

Suffolk Coastal and Waveney District Councils Level 2 Strategic Flood Risk Assessment

East Suffolk Councils

April 2018

Quality information

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Revision History

Revision	Revision date	Details	Authorized	Position
0	February 2018	Draft for Comment	Galo Pinto	Regional Director
1	April 2018	Final	Galo Pinto	Regional Director

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Abbreviations

Acronym	Definition
AAP	Area Action Plan
AEP	Annual Exceedance Probability
EA	Environment Agency
ESC	East Suffolk Councils
FRMS	Flood Risk Management Strategy
NPPF	National Planning Policy Framework
PPG	Planning Practice Guidance
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems

1. Introduction

1.1 Background

This Level 2 Strategic Flood Risk Assessment (SFRA) has been prepared on behalf of Waveney District Council and Suffolk Coastal District Council, jointly referred to as East Suffolk Councils (ESC). This assessment follows completion of the Level 1 SFRA, and should be read in conjunction with this study. The purpose of the Level 2 assessment is to analyse the level of flood risk associated with allocated development sites within the study area, in accordance with the National Planning Policy Framework (NPPF) and the National Planning Practice Guidance (PPG).

Five allocated development sites have been identified by ESC for assessment through this SFRA. These sites have been allocated during the ongoing formulation of the Waveney District Council Local Plan, and are all located in the Lowestoft area. The development proposed at each of the allocated sites is outlined within the Lowestoft, Lake Lothing and Outer Harbour Area Action Plan (AAP)¹ and the Waveney District Council First Draft Plan².

A brief profile has been created for each of these sites, providing an overview of the various sources of flood risk based on the datasets collected during the production of the Level 1 SFRA. This desktop information has been further complemented by observations collected during a site visit, undertaken in December 2017, and discussion with officers from the Coastal Management Partnership East.

Key recommendations for managing flood risk are provided for each site. The suitability of the proposed development in accordance with the NPPF has been identified and the main requirements for satisfying the Sequential and Exception Tests clarified. For full details of the NPPF risk-based approach to planning, including the Sequential and Exception Test process, reference should be made to Chapter 4.1 of the Level 1 SFRA.

In considering each of these assessment reports, it should be noted that the majority of the maps have been adapted from Environment Agency (EA) datasets. Due to the strategic level at which the underlying datasets have been produced, these maps are not appropriate to act as the sole evidence for any site specific planning or regulatory decision or assessment of flood risk.

The following sections provide further detail on key flood risk elements relevant to the Lowestoft area, which are referenced throughout site reports.

1.2 Study Area and Flood History

All five sites are located within the centre of Lowestoft or surrounding area, as shown in Figure 01, Appendix A. Lowestoft is located on the estuary of the River Waveney, locally known as Lake Lothing, which forms the boundary between Waveney District Council and Suffolk Coastal Council. The primary flood risk to the area is associated with tidal sources, caused by a tidal surge that develops in the North Sea, along the east coast of the UK. Flooding associated within this mechanism previously occurred with devastating effect in 1953, and more recently in December 2013.

Lowestoft is additionally vulnerable to surface water flooding, particularly around Kirkley Stream, Aldwick Way and Velda Close, as demonstrated by the significant flooding in July 2015. Within the local area, there is a close interaction between tidal and surface water flooding as many local drainage systems discharge into the tidal watercourse, which has historically led to surcharge of the surface water system during high tidal events. Historic flooding records within the study area are illustrated in Figure 02 in Appendix A.

1.3 Flood Defences

1.3.1 Existing Flood Defence

Lowestoft has very limited existing tidal flood defences and without future investment will remain at significant risk. There are no 'formal' flood defences protecting the area, according to EA asset databases. However, there

¹ <http://consult.waveney.gov.uk/consult/ti/adoptedaap2012/viewCompoundDoc?docid=2686644&sessionId=&voteid=>

² <http://consult.waveney.gov.uk/consult/ti/firstdraftlocalplan2017/>

are extensive lengths of hard engineered river banks along the River Waveney and broad sea walls along the coastline.

Whilst not classified as formal flood defences, these structures, along with the adjacent harbour, offer some level of protection from both fluvial and tidal flooding. The images below were captured during the site visit and provide examples of the of river and sea walls currently existing in Lowestoft.



Figure 1-1 - Example of river wall along the Kirkley Waterfront and Sustainable Urban Neighbourhood Site (source: AECOM, December 2017)



Figure 1-2 - Example of sea wall along the PowerPark site (source: AECOM, December 2017)

The engineered river wall extends from the outer harbour approximately 800m inland, providing protection on both sides of the River Waveney. Construction techniques and condition of the bank varies along this distance. The coastline is protected by a wave-return sea wall which stretches from Links Road in the north to Parade Road in the south, much of which is fronted by rip rap.

These structures are understood to have been built primarily to protect the estuary from fluvial and coastal erosion. Although some level of protection is provided, this is insufficient to protect against flooding from significant tidal surges or extreme rainfall events, as demonstrated by the 2013 event. As a result, further flood protection schemes are being undertaken in the area, as discussed below.

1.3.2 Temporary Flood Defence

In reaction to the recent flooding in the Lowestoft area, the ESC and food risk management partners introduced a temporary flood defence scheme in November 2016. This system comprises of 1.4 km of temporary flood barriers, assisting to reduce the current risk of tidal flooding to the most vulnerable areas in Lowestoft, whilst a longer-term flood alleviation solution is being progressed (further discussed below).

A deployment plan is in place to determine how and when the defences are deployed. The plan has been developed in partnership with members of Suffolk Resilience Forum, including the Environment Agency. Quay heights in Lowestoft differ and therefore the decision to deploy the temporary defences is made based upon the conditions and impacts of each weather event, but is linked to the issuing of Flood Warnings. Quay height for the south side is 2.5 m and for the north side is 2.8 m. The decision to deploy the defences is made by Waveney District Council and taken under advice from the Suffolk Resilience Forum and the Environment Agency.

Such event occurred when a flood warning was received in 2017. The barriers were operated safely and on time; however, due to changes in wind direction, their flood protection functionality was not fully tested. The location of the temporary defences is illustrated in the plan contained in Appendix B.

It should be noted that the temporary flood barriers will provide a significantly lower level of protection as compared to the proposed permanent flood alleviation scheme (discussed below). They are designed to help to reduce flood risk to an estimated 1 in 75 year return period and have much reduced tidal bank coverage. Additionally, the temporary barriers crucially do not fully address the risk of sewer backflow, which was a significant contributing factor in the 2013 flooding event.

1.3.3 Future Flood Defence - Lowestoft Flood Risk Management Project

Tidal Flood Risk

The temporary flood defence scheme was implemented as a provisional mitigation option, to reduce flood risk in the short-term, ahead of delivery of a long-term solution, proposed under the Lowestoft Flood Risk Management Project. Numerous flood risk studies have been undertaken to consider the options for flood mitigation in Lowestoft and support the development of this scheme. In May 2016, the EA approved the Strategic Outline Case for installation of the permanent defences and in June 2017 Waveney District Council (as lead authority), approved the progression of the project to Outline Business Case. This is due for presentation to the EA's Large Project Review Group in 2018. Providing approval is provided, the project will gain access to Flood Defence Grant in Aid funding.

The Lowestoft Flood Risk Management Strategy (FRMS)³ set out the various options assessed for flood protection. The preferred option selected for progression is *Option 5 – Bascule Bridge Barrier and Walls*, shown in Figure 1-3. This option comprises the construction of a barrier across the channel entrance to Lake Lothing on the seaward side of the Bascule Bridge. Additionally, 1.5 km of floodwall will be installed along the Outer Harbour, tying into the river barrier and onwards to Royal Green. The works would provide protection up to the 1 in 200 year tidal event. For the latest information on progress of the Lowestoft Flood Risk Management Project, reference should be made to the project [website](#)⁴.

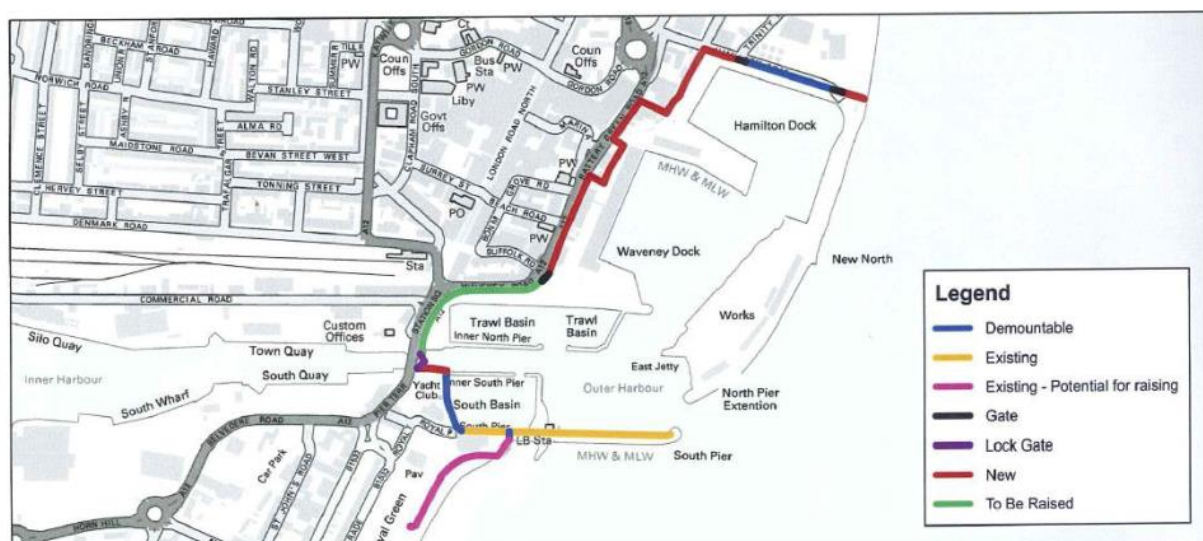


Figure 1-3 – Existing and proposed permanent outer harbour defences (source: Lowestoft hydraulic modelling study, CH2M, 2014)

Once the flood alleviation scheme is in place (if delivered as per current proposals), much of the area will benefit from a higher standard of protection and there will be greater opportunity for future development. However, it is understood that the proposed Lowestoft Flood Alleviation Project is still under development and as the scheme has not yet gained full funding approval, it may be subject to change. For this reason, post-development flood extents have not been published within this report, as these may not provide an accurate indication of future flood risk. Prior to implementation, all current development must be planned and designed to reflect the current levels of flood risk shown Appendix A. However, the impact of the current proposals on potential future flood risk has been considered within each of the site assessments, to provide an indication of future development potential, following implementation of the scheme.

Surface Water Flood Risk

In addition to mitigation of tidal risk, the Lowestoft Flood Risk Management Project is also exploring options to reduce the risk of flooding from extreme rainfall, particularly focusing around the Kirkley Stream Catchment. Hydraulic modelling of the Kirkley Stream is currently being finalised (as further discussed below) and will inform the final outcome options for consultation, these include:

³ Lowestoft Flood Risk Management Strategy (2016) Summary 2016 available at: http://www.lowestoftfmp.org.uk/media/1050/consultation_lowestoft.pdf

⁴ <http://lowestoftfmp.org.uk/>

- Upstream flood storage;
- Retrofitting of Sustainable Drainage Systems (SuDS);
- Improving conveyance of water through the stream;
- Installing non-return valves;
- Local mitigation measures such as property level protection; and
- Construction of a flood wall.

Dependant on the results of subsequent public consultation, a preferred option for the pluvial and fluvial element of the project will be progressed in line with the approval of the Outline Business Case by the EA in spring 2018.

1.3.4 Defence Breach

There are currently no 'formal' flood defences within the Lowestoft area; however, some level of protection is provided through 'informal' and coastal erosion defences. No up-to-date breach modelling is available within the area. As the area is not classified as benefitting from defences, breach modelling is not a strict requirement. However, breach modelling would provide value in understanding flood risk and consideration of breaching may still be required at a site specific level. The nature of flood protection in this area will change significantly following implementation of the permanent defences proposed as a part of the Lowestoft Flood Risk Management Project and therefore it is recommended that strategic scale breach modelling is undertaken at this stage.

1.4 Local Flood Risk Studies

1.4.1 Kirkley Stream Hydraulic Modelling

Kirkley Stream is located to the south of Lowestoft. It is part Main River (managed by the EA), part piped Anglian Water sewer and, further downstream, a Shared Watercourse between SCC and Anglian Water. The source of Kirkley Stream is at the junction between Hall Road and The Street, which is the north eastern corner of the Carlton Colville development site. In recent years this watercourse has flooded due to extreme rainfall and potential hydraulic blockage. Subsequently, hydraulic modelling of the watercourse and surrounding area has been undertaken in order to obtain a greater understanding of the flooding mechanisms and provide improved definition of anticipated flood extents. This modelling considers the interaction between fluvial and surface water/sewer sources within the Kirkley Stream Catchment, thereby providing a combined flood risk outline. This representation varies from the strategic level EA datasets for fluvial, tidal and surface water flood risk, which provide separate consideration of these sources. It should be noted that the modelling has not been included within the strategic datasets mapped within the Level 1 SFRA for this reason.

The draft results of the Kirkley Stream modelling are depicted in Figure 05, Appendix A. This is useful as an alternate reference to provide a greater understanding of flood risk in this area, particularly considering the interaction between different sources of flooding. However, it should be noted that this modelling is currently being further refined and updated, as a part of the ongoing work associated with the Lowestoft Flood Risk Management Project. Therefore, it is recommended that this mapping is only used to provide an initial indication of localised flood risk and that reference is made to the most up-to-date flood outlines, which are due to be available for consideration later in 2018. For the latest available updates regarding the modelling and associated flood alleviation work, reference should be made to the information and contact details contained on the [Lowest Flood Risk Management Project website](http://lowestoftfrmp.org.uk/contact-us/)⁵.

1.4.2 Cumulative Land Raising Study

The Cumulative Land Raising Study⁶ was undertaken in 2008 and considered the potential impacts on tidal flood risk, which would arise from land raising associated with the strategic development of seven sites in the Lake Lothing area. This land raising scheme was initially proposed in order to provide flood risk mitigation in order to facilitate the regeneration of the Lake Lothing waterfront area. Four of the seven sites assessed during this study are within the boundaries of the designated Level 2 development areas; therefore, the results of the land raising study have relevance to this SFRA.

⁵ <http://lowestoftfrmp.org.uk/contact-us/>

⁶ Scott Wilson (2008) Cumulative Land Raising Study; Available at: <http://www.eastsuffolk.gov.uk/assets/Planning/Waveney-Local-Plan/Cumulative-Land-Raising-Study/01-Cumulative-Land-Raising-Study-Main-Document.pdf>

Three land raising scenarios were modelled as part of the study. The analysis generally demonstrated that the impact of the land raising on surrounding tidal levels was minimal, suggesting the majority of sites considered do not perform a tidal flow conveyance function. However, it should be noted that a potential flow path was obstructed by one of the sites (subsequently removed from consideration); thus leading to the conclusion that site-specific consideration of impact is required.

2. PowerPark

2.1 Overview

PowerPark comprises the area south of Ness Point and west of Battery Green Road and includes Hamilton Dock, Waveney Dock, along with parts of Trawl Dock and Outer Harbour. Much of the site is occupied by the Beach Industrial Estate, comprising a mixture of industrial, office and retail wholesale premises. The site covers an area of 24.7 hectares and is home to the OrbisEnergy Centre, which provides start-up space for businesses focused upon the energy sector.

The Area Action Plan (AAP) for Lowestoft seeks to develop a cluster of businesses focused upon the energy sector and offshore engineering within this site. A number of businesses operating in this sector are already present on the site including Sebmarine SLP, SSE and Siemens. It is understood that the site will continue to be employment-led, with no residential development.

2.2 Assessment of Flood Risk

2.2.1 Flood History

The site is located within the extent of historic flooding from the Waveney Estuary (Lake Lothing), as shown in Figure 02, Appendix A.

2.2.2 Tidal and Fluvial Flood Risk

The site is predominately located in Flood Zone 3 as associated with Lake Lothing (>0.5% Annual Exceedance Probability (AEP)). The remaining areas of the site are primarily located in Flood Zone 2 (0.5% – 0.1% AEP), with some small areas of Flood Zone 3b (> 5% AEP) along the coastline, as illustrated in Figure 03, Appendix A.

Figures 09 to 11, Appendix A, show the hazard, depth and velocity for the 5%, 0.5%, 0.5% plus climate change and 0.1% AEP flood events.

Under the 5% AEP event, flooding is anticipated to be relatively shallow (less than 0.25 m in depth) and slow (less than 0.3 m/s velocity), and is confined to localised areas along the site boundary. The extent of flooding increases under the 0.5% AEP event, with depths up to 1 m in some areas of the site. Under this scenario, flood hazard is primarily rated as 'Low Hazard', with some areas of 'Danger for Some'. Under the 0.1% AEP event, the entire site is anticipated to be inundated, with depths over 1 m in some locations and localised flood velocities of up to 1.5 m/s, particularly towards the centre of the site. The flood hazard represents 'Danger for Most' across the majority of the site.

The area is not formally classified as benefitting from defences and therefore there is currently no updated breach modelling available for this stretch of the coastline. However, it is possible for a breach to occur in the 'informal' flood defences which provide protection to the area. Therefore, further site-specific assessment may be required to inform new development.

Considering the alignment of the current temporary flood defences (Appendix B), it is considered unlikely that direct benefit will be provided to the PowerPark area, should the barriers be deployed during a flood event.

Climate Change

As part of the recent hydraulic modelling studies completed by the EA in 2017, the future tidal flood extent has been estimated using predicted climate change conditions. The results of this modelling indicate that climate change will significantly increase the flood depth at the site. As shown in Figure 10.5 (Appendix A), PowerPark is predicted to be almost entirely submerged due to tidal flooding, during the 0.5% AEP plus climate change event. Under this scenario, flood depth, velocity and hazard is anticipated to be greater than the 0.1% AEP event. Flood hazard ranges from 'Danger for Some' to 'Danger for All' across the site.

Lowestoft Flood Risk Management Scheme

In its currently proposed form, the flood risk management scheme will involve construction of a floodwall from Hamilton Road to the new flood barrier across Lake Lothing. Modelling of the post-scheme scenario shows that

the proposed flood wall would prevent floodwaters from encroaching onto the site thus removing flood risk from the majority of the site (apart from some areas along the tidal frontage) during the 0.5% AEP event. As such, the level of flood risk to the site should be re-assessed once the flood alleviation scheme has been fully implemented.

2.2.3 Pluvial Flood Risk

The EA Surface Water Flood Mapping shown in Figure 04 (Appendix A), indicates that there is a localised area of high flood risk (3.3% AEP) between Wilde Street and Hamilton Road, as well as along Newcombe Road.

The 2017 Draft Kirkley Stream modelling results, shown in Figure 05 (Appendix A), depict concentrated flooding between Wilde Street and Hamilton Road. It should be noted that the Kirkley Stream modelling is currently being further refined and therefore reference should be made to the most updated flood outlines, which are due to be available for consideration later in 2018.

2.2.4 Groundwater Flood Risk

Based on geological indicators, the site is suggested to have limited potential for groundwater flooding to occur, as shown on Figure 06, Appendix A.

2.2.5 Flood Risk from Sewers and Artificial Sources

No information on flood risk from sewers or artificial sources has been identified for the site.

2.3 Managing Flood Risk

2.3.1 Conclusions

The Site is located predominantly within Flood Zones 3 and 2 and therefore a site specific flood risk assessment will be required for all development, to demonstrate that the development will be safe for its lifetime and not increase flood risk elsewhere. The Sequential Test is additionally required to demonstrate that development cannot be located in an area of lower flood risk.

The acceptability of each of the proposed land uses, and requirement for justification in accordance with the NPPF, is summarised in Table 2-1.

Table 2-1 - Requirement for justification of proposed land uses

Proposed Use	Vulnerability Classification	NPPF Flood Zone Compatibility	Sequential Test Required?
Commercial	Less vulnerable	✓	Yes
Open Space	Water compatible	✓	No

KEY: ✓ Development is appropriate

2.3.2 Recommendations

The following flood risk mitigation measures are recommended for this site:

- All more vulnerable aspects of development should be sequentially allocated to areas of the site at lower relative risk of flooding, with flood compatible development (such as open space) located in areas at the highest risk. Only water compatible development or essential infrastructure (subject to the Exception Test) should be considered within areas of the site shown to lie within Flood Zone 3b.
- To mitigate against tidal flood risk, Finished Flood Levels for 'more vulnerable' uses should be raised 300 mm above the estimated 0.5% AEP plus climate change tidal flood level. It is recommended that 'less vulnerable' uses also meet these requirements for Finished Floor Levels where achievable. Additionally, a dedicated 'safe haven' should be provided above the flood level to enable rapid escape should flooding occur. This refuge should be provided above the extreme 0.1% AEP flood level including an allowance for climate change. This may be provided in the form of a sheltered communal space on an upper level within the building, accessed via internal stairs and sufficient in size to safely house all occupants. Estimated flood depths are mapped in Figure 10, Appendix A.

- Site specific emergency evacuation procedures must be in place to ensure that risk to life is minimised should a flood event occur. Ideally, safe (low hazard) access and egress routes should be provided and lead to higher ground within Flood Zone 1. The EA tidal flood hazard mapping shows lowest flood hazard toward the west of the site and the Kirkley Stream modelling shows highest surface water flood risk towards the centre of the site. Therefore, site-specific emergency evacuation procedures should encourage occupants to egress the site towards the west. However, it should be noted that low hazard access pathways are not available across much of the site under the 0.5% plus climate change event, and therefore provision of safe access in several areas will be challenging in the current form.
- In areas of the site at flood risk, or where safe access cannot be achieved, an emergency flood plan must be provided, dealing with matters of evacuation and refuge.
- Much of the site is within Flood Zone 3. Any land raising or increased built footprint within the floodplain will require a level for level, volume for volume flood compensation storage if there is a risk of displaced flood waters and associated increase in the flood risk to surrounding areas. However, the 2008 Cumulative Land Raising Study⁹ demonstrated that land raising within this area resulted in minimal impact on surrounding tidal flood levels. Therefore, land raising or increased footprint may be acceptable within this area, without compensation. Any such proposals would need to be further investigated through site-specific analysis and agreement with the EA and Local Authority.
- A buffer strip should be maintained along all areas of water frontage. A 16 m corridor is required along tidal Main Rivers or formal coastal defences in order to ensure ongoing maintenance of the channel/defences can be undertaken. If the development of the site involves any activity within these buffer strips, an Environmental Permit for flood risk activities may be required in addition to planning permission. Details on obtaining an Environmental Permit are available from the EA¹⁰. It is additionally recommended that the Local Authority should be consulted regarding any development within 16 m of the coastal frontage, to confirm buffer requirements.
- A Marine Management Organisation (MMO) license may be required for work below Mean High Water Springs. It should be noted that the EA are consulted on any relevant MMO applications and therefore may advise on whether an Environmental Permit is additionally required. Developers should consult the EA and MMO for further information.
- Any development within Flood Zone 2 and 3 should employ flood resilient construction techniques to reduce damage and increase the speed of recovery should any flooding events of this magnitude occur. As per the Flood Resilient Construction techniques guidance¹¹, development with design flood depths above 0.6 m should adopt the 'Water Entry Strategy'. This is where water is allowed to flow through the property, avoiding any risk to structural damage. Development should be designed to allow water to drain away after flooding, with access to all spaces to permit drying and cleaning. In areas of the site where the predicted flood depth is up to 0.3 m, the 'Water Exclusion Strategy' should be adopted. This strategy involves using materials and construction techniques with low permeability designed to keep water out. For more information on flood resilient construction techniques, refer to the EA [website](#)¹².
- Ground conditions should be confirmed through site investigation and dewatering of excavations and basement waterproofing implemented where required.
- SuDS should be implemented to manage surface water runoff from all new development. Runoff rates should be restricted as close as possible to the equivalent Greenfield runoff rates for the site, in all events up to and including the 1 in 100 year rainfall event including climate change. Runoff should be managed in line with the SuDS Hierarchy. Geological data indicates that the majority of the site has very significant infiltration constraints; therefore, watercourse discharge and/or lined attenuation systems may be required. As the site is predominantly situated within Flood Zone 2 and 3, consideration may be required as to whether above ground surface water storage is appropriate; such that all SuDS features are able to function even during a fluvial/tidal flood event. As this site is adjacent to Lake Lothing, there may be an opportunity for surface water to be directly discharged without attenuation. It is recommended that the latest advice regarding surface water drainage is sought from Suffolk County Council as the Lead Local Flood Authority.
- There are currently no 'formal' flood defences within the Lowestoft area; however, some level of protection is still provided through 'informal' and coastal erosion defences. Therefore, whilst breach modelling is not a strict requirement in this area, consideration of breach flood risk may still be required at a site specific level.

⁹ Scott Wilson (2008) Cumulative Land Raising Study; Available at: <http://www.eastsuffolk.gov.uk/assets/Planning/Waveney-Local-Plan/Cumulative-Land-Raising-Study/01-Cumulative-Land-Raising-Study-Main-Document.pdf>

¹⁰ <https://www.gov.uk/guidance/flood-risk-activities-environmental-permits>

¹¹ Communities and Local Government (2007) Improving the Flood Performance of New Buildings Flood Resilient Construction

¹² <https://www.gov.uk/government/publications/flood-resilient-construction-of-new-buildings>

- In its current form, delivery of development which can be demonstrated to be safe from flood risk will be challenging in several areas of the site, due to the anticipated flood depth, velocity and hazard, unless significant land raising is considered. However, future implementation of the Lowestoft Flood Risk Management Scheme is likely to significantly change the level of flood risk over a large portion of the site, which would provide future opportunity for development to be safely progressed. It is recommended that the level of flood risk is reassessed once this scheme has been implemented.

3. Peto Square

3.1 Overview

Peto Square comprises the area immediately north of Bascule Bridge. The site covers an area of approximately 6.8 ha and includes the Railway Station, Station Square and part of Commercial Road.

Draft Policy WLP2.3 allocates the area around Station Square and Custom House for leisure and retail uses. The planned strategic flood defence measures which form part of the Lowestoft Flood Risk Management Project will have the effect of protecting this site from flooding in the 0.5% AEP plus climate change flood event. Therefore, there may be scope over the plan period for development defined by national planning policy as 'more vulnerable' to take place in this area.

The main objectives of the policy are to support and enhance the town centre, improve the general appearance of the area and protect the area's heritage. There is uncertainty at present as to the amount of development which could be accommodated on this site and when it could be delivered.

3.2 Assessment of Flood Risk

3.2.1 Flood History

The site is located within the extent of historic flooding from the Waveney Estuary (Lake Lothing), as shown in Figure 02, Appendix A.

3.2.2 Fluvial and Tidal Flood Risk

The site is almost entirely located within Flood Zone 3 (>0.5% AEP) associated with Lake Lothing. There are also small areas of the site within Flood Zone 2 (0.5% – 0.1% AEP), as shown in Figure 03, Appendix A.

Figures 09 to 11 within Appendix A show the hazard, depth and velocity for the 5%, 0.5%, 0.5% plus climate change and 0.1% AEP flood events. No flooding is anticipated within the site under the 5% AEP event. Under the 0.5% AEP event, the majority of the site is submerged, with flood depths up to 1 m and localised velocities of up to 1 m/s in some areas of the site, representing a 'Danger for Most' hazard scenario. Under the 0.1% AEP event, flood depths increase up to 1.5 m and the hazard rating increases to 'Danger for All' in certain areas of the site.

The area is not formally classified as benefitting from defences and therefore there is currently no updated breach modelling available for this stretch of the coastline. However, it is possible for a breach to occur in the 'informal' flood defences which provide protection to the area. Therefore, further site-specific assessment may be required to inform new development.

Considering the alignment of the current temporary flood defences (Appendix B), it is likely that some level of protection would be provided to Peto Square, should the barriers be deployed during a flood event.

Climate Change

As part of the recent hydraulic modelling studies completed by the EA in 2017, the future tidal flood extent has been estimated using predicted climate change conditions. As shown in Figure 10.5 (Appendix A), it is predicted that the site will be almost entirely submerged due to tidal flooding, under the 0.5% AEP plus climate change flood event. Under this scenario, flood depth, velocity and hazard is anticipated to be greater than the 0.1% AEP event, with a flood depth of over up to 1.5 to 2 m in some locations and a 'Danger for All' hazard rating across the majority of the site.

Lowestoft Flood Risk Management Scheme

In its currently proposed form, the flood risk management scheme will involve construction of a floodwall from Hamilton Road to the new flood barrier across Lake Lothing. Modelling of the post-scheme flood risk has shown that the new flood wall would restrict the floodwaters from encroaching onto the site, effectively removing the entirety of the site from the 0.5% AEP floodplain. As such, the level of flood risk to the site should be re-assessed once the flood alleviation scheme has been fully implemented.

3.2.3 Pluvial Flood Risk

The EA surface water flood mapping shown in Figure 04 (Appendix A) highlights that much of the site is at high surface water flood risk (3.3% AEP). This flood risk is particularly prevalent in the north of the site, along the railway and at the junction between Commercial Road and the A47. There is comparatively low risk to the south of the site, along the river bank.

The 2017 Draft Kirkley Stream hydraulic model update reveals a much more confined flood extent, with some shallow flooding along the railway, south of Commercial Road and over the pedestrianised area outside of the station. It should be noted that this modelling is currently being further refined and finalised. Reference should be made to the most updated flood outlines, which are due to be available for consideration later in 2018.

3.2.4 Groundwater Flood Risk

Based on geological indicators, the site is suggested to have a limited potential for groundwater flooding to occur, as shown on Figure 06, Appendix A.

3.2.5 Flood Risk from Sewers and Artificial Sources

No information on flood risk from sewers or artificial sources of has been identified for the site.

3.3 Managing Flood Risk

3.3.1 Conclusions

The site is located almost entirely within Flood Zone 3 and therefore a site specific flood risk assessment will be required for all development, to demonstrate that the development will be safe for its lifetime and not increase flood risk elsewhere. The Sequential Test is additionally required to demonstrate that development cannot be located in an area of lower flood risk. The Exception Test will also need to be satisfied for all More Vulnerable Development, demonstrating safety from flood risk.

The acceptability of each of the proposed land uses, and requirement for justification in accordance with the NPPF, is summarised in Table 3-1.

Table 3-1 - Requirement for justification of proposed land uses

Proposed Use	Vulnerability Classification	NPPF Flood Zone Compatibility	Sequential Test Required?
Commercial	Less vulnerable	✓	Yes
Retail and Leisure	Less vulnerable	✓	Yes
Transport	Essential Infrastructure	✓	Yes
Hotel	More Vulnerable	Exception Test required	Yes
Open Space	Water compatible	✓	No

KEY: ✓ Development is appropriate

3.3.2 Recommendations

The following flood risk mitigation measures are recommended for this site:

- All more vulnerable aspects of development should be sequentially allocated to areas of the site at lower risk of flooding. However, as the site lies almost entirely within Flood Zone 3, opportunities for this will be limited. Therefore, less vulnerable site uses should be strategically located at ground level, with flood resilient measures in place, allowing the more vulnerable site uses to be raised above flood levels on the upper floors.
- To mitigate against tidal flood risk, Finished Flood Levels for 'more vulnerable' uses should be raised 300 mm above the estimated 0.5% AEP plus climate change tidal flood level. It is recommended that 'less vulnerable' uses also meet these requirements for Finished Floor Levels where achievable. Additionally, a dedicated 'safe haven' should be provided above the flood level to enable rapid escape should flooding occur. This refuge should be provided above the extreme 0.1% AEP flood level including an allowance for

climate change. This may be provided in the form of a sheltered communal space on an upper level within the building, accessed via internal stairs and sufficient in size to safely house all occupants. Estimated flood depths are mapped in Figure 10, Appendix A.

- Site-specific emergency evacuation procedures must be in place to ensure that the risk to life is minimised should a flood event occur. Ideally, safe access and egress routes should be provided above the flood level and lead to higher ground within Flood Zone 1. However, the majority of the site is indicated to have a hazard rating representing 'Danger for All', and therefore this will be challenging in the current form.
- Any site-specific emergency evacuation procedures should also consider exceedance routes for surface water and plan accordingly. The Kirkley Stream modelling shows surface water flooding along the north of the site with some areas of higher risk in the centre during the 0.5% AEP flood event.
- In areas of the site at flood risk, or where safe access cannot be achieved, an emergency flood plan must be provided, dealing with matters of evacuation and refuge.
- The vast majority of the site is within Flood Zone 3. Any land raising or increased built footprint within the floodplain will require level for level, volume for volume flood compensation storage if there is a risk of displaced flood waters and associated increase in the flood risk to surrounding areas. However, the 2008 Cumulative Land Raising Study demonstrated that land raising within this area resulted in minimal impact on surrounding tidal flood levels. Therefore, land raising or increased footprint may be acceptable within this area, without compensation. Any such proposals would need to be further investigated through site-specific analysis and agreement with the EA and Local Authority.
- A 16 m buffer strip should be maintained along the tidal Lake Lothing, to ensure maintenance of the channel/coastline defences can be undertaken. If the development of the site involves any activity within these buffer strips, an Environmental Permit for flood risk activities may be required in addition to planning permission. Details on obtaining an Environmental Permit for flood risk activities are available from the EA.
- A Marine Management Organisation (MMO) license may be required for work below Mean High Water Springs. It should be noted that the EA are consulted on any relevant MMO applications and therefore may advise on whether an Environmental Permit is additionally required. Developers should consult the EA and MMO for further information.
- Any development within Flood Zone 2 and 3 should employ flood resilient construction techniques to reduce damage and increase the speed of recovery if a flood event of this magnitude was to occur. As per the Flood Resilient Construction techniques guidance¹⁴, development with design flood depths above 0.6 m should adopt the 'Water Entry Strategy'. This is where water is allowed to flow through the property, avoiding any risk to structural damage. Development should be designed to allow water to drain away after flooding, with access to all spaces to permit drying and cleaning. In areas of the site where the predicted flood depth is up to 0.3 m the 'Water Exclusion Strategy' should be adopted. This strategy involves using materials and construction techniques with low permeability designed to keep water out. For more information on flood resilient construction techniques, refer to the EA [website](#)¹⁵.
- Ground conditions should be confirmed through site investigation and dewatering of excavations and basement waterproofing implemented where required.
- SuDS should be implemented to manage surface water runoff from all new development. Runoff rates should be restricted as close as possible to the equivalent Greenfield runoff rates for the site, in all events up to and including the 1 in 100 year rainfall event including climate change. Runoff should be managed in line with the SuDS Hierarchy. Geological data indicates that the majority of the site has very significant infiltration constraints; therefore, watercourse discharge and lined attenuation systems may be required. As the site is predominately situated within Flood Zone 3, consideration may be required as to whether above ground surface water storage is appropriate; such that all SuDS features are able to function even during a fluvial/tidal flood event. As this site is adjacent to Lake Lothing, there may be an opportunity for surface water to be directly discharged without attenuation. It is recommended that the latest advice regarding surface water drainage is sought from Suffolk County Council as the Lead Local Flood Authority.
- There are currently no 'formal' flood defences within the Lowestoft area; however, some level of protection is still provided through 'informal' and coastal erosion defences. Therefore, whilst breach modelling is not a strict requirement in this area, consideration of breach flood risk may still be required at a site specific level.
- In its current form, delivery of development which can be demonstrated to be safe from flood risk will be challenging in several areas of the site, due to the anticipated flood depth, velocity and hazard, unless

¹⁴ Communities and Local Government (2007) Improving the Flood Performance of New Buildings Flood Resilient Construction

¹⁵ <https://www.gov.uk/government/publications/flood-resilient-construction-of-new-buildings>

significant land raising is considered. However, future implementation of the Lowestoft Flood Risk Management Scheme is likely to significantly change the level of flood risk over a large portion of the site, which would provide future opportunity for development to be safely progressed. It is recommended that the level of flood risk is reassessed once this scheme has been implemented.

