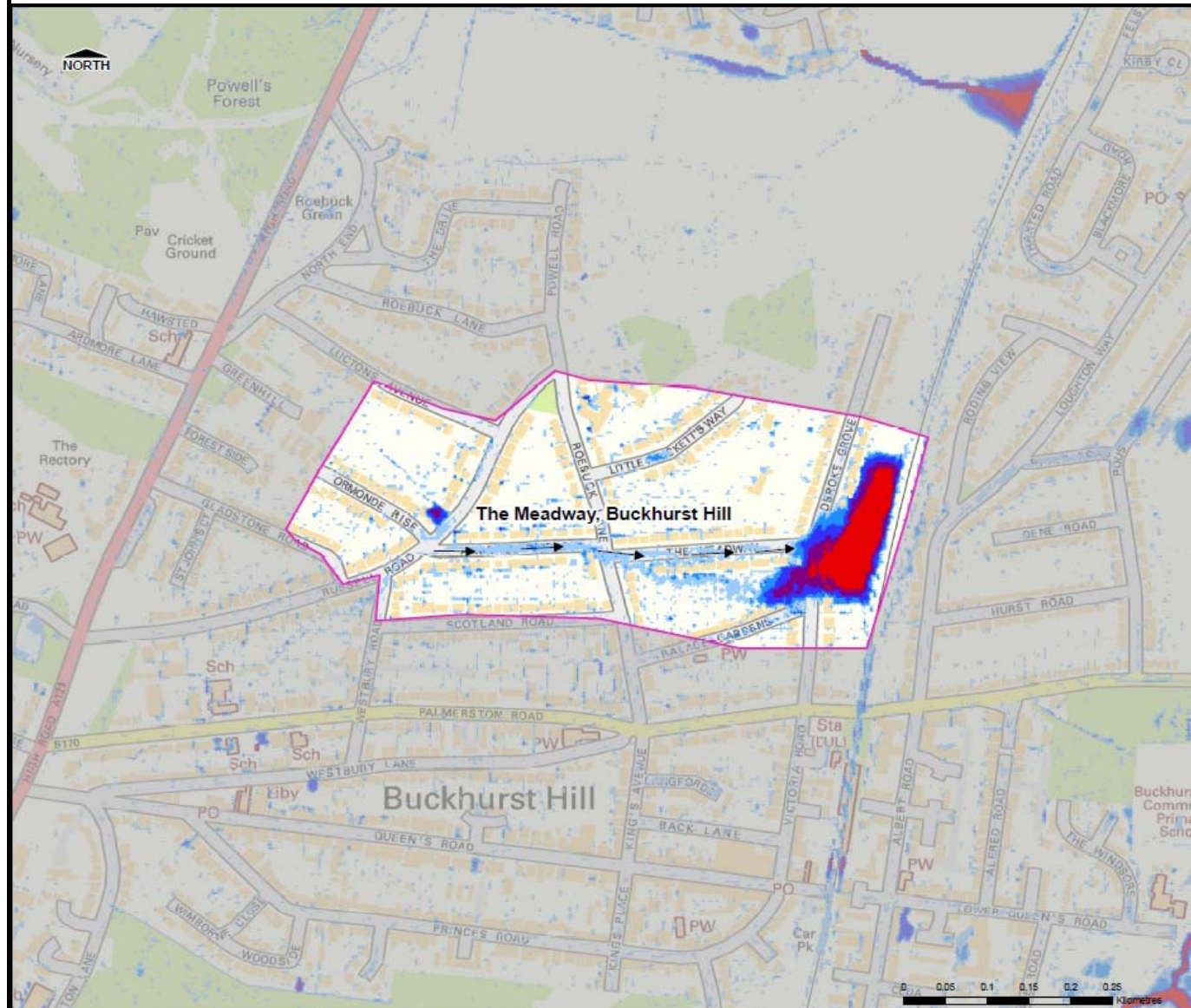
The CDA has low (>25%) susceptibility to groundwater flooding.

Opportunity Area

LBT_06

6

**The Meadway,
Buckhurst Hill**



LEGEND

- Flow Direction
 - Main River
 - Ordinary Watercourse
- Surface Water Flood Depth (m)
- | | |
|---------------|--------------|
| < 0.1m | 0.5m to 1.0m |
| 0.1m to 0.25m | 1.0m to 1.5m |
| 0.25m to 0.5m | > 1.5m |

PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		

Flood Risk Source

Surface Water	Yes
Groundwater	No
Ordinary Watercourse	No
Fluvial	No
Tidal	No

Validation

Historic Events	Yes
Site Inspection	Yes



**LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX**

IDENTIFICATION OF MEASURES

CDA ID: LBT_06 6. The Meadway, Buckhurst Hill					
	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	Green Roof		Green Roofs are an excellent source control measure that can be implemented where soil / geology makes implementing infiltrating SuDS challenging. These are suitable for retrofits on council owned lands, School properties and housing society / social housing sites	Green roofs can potentially be located on properties located at the junction of Palmerston Road and Roebuck Lane.	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Soakaways / sub-surface infiltration can be incorporated into smaller / 'tight' areas without compromising the use of the lands above (such as playing fields). Performance depends upon the infiltration rate of the underlying geology.	Could help alleviate problem in high risk areas. Underlying London Clay may prohibit effective functioning of measure.	Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Swales provide a means of managing surface water above ground - slowing and infiltrating runoff at the surface. They are generally shallower and wider than ditches.	Throughout CDA where possible. Swales can be incorporated into new development or retrofitted into open spaces like parks.	Difficult to implement within this CDA
	Permeable Paving		Permeable paving can be used to promote storage / infiltration when replacing aging car parks as well as be used for parking areas in roads for road reconstruction projects.	Throughout CDA. Permeable paving could be positioned along Amberly Road and The Meadway. Would require a location for water to drain through to.	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Rainwater harvesting involves the collection of rooftop rainwater and storing it for future use (such as toilet flushing or landscape irrigation)	Majority of area is residential, therefore rainwater harvesting would be difficult to implement on a large scale.	Difficult to implement within this CDA
	Detention Basins		A strategically located detention basin could be constructed where runoff flows out of bank (or is diverted into) as a result of the OWC/main river being culverted under the downstream urban area or lost due to urban creep.	These can be located in open areas like parks and can be used to temporarily store surface water from overland flows (like roads).	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA or within the CDA.	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits. Lack of open space associated with flow routes inhibit the use of ponds as a flood alleviation measure.	Review of preferred type of SuD should be considered bioretention, wetland or pond preferred over detention basin.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits.	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	Increasing Capacity in Drainage Systems		The existing drainage system capacity could be increased to accommodate storm water	This option could be coupled with SuDS through the installation of a 'perforated pipe', where water will be encouraged to infiltrate into the ground along the flow path. However, this is a costly approach and would cause disruption to local residents. Improved drainage through the railway embankment would prevent the water from backing up against it but may make the problem worse	Review the incorporation of these measures once large SuDS attenuation and diversion measures have been implemented.
	Separation of Foul and Surface Water Sewers		Separation of combined drainage networks into foul and surface water systems	The combined network in this CDA could be separated. This would require a cost benefit analysis. This could be combined with other measures relating to the drainage network.	
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA. This would have substantial benefits locally to the improved maintenance.	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course.
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' and 'Ponds and Wetlands' comments above.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)		Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates.	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	N/A
	Other 'Pathway' Measures		Modify flow paths within a CDA - could include introducing culverts to reduce area of ponding with overland flow paths that are obstructed etc.	This may prevent the widespread surface water flooding found in the residential areas of the CDA from concentrating flow in one location.	N/A
RECEPTOR	Improved Weather Warning		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Policies can be adopted to specify more stringent SuDS / surface water peak runoff control / volume	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	These can be investigated in areas where other measures are not technically or economically viable.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure.
	Improved Resilience and Resistance Measures		Commercial or property level resilience measures	Review flood risk management measures within the CDA and improve as necessary.	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CDA ID: LBT_06		LBT_06																														
Option No.	Option (Scheme Category)	Standard Measures														Short listing Options					Take Forward Option to Detailed Assessment?	Comments										
		SOURCE				PATHWAY				RECEPTOR						Appropriate Measures Available?	Technical	Economic	Social	Environmental			Objectives	Overall								
Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sowers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures						Improved Weather Warning	Planning Policies to Influence Development			Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures				
1	Do Nothing																							✓	2	-1	-2	0	-2	-3	✗	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	Do Minimum																							✓	2	0	-1	0	-1	0	✗	
3	Improved Maintenance																							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	Planning Policy																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on Greenfield land within the CDA.
5	Source Control, Attenuation and SUDS																						N/A	✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer social and flood risk benefits.
6	Flood Storage / Permeability																							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users.
7	Separate Surface Water and Foul Water Sewer Systems																							✓	-1	-2	0	0	1	-2	✗	The CDA uses a combined system. A cost benefit analysis is required to determine if this should be investigated further.
8	De-culvert / Increase Conveyance																							✓	1	1	0	1	2	5	✓	This may prevent the widespread surface water flooding found in the residential areas of the CDA from concentrating flow in one location.
9	Preferential / Designated Overland Flow Routes																							✓	2	1	0	0	2	5	✓	Modifying kerb and flow patterns along Ambertry Road and The Meadway to divert flows into SuDS measures should be investigated.
10	Community Resilience																							✓	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	Infrastructure Resilience																							✓	2	1	1	0	1	5	✓	This option could be considered for the station and industry predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	Other - Improvement to Drainage Infrastructure																							✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	Other or Combination of Above																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices and preferential overland flows could assist in 'cutting off' the overland flow routes within the CDA.

