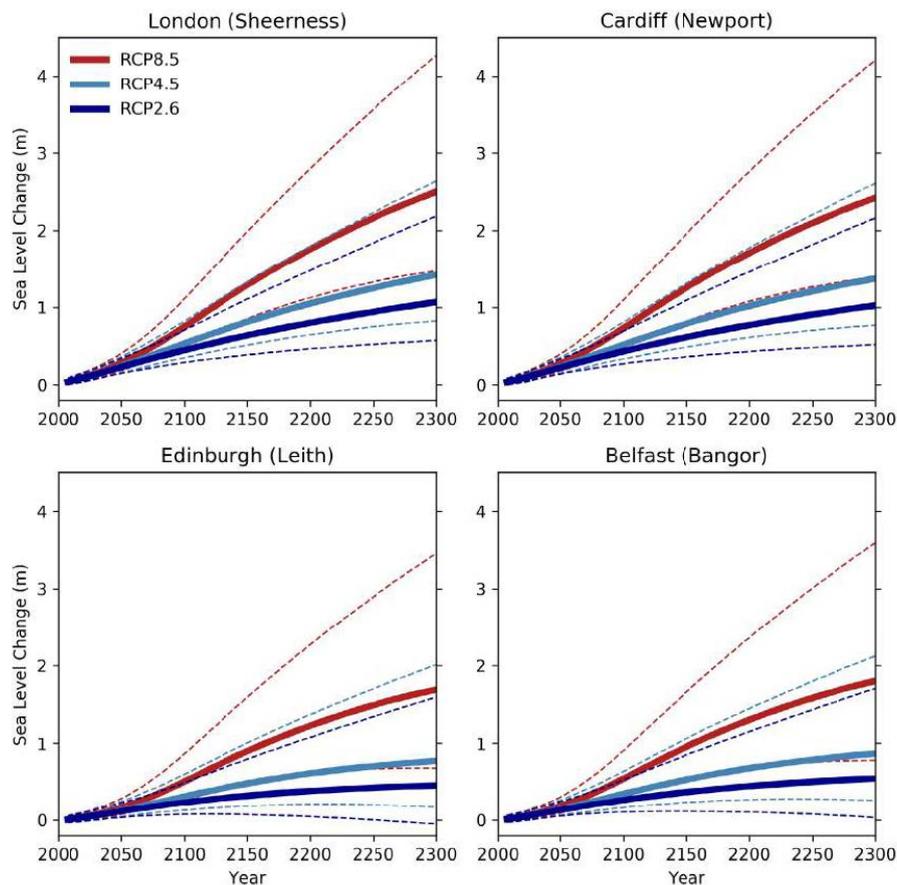


Metrotidal Urban Orbital

The generic Metrotidal Urban Orbital, developed from the Thames case with detailed hydraulic modelling by HR Wallingford, integrates a throttle flood defence system with a new rail link to provide improved flood defences for an estuary region while generating agglomeration benefits by uniting estuary and coastal communities around an urban transport and data orbital. A current flood defence programme of managed retreat that sacrifices land to the sea while increasing the length and height of inland flood defences would be replaced by a shorter, lower, more robust flood defence line that protects a greater area from flooding for a longer period. The new coastal flood defences incorporating a short new rail link transform a vulnerable estuary and radial network into a robust and sustainable urban orbital system with substantially improved transport and data connectivity. The shorter, lower flood defence system protects a larger area of existing assets and natural habitats for a lower cost and carbon audit.