4. Kirkley Waterfront and Sustainable Urban Neighbourhood

4.1 Overview

Kirkley Waterfront and the proposed Sustainable Urban Neighbourhood comprise approximately 60 ha of predominantly underutilised or unoccupied brownfield land on the south bank of Lake Lothing between the waterfront and Victoria Road/Waveney Drive. The site is bounded to the west by Stanley Road and to the east by the water inlet to the north of the Waveney Drive/Horn Hill roundabout. The AAP proposes this site for a comprehensive mixed-use development comprising of:

- 1,380 new homes including homes for sale and affordable housing for rent;
- 12 ha of reconfigured employment land including land for office development at Riverside Road and port related development on the waterfront and on the former Jeld Wen factory site;
- A primary school;
- Leisure and marina development;
- Small-scale retail development to serve the new community;
- New public open space; and
- Pedestrian and cycle bridge over Lake Lothing at Brooke Peninsula.

4.2 Assessment of Flood Risk

4.2.1 Flood History

The site is located within the extent of historic flooding from the Waveney Estuary (Lake Lothing), as shown in Figure 02, Appendix A). A sewer flooding incident has also been recorded on School Road.

4.2.2 Fluvial and Tidal Flood Risk

The distribution of flood risk across the site is reasonably complex, with small areas of Flood Zone 3b (5% AEP) along the river bank, Flood Zone 3 (>0.5% AEP), Flood Zone 2 (0.5% - 0.1% AEP) and Flood Zone 1 (<0.1% AEP). The areas with greatest flood risk are in the north of the site, next to the River Waveney. The shape of the Flood Zones has been influenced by land raising of pre-existing development at some locations, giving its geometric shape, as shown on Figure 03, Appendix A.

Figures 09 to 11 within Appendix A show the hazard, depth and velocity for the 5%, 0.5%, 0.5% plus climate change and 0.1% AEP flood events. Only minimal areas of flooding are shown under the 5% AEP event, close to the waterfront. Under the 0.5% AEP event, localised areas of flooding are shown. Flood depths are varied within these areas, generally below 0.25 m, but with small areas up to 1 m. Flood velocities are generally less than 0.3 m/s. Flood hazard across the site is generally 'Low', although some areas of 'Danger for Most' and 'Danger for Some' are present. Under the 0.1% AEP event, the extent of flooding increases across the majority of the site, with increase in anticipated depth and velocity. The associated flood hazard indicates 'Danger for Most' across much of the site.

The area is not formally classified as benefitting from defences and therefore there is currently no updated breach modelling available for this stretch of the coastline. However, it is possible for a breach to occur in the 'informal' flood defences which provide protection to the area. Therefore, further site-specific assessment may be required to inform new development.

Considering the alignment of the current temporary flood defences (Appendix B), some level of protection may be provided to the Kirkley Waterfront area should the barriers be deployed during a flood event. However, the barrier does not extend along the frontage to Lake Lothing in this area, so any associated protection is likely to be limited.

Climate Change

As part of the recent hydraulic modelling studies completed by the EA in 2017, the future tidal flood extent has been estimated using predicted climate change conditions. As shown in Figure 10.5 (Appendix A), the majority of the site is anticipated to be flooded during the 0.5% AEP plus climate change event. Under this scenario, flood depth and velocity is anticipated to be greater than the 0.1% AEP event, representing 'Danger for Most' across the majority of the site.

Lowestoft Flood Risk Management Scheme

In its currently proposed form, the flood risk management scheme will involve construction of a floodwall from Hamilton Road to the new flood barrier across Lake Lothing and beyond, in front of the Royal Norfolk and Suffolk Yacht Club. Modelling of the post-scheme flood risk has shown that the new flood wall would restrict the floodwaters from encroaching onto the site thus removing the vast majority of the site from the floodplain, with the exception of a small number of localised areas along the water frontage. As such, the level of flood risk to the site should be re-assessed once the flood alleviation scheme has been fully implemented.

4.2.3 Pluvial Flood Risk

The EA surface water flood mapping shown in Figure 04 (Appendix A) shows some localised areas of high surface water flood risk (3.3% AEP) throughout the site. The 2017 Draft Kirkley Stream modelling (Figure 05, Appendix A) shows a more confined flood extent, with areas of high flood risk towards west and centre of the site. It should be noted that this modelling is currently being further refined and finalised. Reference should be made to the most updated flood outlines, which are due to be available for consideration later in 2018.

4.2.4 Groundwater Flood Risk

Based on geological indicators, the site is suggested to have a limited potential for groundwater flooding to occur, as shown on Figure 06, Appendix A.

4.2.5 Flood Risk from Sewers and Artificial Sources

No information on flood risk from sewers or artificial sources of has been identified for the site.

4.3 Managing Flood Risk

4.3.1 Conclusions

All development located in Flood Zone 2 and 3 (and development sites over 1 hectare in Flood Zone 1) will require a site specific flood risk assessment, to demonstrate that the development will be safe for its lifetime and not increase flood risk elsewhere. The Sequential Test is additionally required to demonstrate that development cannot be located in an area of lower flood risk. The Exception Test will also be required to be satisfied for more vulnerable development in Flood Zone 3, demonstrating safety from flood risk.

The acceptability of each of the proposed land uses, and requirement for justification in accordance with the NPPF, is summarised in Table 4-1.

Table 4-1 - Requirement for justification of proposed land uses

Proposed Use	Vulnerability Classification	NPPF Flood Zone Compatibility	Sequential Test Required?
Residential	More Vulnerable	Exception Test required in Flood Zone 3	Yes
Commercial	Less vulnerable	✓	Yes
School	More Vulnerable	Exception Test required in Flood Zone 3	Yes
Open Space	Water compatible	✓	No

KEY: ✓ Development is appropriate

4.3.2 Recommendations

The following flood risk mitigation measures are recommended for this site:

- The site contains areas of Flood Zones 3b, 3, 2 and 1. All more vulnerable aspects of development should be sequentially allocated to areas of lower flood risk, with flood compatible development (such as open space) located in areas at the highest risk. Only water compatible development or essential infrastructure (subject to the Exception Test) should be considered within areas of the site shown to lie within Flood Zone 3b.
- To mitigate against tidal flood risk, Finished Flood Levels for 'more vulnerable' uses should be raised 300 mm above the estimated 0.5% AEP plus climate change tidal flood level. It is recommended that 'less vulnerable' uses also meet these requirements for Finished Floor Levels where achievable. Additionally, a dedicated 'safe haven' should be provided above the flood level to enable rapid escape should flooding occur. This refuge should be provided above the extreme 0.1% AEP flood level including an allowance for climate change. This may be provided in the form of a sheltered communal space on an upper level within the building, accessed via internal stairs and sufficient in size to safely house all occupants. Estimated flood depths are mapped in Figure 10, Appendix A.
- Within floodplain areas, Site-specific emergency evacuation procedures must be in place to ensure that the risk to life is minimised should a flood event occur. Safe access and egress routes should be provided above the anticipated flood level and lead to higher ground within Flood Zone 1. There are areas in the south of the site that are outside the Flood Zone during the 0.5% AEP plus climate change flood events. Therefore, for some of the site, emergency evacuation procedures may be provided towards this area. However, flood hazard under this event represents 'Danger for Most' across much of the site; therefore, provision of safe access may be challenging for areas closer to the river front.
- The site-specific emergency evacuation procedure should also consider exceedance routes for surface water and plan accordingly. The Kirkley Stream modelling shows surface water flooding along the south of the site during the 0.5% AEP flood event, particularly along School Road and Victoria Road.
- In areas of the site at flood risk, or where safe access cannot be achieved, an emergency flood plan must be provided, dealing with matters of evacuation and refuge.
- Several areas of the site are within Flood Zone 3. Any land raising or increased built footprint within the floodplain will require a level for level, volume for volume flood compensation storage, if there is a risk of displaced flood waters and associated increase in the flood risk to surrounding areas. However, the 2008 Cumulative Land Raising Study demonstrated that land raising within this area resulted in minimal impact on surrounding tidal flood levels. Therefore, land raising or increased footprint may be acceptable within this area, without compensation. Any such proposals would need to be further investigated through site-specific analysis and agreement with the EA and Local Authority.
- A 16 m buffer strip should be maintained along the tidal Lake Lothing, to ensure maintenance of the channel/coastline defences can be undertaken. If the development of the site involves any activity within these buffer strips, an Environmental Permit for flood risk activities may be required in addition to planning permission. Details on obtaining an Environmental Permit are available from the EA.
- A Marine Management Organisation (MMO) license may be required for work below Mean High Water Springs. The EA are consulted on any relevant MMO applications and therefore may determine if an Environmental Permit is required. Developers should consult the EA for more information.
- Any development within Flood Zone 2 and 3 should employ, flood resilient construction techniques to reduce damage and increase the speed of recovery should a flood event of this magnitude occur. As per the Flood Resilient Construction techniques guidance¹⁸, development with design flood depths above 0.6 m should adopt the 'Water Entry Strategy'. This is where water is allowed to flow through the property, avoiding any risk to structural damage. Development should be designed to allow water to drain away after flooding, with access to all spaces to permit drying and cleaning. In areas of the site where the predicted flood depth is up to 0.3 m the 'Water Exclusion Strategy' should be adopted, which involves using materials and construction techniques with low permeability designed to keep water out. For more information on flood resilient construction techniques, refer to the EA website¹⁹.
- Ground conditions should be confirmed through site investigation and dewatering of excavations and dewatering of excavations and basement waterproofing implemented where required.

¹⁸ Communities and Local Government (2007) Improving the Flood Performance of New Buildings Flood Resilient Construction

¹⁹ <https://www.gov.uk/government/publications/flood-resilient-construction-of-new-buildings>

- SuDS should be implemented to manage surface water runoff from all new development. Runoff rates should be restricted as close as possible to the equivalent Greenfield runoff rates for the site, in all events up to and including the 1 in 100 year rainfall event including climate change. Runoff should be managed in line with the SuDS Hierarchy. Geological data indicates that the majority of the site has very significant constraints against SuDS; therefore, watercourse discharge and lined attenuation systems may be required. The site is partially situated within Flood Zone 2 and 3 and therefore consideration may be required as to whether above ground surface water storage is appropriate; such that all SuDS features are able to function even during a fluvial/tidal flood event. As this site is adjacent to Lake Lothing, there may be an opportunity for surface water to be directly discharged without attenuation. It is recommended that the latest advice regarding surface water drainage is sought from Suffolk County Council as the Lead Local Flood Authority.
- There are currently no 'formal' flood defences within the Lowestoft area; however, some level of protection is still provided through 'informal' and coastal erosion defences. Therefore, whilst breach modelling is not a strict requirement in this area, consideration of breach flood risk may still be required at a site specific level.
- In its current form, delivery of development which can be demonstrated to be safe from flood risk will be challenging in several areas of the site, due to the anticipated flood depth, velocity and hazard, unless significant land raising is considered. However, future implementation of the Lowestoft Flood Risk Management Scheme is likely to significantly change the level of flood risk over a large portion of the site, which would provide future opportunity for development to be safely progressed. It is recommended that the level of flood risk is reassessed once this scheme has been implemented.

5. Western End of Lake Lothing

5.1 Overview

This site covers the area to the south west of Lake Lothing between South Elmham Terrace and Stanley Road. The area is currently characterised by small scale industrial uses and under-utilised land. The AAP proposes this area for mixed-use redevelopment, including waterfront tourism, marine uses, employment and residential development of up to 57 new homes.

5.2 Assessment of Flood Risk

5.2.1 Flood History

The site is located within the extent of historic flooding from the Waveney Estuary (Lake Lothing), as shown in Figure 02, Appendix A.

5.2.2 Fluvial and Tidal Flood Risk

There are areas of Flood Zone 3b (5% AEP), Flood Zone 3 (0.5% AEP), Flood Zone 2 (0.5% to 0.1% AEP) and Flood Zone 1 (>0.1% AEP) across the site. The areas with greatest flood risk are in the north and west of the site, next to Lake Lothing, as shown on Figure 03, Appendix A. The south eastern corner lies within Flood Zone 1.

Figures 09 to 11 within Appendix A show the hazard, depth and velocity for the 5%, 0.5%, 0.5% plus climate change and 0.1% AEP flood events. Under the 5% AEP event, flooding is anticipated to the west of the site, with localised depths up to 1 m and velocities of up to 0.3 m/s. Under the 0.5% event, the extent of this flooding increases, with a 'Danger for Most' hazard rating across the west of the site. The anticipated depth of flooding increases up to 1.5 m during the 0.1% AEP event.

The area is not formally classified as benefitting from defences and therefore there is currently no updated breach modelling available for this stretch of the coastline. However, it is possible for a breach to occur in the 'informal' flood defences which provide protection to the area. Therefore, further site-specific assessment may be required to inform new development.

Considering the alignment of the current temporary flood defences (Appendix B), it is considered unlikely that direct benefit will be provided to the Western End of Lake Lothing, should the barriers be deployed during a flood event.

Climate Change

As part of the recent hydraulic modelling studies completed by the EA in 2017, the future tidal flood extent has been estimated using predicted climate change conditions. As shown in Figure 10.5 (Appendix A), the western extent of the site is entirely submerged during the 0.5% AEP plus climate change event. Under this scenario, flood depth, velocity and hazard is anticipated to be more extreme than the 0.1% AEP event, with flood depths up to 2 m in some locations.

Lowestoft Flood Risk Management Scheme

In its currently proposed form, the flood risk management scheme will involve construction of a floodwall from Hamilton Road to the new flood barrier across Lake Lothing and beyond in front of the Royal Norfolk & Suffolk Yacht Club. Ongoing modelling of the post-scheme flood risk has shown that the new flood wall would restrict the floodwaters from encroaching onto the site, effectively removing the site from the floodplain. As such, the level of flood risk to the site should be re-assessed once the flood alleviation scheme has been fully implemented.

5.2.3 Pluvial Flood Risk

The EA surface water flood mapping shown in Figure 04 (Appendix A) shows a concentrated area of high surface water flood risk (3.3% AEP) in the centre of the site.

The 2017 Draft Kirkley Stream modelling shows a more confined flood extent in the centre of the site with flood depths 0.2 m to 0.5 m during the 0.5% AEP flood event. It should be noted that this modelling is currently being

further refined and therefore reference should be made to the most updated flood outlines, which are due to be available for consideration later in 2018.

5.2.4 Groundwater Flood Risk

Based on geological indicators, the site is suggested to have a limited potential for groundwater flooding to occur, as shown on Figure 06 (Appendix A).

5.2.5 Flood Risk from Sewers and Artificial Sources

No information on flood risk from sewers or artificial sources of has been identified for the site.

5.3 Managing Flood Risk

5.3.1 Conclusions

All development located in Flood Zone 2 and 3 (and development sites over 1 ha in Flood Zone 1) will require a site specific flood risk assessment, to demonstrate that the development will be safe for its lifetime and not increase flood risk elsewhere. The Sequential Test is additionally needed to demonstrate that development cannot be located in an area of lower flood risk. The Exception Test will also be required to be satisfied for More Vulnerable Development in Flood Zone 3, demonstrating safety from flood risk.

The acceptability of each of the proposed land uses, and requirement for justification in accordance with the NPPF, is summarised in Table 5-1.

Table 5-1 - Requirement for justification of proposed land uses

Proposed Use	Vulnerability Classification	NPPF Flood Zone Compatibility	Sequential Test Required?
Residential	More Vulnerable	Exception Test required in Flood Zone 3	Yes
Commercial	Less vulnerable	✓	Yes
Marine	Water compatible	✓	No

KEY: ✓ Development is appropriate

5.3.2 Recommendations

The following flood risk mitigation measures are recommended for this site:

- The site contains areas of Flood Zones 3b, 3, 2 and 1. All more vulnerable aspects of development should be sequentially allocated to areas of lower flood risk, with flood compatible development (such as open space) located in areas at the highest risk. Only water compatible development or essential infrastructure (subject to the Exception Test) should be considered within areas of the site shown to lie within Flood Zone 3b.
- To mitigate against tidal flood risk, Finished Flood Levels for 'more vulnerable' uses should be raised 300 mm above the estimated 0.5% AEP plus climate change tidal flood level. It is recommended that 'less vulnerable' uses also meet these requirements for Finished Floor Levels where achievable. Additionally, a dedicated 'safe haven' should be provided above the flood level to enable rapid escape should flooding occur. This refuge should be provided above the extreme 0.1% AEP flood level including an allowance for climate change. This may be provided in the form of a sheltered communal space on an upper level within the building, accessed via internal stairs and sufficient in size to safely house all occupants. Estimated flood depths are mapped in Figure 10, Appendix A.
- A substantial proportion of the site is located within Flood Zone 3. As per the NPPF, any land raising or increased built footprint within the floodplain will require a level for level, volume for volume flood compensation storage, if there is a risk of displaced flood waters and associated increase in the flood risk to surrounding areas. However, the 2008 Cumulative Land Raising Study demonstrated that land raising within this area resulted in minimal impact on surrounding tidal flood levels. Therefore, land raising or increased footprint may be acceptable within this area, without compensation. Any such proposals would need to be further investigated through site-specific analysis and agreement with the EA and Local Authority.

- A 16 m buffer strip should be maintained along the tidal Lake Lothing, to ensure maintenance of the channel/coastline defences can be undertaken. If the development of the site involves any activity within these buffer strips, an Environmental Permit for flood risk activities may be required in addition to planning permission. Details on obtaining an Environmental Permit for flood risk activities are available from the EA.
- A Marine Management Organisation (MMO) license may be required for work below Mean High Water Springs. It should be noted that the EA are consulted on any relevant MMO applications and therefore may advise on whether an Environmental Permit is additionally required. Developers should consult the EA and MMO for further information.
- Within floodplain areas, site-specific emergency evacuation procedures must be in place to ensure that the risk to life is minimised should a flood event occur. Safe access and egress routes should be provided above the anticipated flood level and lead to higher ground within Flood Zone 1. The east of the site is outside of the floodplain and therefore, emergency evacuation routes may be provided towards this area for some portions of the site. However, flood hazard under this event represents 'Danger for Most' across much of the site; therefore, provision of safe access may be challenging for areas further towards the west.
- The site-specific emergency evacuation procedure should also consider exceedance routes for surface water and plan accordingly. The Kirkley Stream modelling shows surface water flooding in the centre of the site during the 0.5% AEP flood event, particularly along South Elmham Terrace.
- In areas of the site at flood risk, or where safe access cannot be achieved, an emergency flood plan must be provided, dealing with matters of evacuation and refuge.
- Any development within Flood Zone 2 and 3 should employ, flood resilient construction techniques to reduce damage and increase the speed of recovery should a flood event of this magnitude occur. As per the Flood Resilient Construction techniques guidance²², development within areas at risk of flooding to depths above 0.6 m should adopt the 'Water Entry Strategy'. This is where water is allowed to flow through the property, avoiding any risk to structural damage. Development should be designed to allow water to drain away after flooding, with access to all spaces to permit drying and cleaning. In areas of the site where the predicted flood depth is up to 0.3 m the 'Water Exclusion Strategy' should be adopted, which involves materials and construction techniques with low permeability designed to keep water out. For more information on flood resilient construction techniques, refer to the EA [website](#)²³.
- Ground conditions should be confirmed through site investigation and dewatering of excavations and basement waterproofing implemented where required.
- SuDS should be implemented to manage surface water runoff from all new development. Runoff rates should be restricted as close as possible to the equivalent Greenfield runoff rates for the site, in all events up to and including the 1 in 100 year rainfall event including climate change. Runoff should be managed in line with the SuDS Hierarchy. Geological data indicates that the majority of the site has very significant infiltration constraints; therefore, watercourse discharge and lined attenuation systems may be required. As this site is adjacent to Lake Lothing, there may be an opportunity for surface water to be directly discharged without attenuation. It is recommended that the latest advice regarding surface water drainage is sought from Suffolk County Council as the Lead Local Flood Authority.
- There are currently no 'formal' flood defences within the Lowestoft area; however, some level of protection is still provided through 'informal' and coastal erosion defences. Therefore, whilst breach modelling is not a strict requirement in this area, consideration of breach flood risk may still be required at a site specific level.
- In its current form, delivery of development which can be demonstrated to be safe from flood risk will be challenging in several areas of the site, due to the anticipated flood depth, velocity and hazard, unless significant land raising is considered. However, future implementation of the Lowestoft Flood Risk Management Scheme is likely to significantly change the level of flood risk over a large portion of the site, which would provide future opportunity for development to be safely progressed. It is recommended that the level of flood risk is reassessed once this scheme has been implemented.

²² Communities and Local Government (2007) Improving the Flood Performance of New Buildings Flood Resilient Construction

²³ <https://www.gov.uk/government/publications/flood-resilient-construction-of-new-buildings>

6. The Street, Carlton Colville

6.1 Overview

Land South of the Street, Carlton Colville/Gisleham covers an area of approximately 55 ha and is allocated for a comprehensive mixed-use development including:

- Up to 800 new dwellings;
- A retirement community comprising a care home or nursing home and extra care and/or sheltered dwellings;
- 1 form entry primary school (2 ha);
- Country Park (at least 15 ha);
- Allotments, flood mitigation and play space (at least 3.4 ha);
- Local shops, including a convenience store; and
- A community centre.

6.2 Assessment of Flood Risk

6.2.1 Flood History

There are no previous recorded flood incidents with the site boundary. There are, however, some recorded flood incidents from surface water along The Street and Hall Road, adjacent to the site boundary, as shown in Figure 02, Appendix A.

6.2.2 Fluvial Flood Risk

There are areas of fluvial Flood Zone 3 (>1% AEP), Flood Zone 2 (1% - 0.1% AEP) and Flood Zone 1 (<0.1% AEP) within the site boundary, as defined by the EA strategic datasets. The areas of greatest flood risk are in the north and west of the site, associated with the Kirkley Stream, as shown on Figure 03, Appendix A. The remainder of the site is designated Flood Zone 1.

As the Kirkley Stream modelling is a combined fluvial and surface water model; the Draft outputs shown in Figure 05, Appendix A are also relevant to consideration of fluvial flood risk. This shows a similar, but slightly reduced flood outline, with a flood depth of 0.5 to 1.0 m during the 0.5% AEP flood event, along the northwest site boundary. It should be noted that, as a Draft combined tidal and fluvial model, the outputs cannot currently be directly compared with the Flood Zone outputs. The EA are responsible for mapping Flood Zones and it is anticipated that the current Flood Zones will be revised and new outlines confirmed in due course.

Reference should be made to the most updated flood outlines, which are due to be available for consideration later in 2018. It is additionally recommended that Suffolk County Council, as the Lead Local Flood Authority, is contacted to confirm the understanding of flood risk in this area, including the extent of functional floodplain.

Climate Change

As part of the recent hydraulic modelling studies completed by the EA in 2017, the future tidal flood extent has been estimated using predicted climate change conditions. As shown in Figure 07.2, Appendix A, tidal flood waters are anticipated to extend up Kirkley Stream, almost to the site boundary.

Modelled fluvial climate change outlines for the Kirkley Stream were not available at the time of writing this SFRA. In the absence of such information, the 0.1% AEP may be used as a proxy to provide an initial indication of the potential impact of climate change. Modelled outlines for the 0.1% AEP event are not available for the Kirkley Stream modelling; however, the EA Flood Zone 2 outline indicates the anticipated fluvial extent under the 0.1 % AEP event. Under this scenario, the extent of fluvial flooding marginally increases in extent. However, it should be noted that the modelling informing these flood zones has only been undertaken at a strategic level and applicability as a surrogate for site-specific climate change impact is unknown. Therefore, further assessment will be required to assess and confirm the anticipated climate change impacts at a site-specific level.

It should be further noted that the Kirkley Stream modelling is currently being finalised and therefore reference should be made to the most up to date information, anticipated to be available later in 2018.

Lowestoft Flood Risk Management Scheme

The allocated development site is covered by the pluvial and fluvial elements of the emerging Lowestoft Flood Risk Management Project. As part of this project, flood mitigation measures are proposed to benefit access to the site and the surrounding area. The current proposals include approximately 66,553 m³ of attenuation of flood water in the northern part of the site and a diversion channel of the Kirkley stream from the west of Belle Vue Farm to the culvert under Low Farm Drive. As such, the level of flood risk to the site should be re-assessed once the flood risk management proposals have been fully implemented.

6.2.3 Pluvial Flood Risk

The EA Surface Water Flood Mapping shown in Figure 04 (Appendix A) shows two surface water flow pathways across the site to the Kirkley Stream, one of which is designated high (3.3% AEP) surface water flood risk, the other medium-low (1% AEP - 0.1% AEP). There are localised areas of high surface water flood risk along the north western site boundary. The rest of the site is a very low surface water flood risk (<0.1% AEP).

The 2017 Draft Kirkley Stream modelling has been described in Section 6.2.2 above, due to the integrated nature of modelling. The source of the Kirkley Stream is understood to be located within immediate proximity to the site, where it is classified as a Main River, therefore, the represented flood risk is understood to be primarily fluvial in nature.

6.2.4 Groundwater Flood Risk

Based on geological indicators, the site is suggested to have a limited potential for groundwater flooding to occur, as shown on Figure 06, Appendix A.

6.2.5 Flood Risk from Sewers and Artificial Sources

No information on flood risk from sewers or artificial sources of has been identified for the site.

6.3 Managing Flood Risk

6.3.1 Conclusions

All development located in Flood Zone 2 and 3 (and development sites over 1 ha in Flood Zone 1) will require a site specific flood risk assessment, to demonstrate that the development will be safe for its lifetime and not increase flood risk elsewhere. The Sequential Test is additionally needed to demonstrate that development cannot be located in an area of lower flood risk. The Exception Test will also be required for more vulnerable development in Flood Zone 3.

The acceptability of each of the proposed land uses, and requirement for justification in accordance with the NPPF, is summarised in Table 6-1.

Table 6-1 - Requirement for justification of proposed land uses

Proposed Use	Vulnerability Classification	NPPF Flood Zone Compatibility	Sequential Test Required?
Residential	More Vulnerable	Exception Test Required in Flood Zone 3	Yes
School	More Vulnerable	Exception Test Required in Flood Zone 3	Yes
Commercial	Less vulnerable	✓	Yes
Open Space	Water compatible	✓	No

KEY: ✓ Development is appropriate

6.3.2 Recommendations

The following flood risk mitigation measures are recommended for this site:

- The site contains areas of Flood Zone 3, 2 and 1. All more vulnerable aspects of development should be sequentially allocated to areas of lower flood risk, with flood compatible development (such as open space) located in areas at the highest risk.
- To mitigate against fluvial flood risk, Finished Floor Levels for any 'more vulnerable' uses should be a minimum of 300 mm above the estimated 1% AEP plus climate change fluvial flood level. It is recommended that 'less vulnerable' uses also meet these requirements for Finished Floor Levels where achievable. Additionally, a dedicated 'safe haven' should be provided above the flood level to enable rapid escape should flooding occur. This refuge should be provided above the extreme 0.1% AEP flood level including an allowance for climate change. This may be provided in the form of a sheltered communal space on an upper level within the building, accessed via internal stairs and sufficient in size to safely house all occupants. The relevant climate change allowances are as follows:
 - For More Vulnerable Developments in Flood Zone 2, the 'central' climate change allowance should be adopted, and in Flood Zone 3 the 'higher central' climate change allowance is the EA's minimum benchmark for flood risk mitigation²⁵.
 - For Water Compatible or Less Vulnerable development (e.g. commercial), the 'central' climate change allowance for the epoch that most closely represents the lifetime of the development is the EA's minimum benchmark for flood risk mitigation²⁵.

This information is extracted from the EA's Climate Change Fact Sheet which details how to apply climate change allowances to local development with specific considerations for East Anglia. This document is regularly updated and can be found on the East Suffolk [website](#).

- Within floodplain areas, site-specific emergency evacuation procedures must be in place to ensure that the risk to life is minimised should a flood event occur. Ideally, safe access and egress routes should be provided above the flood level and lead to higher ground within Flood Zone 1. The north-western area of the site is at greatest flood risk therefore the emergency evacuation procedure should ensure that safe access and egress routes are provided from these areas towards the remainder of the site (which is outside the floodplain). Additionally, for more vulnerable development within the floodplain, a dedicated 'safe haven' should be provided above the flood level to enable rapid escape should flooding occur. This refuge should be provided above the extreme 0.1% AEP flood level including an allowance for climate change. This may be provided in the form of a sheltered communal space on an upper level within the building, accessed via internal stairs and sufficient in size to safely house all occupants.
- An 8 m buffer strip should be maintained along the Kirkley Stream in this area (as a fluvial Main River), to ensure maintenance of the channel or and any associated channel structures or other flood risk management infrastructure. If the development of the site involves any activity within these buffer strips, an Environmental Permit for flood risk activities may be required in addition to planning permission. Details on obtaining an Environmental Permit are available from the EA.
- As per the NPPF, any land raising or increased built footprint within the floodplain would require a level for level, volume for volume flood compensation storage. However, it should additionally be noted that this is understood to be a sensitive area with a history of flooding and therefore land-raising within flood risk areas of the site is unlikely to be an acceptable approach.
- The site-specific emergency evacuation procedure should also consider exceedance routes for surface water and plan accordingly. The Kirkley Stream modelling shows surface water flooding in the northwest of the site during the 0.5% AEP flood event, particularly along The Street. During a surface water flood event of this magnitude it is recommended that occupants of the site avoid this route and egress via Rushmere Road, located to the west of the site.
- Given the recent nature of the Kirkley Stream modelling, it is likely that the currently mapped Flood Zones within the area will be revised in the near future. Reference should be made to the latest available flood risk information in planning for new development. It is recommended that the EA and Suffolk County Council (as the Lead Local Flood Authority) are contacted for the latest available information.
- Consideration should be given to site specific flood characteristics including depth, velocity and hazard in planning and assessing safety of new development. Flood depth outputs have been mapped for the Draft

²⁵ Environment Agency (2016) Flood risk assessments: Climate change allowances

Kirkley Stream modelling (shown in Figure 5, Appendix A), indicating flood depth in the northwest of the site during the 0.5% AEP flood event reaches 0.5 to 1.0 m.

- Any development within flood risk areas of the site should employ flood resilient construction should to reduce damage and increase the speed of recovery should a flood event of this magnitude occur. As per the Flood Resilient Construction techniques guidance²⁶, development within areas at risk of flooding to depths above 0.6 m should adopt the 'Water Entry Strategy'. This is where water is allowed to flow through the property, avoiding any risk to structural damage. Development should be designed to allow water to drain away after flooding, with access to all spaces to permit drying and cleaning. In areas of the site where the predicted flood depth is up to 0.3 m the 'Water Exclusion Strategy' should be adopted, which involves materials and construction techniques with low permeability designed to keep water out. For more information on flood resilient construction techniques, refer to the EA [website](#)²⁷.
- Ground conditions should be confirmed through site investigation and dewatering of excavations and basement waterproofing implemented where required.
- SuDS should be implemented to manage surface water runoff from all new development. Runoff rates will be restricted to the 1 in 1 year, in all events up to and including the 1 in 100 year rainfall event including climate change. Runoff should be managed in line with the SuDS Hierarchy. Geological data indicates that the site has opportunities for bespoke infiltration SuDS; therefore infiltration techniques should be prioritised wherever possible. It should be noted that the development is located in immediate proximity to the Kirkley Stream, and is covered by the emerging Lowestoft Flood Risk Management Project. As such, more stringent criteria for SuDS planning and design may be applicable and it is recommended that the latest advice is sought from Suffolk County Council as the Lead Local Flood Authority.
- The allocated development site is covered by the emerging Lowestoft Flood Risk Management Project. The site is highlighted to deliver flood risk mitigation measures, benefiting access to the site and the surrounding area. Therefore, the development should incorporate findings from the emerging Lowestoft Flood Risk Management Project. To date this includes attenuation of flood water in the northern part of the site of approximately 66,553 m³ and a diversion channel of the Kirkley stream from the west of Belle Vue Farm to the culvert under Low Farm Drive.