Loughton, Buckhurst Hill and Theydon Bois Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in the north eastern portion of the study area. The main flow route shown by the modelling is from west to east towards the River Roding. Surface water flooding is predicted in various locations through the CDA due to the topography and being trapped behind raised features of building. Water flows along Coppice Row and Piercing Hill in an easterly direction and ponds in Theydon Bois station car park and in the properties around Slade End.

Tidal/fluvial flood zones are not located within the CDA.

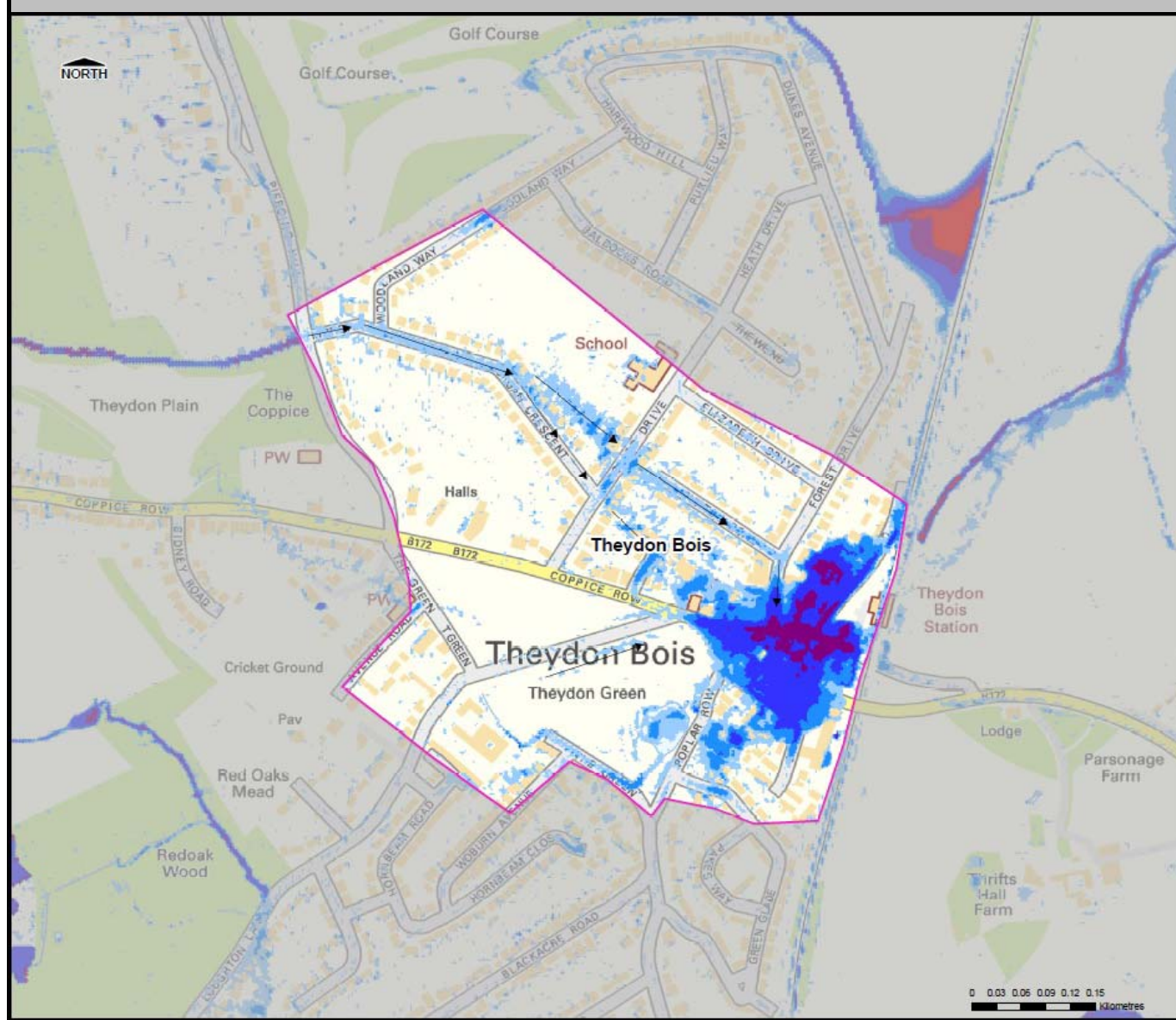
The northern part of the CDA is at moderate susceptibility to groundwater flooding. The southern part is located at a low susceptibility to groundwater flooding.