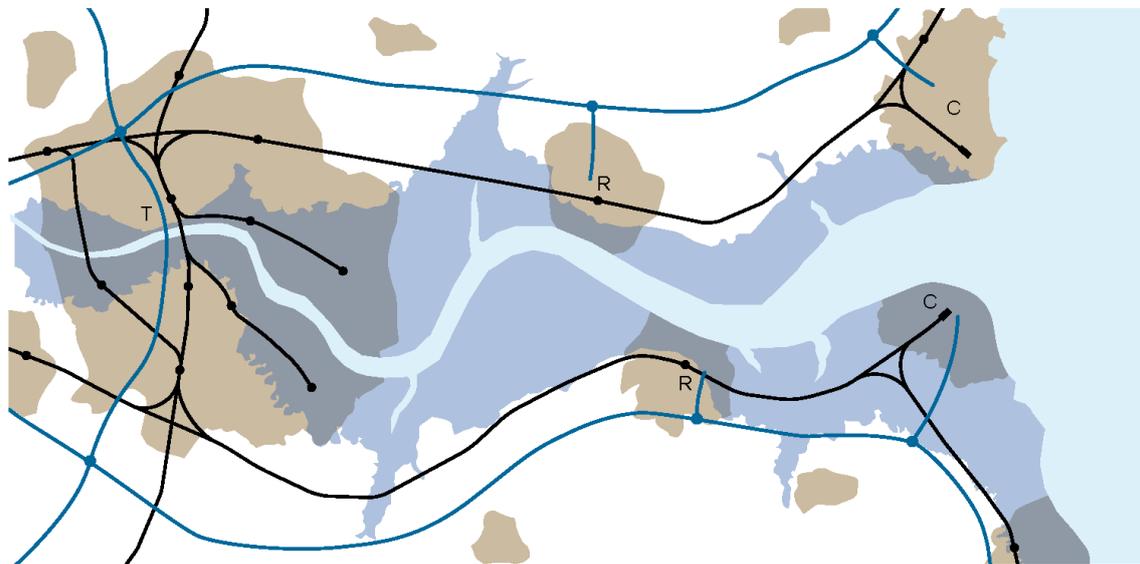
A climate change scenario is emerging in which actions taken around the world will not prevent a rise of sea level in the low to mid-range of the UK CP18

predictions by 2050, with a corresponding increase in the severity of storms, the two factors combining to create an increase in sea flood risks. Except for the Netherlands, few large national economies have a higher proportion of urban assets exposed to the risk of rising sea levels than the UK. These assets are located around urban estuaries including the Thames and Medway, Tyneside and Teesside, Humberside and Clydeside. UKCP18 data and on-going research will show that, even with co-ordinated international action, sea levels are likely to rise significantly before being brought under control in the 22nd century. Where the latest predictions indicate a rise of 1m this century another meter rise should be considered in the next before climate change policies can bring matters under control. This means that a current programme of managed retreat, to cope with a one meter rise this century, will need to be repeated in the next century and again if the rise in sea levels continues on current projections.

Fortunately, most urban estuaries around the UK already experience a tidal range of more than 3m, with flood defences raised to meet the associated risks including storm surges. Accordingly, most urban estuaries around the UK can manage a significant rise in mean sea level, subject to the tides being tamed by a flood defence system across the outer estuary. It is also fortunate that most of these estuaries have an extensive network of existing and former railway lines, with routes running each side to the coast, so that only a short new connection across the outer estuary is required to transform a vulnerable radial network into a robust orbital system. The assets at stake are substantial compared with the costs of the integration. The expense of the flood defence system across the outer estuary is offset by the additional assets and habitats that are protected, by the green-growth agglomeration benefits of the integrated urban orbital infrastructure and by the greater resilience and duration of the shorter flood defence line, allowing the flood datum to be raised easily as required to meet the risk of rising sea levels through not just this century but the next.