²⁶ Communities and Local Government (2007) Improving the Flood Performance of New Buildings Flood Resilient Construction

²⁷ <https://www.gov.uk/government/publications/flood-resilient-construction-of-new-buildings>

7. Conclusions

Currently, several of the sites proposed for strategic development by ESC within the Outer Harbour and Lake Lothing area have significant flood risk constraints, due to location within the undefended floodplain of the tidal River Waveney estuary. In particular this includes Peto Square, PowerPark, Kirkley Waterfront and Sustainable Urban Neighbourhood, and the Western End of Lake Lothing.

All development sites located within the floodplain will be required to complete a site specific flood risk assessment, demonstrating safety from flood risk for the lifetime of the development. Additionally, the Exception Test needs to be passed for all more vulnerable development in Flood Zone 3. Consideration should be given to the mitigation approaches suggested within this report, including sequential allocation of development sites, raised floor levels, flood resilience and emergency planning, which can be adopted to assist in managing the level of flood risk. However, the flexibility in applicability of such mitigation approaches varies across the sites. For sites which encompass areas of Flood Zone 2 and 1, there is greater opportunity for sequential allocation of development sites. For some sites within Flood Zone 3, consideration may need to be given to floodplain compensation for any increased ground levels or built footprint, requiring site specific investigation. For certain areas within the proposed sites, demonstrating safety from flood risk may be challenging, particularly where significant depths of flooding are anticipated, ahead of implementation of the proposed permanent flood alleviation works.

In the long-term, the protection afforded by this flood alleviation project is likely to significantly change the flood risk characteristics over a substantial proportion of the proposed development areas, if implemented in its currently proposed form. Based on modelling undertaken during the Local Flood Risk Management Strategy, the currently proposed scheme will almost entirely remove Peto Square, Kirkley Waterfront and Sustainable Urban Neighbourhood and the Western End of Lake Lothing from the current 1 in 200 year floodplain. The majority of the PowerPark site will also be protected from the 1 in 200 year flood event. As such, this is likely to enable substantial future opportunity for development to be safely progressed. However, it should be noted that the proposals and associated standard and extent of protection may change, as this scheme is further developed and progressed. Reference should be made to the project website²⁸, for the latest available updates.

There are currently no 'formal' flood defences within the Lowestoft area; however, some level of protection is provided through 'informal' and coastal erosion defences. No up-to-date breach modelling is available within the area and, as the area is not classified as benefitting from defences, this is not a strict requirement. However, this would provide value in understanding flood risk and consideration of breaching may still be required at a site-specific level. The nature of flood defence in this area will change significantly following implementation of the permanent defences proposed as a part of the Lowestoft Flood Risk Management Project and therefore it is recommended that strategic scale breach modelling is undertaken at this stage.

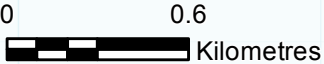
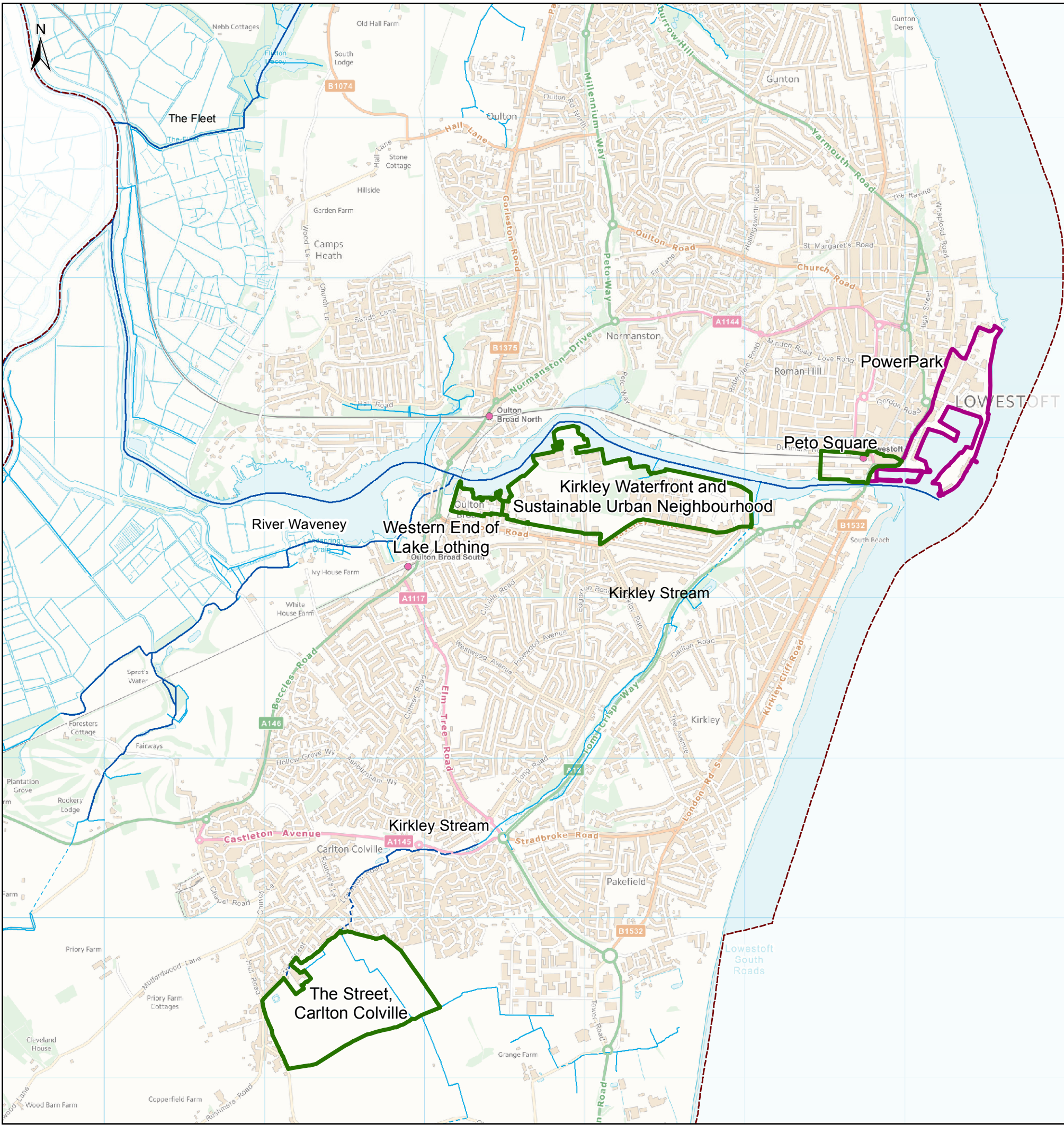
Consideration and mitigation of surface water flood risk will additionally be important at all of the development sites, including the use of SuDS. It is recommended that reference is also made to the latest outputs from the ongoing Kirkley Stream modelling study, in order to gain an increased understanding of surface water flood risk. At The Street, Carlton Colville, the latest modelling should also be referenced in order to confirm the fluvial flood risk characteristics associated with the Kirkley Stream. It is recommended that the latest advice is sought from Suffolk County Council (as the Lead Local Flood Authority) with respect to surface water management and development within the Kirkley Stream catchment.

²⁸ <http://lowestoftfrmp.org.uk/>

Appendix A Flood Risk Mapping

List of Maps

Map Number	Map Title
Figure 01	Study Area and River Network
Figure 02	Historic Flood Records
Figure 03	Risk of Flooding from Rivers and Sea
Figure 04	Risk of Flooding from Surface Water
Figure 05	Draft Kirkley Stream Modelling – Flood Depth
Figure 06	Susceptibility to Groundwater Flooding
Figure 07	Risk of Flooding from Rivers and Sea with an allowance for Climate Change
Figure 08	Infiltration SuDS Suitability
Figure 09	Lowestoft Tidal Modelling - Flood Hazard
Figure 10	Lowestoft Tidal Modelling - Flood Depth
Figure 11	Lowestoft Tidal Modelling - Flood Velocity



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

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Project Title
**EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title
**LEVEL 2 SITES
STUDY AREA AND
WATERCOURSE NETWORK**

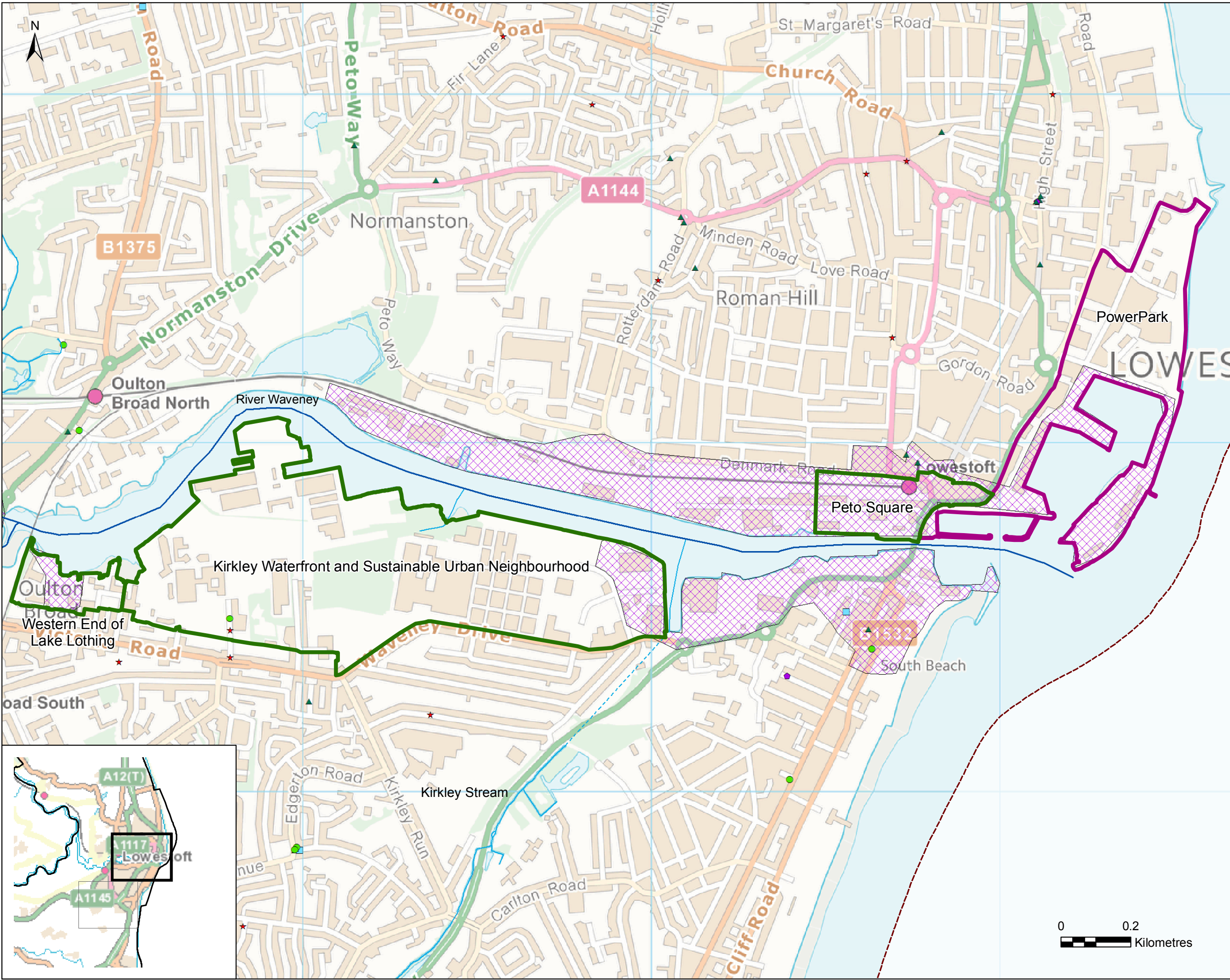
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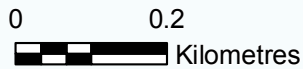
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- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use
- Recorded Flood Outlines

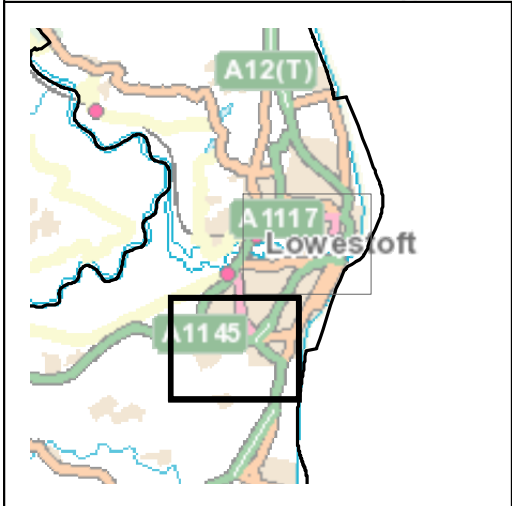
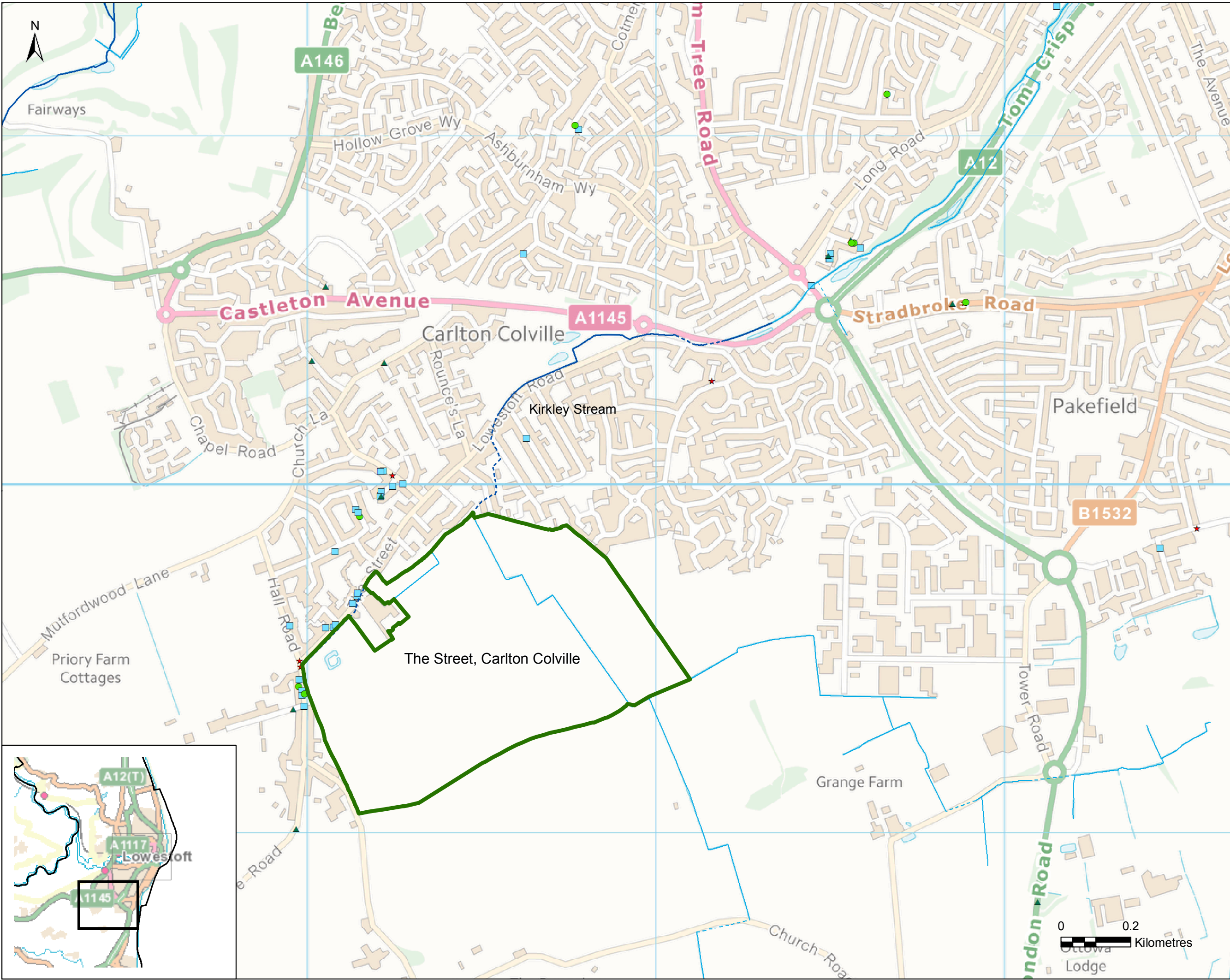
Flood Incident Type

- Foul or Surface Sewer
- Groundwater
- Highways Drainage
- Other/Unknown
- Surface Water

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Drawing Title	LEVEL 2 SITES NORTH HISTORIC FLOOD RECORDS						
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- Level 2 Site - Mixed use
- Recorded Flood Outlines

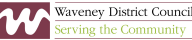

Flood Incident Type

- Foul or Surface Sewer
- Groundwater
- Highways Drainage
- Other/Unknown
- Surface Water

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Project Title

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STRATEGIC FLOOD
RISK ASSESSMENT


Drawing Title

LEVEL 2 SITES SOUTH
HISTORIC FLOOD RECORDS

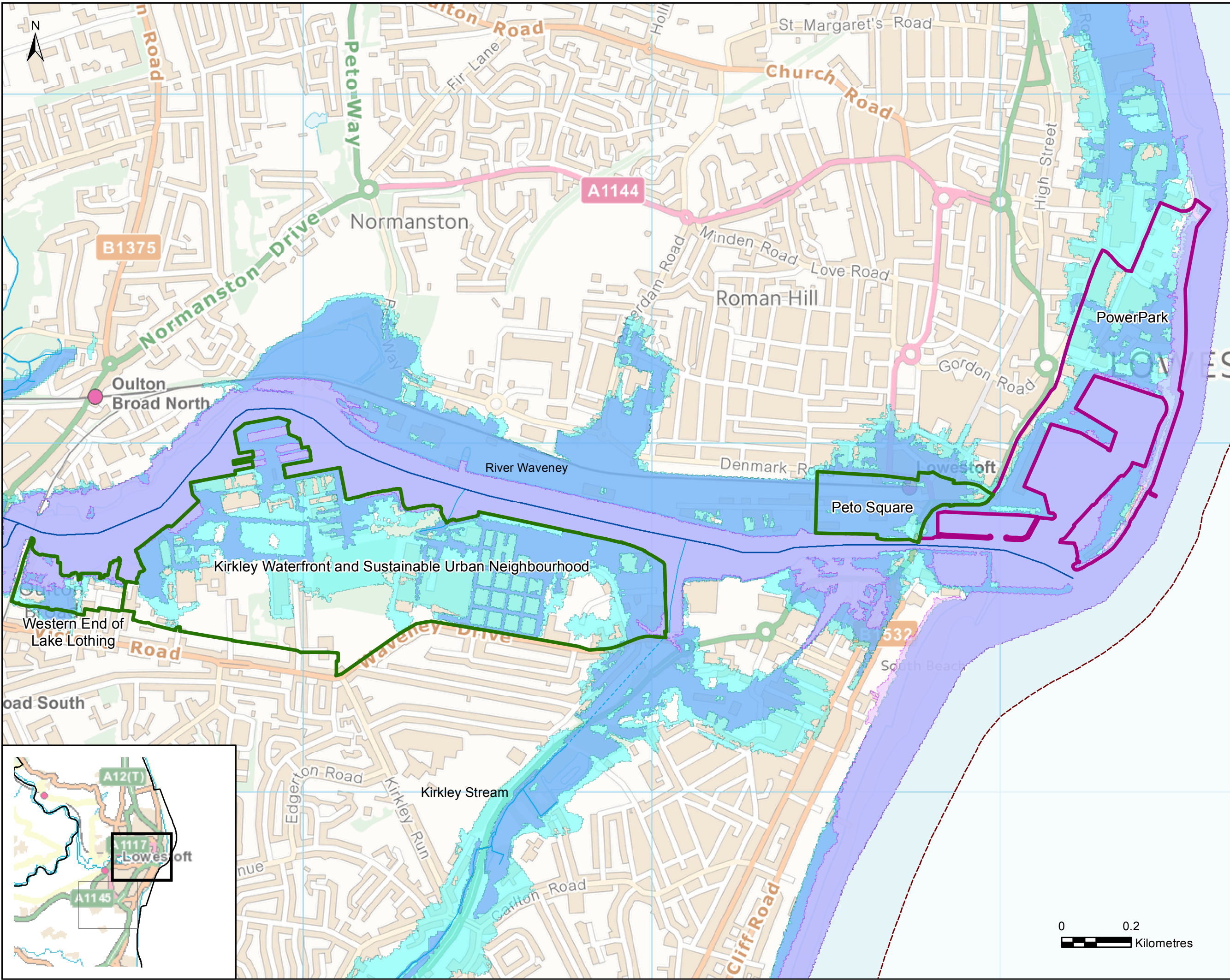
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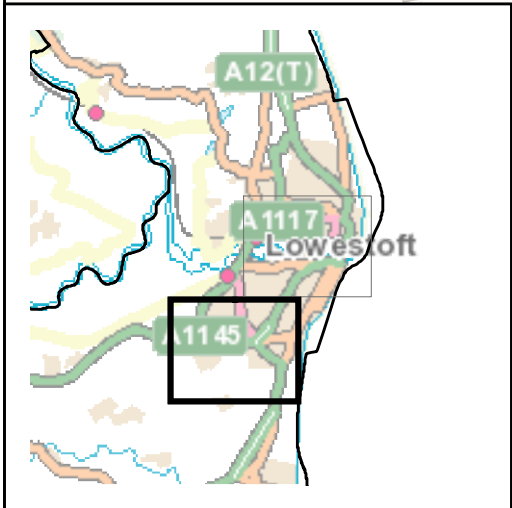
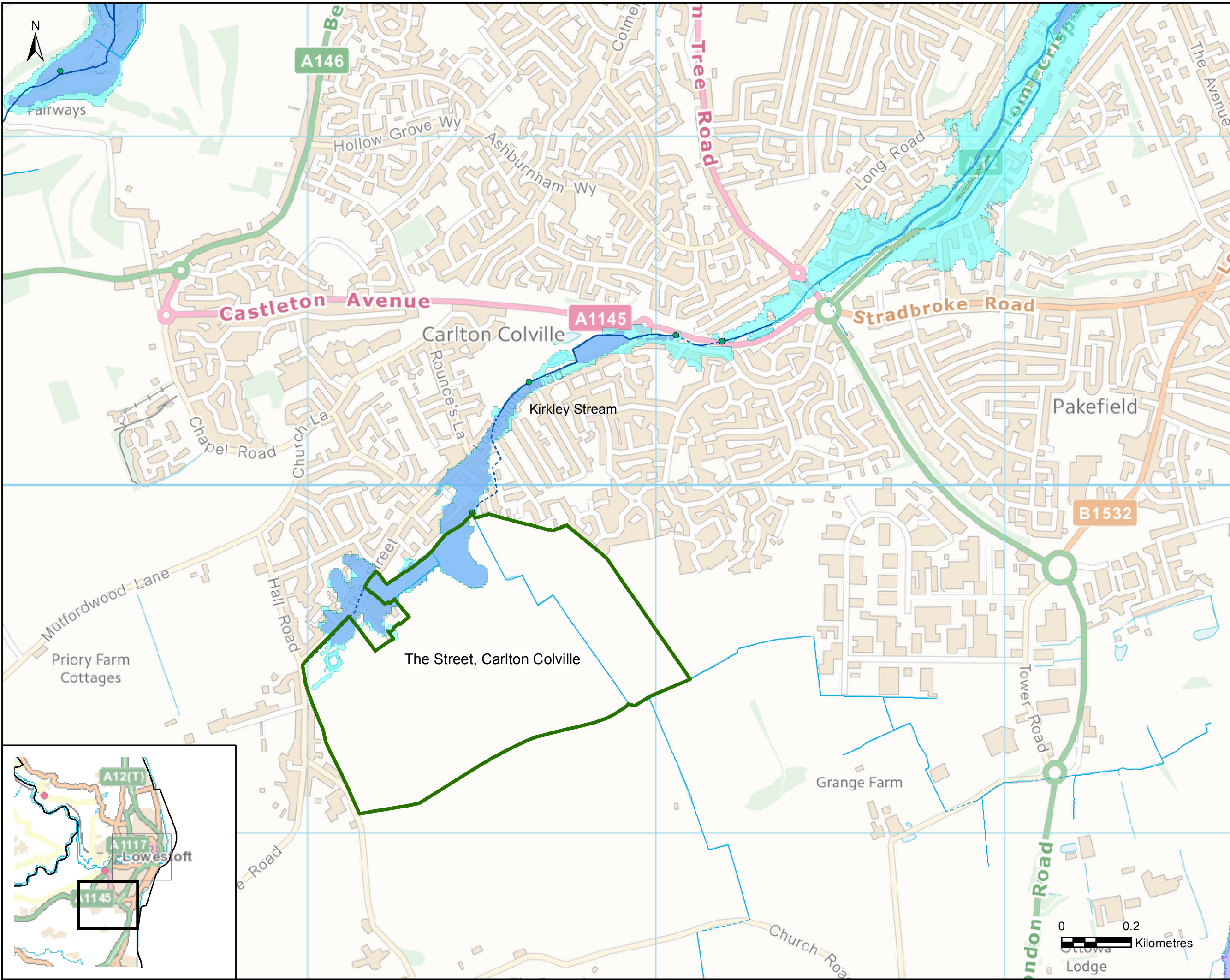
- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use
- Flood Management Structures (EA Database)

Risk of Flooding from Rivers and the Sea

- Flood Zone 2
- Flood Zone 3
- Flood Zone 3b

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- Ordinary Watercourse (Culverted)
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- Level 2 Site - Mixed use
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Risk of Flooding from Rivers and the Sea

- Flood Zone 2
- Flood Zone 3
- Flood Zone 3b

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RISK ASSESSMENT

Drawing Title: LEVEL 2 SITES SOUTH
RISK OF FLOODING
FROM RIVERS AND SEA

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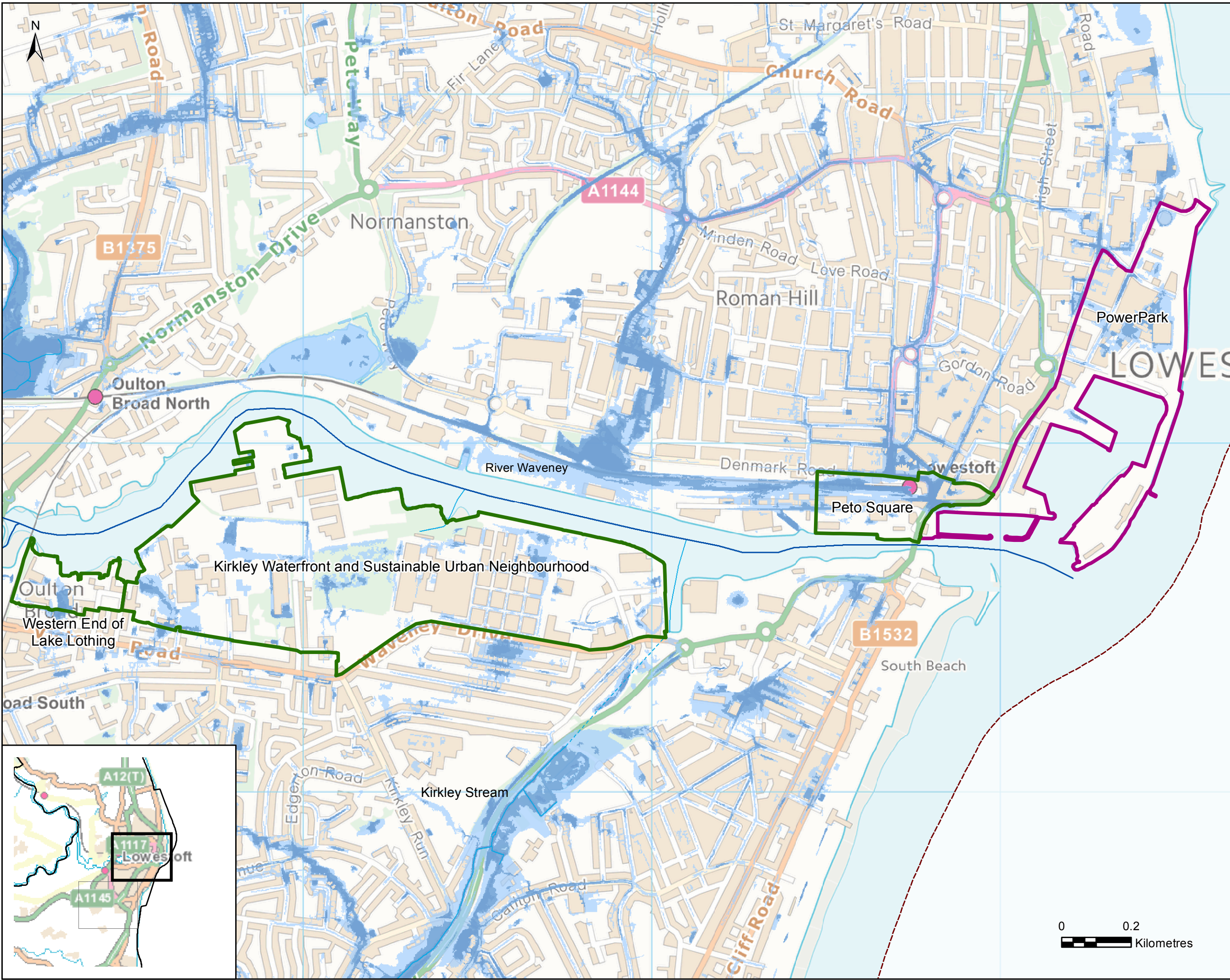
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- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Risk of flooding

- High risk (3.3% AEP)
- Medium Risk (1% AEP)
- Low Risk (0.1% AEP)


Notes

Additional information regarding surface water flood risk in the study area is shown in the Draft Kirkley Stream Modelling (Figure 05)

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FROM SURFACE WATER

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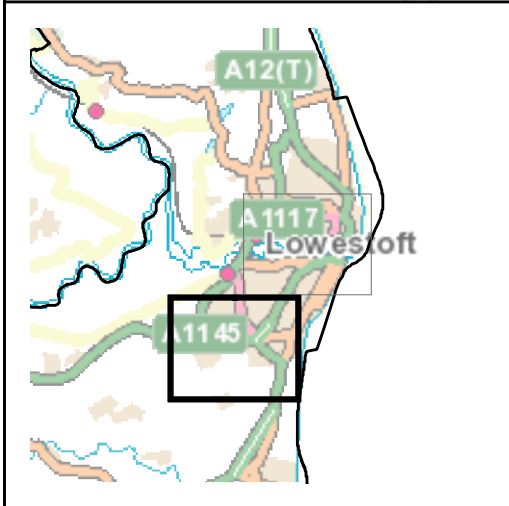
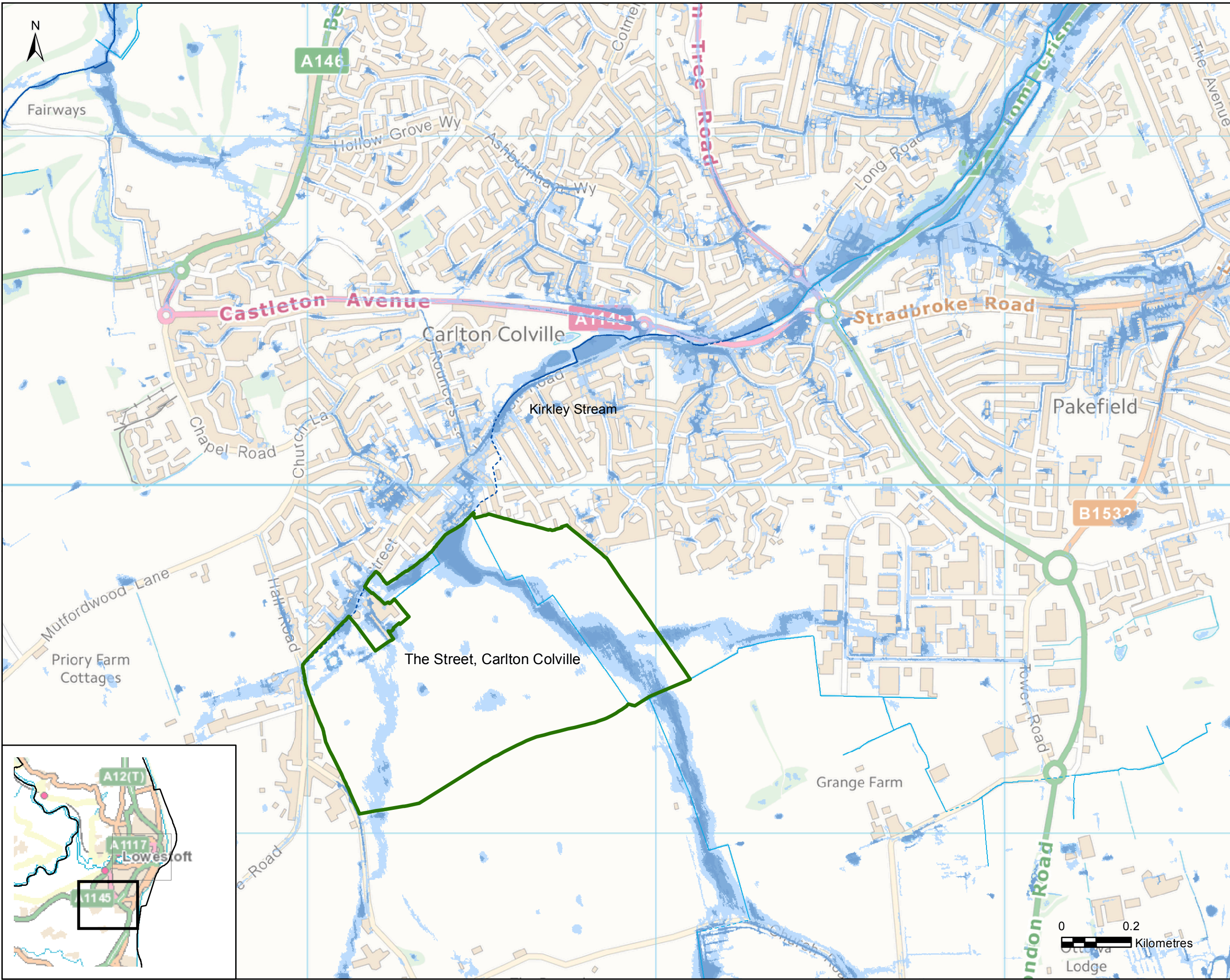
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- Level 2 Site - Mixed use

Risk of flooding

- High risk (3.3% AEP)
- Medium Risk (1% AEP)
- Low Risk (0.1% AEP)

Notes

Additional information regarding surface water flood risk in the study area is shown in the Draft Kirkley Stream Modelling (Figure 05)


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No changes - Issued as final	LM	MD	18/04/18	2
Revision Details	By	Check	Date	Suffix

Purpose of Issue

DRAFT

Client

 Waveney District Council
Serving the Community

Project Title

EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title

LEVEL 2 SITES SOUTH
RISK OF FLOODING
FROM SURFACE WATER

Drawn	Checked	Approved	Date
LM	MD	GP	18/04/2018

AECOM Internal Project No.