Opportunity Area

LBT_01

1

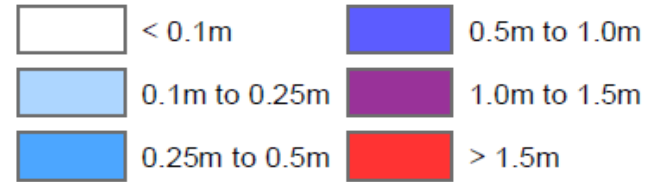
Theydon Bois



LEGEND

➔ Flow Direction

Surface Water Flood Depth (m)



PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		

Flood Risk Source

Surface Water		Yes
Groundwater		No
Ordinary Watercourse		No
Fluvial		No
Tidal		No

Validation

Historic Events		Yes
Site Inspection		Yes



**LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX**

IDENTIFICATION OF MEASURES

CDA ID: LBT_01 1. Theydon Bois					
	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	Green Roof		Green Roofs are an excellent source control measure that can be implemented where soil / geology makes implementing infiltrating SuDS challenging. These are suitable for retrofits on council owned lands, School properties and housing society / social housing sites	Some potential for the Theydon Bois County Primary School within the CDA to provide some attenuation for the flooding predicted.	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Soakaways / sub-surface infiltration can be incorporated into smaller / 'tight' areas without compromising the use of the lands above (such as playing fields). Performance depends upon the infiltration rate of the underlying geology.	Could help alleviate problem in high risk areas. Underlying London Clay may prohibit effective functioning of measure.	Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Swales provide a means of managing surface water above ground - slowing and infiltrating runoff at the surface. They are generally shallower and wider than ditches.	Swales can be incorporated into new development or retrofitted into open spaces like parks.	Site identified to the south of the CDA within Theydon Green.
	Permeable Paving		Permeable paving can be used to promote storage / infiltration when replacing aging car parks as well as be used for parking areas in roads for road reconstruction projects.	Throughout CDA. Could be effective in large areas of paving such as Theydon Bois station car park. Would require a location for water to drain through to.	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Rainwater harvesting involves the collection of rooftop rainwater and storing it for future use (such as toilet flushing or landscape irrigation)	Majority of area is residential, therefore Rainwater Harvesting would be difficult to implement.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located on the Theydon Bois County Primary School.
	Detention Basins		A strategically located detention basin could be constructed where runoff flows out of bank (or is diverted into) as a result of the OWC/main river being culverted under the downstream urban area or lost due to urban creep.	These can be located in open areas like parks and can be used to temporarily store surface water from overland flows (like roads). One area identified to the south of the CDA. Lack of open space near entrances to culverts makes this measure difficult to implement.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA or within the CDA.	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits, large open spaces within the CDA could provide considerable attenuation if turned into ponds. Two ponds can be located within Theydon Bois County School and two additional ponds can be located in the east and west of Theydon Bois Green.	Review of preferred type of SuD should be considered bioretention, wetland or pond preferred over detention basin.
	Other 'Source' Measures		Strategically placed bioretention devices / rain gardens can be incorporated throughout the CDA	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits. Bioretention can be situated just to the south east of CDA along Theydon Park Road and in the north east of the CDA along Forest Drive.	An assessment of any parking requirements (based on number of properties etc.) should be undertaken along with a review of any impacts to services and a determination of the drainage network that it would connect into.
PATHWAY	Increasing Capacity in Drainage Systems		The existing drainage system capacity could be increased to accommodate storm water	This option could be coupled with SuDS through the installation of a 'perforated pipe', where water will be encouraged to infiltrate into the ground along the flow path. However, this is a costly approach and would cause disruption to local residents. Increasing drainage capacity through the railway embankment could reduce flood depths in Theydon Bois station car park.	Review the incorporation of these measures once large SuDS attenuation and diversion measures have been implemented.
	Separation of Foul and Surface Water Sewers		Separation of combined drainage networks into foul and surface water systems	The combined network in this CDA could be separated. This would require a cost benefit analysis. This could be combined with other measures relating to the drainage network.	
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course.
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' and 'Ponds and Wetlands' comments above.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)	Modifying kerb and flow patterns along Coppice Row could prevent flow reaching areas where water is shown to pond. Unlikely to alleviate problem but could improve the situation.	Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates.	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	No watercourses impact the CDA.
	Other 'Pathway' Measures	N/A	Modify flow paths within a CDA - could include introducing culverts to reduce area of ponding with overland flow paths that are obstructed etc.	N/A	N/A
RECEPTOR	Improved Weather Warning		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more effective if coupled with community education. Added flood alleviation value could be achieved if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Policies can be adopted to specify more stringent SuDS / surface water peak runoff control / volume	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	These can be investigated in areas where other measures are not technically or economically viable.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure.
	Improved Resilience and Resistance Measures		Commercial or property level resilience measures	Review flood risk management measures within the CDA and improve as necessary.	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CDA ID: LBT_01		LBT_01																														
Option No.	Option (Scheme Category)	Standard Measures														Short listing Options					Take Forward Option to Detailed Assessment?	Comments										
		SOURCE				PATHWAY				RECEPTOR						Appropriate Measures Available?	Technical	Economic	Social	Environmental			Objectives	Overall								
Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sowers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures						Improved Weather Warning	Planning Policies to Influence Development			Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures				
1	Do Nothing																							✓	2	-1	-2	0	-2	-3	✗	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	Do Minimum																							✓	2	0	-1	0	-1	0	✗	
3	Improved Maintenance																							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	Planning Policy																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on Greenfield land within the CDA.
5	Source Control, Attenuation and SUDS																							✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer social and flood risk benefits.
6	Flood Storage / Permeability																							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated within the area of open space south of Coppice Row.
7	Separate Surface Water and Foul Water Sewer Systems																							✓	-1	-2	0	0	1	-2	✗	The CDA uses a combined system. A cost benefit analysis is required to determine if this should be investigated further.
8	De-culvert / Increase Conveyance																							✗	1	1	0	1	2	✓	N/A	
9	Preferential / Designated Overland Flow Routes																							✓	2	1	0	0	2	5	✓	Modifying kerb and flow patterns along Coppice Row to divert flows into SuDS measures within the open space south of that location should be investigated.
10	Community Resilience																							✓	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	Infrastructure Resilience																							✓	2	1	1	0	1	5	✓	This option could be considered for the station and industry predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	Other - Improvement to Drainage Infrastructure																							✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	Other or Combination of Above																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices and preferential overland flows could assist in 'cutting off' the overland flow routes within the CDA.