TYPICAL EXISTING URBAN ESTUARY

LARGE FLOOD RISK AREA + POOR CONNECTIVITY



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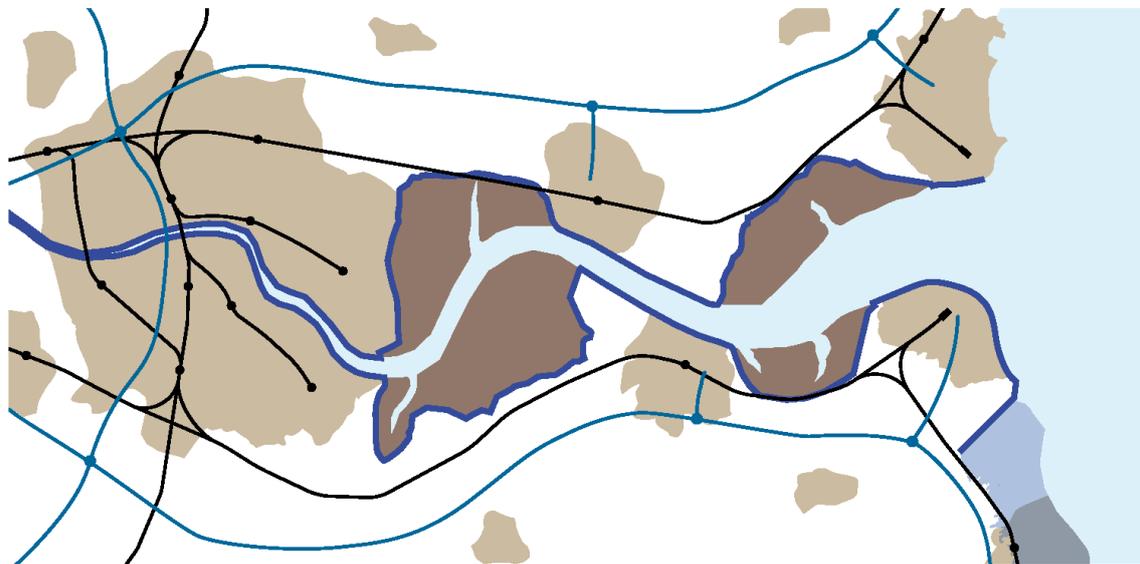
The typical urban estuary in the UK has a radial transport network developed from a historic crossing located inland towards the tidal head. From this early crossing radial roads served each side of the estuary downstream before heading along the coast. The roads were supplemented by railways in the 19thC and motorways in the 20thC without significantly changing the network. Separate riparian settlements developed on the banks downstream to serve docks and industry followed by the growth of resorts and dormitory towns at the mouth of the estuary and along the coast. With the gradual rise in sea level since the 18thC the result is an urban network with a large flood risk area, increasing vulnerability and poor connectivity.

MANAGED RETREAT

FLOOD DEFENCE ONLY

- LONGER FLOOD DEFENCE LINE
- HIGHER FLOOD DEFENCES
- LOSS OF LAND
- LOSS OF EXISTING HABITATS
- ISOLATION OF COASTAL AND RIPARIAN SETTLEMENTS
- LOW RESILIENCE

FLOOD DEFENCE LINE
MANAGED RETREAT
FLOOD RISK AREAS



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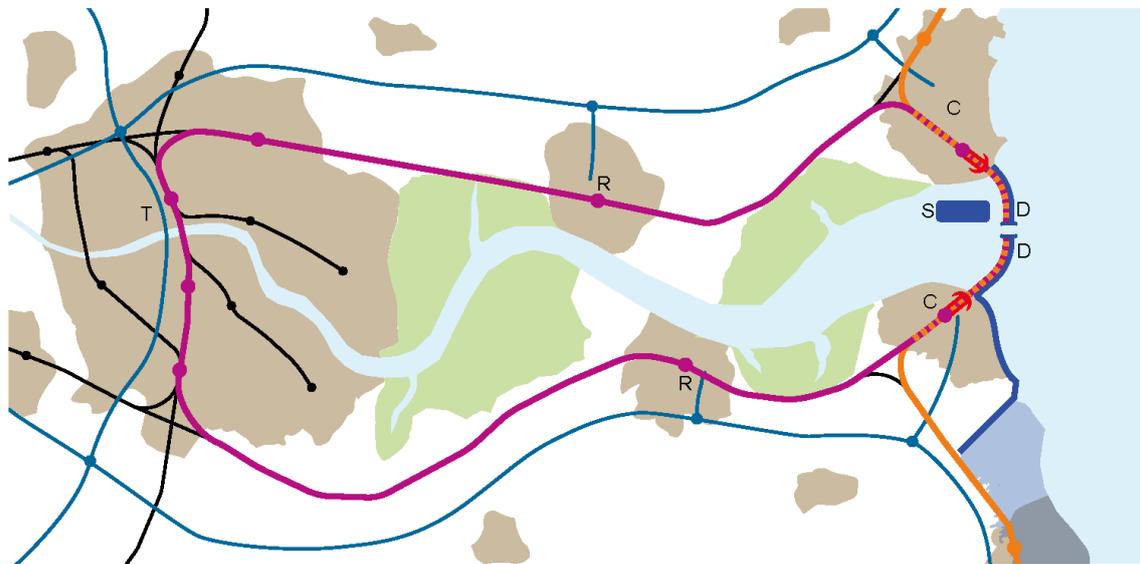
Flood risks are currently managed by raising sea walls along the banks of estuaries and creeks, providing gates and sluices where required. As areas become vulnerable a strategy of managed retreat is applied in which the cost of maintaining a flood risk is compared with the value of the public assets protected. Defences retreat from areas where protected asset values are too low, and a new flood defence line is formed further inland. The loss of land increases the isolation of defended riparian and coastal settlements. Valuable freshwater habitats are lost and replaced by intertidal habitats and flats that take decades to mature by which time the sea will have risen again. Managed retreat follows an adaptive flood management plan designed to spend as little as possible as late as possible to maintain the current levels of flood risk for the public assets being protected. With increased rates of rising sea levels, the big-ticket costs for coastal flood defences are coming sooner rather than later. A new adaptive flood management plan is required that spends as little as possible as productively as possible to maintain current levels of flood risk.