60520248

Scale at A3

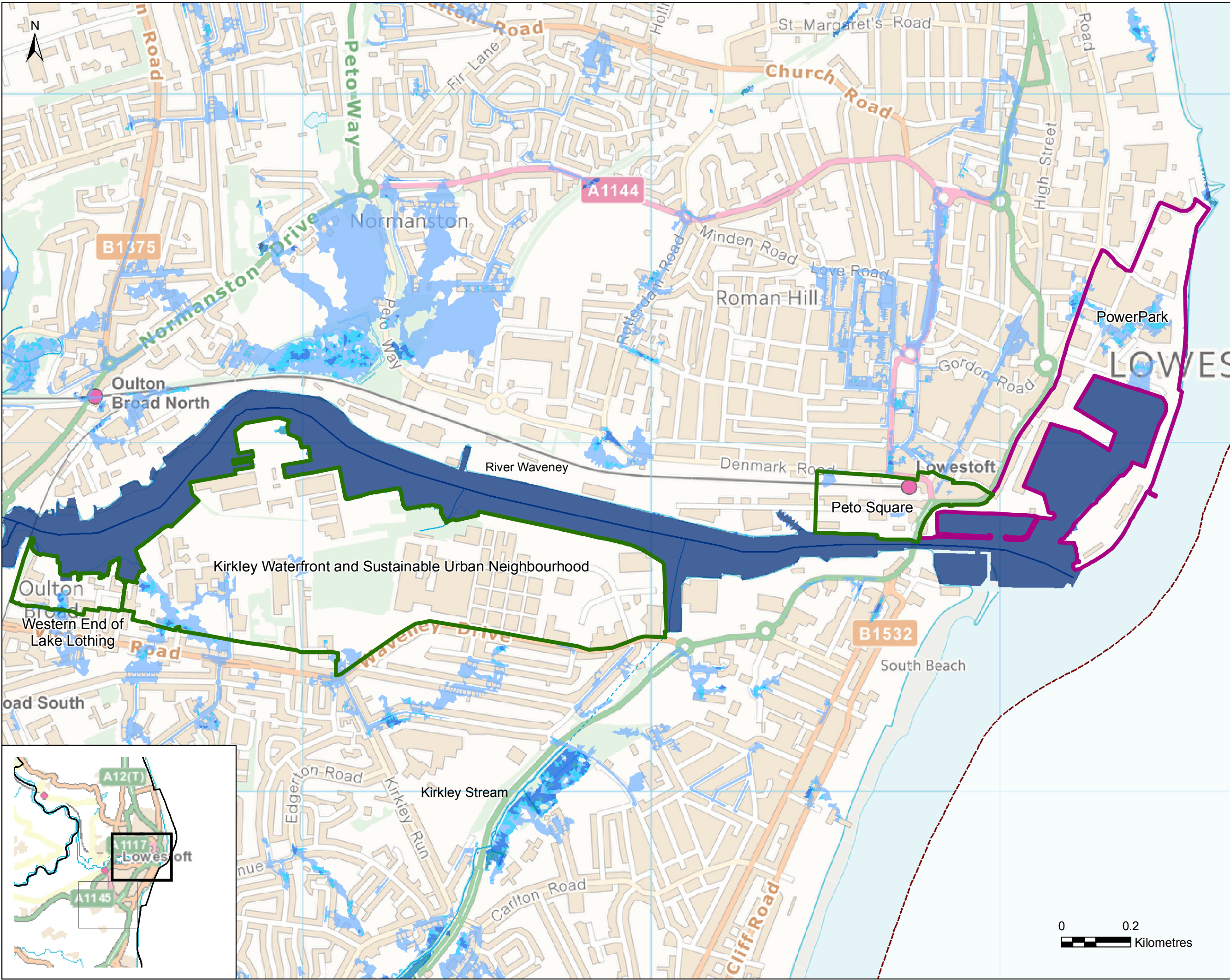
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Drawing Number	Rev
FIGURE 04.2	2



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Kirkley Stream Modelling - 3.33% AEP Flood Depth

- < 0.10m
- 0.10m - 0.20m
- 0.20m - 0.50m
- 0.50m - 1.00m
- >1.00m

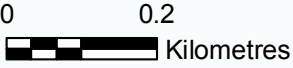
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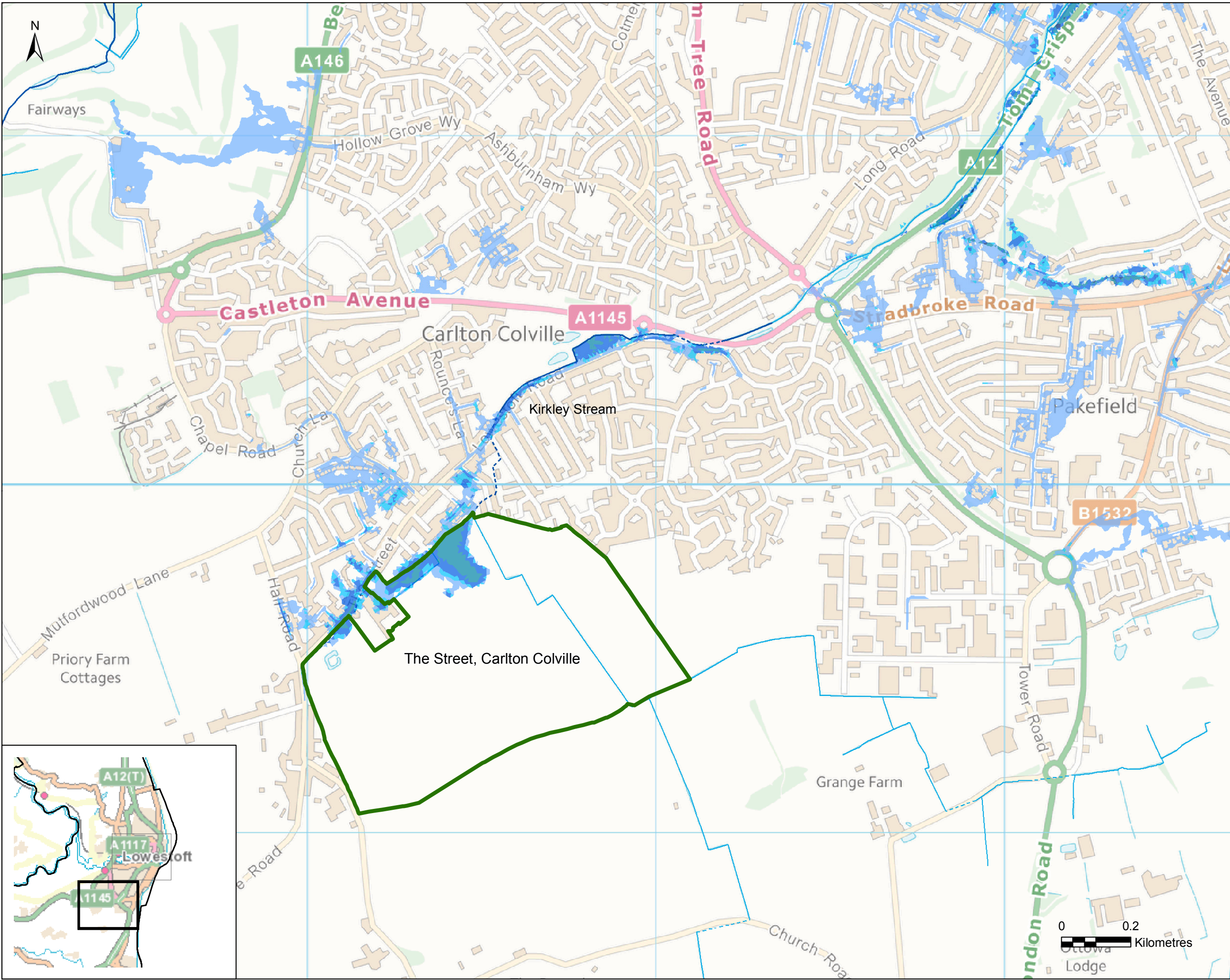
The modelled flood depths represent combined surface water and fluvial flood risk within the Kirkley Stream catchment.

It should be noted that this modelling is currently being further refined and therefore reference should be made to the most updated flood outlines, which are due to be available for consideration later in 2018.

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3.33% and 0.5% AEP events added	LM	MD	22.03.18	2
Revision Details	By	Check	Date	Suffix
Purpose of Issue	FINAL			
Client	Waveney District Council Serving the Community			
Project Title	EAST SUFFOLK COUNCILS STRATEGIC FLOOD RISK ASSESSMENT			
Drawing Title	LEVEL 2 SITES NORTH DRAFT KIRKLEY STREAM MODELLING 1 IN 30 YEAR EVENT - FLOOD DEPTH			
Drawn	LM	Checked	MD	Approved
				GP
AECOM Internal Project No.	Date			
60520248	22/03/2018			
Scale at A3		1:10,000		
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Drawing Number				Rev.
FIGURE 05.1				2





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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Kirkley Stream Modelling - 3.33% AEP Flood Depth

- < 0.10m
- 0.10m - 0.20m
- 0.20m - 0.50m
- 0.50m - 1.00m
- > 1.00m

Notes

The modelled flood depths represent combined surface water and fluvial flood risk within the Kirkley Stream catchment.

It should be noted that this modelling is currently being further refined and therefore reference should be made to the most updated flood outlines, which are due to be available for consideration later in 2018.

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3.33% and 0.5% AEP events added	LM	MD	22.03.18	2
Revision Details	By	Check	Date	Suffix

Purpose of Issue: **FINAL**

Client: Waveney District Council
Serving the Community

Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES SOUTH
DRAFT KIRKLEY STREAM MODELLING
1 IN 30 YEAR EVENT - FLOOD DEPTH**

Drawn	Checked	Approved	Date
LM	MD	GP	22/03/2018

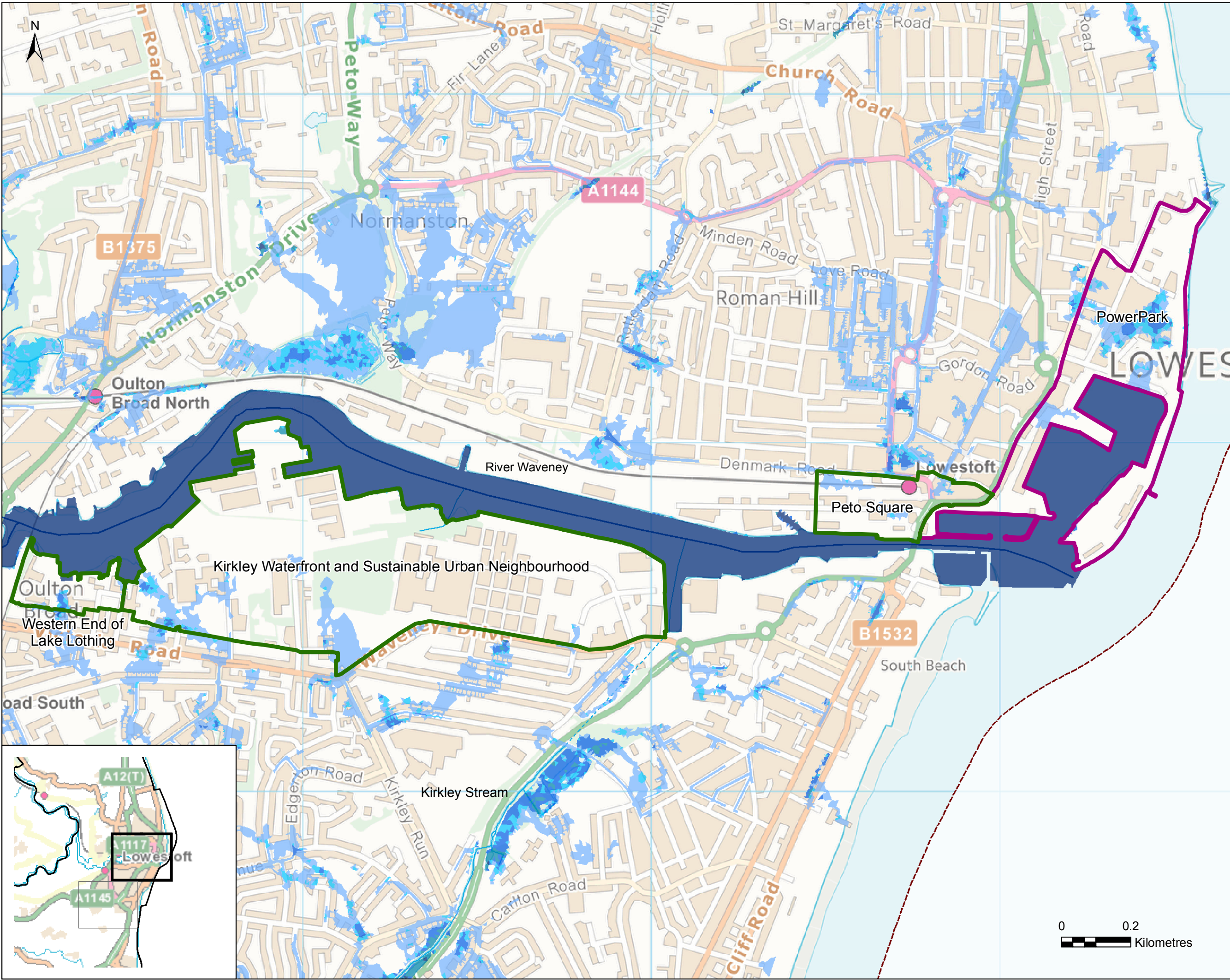
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FIGURE 05.2	2



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Kirkley Stream Modelling - 1% AEP Flood Depth


- < 0.10m
- 0.10m - 0.20m
- 0.20m - 0.50m
- 0.50m - 1.00m
- >1.00m

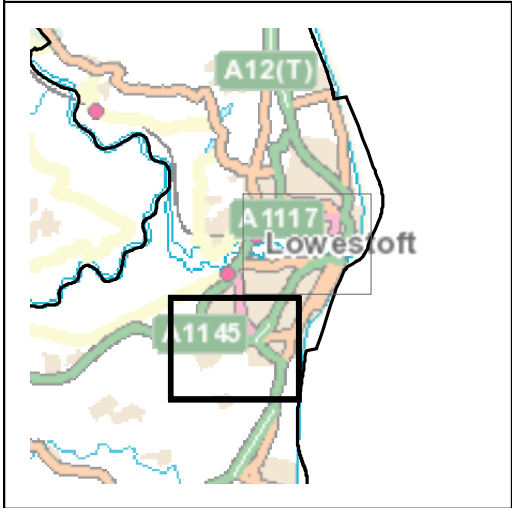
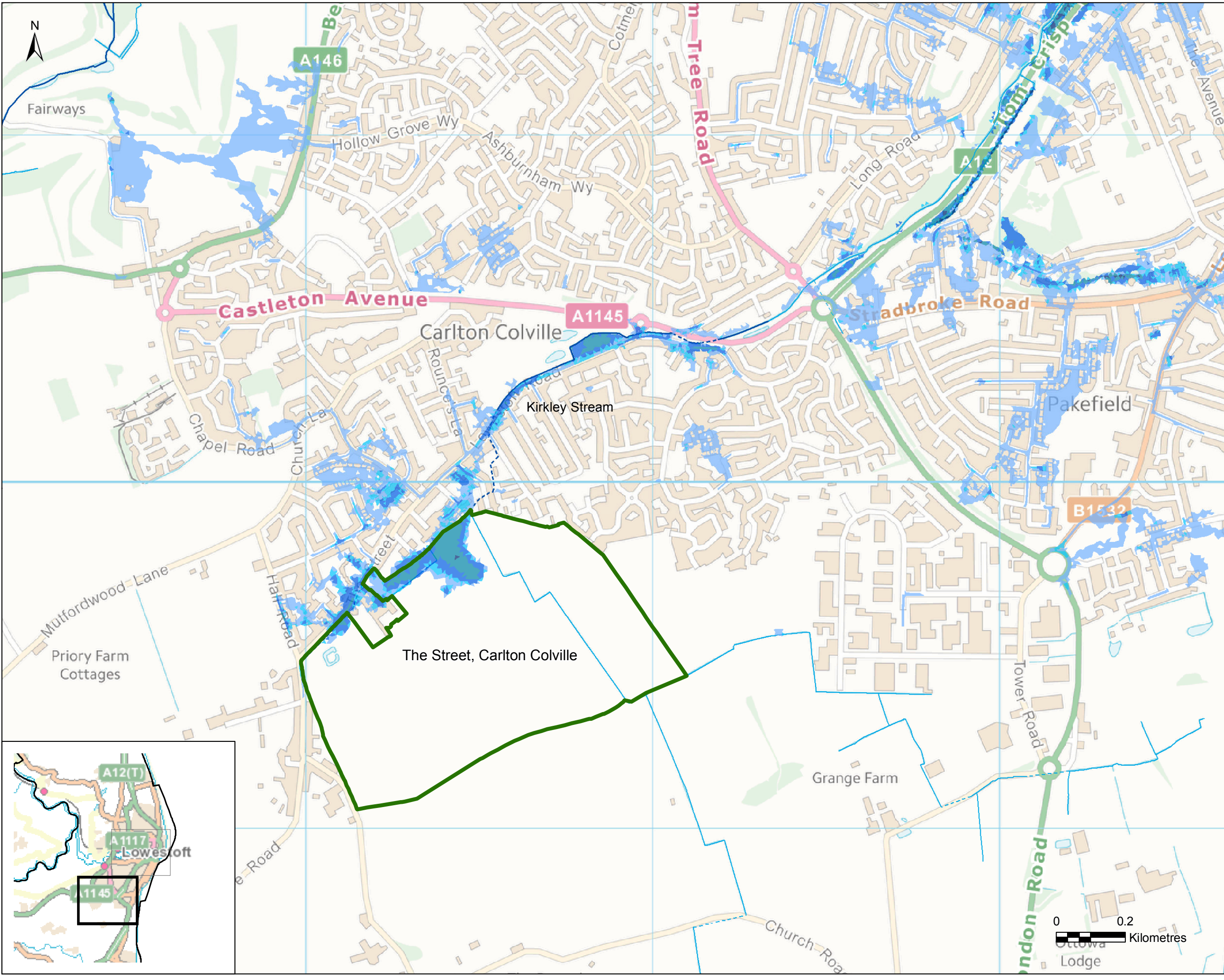
Notes

The modelled flood depths represent combined surface water and fluvial flood risk within the Kirkley Stream catchment.

It should be noted that this modelling is currently being further refined and therefore reference should be made to the most updated flood outlines, which are due to be available for consideration later in 2018.

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3.33% and 0.5% AEP events added	LM	MD	22.03.18	2
Revision Details	By	Check	Date	Suffix
Purpose of Issue	FINAL			
Client	 Waveney District Council Serving the Community			
Project Title	EAST SUFFOLK COUNCILS STRATEGIC FLOOD RISK ASSESSMENT			
Drawing Title	LEVEL 2 SITES NORTH DRAFT KIRKLEY STREAM MODELLING 1 IN 100 YEAR EVENT - FLOOD DEPTH			
Drawn	Checked	Approved	Date	
LM	MD	GP	22/03/2018	
AECOM Internal Project No.	Scale at A3			
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Drawing Number	Rev.			
FIGURE 05.3				2



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Kirkley Stream Modelling - 1% AEP Flood Depth

- < 0.10m
- 0.10m - 0.20m
- 0.20m - 0.50m
- 0.50m - 1.00m
- >1.00m

Notes

The modelled flood depths represent combined surface water and fluvial flood risk within the Kirkley Stream catchment.

It should be noted that this modelling is currently being further refined and therefore reference should be made to the most updated flood outlines, which are due to be available for consideration later in 2018.

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3.33% and 0.5% AEP events added	LM	MD	22.03.18	2
Revision Details	By	Check	Date	Suffix

Purpose of Issue

FINAL

Client

Waveney District Council
Serving the Community

Project Title

EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title

LEVEL 2 SITES SOUTH
DRAFT KIRKLEY STREAM MODELLING
1 IN 100 YEAR EVENT - FLOOD DEPTH

Drawn	Checked	Approved	Date
LM	MD	GP	22/03/2018

AECOM Internal Project No.

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Scale at A3

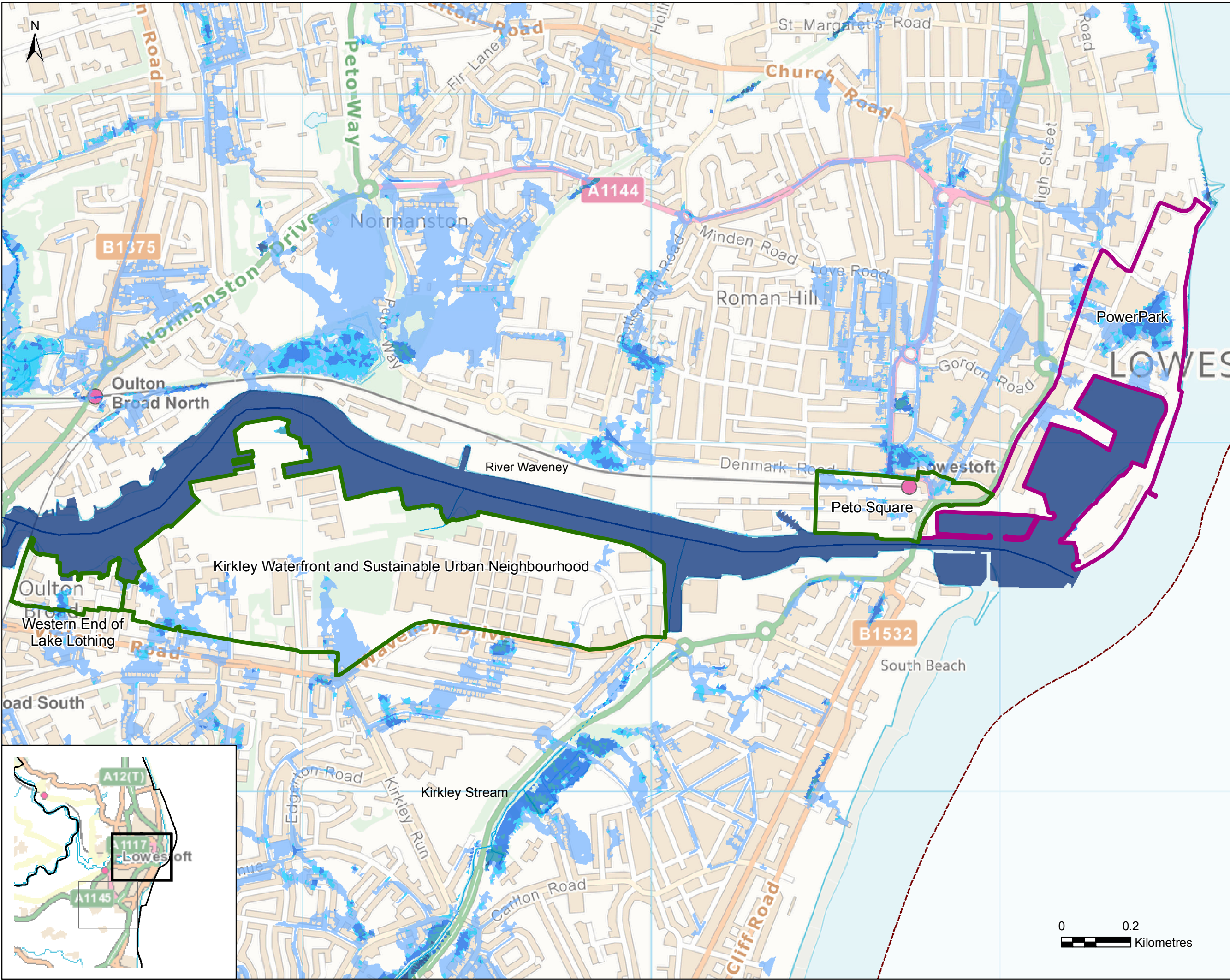
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FIGURE 05.4	2



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Kirkley Stream Modelling - 0.5% AEP Flood Depth

- < 0.10m
- 0.10m - 0.20m
- 0.20m - 0.50m
- 0.50m - 1.00m
- >1.00m

Notes

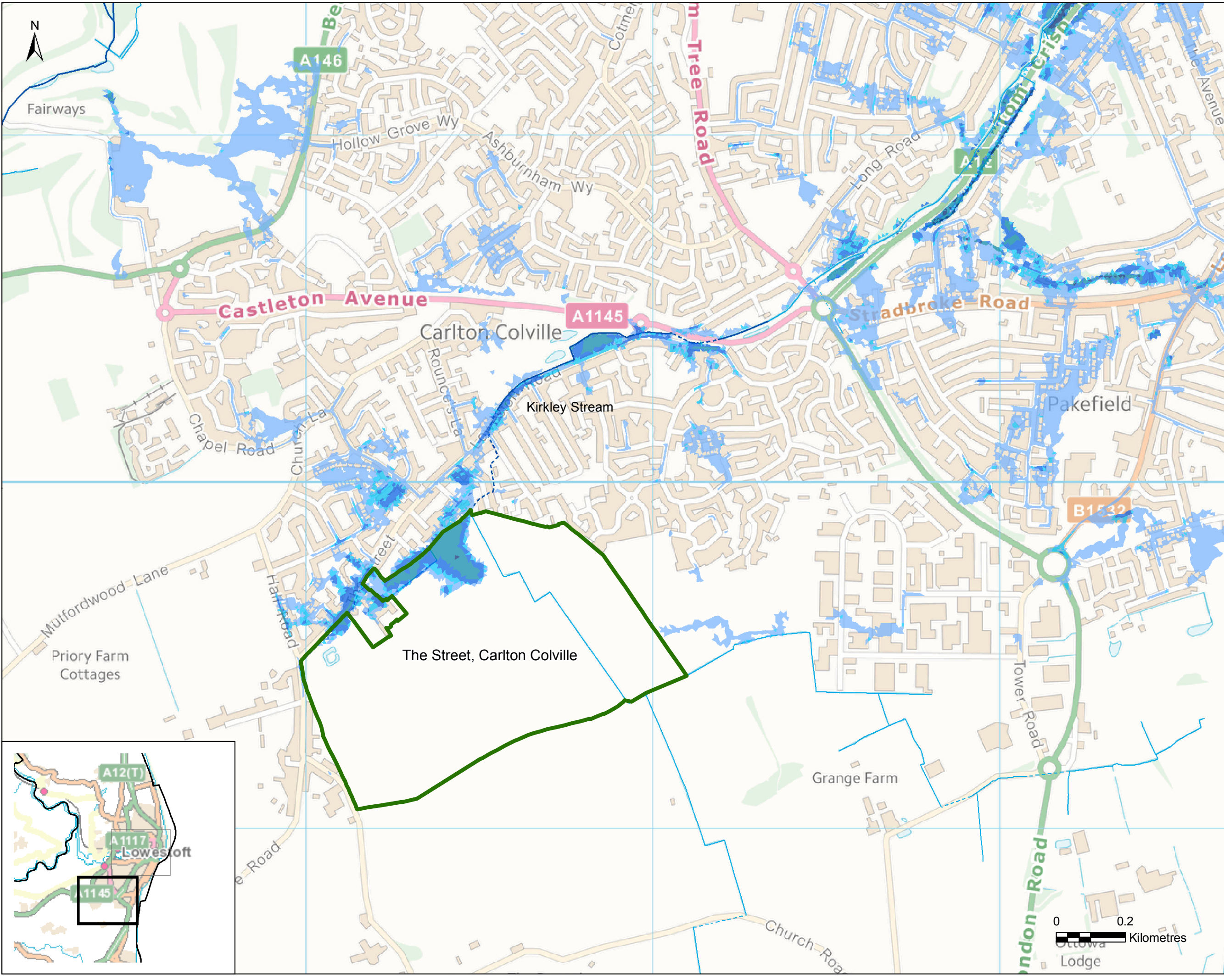
The modelled flood depths represent combined surface water and fluvial flood risk within the Kirkley Stream catchment.

It should be noted that this modelling is currently being further refined and therefore reference should be made to the most updated flood outlines, which are due to be available for consideration later in 2018.

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3.33% and 0.5% AEP events added	LM	MD	22.03.18	2
Revision Details	By	Check	Date	Suffix
Purpose of Issue	FINAL			
Client	Waveney District Council Serving the Community			
Project Title	EAST SUFFOLK COUNCILS STRATEGIC FLOOD RISK ASSESSMENT			
Drawing Title	LEVEL 2 SITES NORTH DRAFT KIRKLEY STREAM MODELLING 1 IN 200 YEAR EVENT - FLOOD DEPTH			
Drawn	LM	Checked	MD	Approved
				GP
AECOM Internal Project No.	Date			
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FIGURE 05.5				2

0 0.2 Kilometres



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Kirkley Stream Modelling - 0.5% AEP Flood Depth

- < 0.10m
- 0.10m - 0.20m
- 0.20m - 0.50m
- 0.50m - 1.00m
- >1.00m

Notes

The modelled flood depths represent combined surface water and fluvial flood risk within the Kirkley Stream catchment.

It should be noted that this modelling is currently being further refined and therefore reference should be made to the most updated flood outlines, which are due to be available for consideration later in 2018.

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Revision Details	By	Check	Date	Suffix

Purpose of Issue

FINAL

Client

Waveney District Council
Serving the Community

Project Title

EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title

LEVEL 2 SITES SOUTH
DRAFT KIRKLEY STREAM MODELLING
1 IN 200 YEAR EVENT - FLOOD DEPTH

Drawn	Checked	Approved	Date
LM	MD	GP	22/03/2018

AECOM Internal Project No.