Loughton, Buckhurst Hill and Theydon Bois Surface Water Management Plan - Options Appraisal Summary

PROBLEM IDENTIFIED:

This CDA is located in the central portion of the study area. The risk of surface water flooding within the CDA is high as Loughton Brook flows through the area. Ponding is shown in the topographic low point across Church Hill and in the supermarket car park. An overland flow route is present where Loughton Brook is culverted within the CDA. The pipe network is running at or near to capacity during the model simulation.

Fluvial Flood Zones 3 and 2 are located within the CDA. No tidal Flood Zones are found within the CDA.

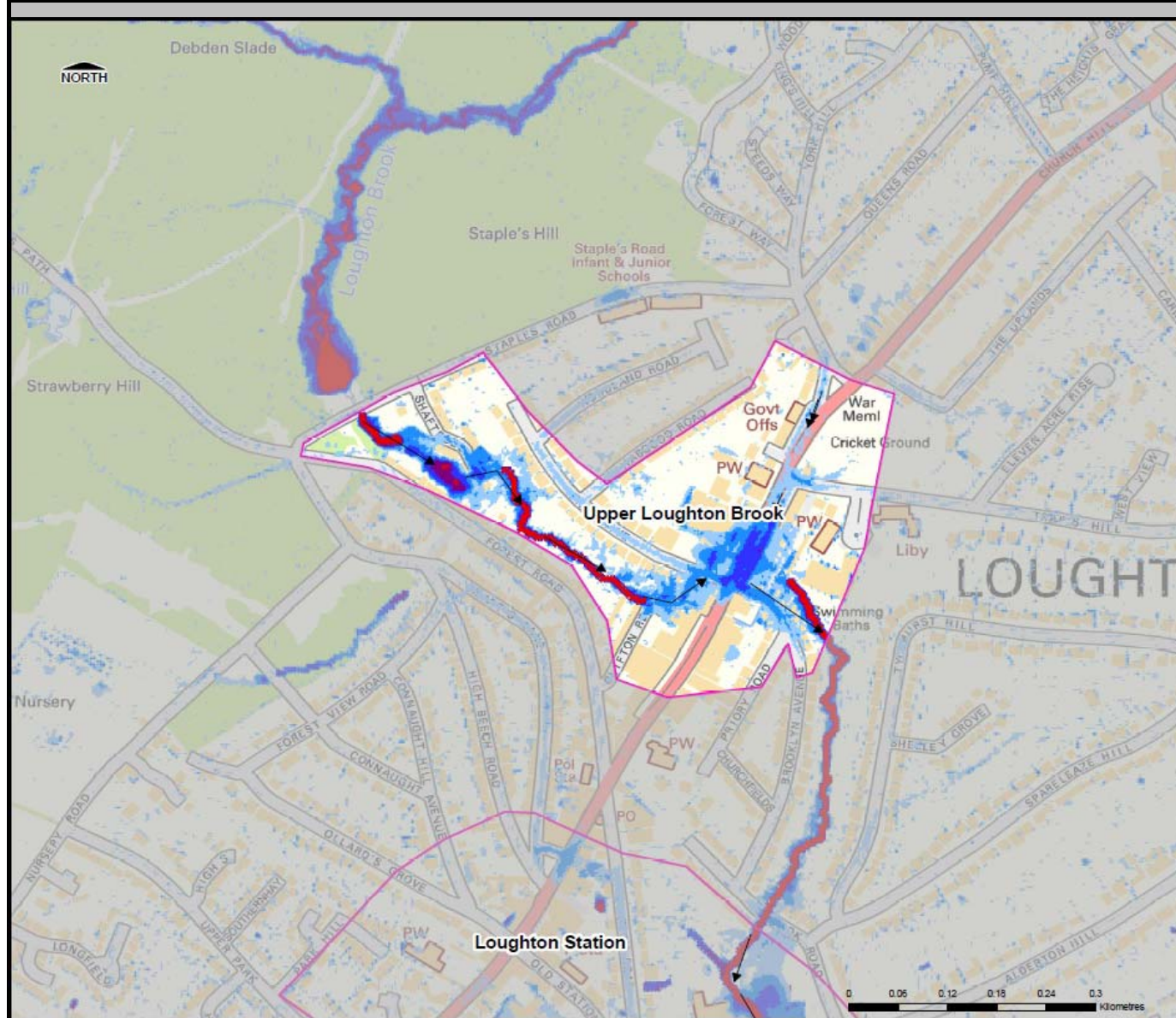
The CDA has low (<25%) susceptibility to groundwater flooding.