METROTIDAL URBAN ORBITAL

FLOOD DEFENCE + TRANSPORT AND DATA ORBITAL + RENEWABLES

- SHORTER FLOOD DEFENCE LINE
- LOWER FLOOD DEFENCES
- PROTECTS ALL LANDWARD ASSETS AND HABITATS
- UNITES THE ESTUARY AND COASTAL ECONOMIES
- PROVIDES GREEN GROWTH
- HIGH RESILIENCE

FLOOD DEFENCE THROTTLE AND LINE	
FLOOD RISK AREAS	
PROTECTED HABITAT	
NEW RAIL LINK & TUNNEL	
URBAN ORBITAL	
URBAN COASTAL	
FLOATING SOLAR	S
DATA STORAGE	D



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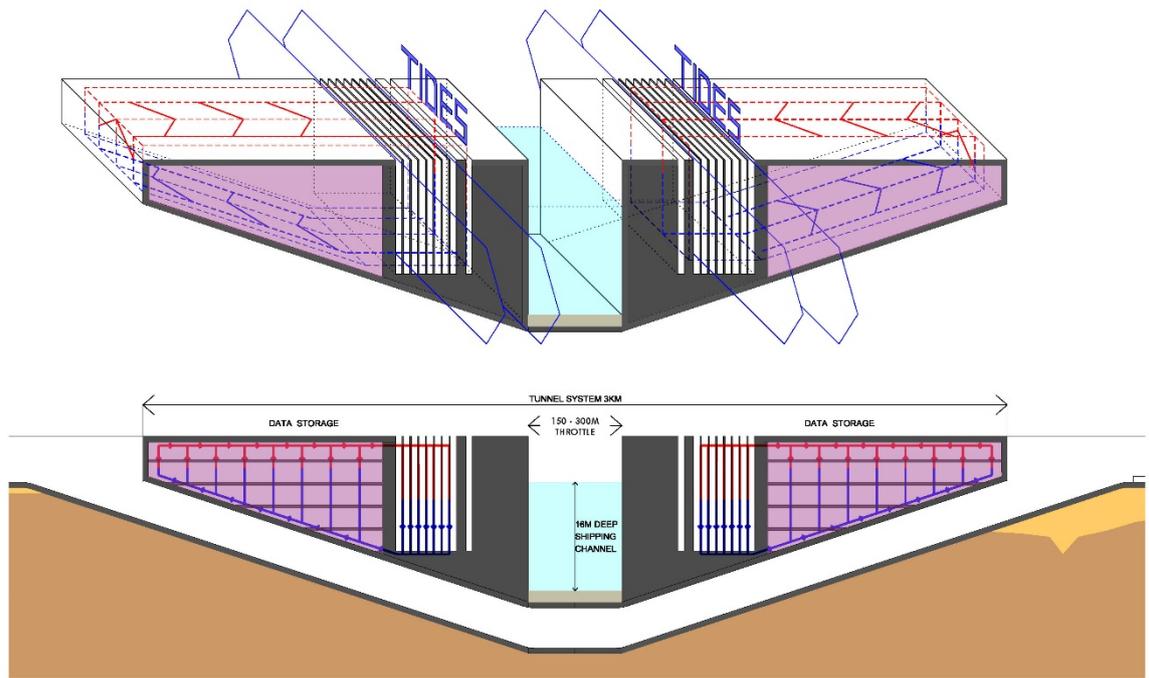
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The Metrotidal Urban Orbital integrates a flood defence throttle with a short new rail link to transform an existing radial network into an orbital system. The landward tidal range is reduced while leaving the shipping channel open to navigation. The flood defence line is shorter and the flood datum lower, as the tidal range on the outer estuary is lower than inland. All existing landward assets and habitats are protected including habitats in the tideway. The transport and data orbital unites the urban estuary and coastal communities to provide green-growth agglomeration benefits. The improved urban connectivity enables railways and micro-mobility to reduce the reliance on cars. Wayleaves around the rail orbital accommodate fibre optic cables for FTTP services.