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Scale at A3

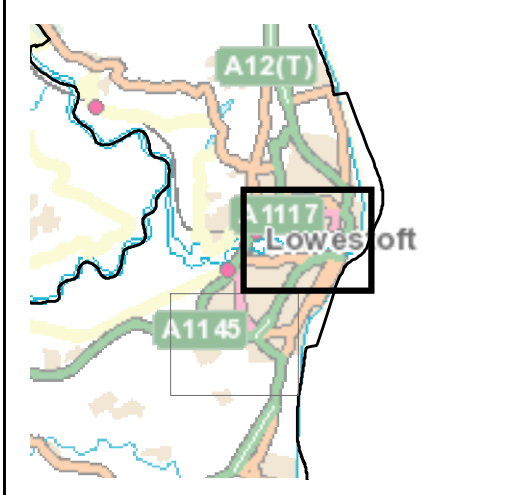
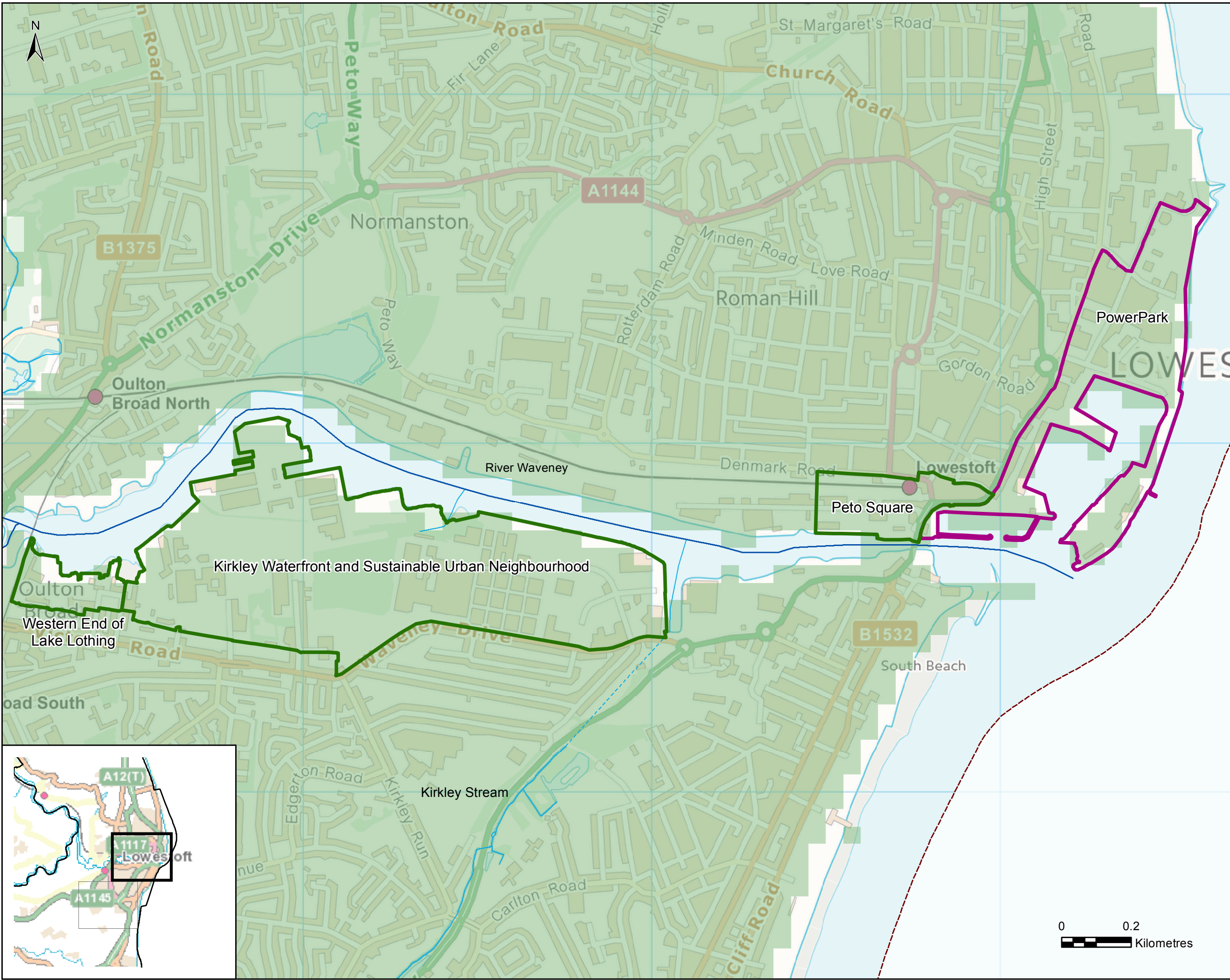
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FIGURE 05.6	2



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

BGS Susceptibility to Groundwater flooding

- Potential for groundwater flooding to occur at surface
- Potential for groundwater flooding of property situated below ground level
- Limited potential for groundwater flooding to occur
- Not considered to be prone to groundwater flooding

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Revision Details	By	Check	Date	Suffix
Purpose of Issue	FINAL			

Client

Waveney District Council
Serving the Community

Project Title

EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title

LEVEL 2 SITES NORTH
SUSCEPTIBILITY TO
GROUNDWATER FLOODING

Drawn	Checked	Approved	Date
LM	MD	GP	18/04/2018

AECOM Internal Project No. 60520248

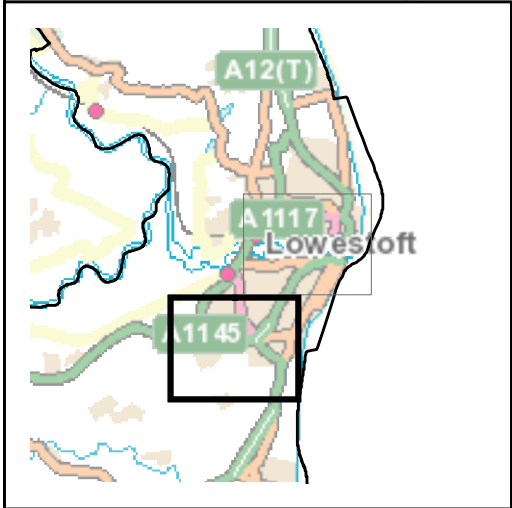
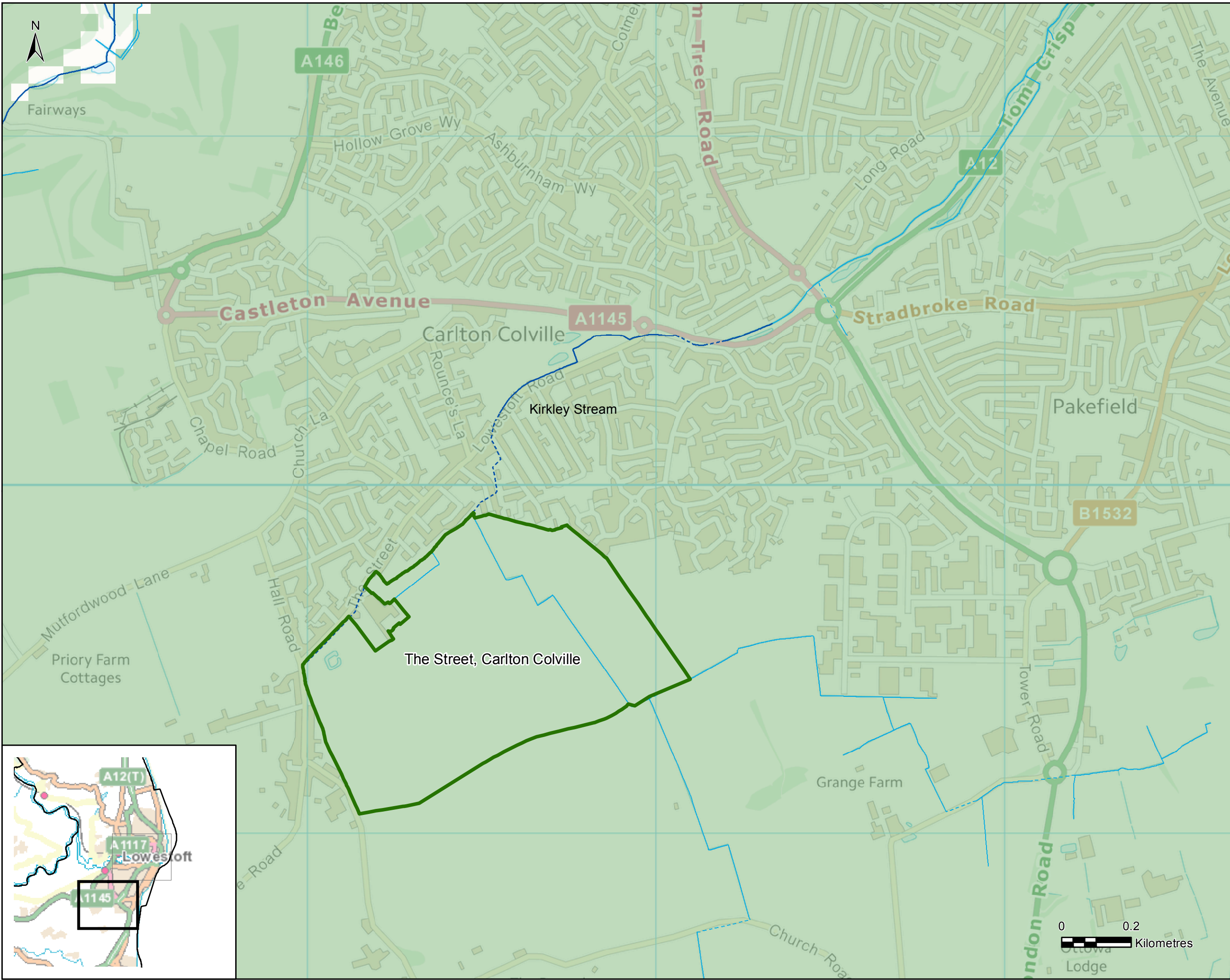
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FIGURE 06.1	2



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LEGEND

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- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

BGS Susceptibility to Groundwater flooding

- Potential for groundwater flooding to occur at surface
- Potential for groundwater flooding of property situated below ground level
- Limited potential for groundwater flooding to occur
- Not considered to be prone to groundwater flooding

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No changes - Issued as final	LM	MD	18/04/18	2
Revision Details	By	Check	Date	Suffix

Purpose of Issue: **FINAL**

Client: Waveney District Council
Serving the Community

Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES SOUTH
SUSCEPTIBILITY TO
GROUNDWATER FLOODING**

Drawn	Checked	Approved	Date
LM	MD	GP	18/04/2018

AECOM Internal Project No. 60520248

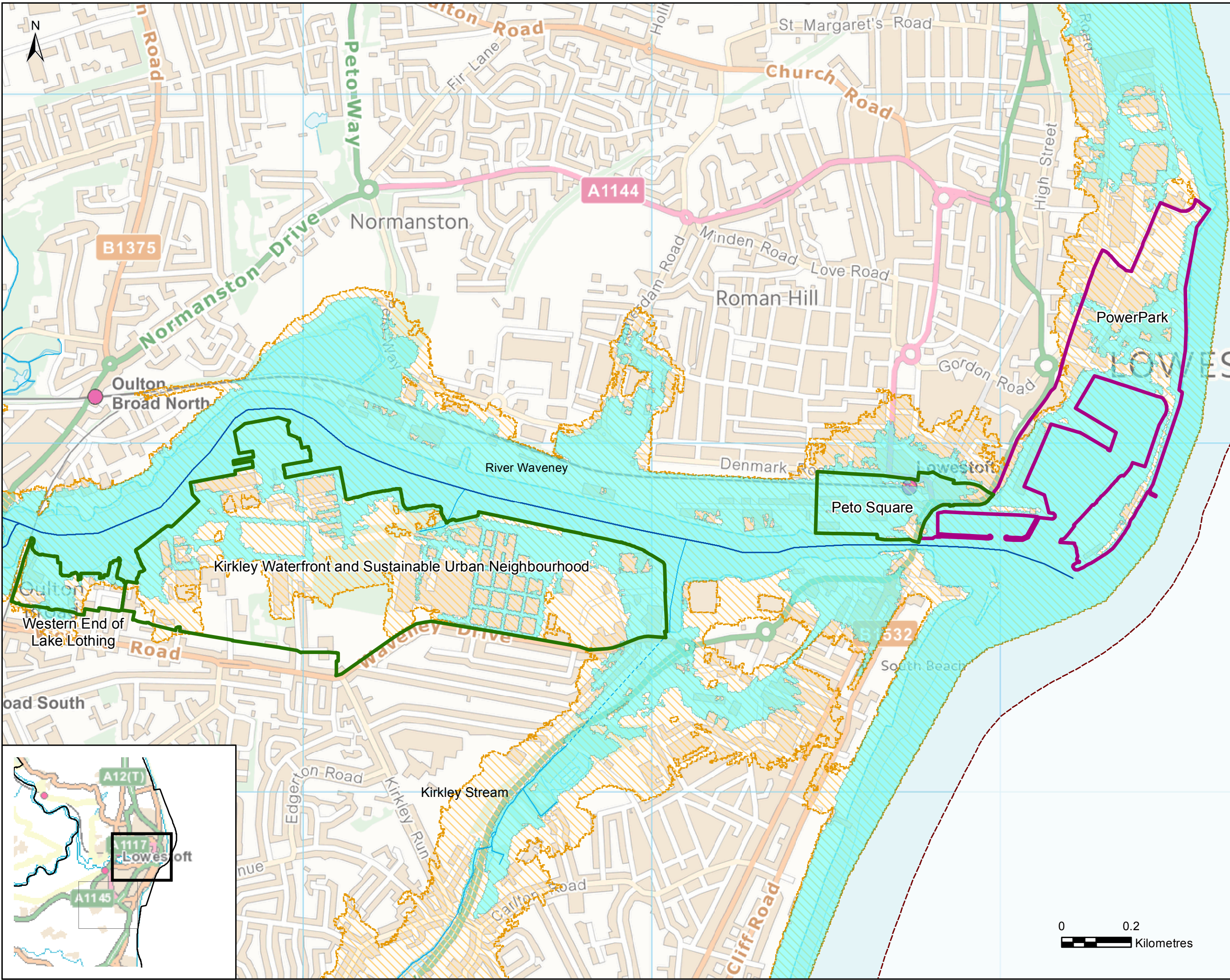
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Drawing Number	Rev
FIGURE 06.2	2



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use
- Modelled 1 in 200 year Tidal Event
- Modelled 1 in 200 year Tidal Event with Climate Change

Notes

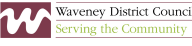

Only tidal climate change outlines are shown on this figure. No fluvial climate change modelling is available in this area.

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Note added.	LM	MD	18.04.18	2
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Purpose of Issue: **FINAL**

Client



Project Title

**EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title

**LEVEL 2 SITES NORTH - RISK OF
FLOODING FROM RIVERS AND SEA WITH
AN ALLOWANCE FOR CLIMATE CHANGE**

Drawn	Checked	Approved	Date
LM	MD	GP	18/04/2018

AECOM Internal Project No. 60520248

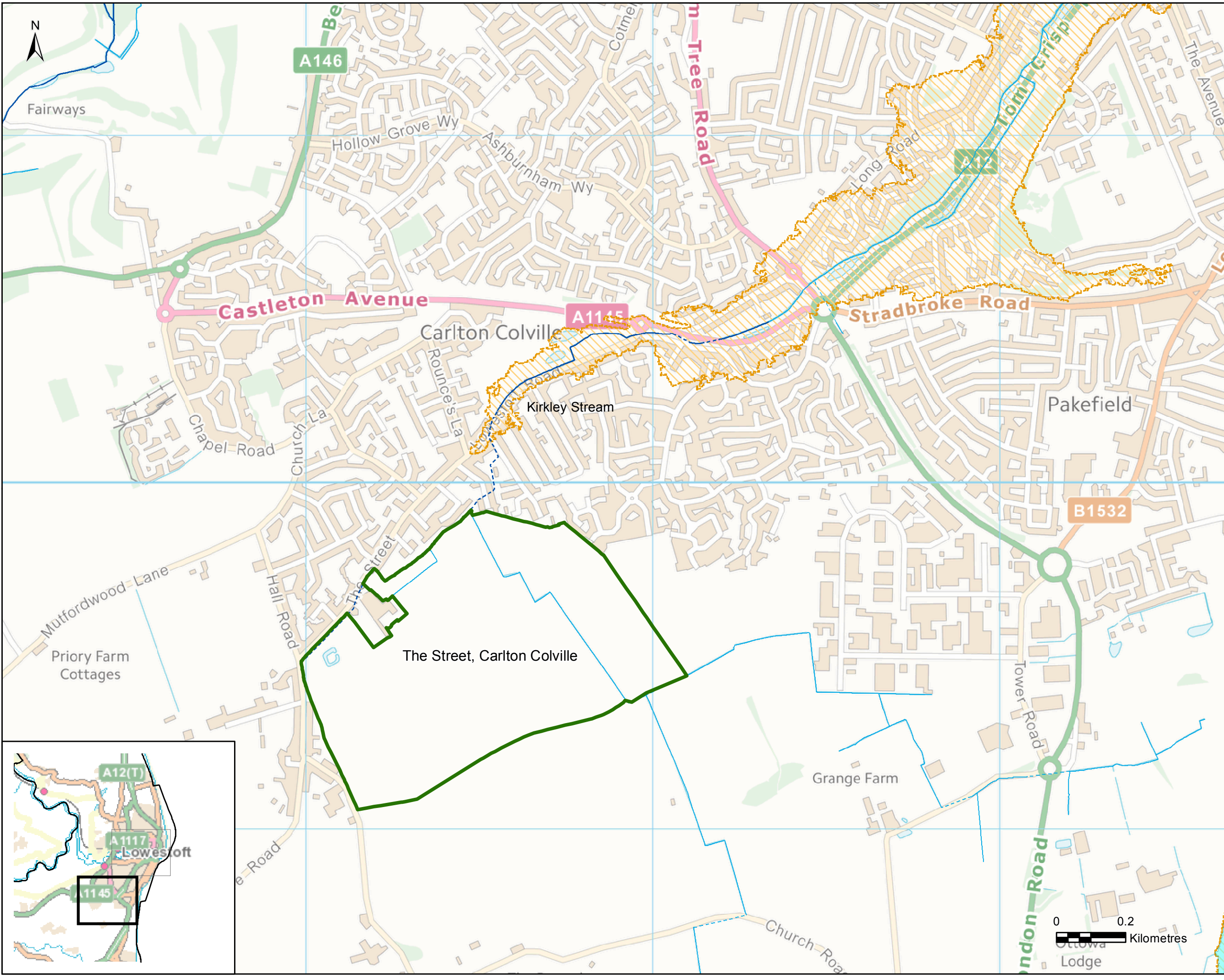
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Drawing Number	Rev
FIGURE 07.1	2



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use
- Modelled 1 in 200 year Tidal Event
- Modelled 1 in 200 year Tidal Event with Climate Change

Notes

Only tidal climate change outlines are shown on this figure. No fluvial climate change modelling is available in this area.

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Note added.	LM	MD	18/04/18	2
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Purpose of Issue: **FINAL**

Client: Waveney District Council
Serving the Community

Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES SOUTH - RISK OF
FLOODING FROM RIVERS AND SEA WITH
AN ALLOWANCE FOR CLIMATE CHANGE**

Drawn	Checked	Approved	Date
LM	MD	GP	18/04/2018

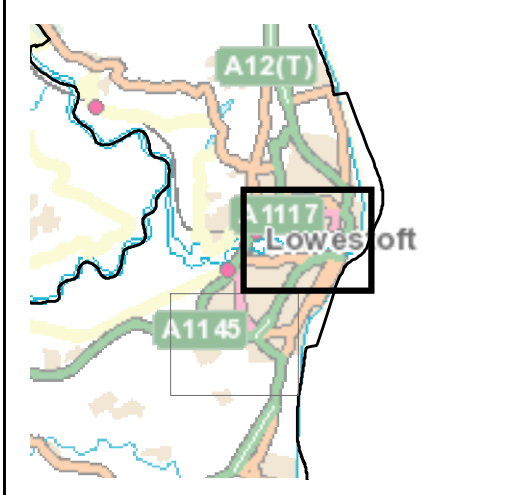
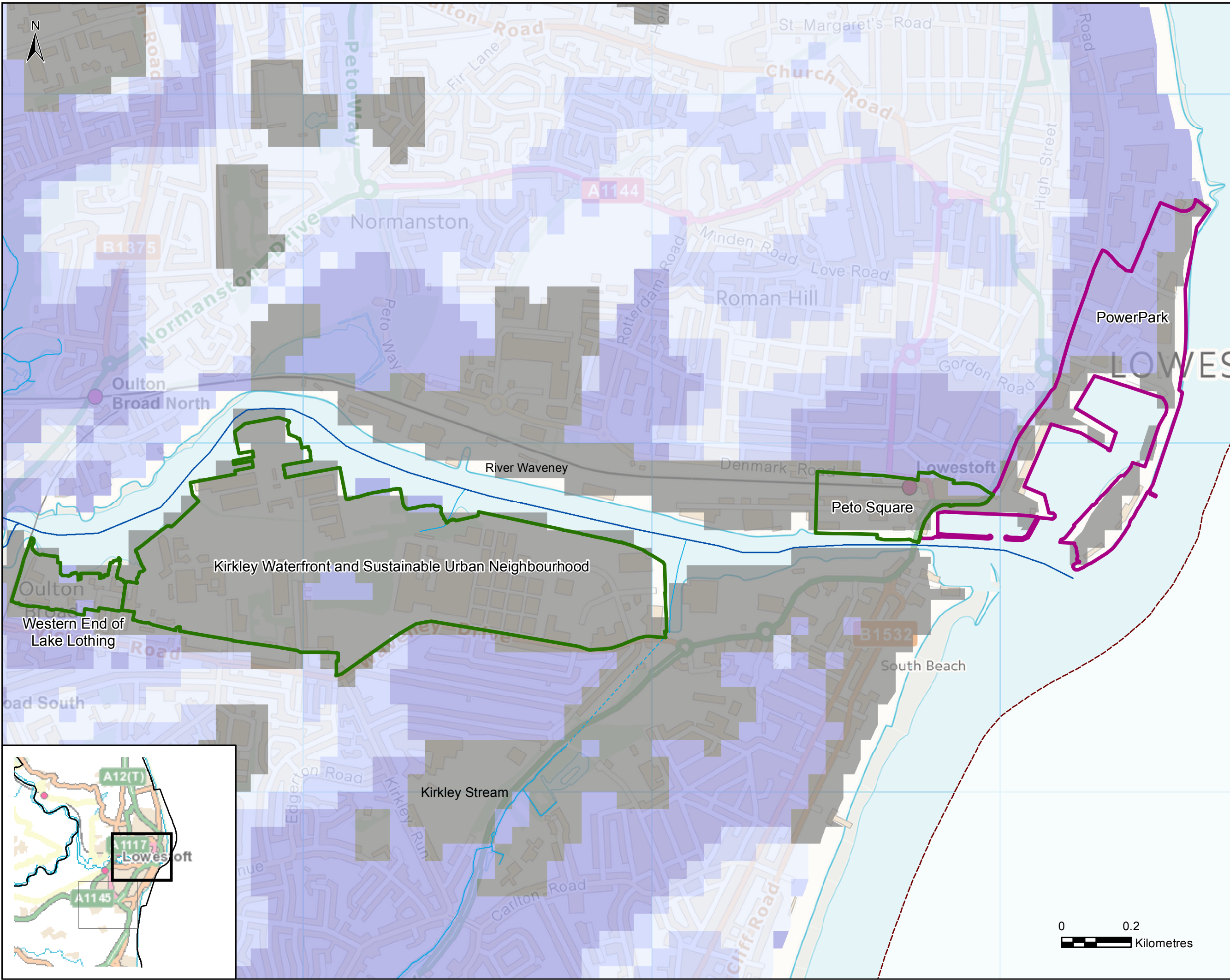
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Drawing Number	Rev
FIGURE 07.2	2



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

BGS Infiltration SuDS Suitability Map (Summary)

- Highly compatible for infiltration SuDS
- Probably compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Very significant constraints are indicated

Notes

The 1:50,000 scale digital map data is generalised and the geological interpretation should be used only as a guide to the geology at a local level. Site-specific investigation is required to confirm infiltration suitability.

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Revision	By	Check	Date	Suffix
No changes - Issued as final	LM	MD	18/04/18	2

Purpose of Issue

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Client

Waveney District Council
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Project Title

EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title

LEVEL 2 SITES NORTH
INFILTRATION SUDS
SUITABILITY

Drawn	Checked	Approved	Date
LM	MD	GP	18/04/2018

AECOM Internal Project No.

60520248

Scale

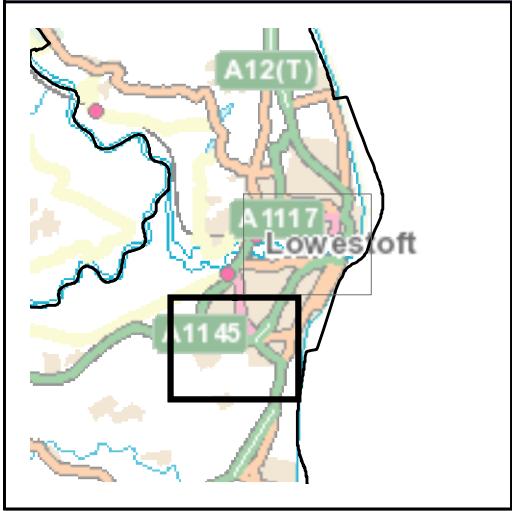
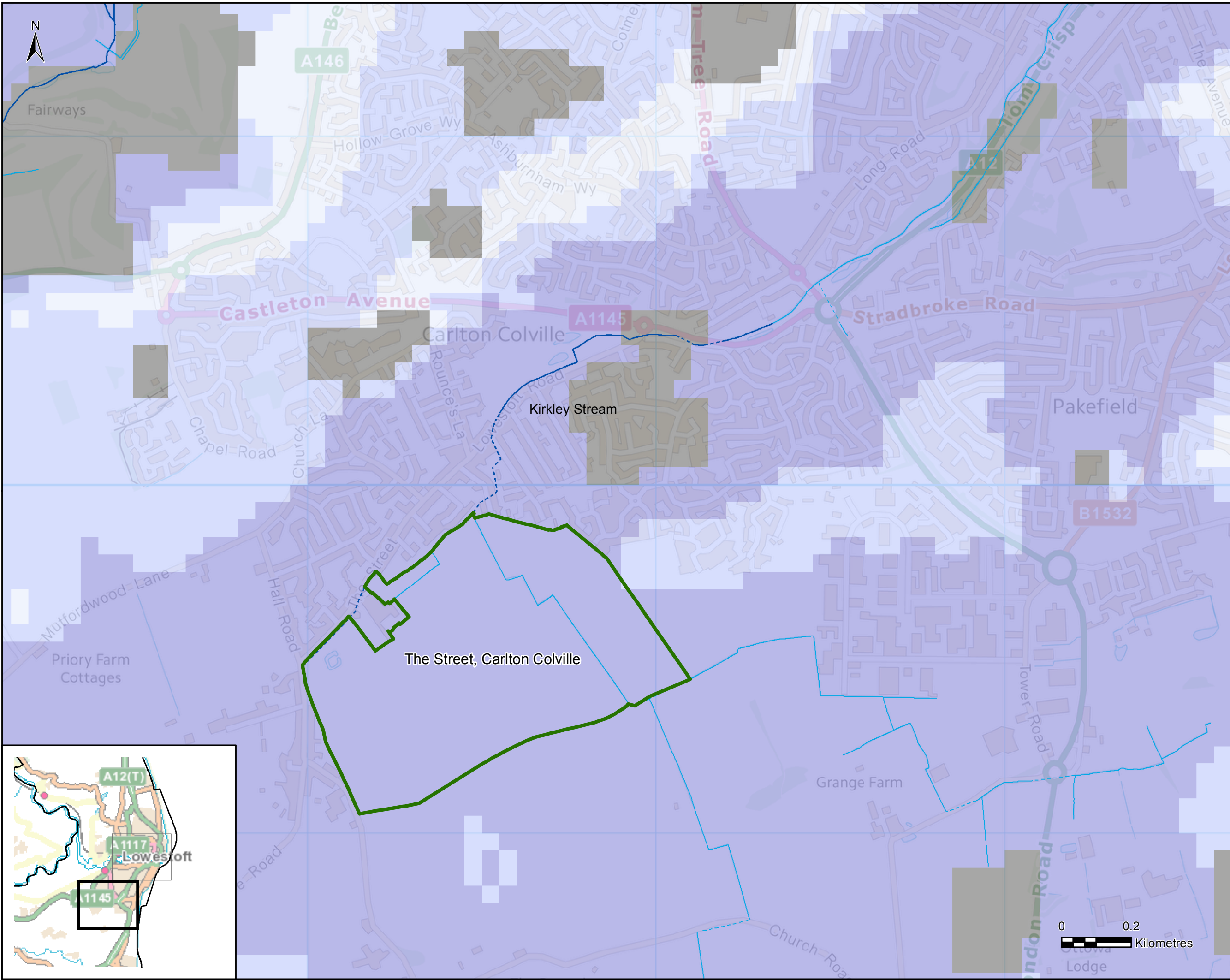
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Drawing Number	Rev
FIGURE 08.1	2



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

BGS Infiltration SuDS Suitability Map (Summary)

- Highly compatible for infiltration SuDS
- Probably compatible for infiltration SuDS
- Opportunities for bespoke infiltration SuDS
- Very significant constraints are indicated

Notes


The 1:50,000 scale digital map data is generalised and the geological interpretation should be used only as a guide to the geology at a local level. Site-specific investigation is required to confirm infiltration suitability.

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No changes - Issued as final	LM	MD	18/04/18	2
Revision Details	By	Check Date	Suffix	

Purpose of Issue: **FINAL**

Client

 **Waveney District Council**
Serving the Community

Project Title

**EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title

**LEVEL 2 SITES SOUTH
INFILTRATION SUDS
SUITABILITY**

Drawn	Checked	Approved	Date
LM	MD	GP	18/04/2018

AECOM Internal Project No. 60520248

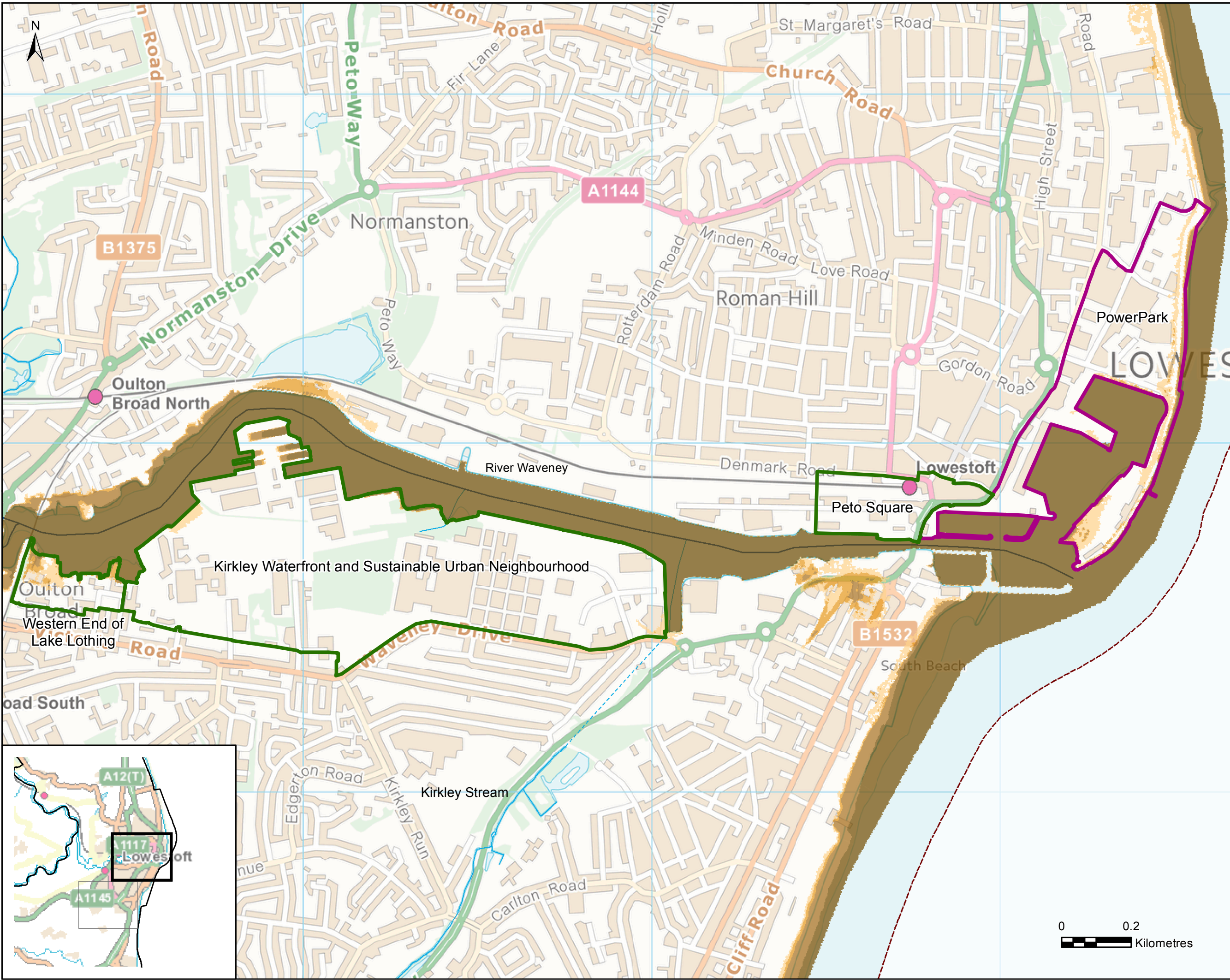
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FIGURE 08.2	2



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LEGEND

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- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 20 Return Period

Defended Scenario - Hazard Rating

- Less than 0.75 (Low Hazard)
- Between 0.75 and 1.25 (Danger for Some)
- Between 1.25 and 2.00 (Danger for Most)
- Greater than 2.00 (Danger for All)

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Revision Details	By	Check	Date	Suffix

Purpose of Issue: FINAL

Client: Waveney District Council
Serving the Community

Project Title: EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title: LEVEL 2 SITES NORTH
LOWESTOFT COASTAL MODELLING
1 IN 20 YEAR FLOOD HAZARD

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

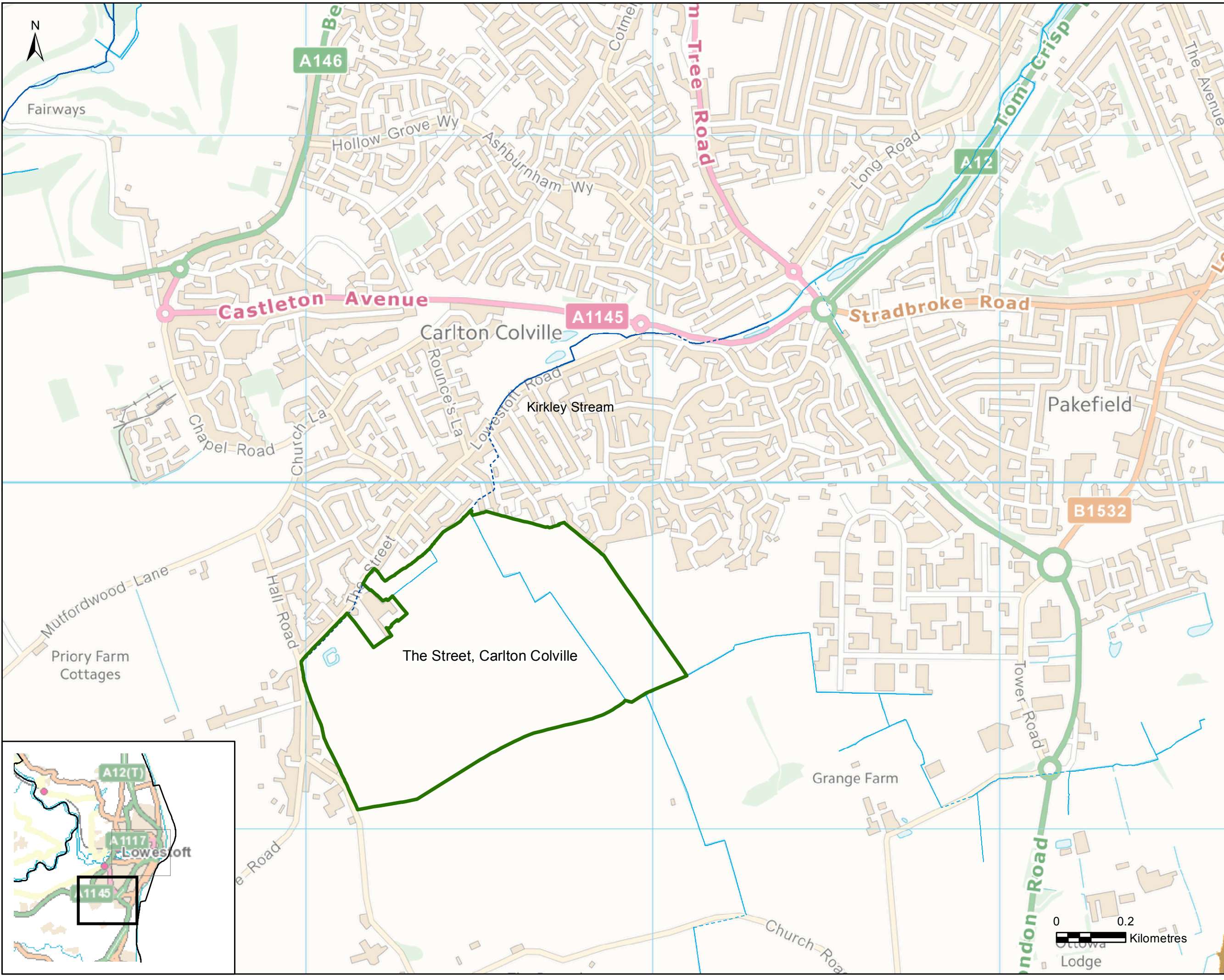
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Drawing Number	Rev
FIGURE 09.1	1