Opportunity Area

LBT_03

3

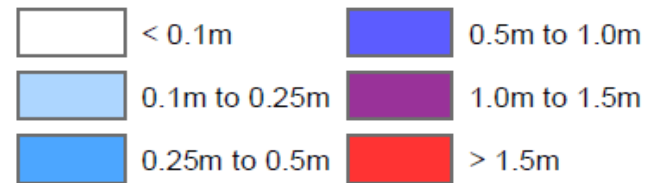
Upper Loughton Brook



LEGEND

➔ Flow Direction

Surface Water Flood Depth (m)



PREFERRED OPTIONS SUMMARY:

Options Summary	Available Option	Preferred
Do Nothing		
Do Minimum		
Improved Maintenance		
Planning Policy		
Source Control, Attenuation and SUDS		
Flood Storage / Permeability		
Separate Surface Water and Foul Water Sewer Systems		
De-culvert / Increase Conveyance		
Preferential / Designated Overland Flow Routes		
Community Resilience		
Infrastructure Resilience		
Other - Improvement to Drainage Infrastructure		
Other or Combination of Above		

Flood Risk Source

Surface Water		Yes
Groundwater		No
Ordinary Watercourse		No
Fluvial		Yes
Tidal		No

Validation

Historic Events		Yes
Site Inspection		Yes



**LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX**

IDENTIFICATION OF MEASURES

CDA ID: LBT_03 3. Upper Loughton Brook					
	Measure	Opportunity Assessment	Description	Location / Specific Details	Comments
SOURCE	Green Roof		Green Roofs are an excellent source control measure that can be implemented where soil / geology makes implementing infiltrating SuDS challenging. These are suitable for retrofits on council owned lands, School properties and housing society / social housing sites	High proportion of residential properties within CDA would make this difficult to implement	Implementation of this measures is to be identified on site-by-site basis when opportunities arise but likely to be limited opportunity for implementation of measure within the CDA.
	Soakaways		Soakaways / sub-surface infiltration can be incorporated into smaller / 'tight' areas without compromising the use of the lands above (such as playing fields). Performance depends upon the infiltration rate of the underlying geology.	Could help alleviate problem in high risk areas. Underlying London Clay may prohibit effective functioning of measure in some areas of CDA.	Further investigation is needed to assess the infiltration potential due to geology.
	Swales		Swales provide a means of managing surface water above ground - slowing and infiltrating runoff at the surface. They are generally shallower and wider than ditches.	Throughout CDA where possible. Swales can be incorporated into new development or retrofitted into open spaces like parks. Lack of open space within CDA may prohibit implementation of measure.	Possible location within the cricket ground in the north easter part of the CDA to divert water to the pond.
	Permeable Paving		Permeable paving can be used to promote storage / infiltration when replacing aging car parks as well as be used for parking areas in roads for road reconstruction projects.	Throughout CDA. May help to prevent water following road network. Permeable paving can be placed along King's Green in the north east of the CDA.	Infiltration from base of measure is likely to be limited due to geology. Permeable paving with subsurface drainage may be suitable for the area. Further investigation is needed to assess the infiltration potential due to geology.
	Rainwater Harvesting		Rainwater harvesting involves the collection of rooftop rainwater and storing it for future use (such as toilet flushing or landscape irrigation)	Majority of area is residential, therefore Rainwater Harvesting would be difficult to implement in these areas. May be feasible outside the CDA to the North at Staples Road Primary School and within the CDA at the leisure centre.	Locate waterbutts (or harvesting) on all buildings within the CDA with large re-use harvesting measures located at Staples Road Primary School and at the leisure centre.
	Detention Basins		A strategically located detention basin could be constructed where runoff flows out of bank (or is diverted into) as a result of the OWC/main river being culverted under the downstream urban area or lost due to urban creep.	These can be located in open areas like parks and can be used to temporarily store surface water from overland flows (like roads). Lack of open space in areas showing surface water flooding makes this measure hard to implement. Large open spaces upstream of CDA can provide some attenuation.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Ponds and Wetlands		A strategically located pond could be constructed to manage the surface water from the upstream catchment of the CDA or within the CDA.	Open spaces along surface water flowpaths can be identified for pond / wetland retrofits, these can be located just upstream of the CDA to the west. Large open spaces upstream of CDA can provide some attenuation.	Review of preferred type of SuD should be considered bioretention, wetland or pond preferred over detention basin.