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LEGEND


- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 20 Return Period

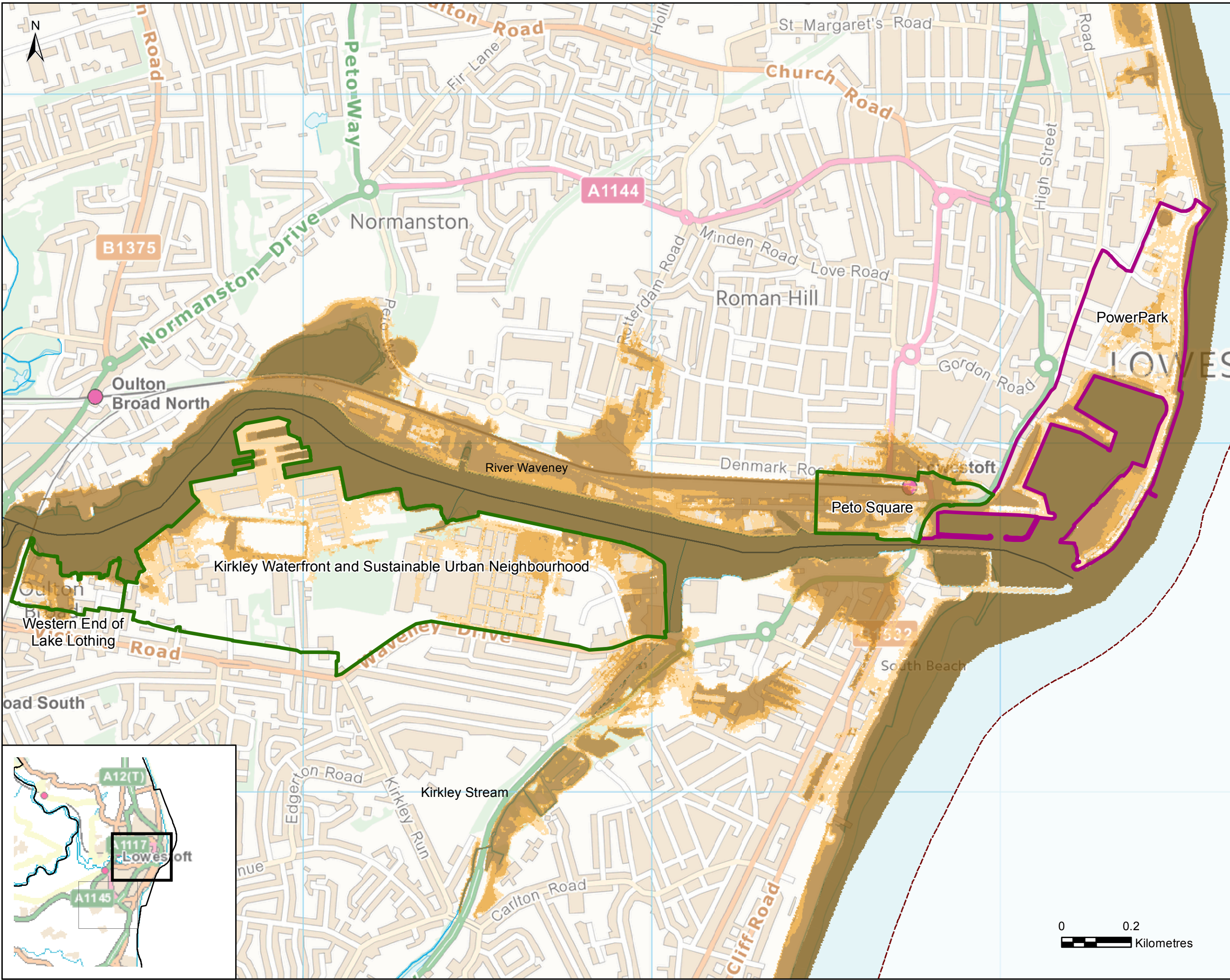
Defended Scenario - Hazard Rating

- Less than 0.75 (Low Hazard)
- Between 0.75 and 1.25 (Danger for Some)
- Between 1.25 and 2.00 (Danger for Most)
- Greater than 2.00 (Danger for All)

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Revision Details	By	Check	Date	Suffix
Purpose of Issue	FINAL			
Client	 Waveney District Council Serving the Community			
Project Title	EAST SUFFOLK COUNCILS STRATEGIC FLOOD RISK ASSESSMENT			
Drawing Title	LEVEL 2 SITES SOUTH LOWESTOFT COASTAL MODELLING 1 IN 20 YEAR FLOOD HAZARD			
Drawn	Checked	Approved	Date	
LM	MD	GP	24/04/2018	
AECOM Internal Project No. 60520248		Scale at A3 1:10,000		
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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 200 Return Period

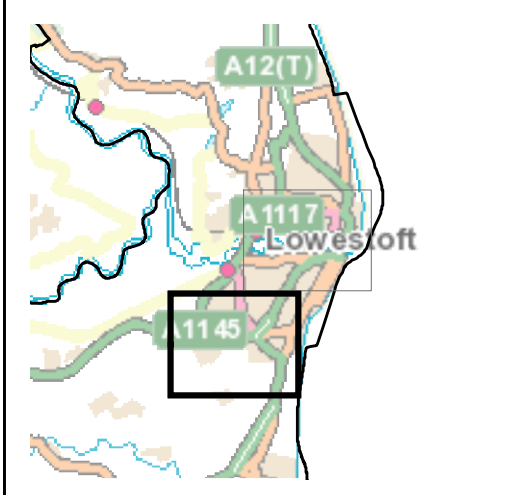
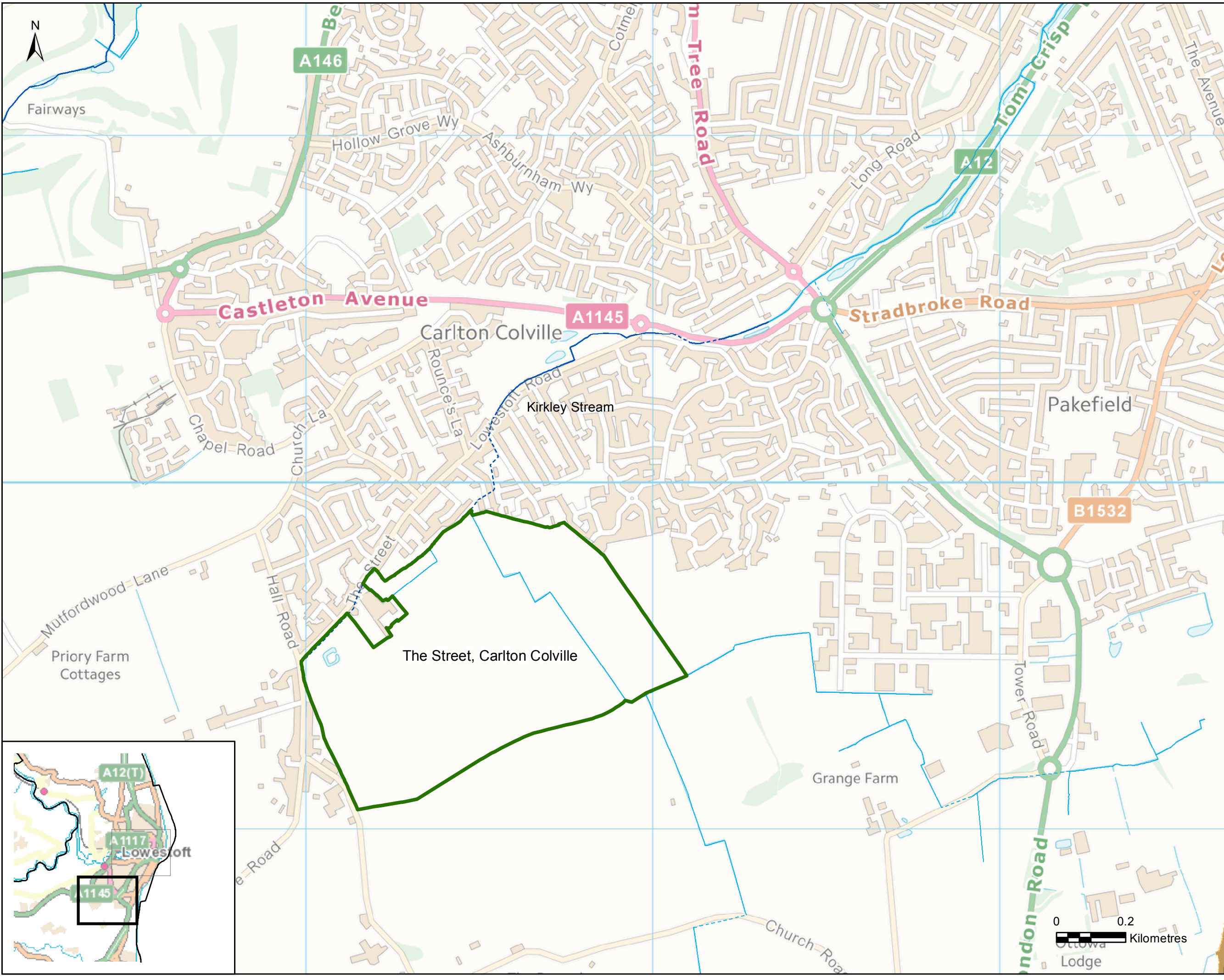
Defended Scenario - Hazard Rating

- Less than 0.75 (Low Hazard)
- Between 0.75 and 1.25 (Danger for Some)
- Between 1.25 and 2.00 (Danger for Most)
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Revision Details	By	Check	Date	Suffix
Purpose of Issue	FINAL			
Client	Waveney District Council Serving the Community			
Project Title	EAST SUFFOLK COUNCILS STRATEGIC FLOOD RISK ASSESSMENT			
Drawing Title	LEVEL 2 SITES NORTH LOWESTOFT COASTAL MODELLING 1 IN 200 YEAR FLOOD HAZARD			
Drawn	Checked	Approved	Date	
LM	MD	GP	24/04/2018	
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Drawing Number FIGURE 09.3				Rev. 1

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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 200 Return Period

Defended Scenario - Hazard Rating

- Less than 0.75 (Low Hazard)
- Between 0.75 and 1.25 (Danger for Some)
- Between 1.25 and 2.00 (Danger for Most)
- Greater than 2.00 (Danger for All)

Revision Details

By	Check	Date	Suffix

Purpose of Issue

FINAL

Client

Waveney District Council
Serving the Community

Project Title

EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title

LEVEL 2 SITES SOUTH
LOWESTOFT COASTAL MODELLING
1 IN 200 YEAR FLOOD HAZARD

Drawn LM **Checked** MD **Approved** GP **Date** 24/04/2018

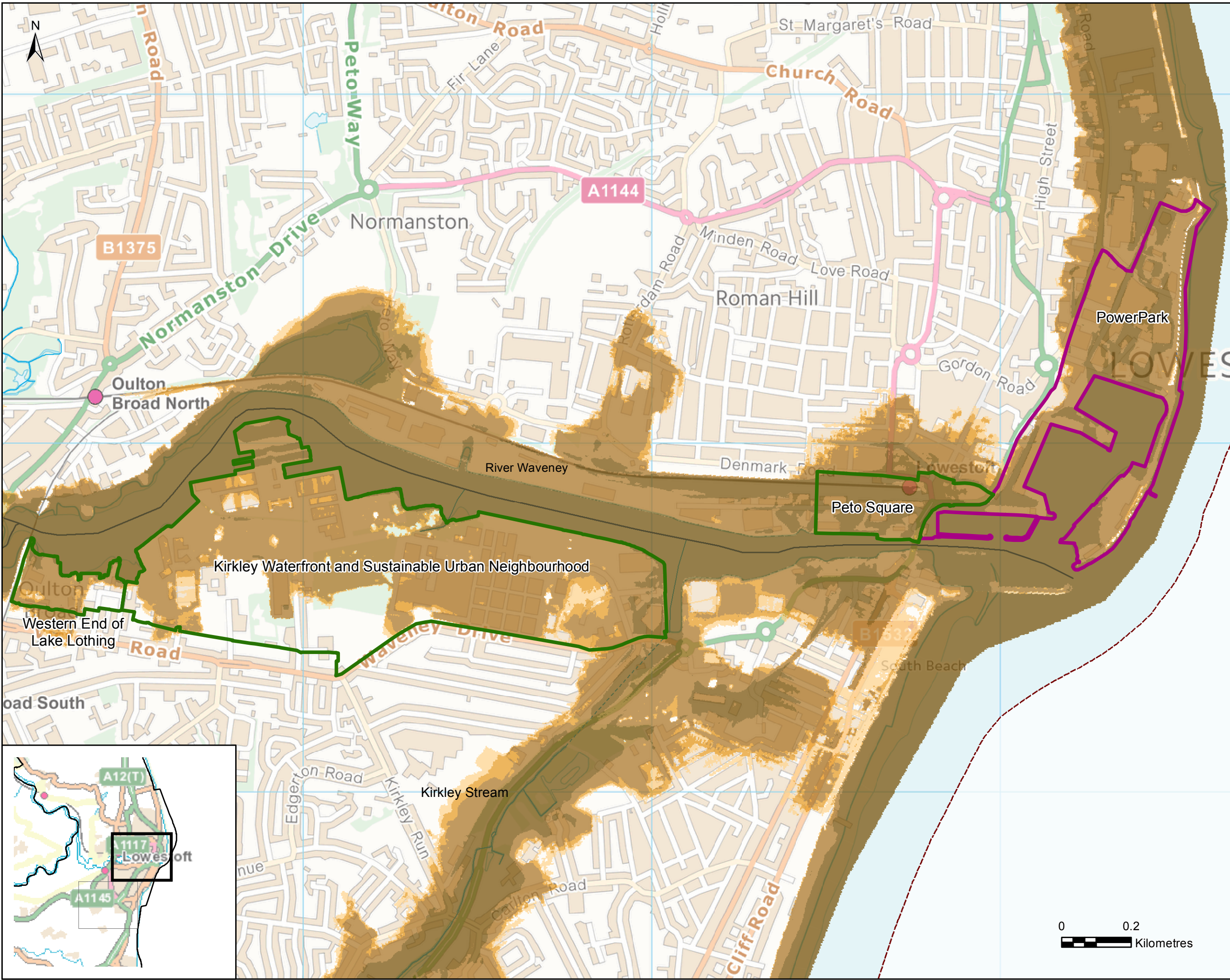
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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 200 + CC Return Period

Defended Scenario - Hazard Rating

- Less than 0.75 (Low Hazard)
- Between 0.75 and 1.25 (Danger for Some)
- Between 1.25 and 2.00 (Danger for Most)
- Greater than 2.00 (Danger for All)

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Revision Details	By	Check	Date	Suffix

Purpose of Issue: **FINAL**

Client: Waveney District Council
Serving the Community

Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES NORTH
LOWESTOFT COASTAL MODELLING
1 IN 200 + CC YEAR FLOOD HAZARD**

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

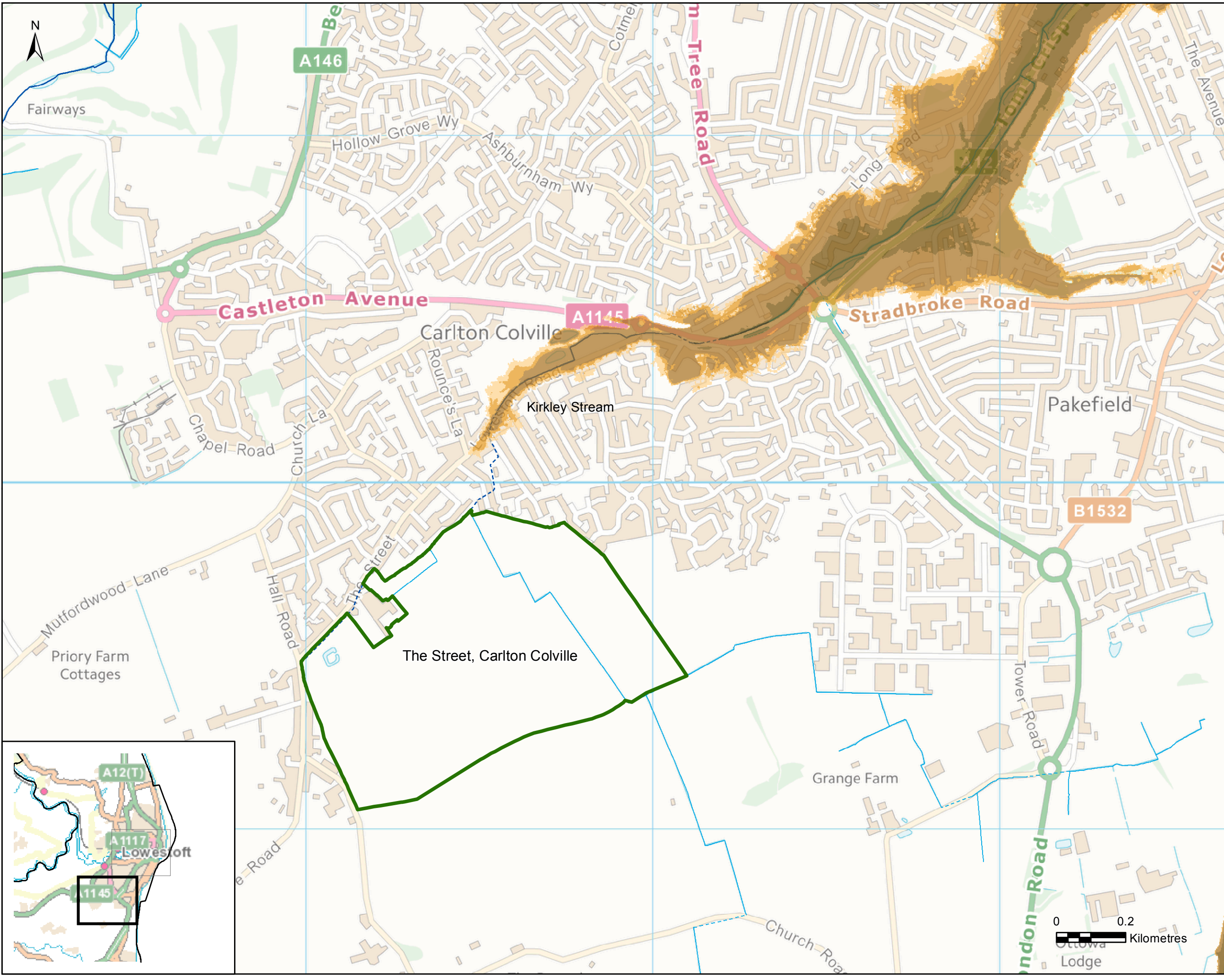
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FIGURE 09.5	1



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 200 + CC Return Period

Defended Scenario - Hazard Rating

- Less than 0.75 (Low Hazard)
- Between 0.75 and 1.25 (Danger for Some)
- Between 1.25 and 2.00 (Danger for Most)
- Greater than 2.00 (Danger for All)

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Purpose of Issue: **FINAL**

Client: Waveney District Council
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Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES SOUTH
LOWESTOFT COASTAL MODELLING
1 IN 200 + CC YEAR FLOOD HAZARD**

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

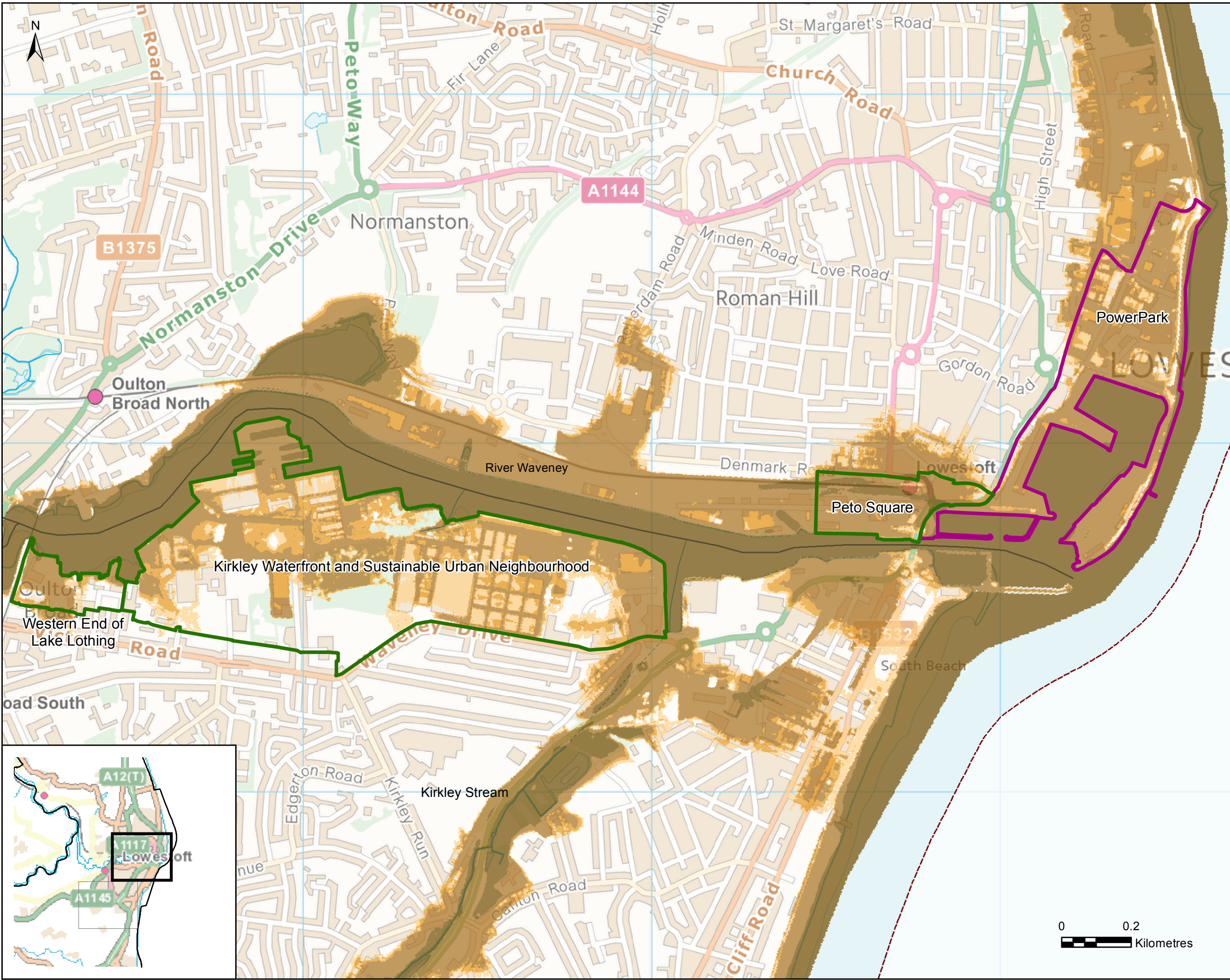
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Drawing Number	Rev
FIGURE 09.6	1



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 1000 Return Period

Defended Scenario - Hazard Rating

- Less than 0.75 (Low Hazard)
- Between 0.75 and 1.25 (Danger for Some)
- Between 1.25 and 2.00 (Danger for Most)
- Greater than 2.00 (Danger for All)

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Purpose of Issue: **FINAL**

Client: Waveney District Council
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Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES NORTH
LOWESTOFT COASTAL MODELLING
1 IN 1000 YEAR FLOOD HAZARD**

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

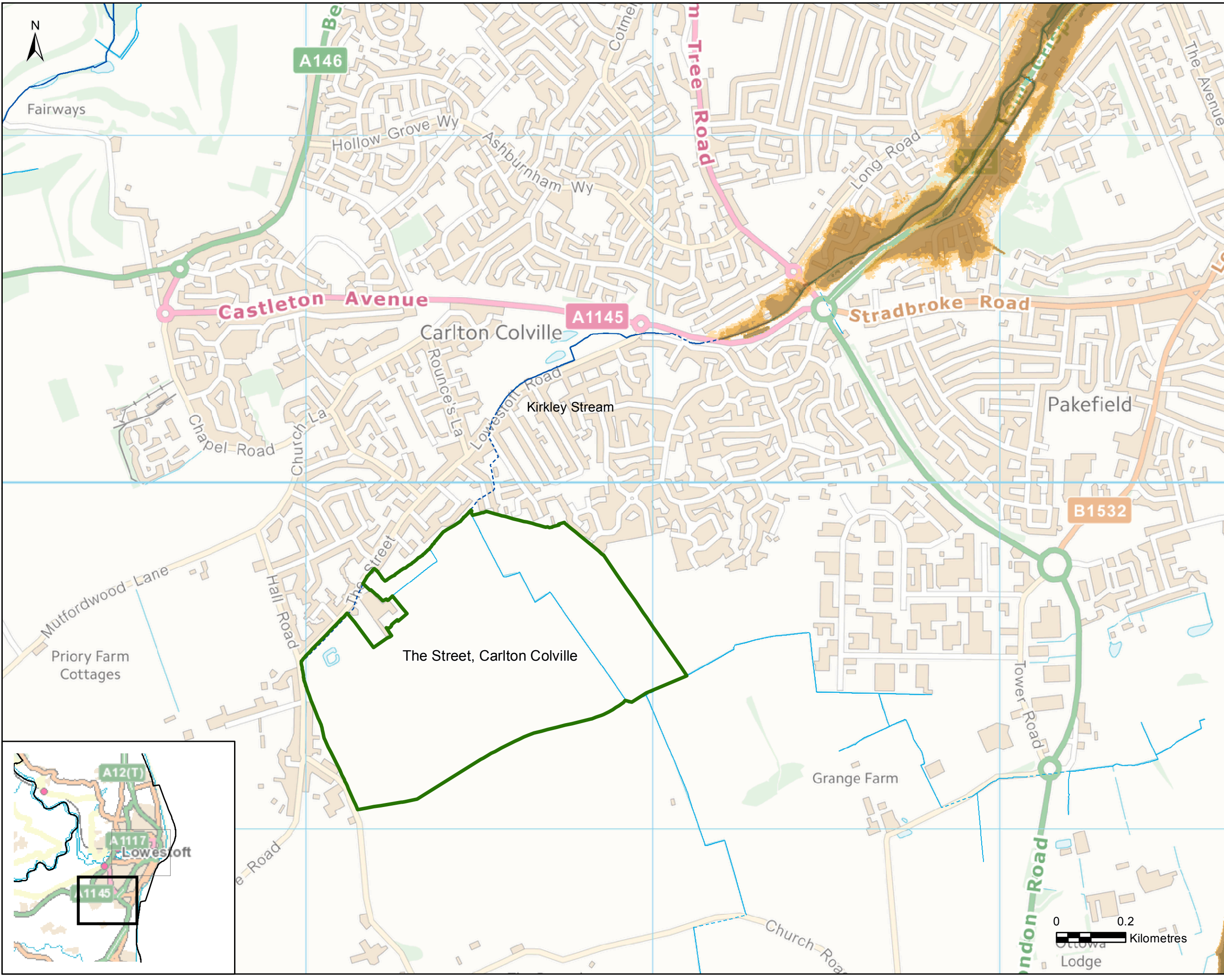
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Drawing Number	Rev
FIGURE 09.7	1



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 1000 Return Period

Defended Scenario - Hazard Rating

- Less than 0.75 (Low Hazard)
- Between 0.75 and 1.25 (Danger for Some)
- Between 1.25 and 2.00 (Danger for Most)
- Greater than 2.00 (Danger for All)

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Purpose of Issue: FINAL

Client: Waveney District Council
Serving the Community

Project Title: EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title: LEVEL 2 SITES SOUTH
LOWESTOFT COASTAL MODELLING
1 IN 1000 YEAR FLOOD HAZARD

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

AECOM Internal Project No. 60520248

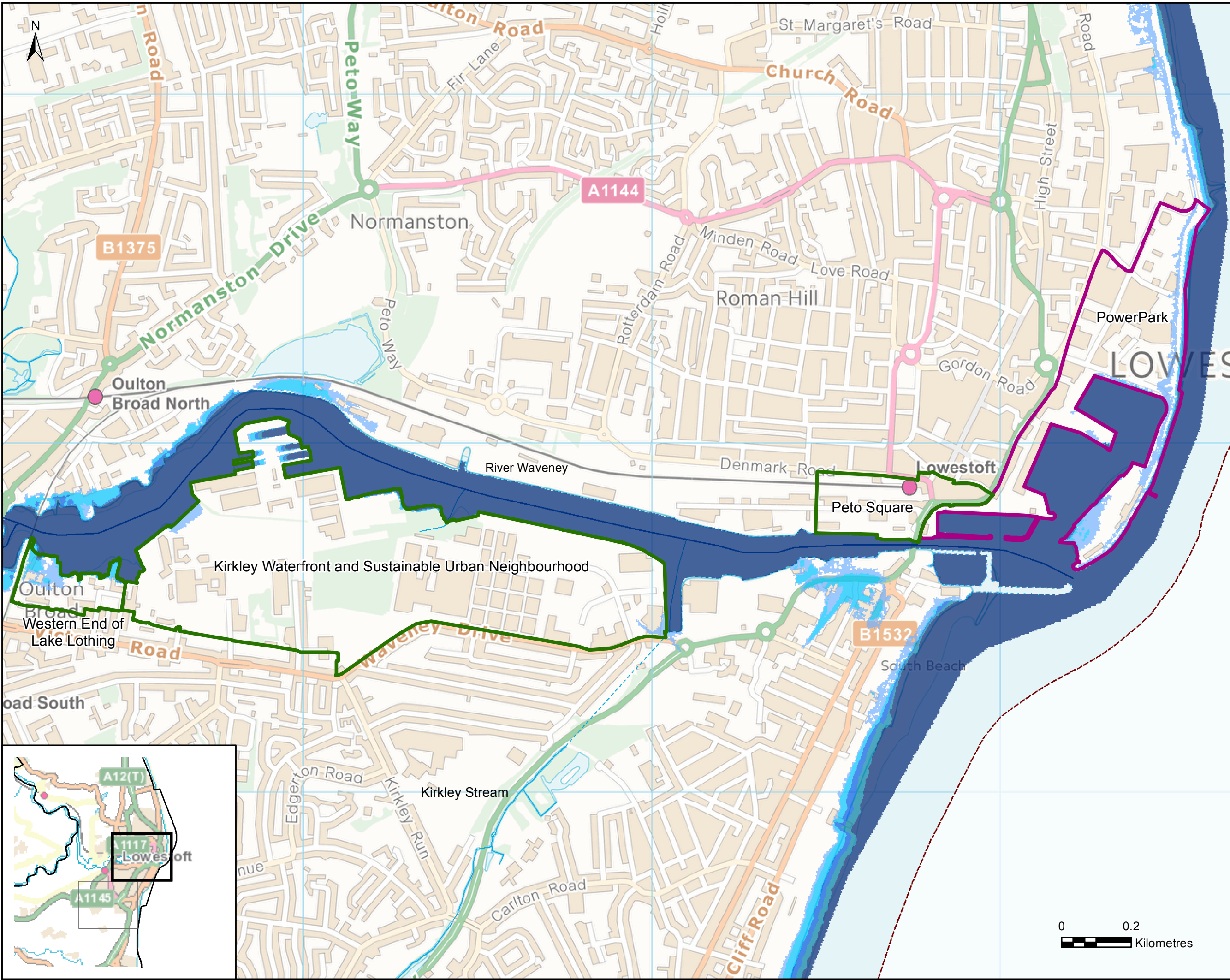
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FIGURE 09.8	1



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 20 Return Period

Defended Scenario - Depth (m)

- 0 - 0.25
- 0.25 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

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Revision Details	By	Check	Date	Suffix

Purpose of Issue

FINAL

Client

Waveney District Council
Serving the Community

Project Title

EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title

LEVEL 2 SITES NORTH
LOWESTOFT COASTAL MODELLING
1 IN 20 YEAR FLOOD DEPTH

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

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Scale at A3

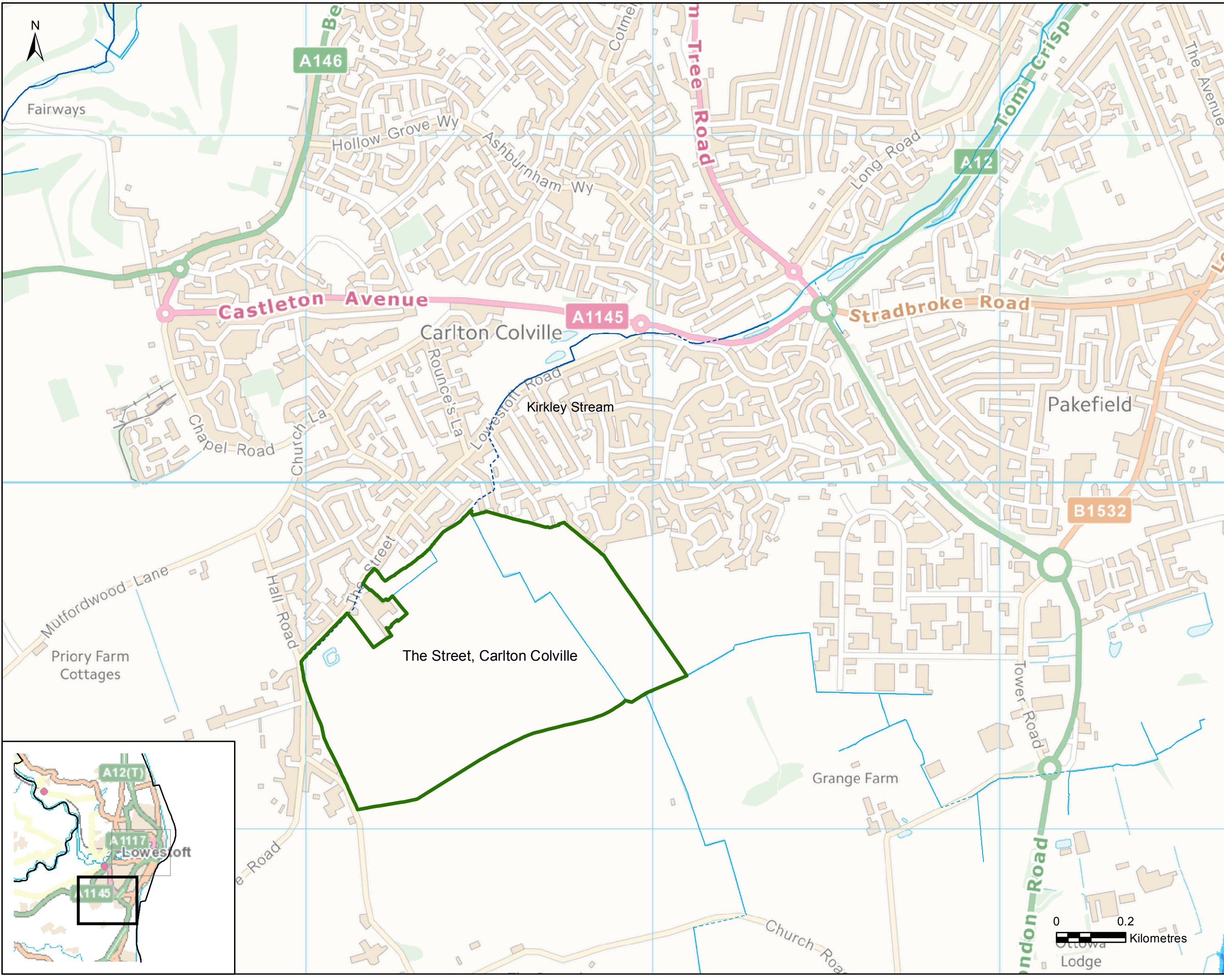
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Drawing Number	Rev
FIGURE 10.1	1



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 20 Return Period


Defended Scenario - Depth (m)

- 0 - 0.25
- 0.25 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

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Purpose of Issue: **FINAL**

Client:  Waveney District Council
Serving the Community

Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES SOUTH
LOWESTOFT COASTAL MODELLING
1 IN 20 YEAR FLOOD DEPTH**

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

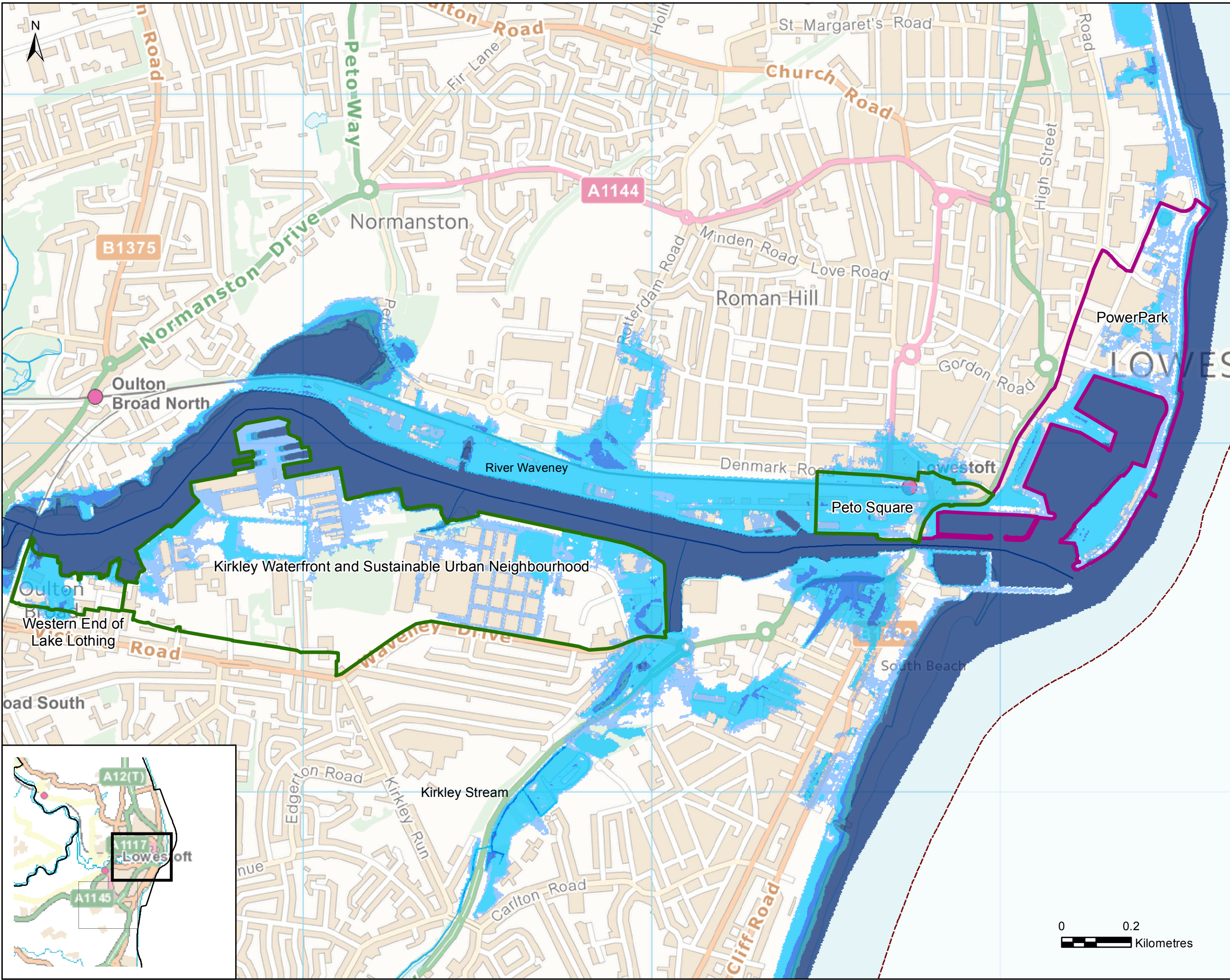
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FIGURE 10.2	1



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 200 Return Period

Defended Scenario - Depth (m)

- 0 - 0.25
- 0.25 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

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Purpose of Issue

FINAL

Client

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Serving the Community

Project Title

EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title

LEVEL 2 SITES NORTH
LOWESTOFT COASTAL MODELLING
1 IN 200 YEAR FLOOD DEPTH

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

AECOM Internal Project No.

60520248

Scale at A3

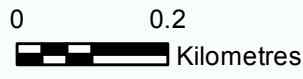
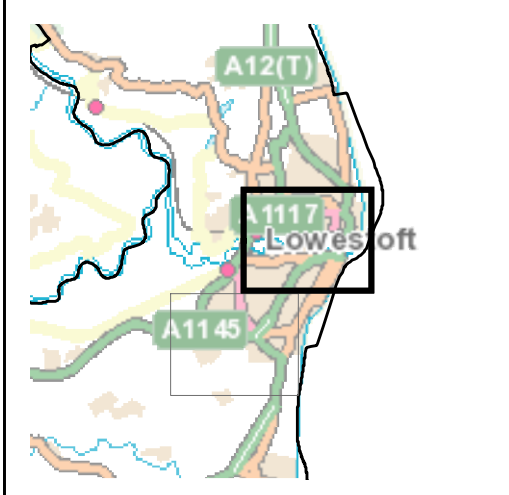
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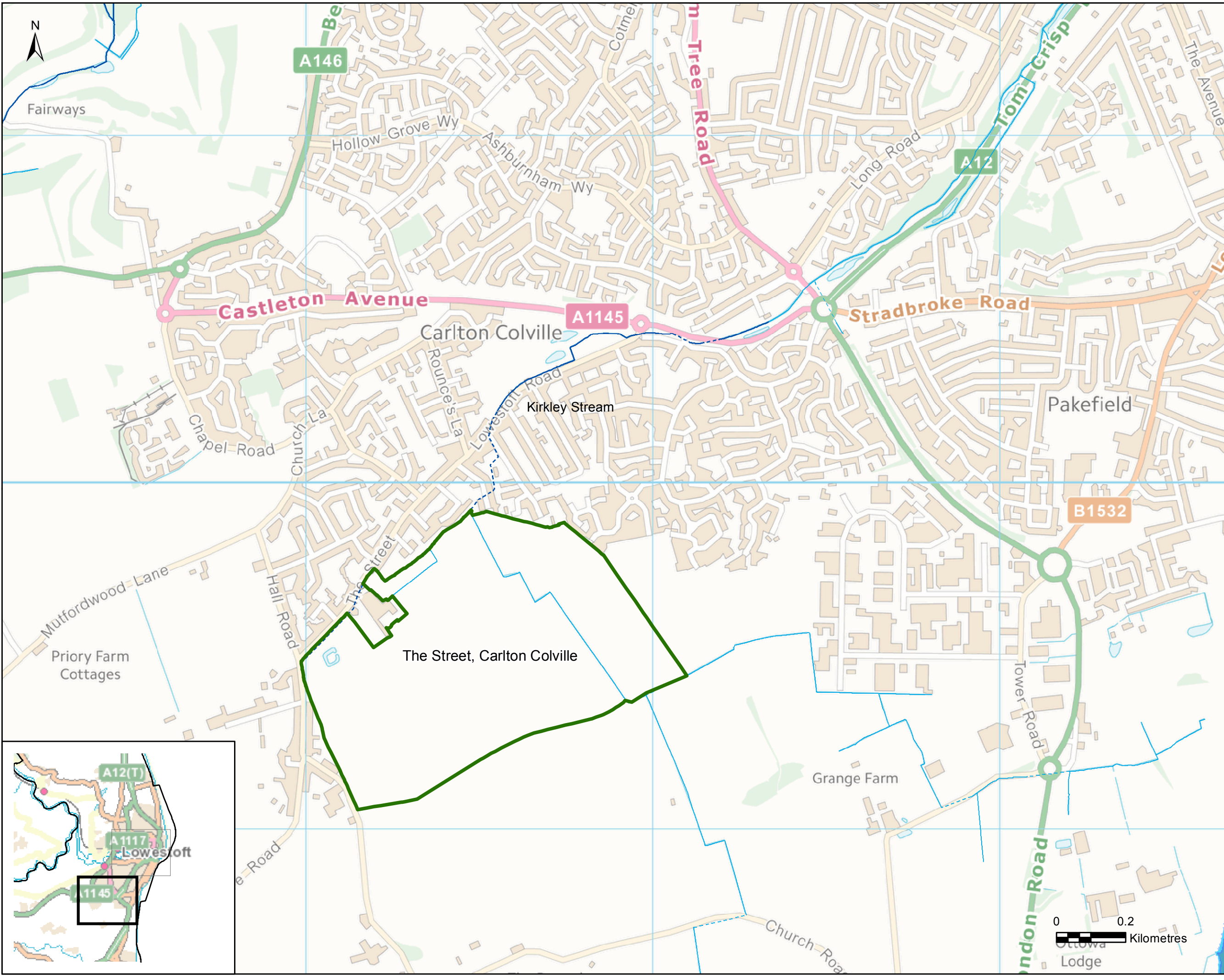
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Drawing Number	Rev
FIGURE 10.3	1





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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 200 Return Period


Defended Scenario - Depth (m)

- 0 - 0.25
- 0.25 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

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Revision Details	By	Check	Date	Suffix

Purpose of Issue: **FINAL**

Client:  Waveney District Council
Serving the Community

Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES SOUTH
LOWESTOFT COASTAL MODELLING
1 IN 200 YEAR FLOOD DEPTH**

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

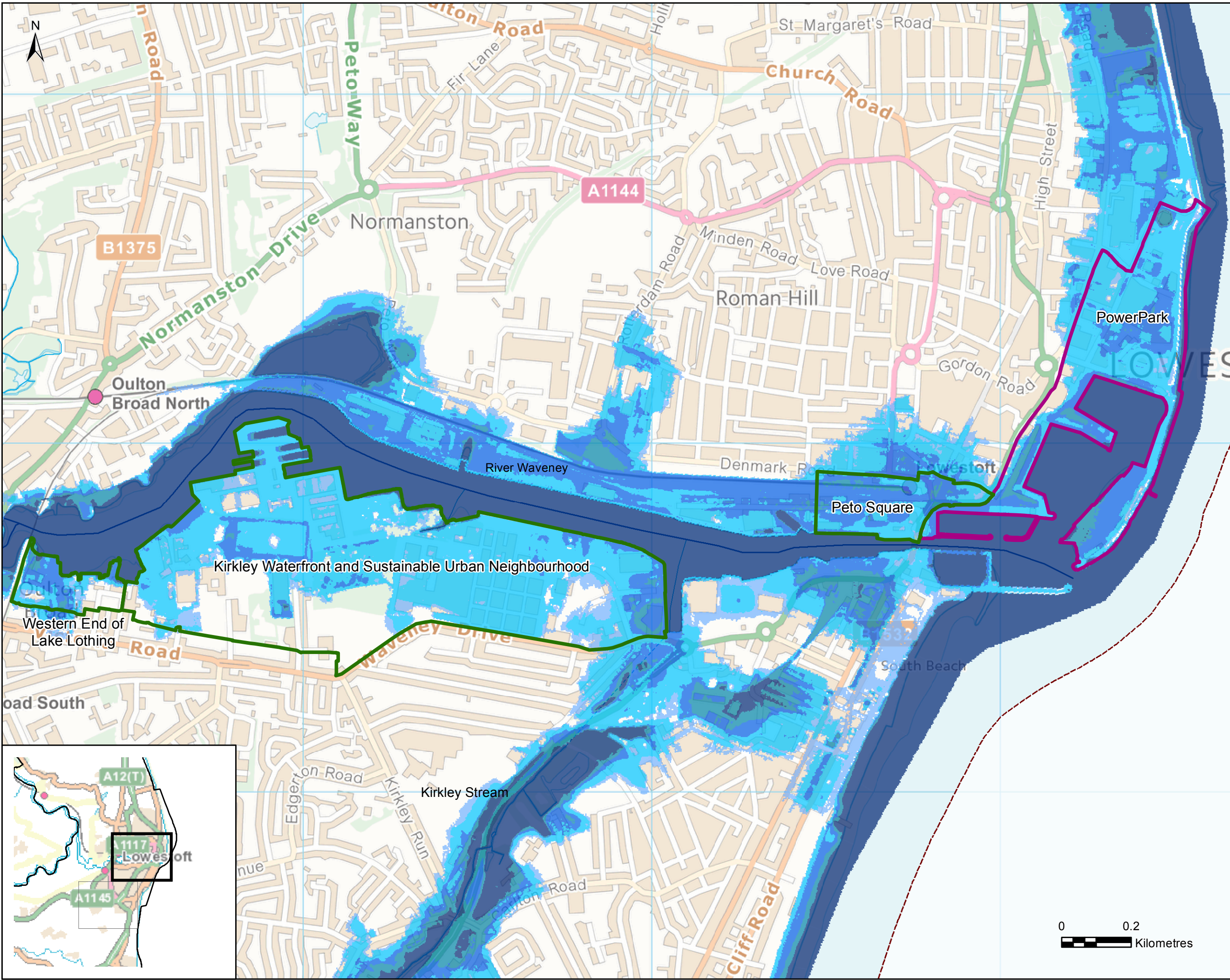
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FIGURE 10.4	1



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 200 + CC Return Period

Defended Scenario - Depth (m)

- 0 - 0.25
- 0.25 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

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Purpose of Issue: FINAL

Client: Waveney District Council
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Project Title: EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title: LEVEL 2 SITES NORTH
LOWESTOFT COASTAL MODELLING
1 IN 200 + CC YEAR FLOOD DEPTH

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

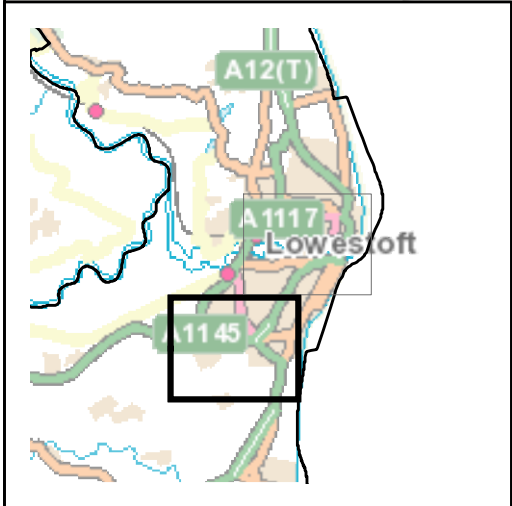
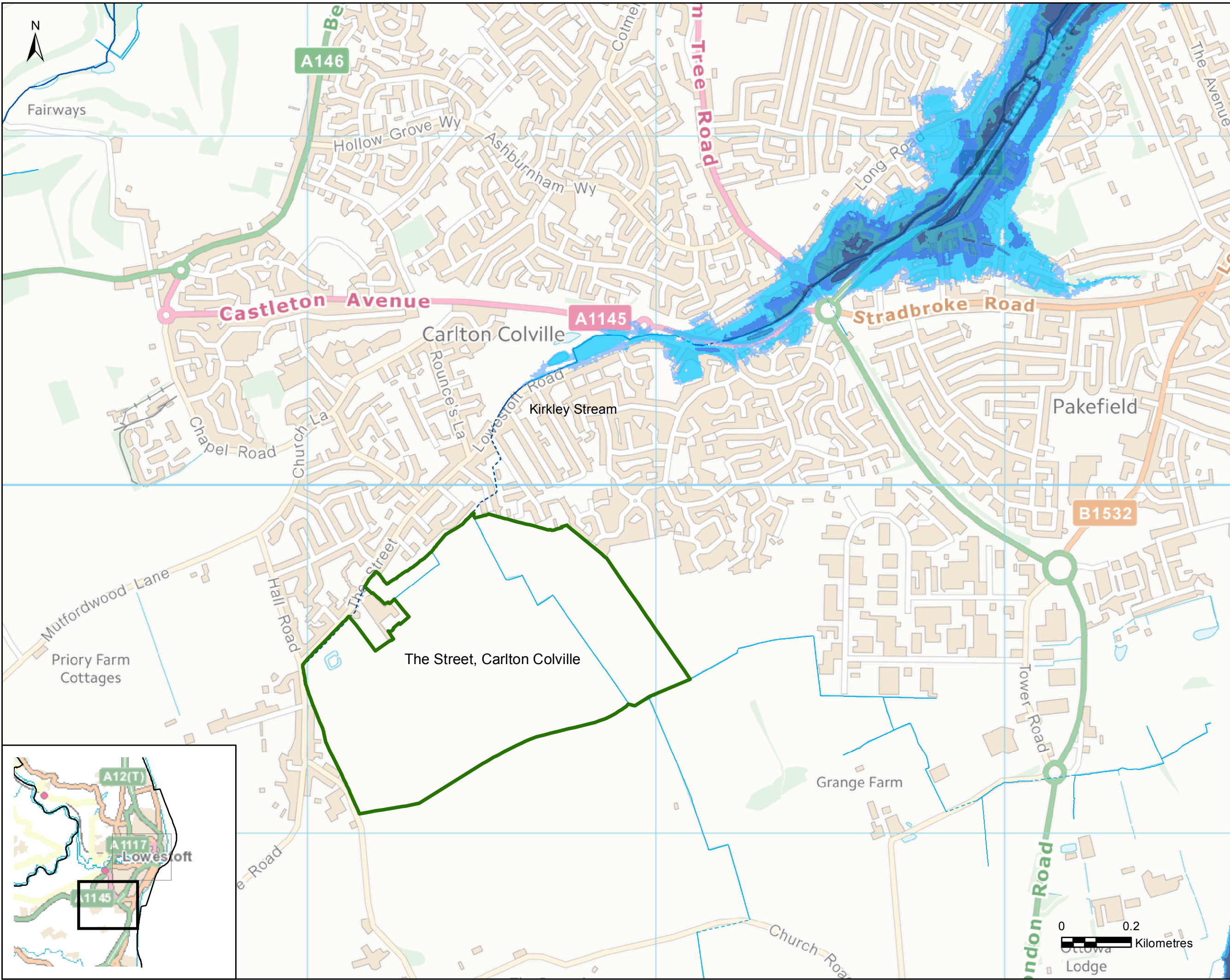
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FIGURE 10.5	1



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LEGEND

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- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 200 + CC Return Period

Defended Scenario - Depth (m)

- 0 - 0.25
- 0.25 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

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Project Title

EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title

LEVEL 2 SITES SOUTH
LOWESTOFT COASTAL MODELLING
1 IN 200 + CC YEAR FLOOD DEPTH

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

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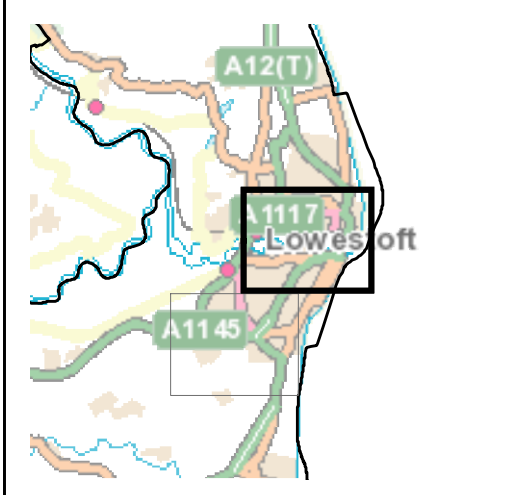
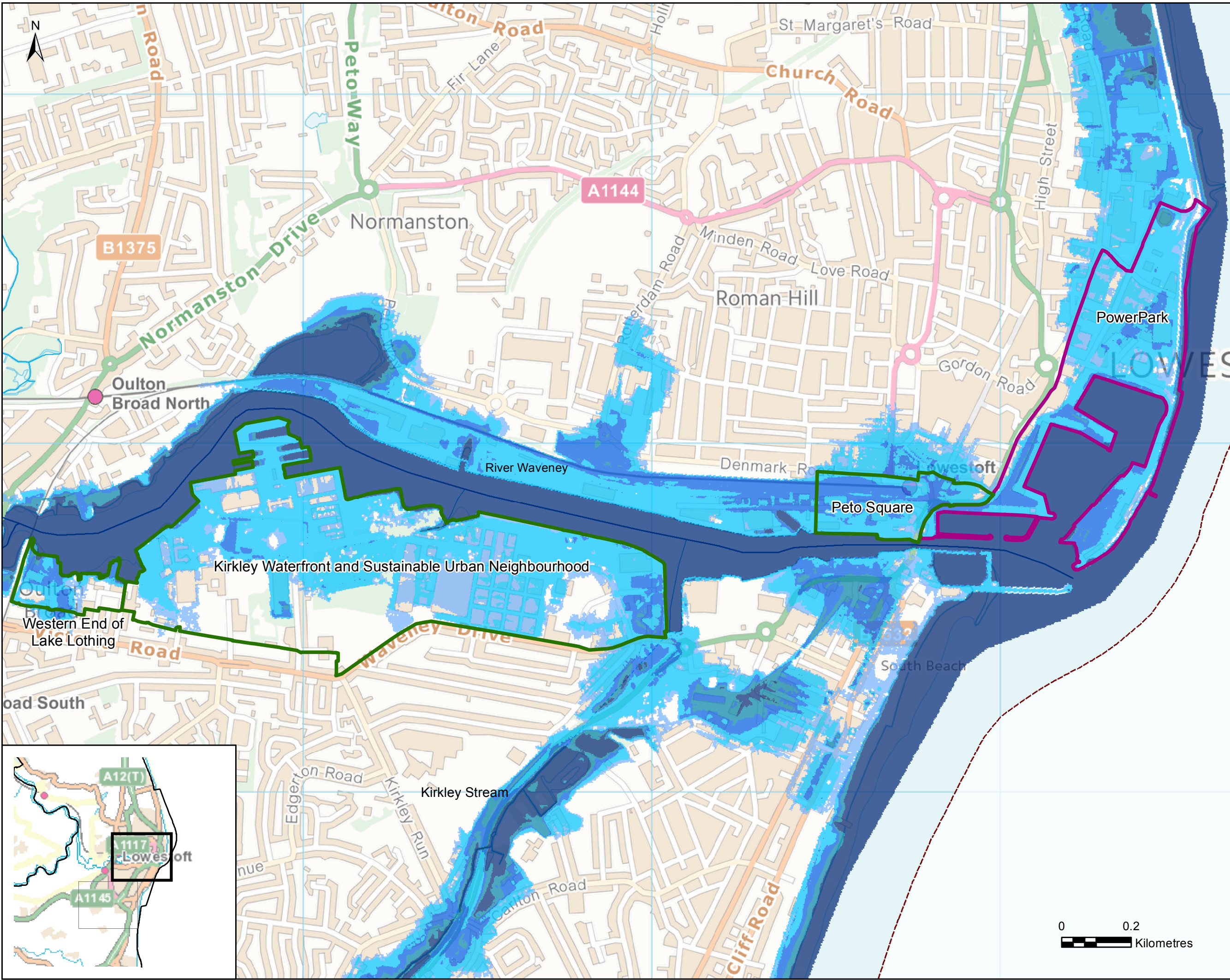
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FIGURE 10.6	1



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 1000 Return Period


Defended Scenario - Depth (m)

- 0 - 0.25
- 0.25 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

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Purpose of Issue: **FINAL**

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Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES NORTH
LOWESTOFT COASTAL MODELLING
1 IN 1000 YEAR FLOOD DEPTH**

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

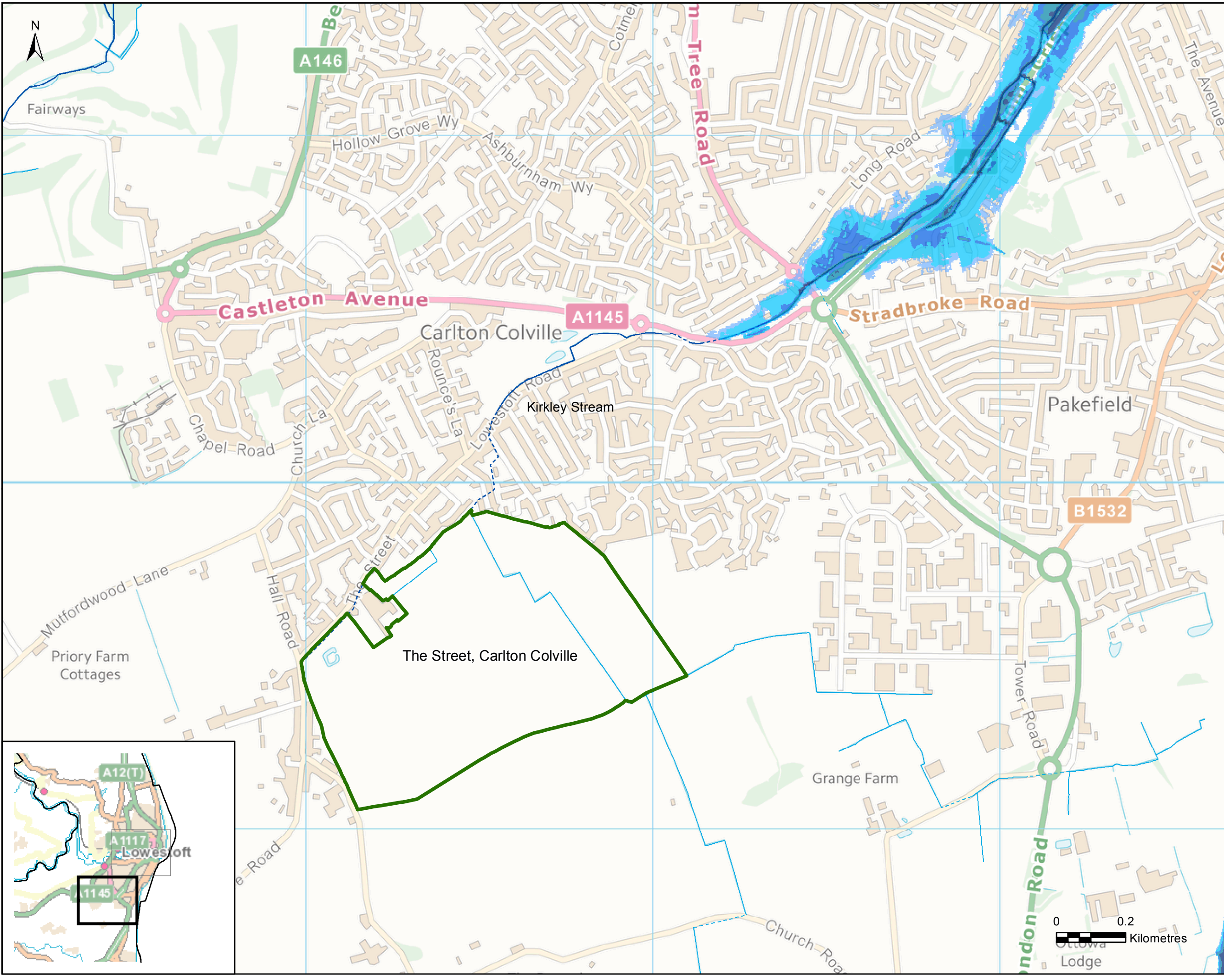
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FIGURE 10.7	1



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 1000 Return Period

Defended Scenario - Depth (m)

- 0 - 0.25
- 0.25 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

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Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES SOUTH
LOWESTOFT COASTAL MODELLING
1 IN 1000 YEAR FLOOD DEPTH**

Drawn	Checked	Approved	Date
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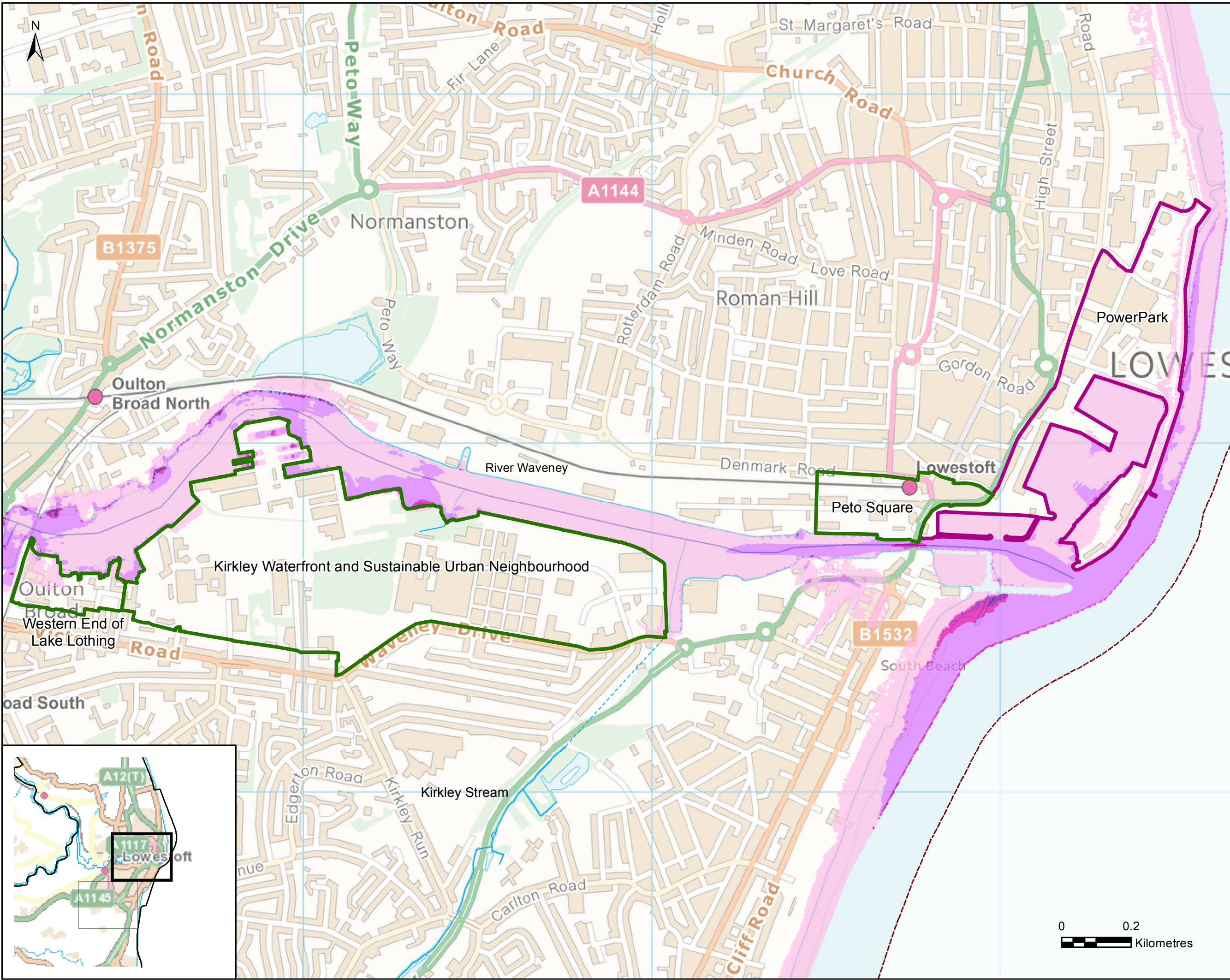
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FIGURE 10.8	1



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 20 Return Period

Defended Scenario - Velocity (m/s)