	Other 'Source' Measures	N/A	Strategically placed bioretention devices / rain gardens can be incorporated throughout the OA	N/A	N/A
PATHWAY	Increasing Capacity in Drainage Systems		The existing drainage system capacity could be increased to accommodate storm water	This option could be coupled with SuDS through the installation of a 'perforated pipe', where water will be encouraged to infiltrate into the ground along the flow path. However, this is a costly approach and would cause disruption to local residents. Increased capacity of Loughton Brook culverts may help alleviate surface water flow routes. This would require consultation with the EA	Review the incorporation of these measures once large SuDS attenuation and diversion measures have been implemented.
	Separation of Foul and Surface Water Sewers		Separation of combined drainage networks into foul and surface water systems	The combined network in this CDA could be separated. This would require a cost benefit analysis. This could be combined with other measures relating to the drainage network.	
	Improved Maintenance Regimes		Generic Measure. More regular inspection of the current sewer system to remove debris and improve conveyance.	Throughout CDA. Improved conveyance of Loughton Brook may help to convey surface water away from the CDA.	To be identified on site-by-site basis focussing on those areas / streets known to regularly flood and the maintaining and clearing debris of the ordinary water course.
	Managing Overland Flows (Online Storage)		Creating areas for temporarily storing runoff during a storm event	Refer to 'Detention Basin' and 'Ponds and Wetlands' comments above.	Impacts on the dual use (recreation and runoff management) of the area should be assessed.
	Managing Overland Flows (Preferential Flowpaths)		Modifying street and kerb levels to create a formal flow path (blue corridor)	This could be used in combination with storage measures to direct flow into areas of temporary or permanent storage.	Disabled access along the road would need to be considered when assessing this measure.
	Land Management Practices		Manage runoff rates / volumes from upstream catchment areas to ensure they are not increase from the existing scenario	Include policy to manage runoff rates.	Not applicable due to CDA being heavily urbanised.
	Deculverting Watercourse(s)	N/A	Deculverting watercourses to a natural condition or reducing the length of a culverted ditch	N/A	High proportion of residential properties within CDA would make this difficult to implement
	Other 'Pathway' Measures		Modify flow paths within a CDA - could include introducing culverts to reduce area of ponding with overland flow paths that are obstructed etc.	Surface water flow routes are present due to Loughton Brook and would be difficult to modify.	N/A
RECEPTOR	Improved Weather Warning		Provide greater warning to residents on the risk of a possible flood event.	Depending on the timings of the storm event evacuation of these properties could be possible.	This measure is likely to be more affective if coupled with community education. Added flood alleviation value could be achieve if this measure was carried in tandem with a property level demountable flood barriers.
	Planning Policies to Influence Development		Generic Measure	Policies can be adopted to specify more stringent SuDS / surface water peak runoff control / volume	For all new development or areas of urban creep which may increase the total volume of runoff within the CDA
	Temporary or Demountable Flood Defences		Household / building level demountable flood barriers.	These can be investigated in areas where other measures are not technically or economically viable.	This measure will need to be deployed in parallel with an efficient flood warning system and community education so that site users are aware of their roles and responsibilities before and during a flood event
	Social Change, Education and Awareness		Generic Measure	Throughout CDA	Will be dependent on engagement opportunities with community. In areas with a large migration of population it will be difficult to undertake / pass on information from one property owner to other. The inclusion of advice on flooding during the sale and lease of properties may assist in promoting this measure.
	Improved Resilience and Resistance Measures		Commercial or property level resilience measures	Review flood risk management measures within the CDA and improve as necessary.	This measure would achieve additional effectiveness when coupled with an appropriate flood warning system as well as education and awareness. To be identified on site-by-site basis.
	Other 'Receptor' Measures	N/A			