- 0 - 0.3
- 0.3 - 1.0
- 1.0 - 1.5
- 1.5 - 2.5
- > 2.5

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Purpose of Issue: **FINAL**

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Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES NORTH
LOWESTOFT COASTAL MODELLING
1 IN 20 YEAR FLOOD VELOCITY**

Drawn	Checked	Approved	Date
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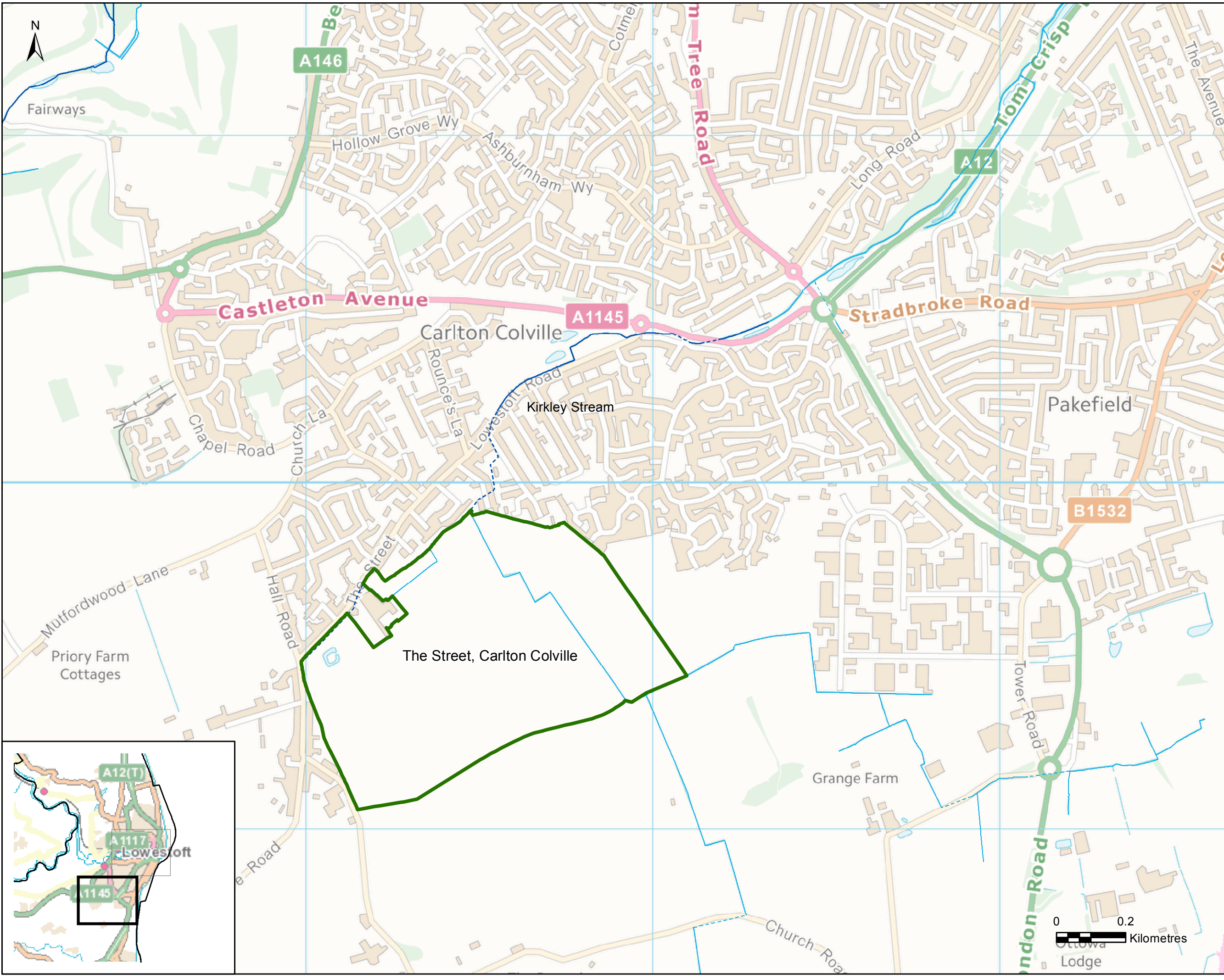
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FIGURE 11.1	1



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- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 20 Return Period


Defended Scenario - Velocity (m/s)

- 0 - 0.3
- 0.3 - 1.0
- 1.0 - 1.5
- 1.5 - 2.5
- > 2.5

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Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES SOUTH
LOWESTOFT COASTAL MODELLING
1 IN 20 YEAR FLOOD VELOCITY**

Drawn	Checked	Approved	Date
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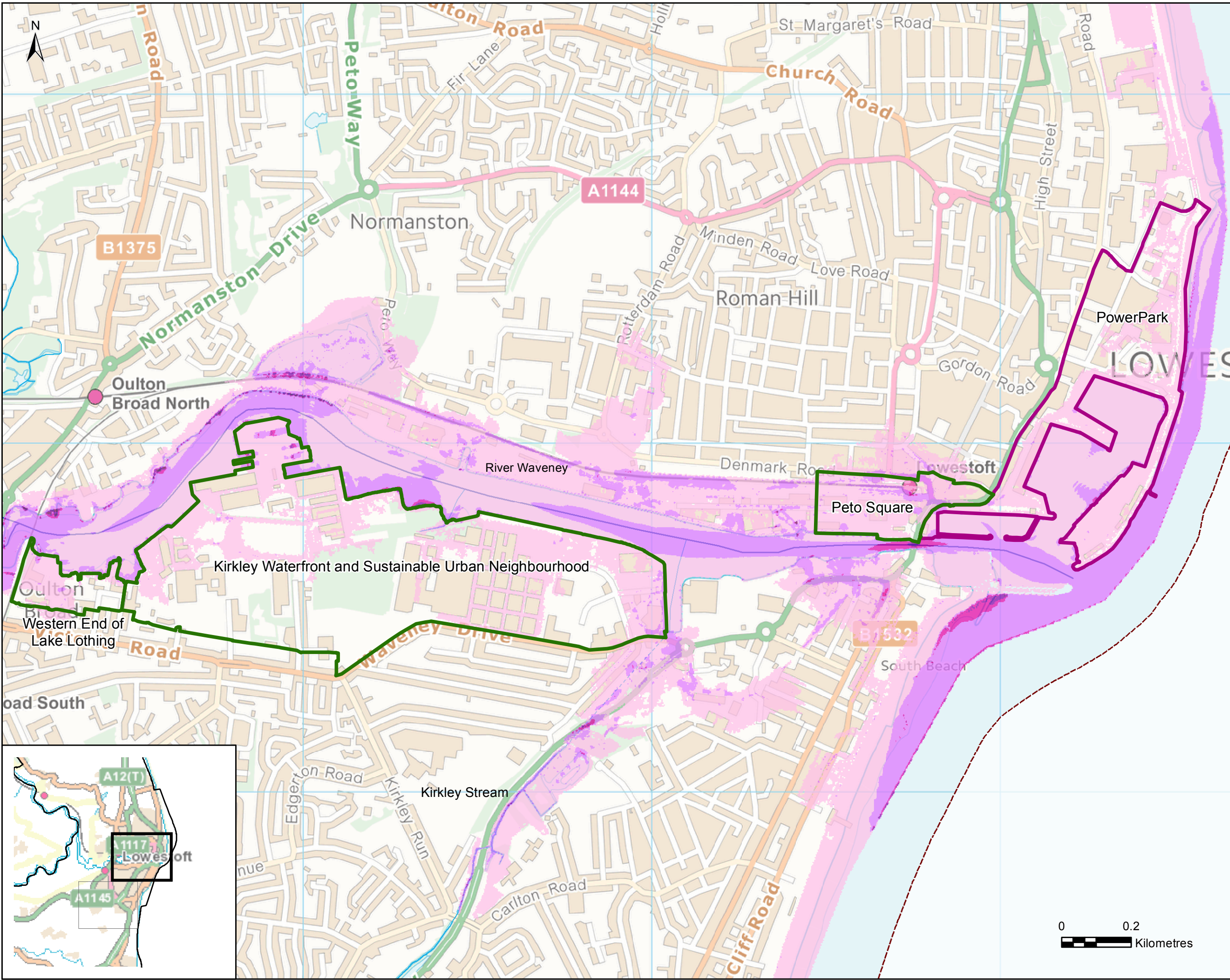
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FIGURE 11.2	1



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 200 Return Period

Defended Scenario - Velocity (m/s)

- 0 - 0.3
- 0.3 - 1.0
- 1.0 - 1.5
- 1.5 - 2.5
- > 2.5

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Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES NORTH
LOWESTOFT COASTAL MODELLING
1 IN 200 YEAR FLOOD VELOCITY**

Drawn	Checked	Approved	Date
LM	MD	GP	24/04/2018

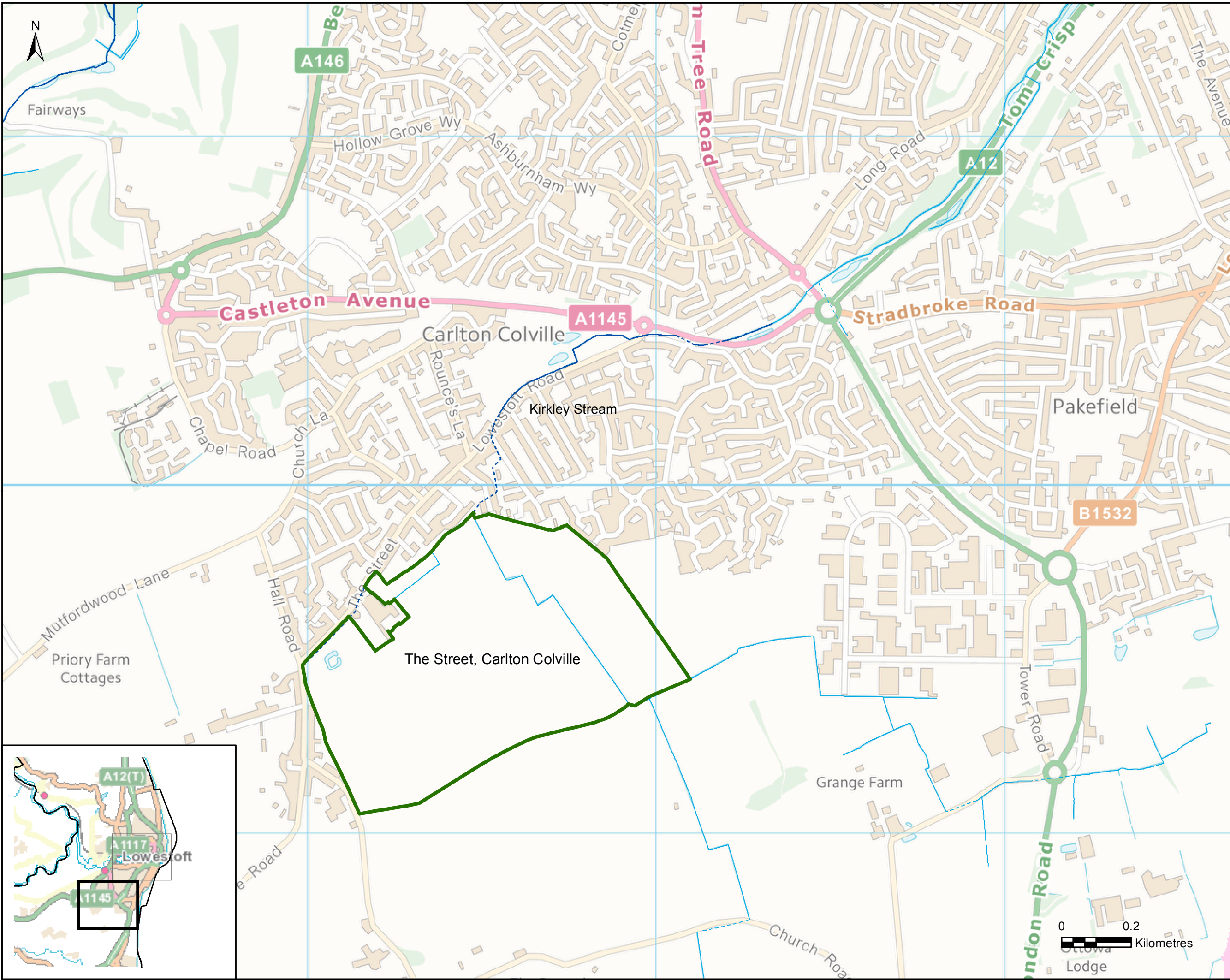
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FIGURE 11.3	1



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LEGEND

- Waveney District
- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 200 Return Period

Defended Scenario - Velocity (m/s)

- 0 - 0.3
- 0.3 - 1.0
- 1.0 - 1.5
- 1.5 - 2.5
- > 2.5

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Project Title: **EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT**

Drawing Title: **LEVEL 2 SITES SOUTH
LOWESTOFT COASTAL MODELLING
1 IN 200 YEAR FLOOD VELOCITY**

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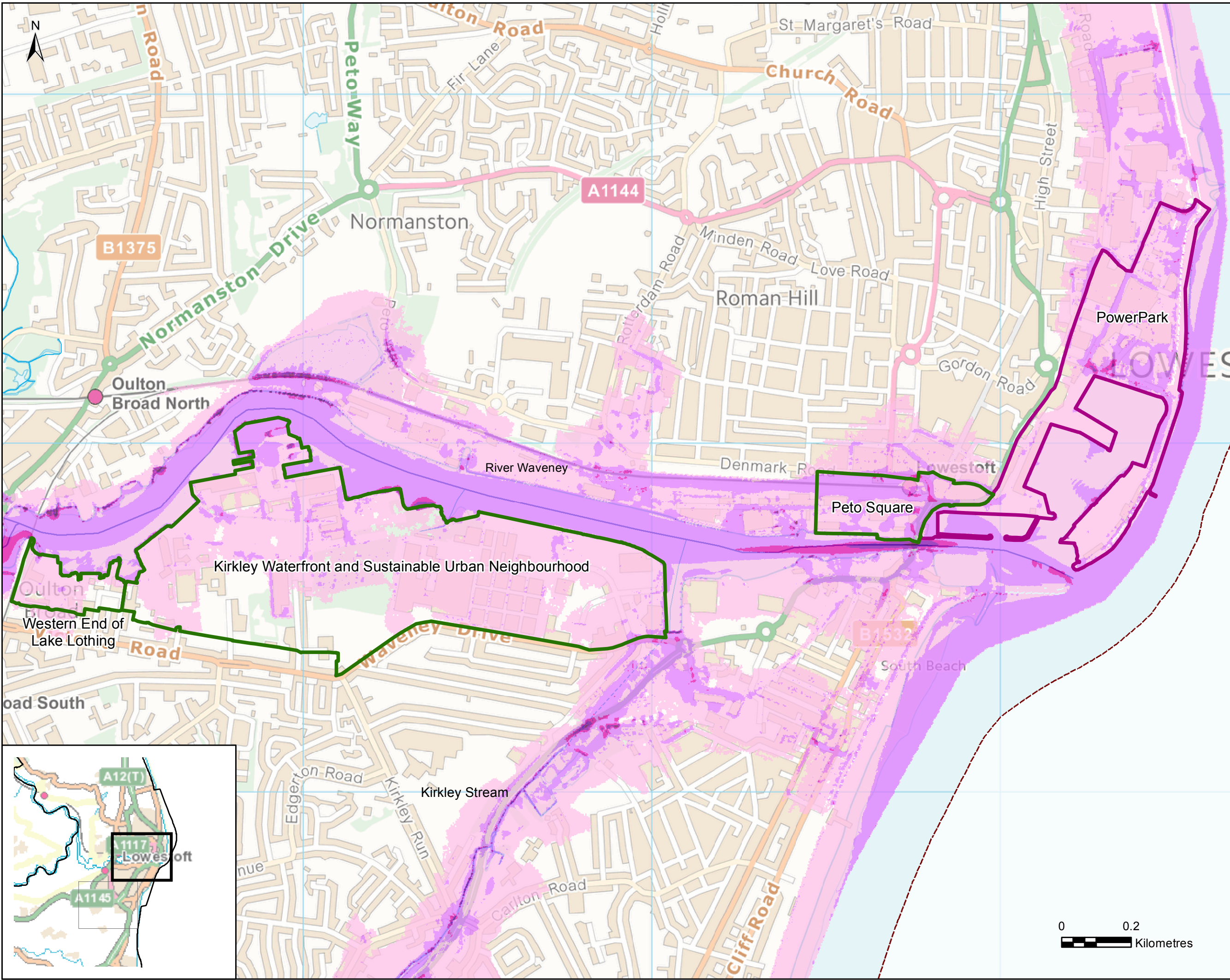
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- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 200 + CC Return Period

Defended Scenario - Velocity (m/s)

- 0 - 0.3
- 0.3 - 1.0
- 1.0 - 1.5
- 1.5 - 2.5
- > 2.5

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Project Title

EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title

LEVEL 2 SITES NORTH
LOWESTOFT COASTAL MODELLING
1 IN 200 + CC YEAR FLOOD VELOCITY

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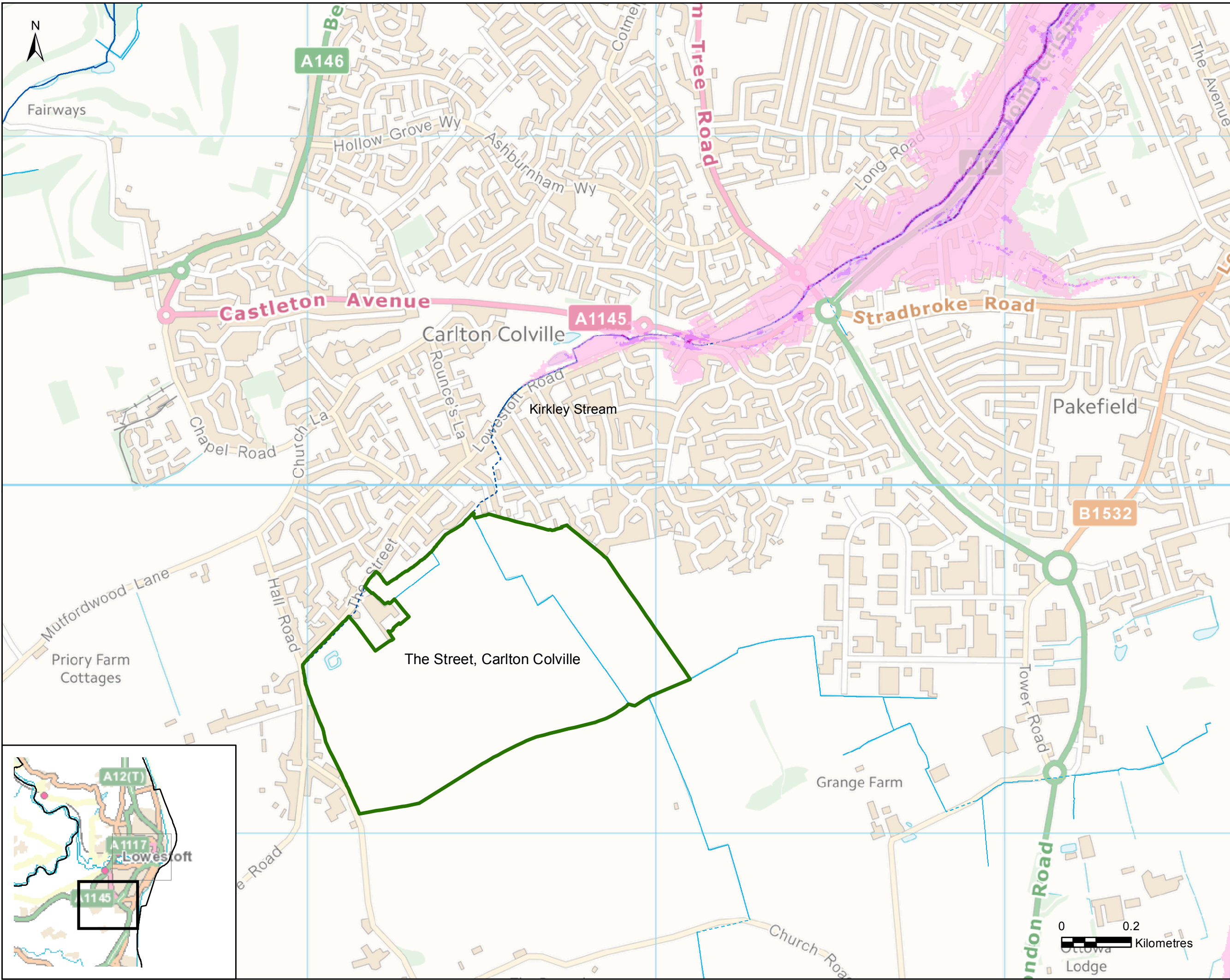
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FIGURE 11.5	1



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LEGEND


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- Main River
- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 200 + CC Return Period

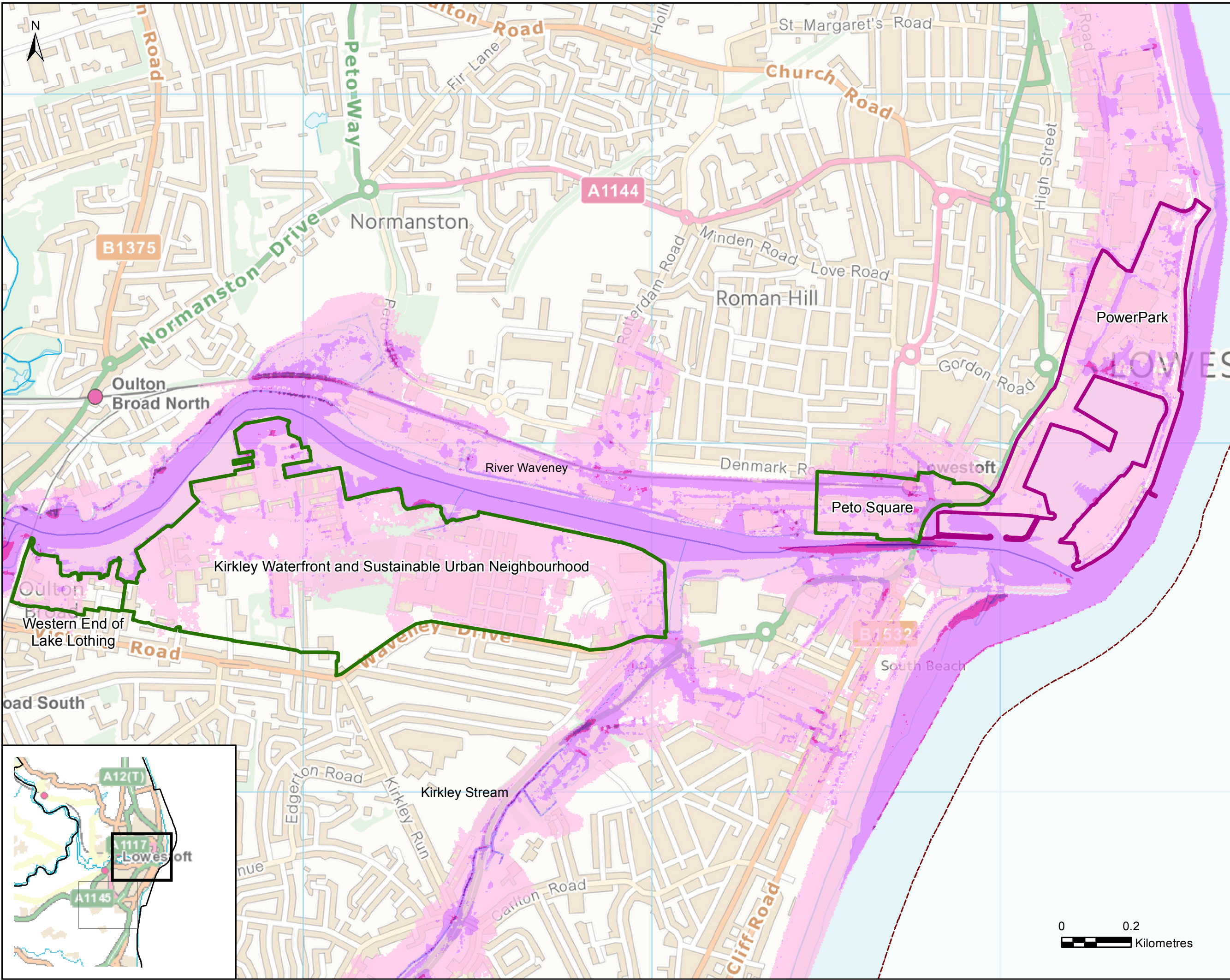
Defended Scenario - Velocity (m/s)

- 0 - 0.3
- 0.3 - 1.0
- 1.0 - 1.5
- 1.5 - 2.5
- > 2.5

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Project Title					
EAST SUFFOLK COUNCILS STRATEGIC FLOOD RISK ASSESSMENT					
Drawing Title					
LEVEL 2 SITES SOUTH LOWESTOFT COASTAL MODELLING 1 IN 200 + CC YEAR FLOOD VELOCITY					
Drawn	Checked	Approved	Date		
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- Main River (Culverted)
- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 1000 Return Period

Defended Scenario - Velocity (m/s)

- 0 - 0.3
- 0.3 - 1.0
- 1.0 - 1.5
- 1.5 - 2.5
- > 2.5

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Project Title

EAST SUFFOLK COUNCILS
STRATEGIC FLOOD
RISK ASSESSMENT

Drawing Title

LEVEL 2 SITES NORTH
LOWESTOFT COASTAL MODELLING
1 IN 1000 YEAR FLOOD VELOCITY

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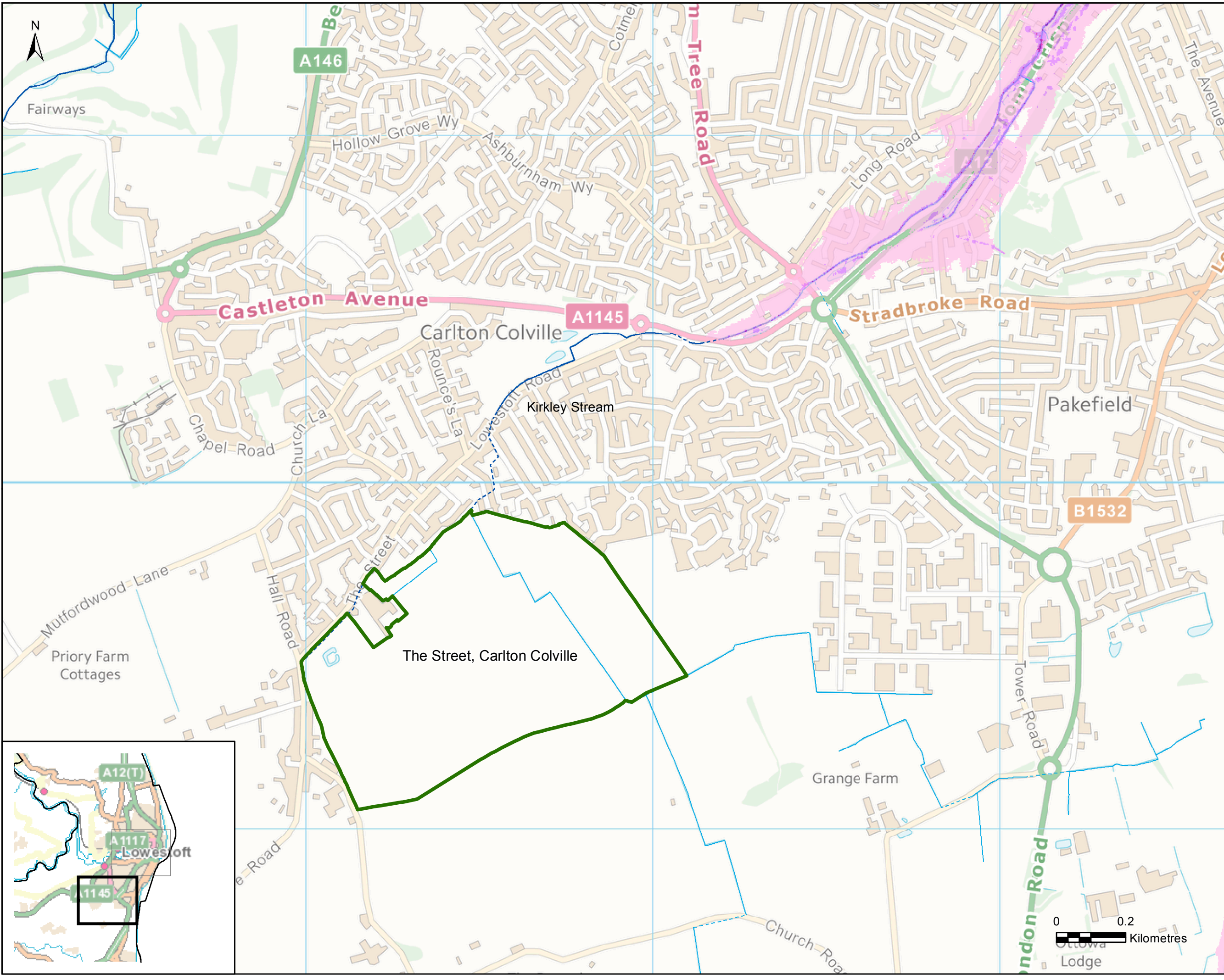
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FIGURE 11.7	1



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- Ordinary Watercourse
- Ordinary Watercourse (Culverted)
- Level 2 Site - Employment
- Level 2 Site - Mixed use

Lowestoft Tidal Model 1 in 1000 Return Period

Defended Scenario - Velocity (m/s)

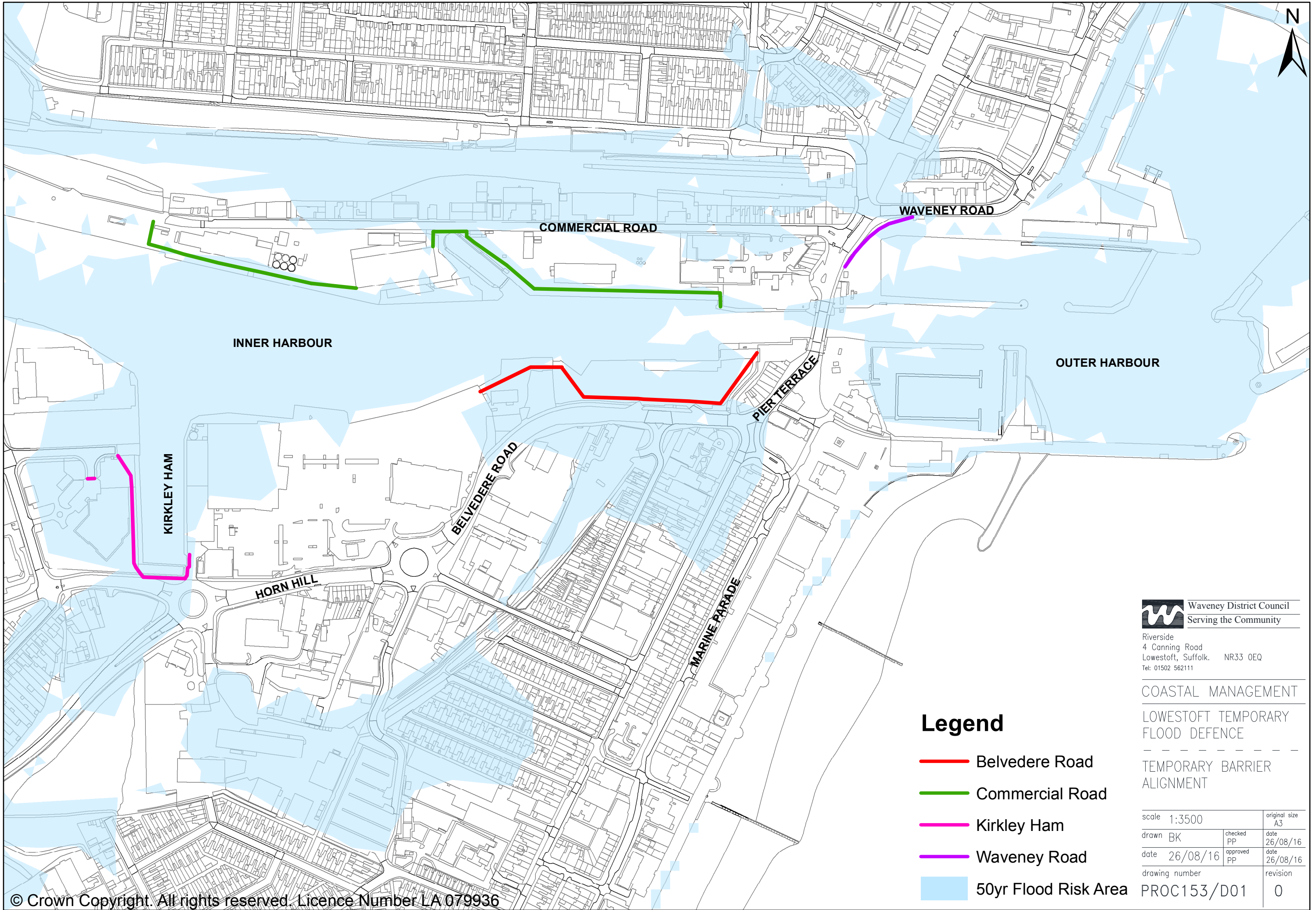
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- 1.0 - 1.5
- 1.5 - 2.5
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Project Title					
EAST SUFFOLK COUNCILS STRATEGIC FLOOD RISK ASSESSMENT					
Drawing Title					
LEVEL 2 SITES SOUTH LOWESTOFT COASTAL MODELLING 1 IN 1000 YEAR FLOOD VELOCITY					
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LM	MD	GP	24/04/2018		
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Drawing Number					Rev
FIGURE 11.8					1

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Appendix B Lowestoft Temporary Flood Barrier Alignment



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Tel: 01502 562111

COASTAL MANAGEMENT

LOWESTOFT TEMPORARY
FLOOD DEFENCE

TEMPORARY BARRIER
ALIGNMENT

scale	1:3500	original size	A3
drawn	BK	checked	PP
date	26/08/16	approved	PP
drawing number	PROC153/D01	revision	0