LOUGHTON, BUCKHURST HILL and THEYDON BOIS SURFACE WATER MANAGEMENT PLAN
SURFACE WATER OPTION SCORING MATRIX

OPTIONS IDENTIFICATION AND SHORTLISTING

CDA ID: LBT_03		LBT_03																														
Option No.	Option (Scheme Category)	Standard Measures														Short listing Options					Take Forward Option to Detailed Assessment?	Comments										
		SOURCE				PATHWAY				RECEPTOR						Appropriate Measures Available?	Technical	Economic	Social	Environmental			Objectives	Overall								
Green Roof	Soakaways	Swales	Permeable Paving	Rainwater Harvesting	Detention Basins	Ponds and Wetlands	Other 'Source' Measures	Increasing Capacity in Drainage Systems	Separation of Foul and Surface Water Sowers	Improved Maintenance Regimes	Managing Overland Flows (Online Storage)	Managing Overland Flows (Preferential Flowpaths)	Land Management Practices	Deculverting Watercourse(s)	Other 'Pathway' Measures						Improved Weather Warning	Planning Policies to Influence Development			Temporary or Demountable Flood Defences	Social Change, Education and Awareness	Improved Resilience and Resistance Measures	Other 'Receptor' Measures				
1	Do Nothing																							✓	2	-1	-2	0	-2	-3	×	In line with PAG the 'do nothing' option (no intervention and no maintenance) and 'do minimum' (continuation of current practise) should be taken forward to the detailed options assessment.
2	Do Minimum																							✓	2	0	-1	0	-1	0	×	
3	Improved Maintenance																							✓	2	2	1	0	1	6	✓	This option will be relatively easy to implement by increasing the regularity of the existing maintenance regime. It is however only likely to see localised flooding benefits.
4	Planning Policy																							✓	2	2	0	1	0	5	✓	To implement this option into new developments would be relatively simple. Once an area has been identified as being in a CDA policies to manage the surface water on the site are already in place. These could be reiterated in forthcoming policy documents. This could relate to development on Greenfield land within the CDA.
5	Source Control, Attenuation and SUDS																							✓	1	1	1	1	1	5	✓	Implementation of property level SuDS measures such as rainwater harvesting systems, bioretention devices, permeable driveways etc. are likely to offer the some social and flood risk benefits.
6	Flood Storage / Permeability																							✓	1	1	0	2	1	5	✓	Providing additional storage within the CDA may assist with reducing the overall risk to properties and residents/site users. It is recommended that temporary storage of flows from the upper catchment is investigated within the area of open space to the east of High Road and to the West of the CDA at the start of a tributary to Loughton Brook.
7	Separate Surface Water and Foul Water Sewer Systems																							✓	-1	-2	0	0	1	-2	×	The CDA uses a combined system. A cost benefit analysis is required to determine if this should be investigated further.
8	De-culvert / Increase Conveyance																							✓	1	1	0	1	2	5	✓	Surface water flow routes are present due to Loughton Brook and would be difficult to modify.
9	Preferential / Designated Overland Flow Routes																							✓	2	1	0	0	2	5	✓	Modifying kerb and flow patterns within the cricket ground to divert flows into SuDS measures (pond) should be investigated.
10	Community Resilience																							✓	2	1	1	0	1	5	✓	This option could protect properties from flooding through the installation of flood barriers on the doors of properties. There may be local resistance to the uptake of the barriers and the success of the barriers relies on human intervention and the dissemination of appropriate flood warnings. It is also a costly exercise to fit multiple properties with demountable barriers and/or property level resilience measures. Property level measures, such as ensuring building and gate thresholds and installation of water butts, for example, may provide some benefits.
11	Infrastructure Resilience																							✓	2	1	1	0	1	5	✓	This option could be considered for the station and industry predicted to flood in the CDA, but is likely to be achieved through improved education / awareness and small scale SuDS measures such as rainwater harvesting.
12	Other - Improvement to Drainage Infrastructure																							✓	1	0	1	1	2	5	✓	A local increase in drainage capacity within the CDA is technically feasible and will achieve local flood alleviation and potentially more widespread flood alleviation. However, further investigation into the local drainage capacity is required prior to implementation.
13	Other or Combination of Above																							✓	2	0	1	1	2	6	✓	It is recommended that a combination of rainwater harvesting, bioretention / rain garden devices and preferential overland flows could assist in 'cutting off' the overland flow routes within the CDA.