DATA STORAGE AND UTILITIES

TIDAL COOLING SYSTEM

DATA AND COLD STORAGE  TIDAL COOLING SYSTEM 
 AGGREGATE FILL  RIVER BED 



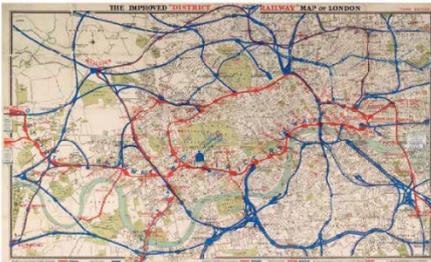
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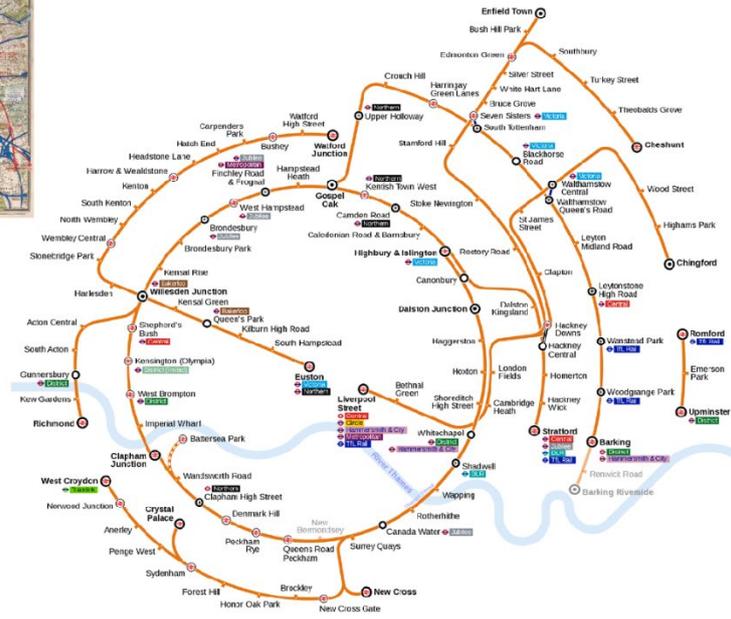
A generic 3km flood defence system across an estuary enables the railway to dive below a 300m wide, 16m deep shipping channel, this setting a maximum requirement that can be tailored to local circumstances. The navigation remains open with gates fitted when required by rising sea levels and then only closed for surge tides. Sluices reduce peak flows during normal tides. Relatively short lengths of sea wall from the throttle, with an upgrade of local coastal defences to high ground, complete the system. The new flood defence line across the lower estuary is a fraction of the length of existing landward defences all the way inland around the estuary. The short new rail link creates a high-capacity urban orbital with data wayleaves.

RAIL ORBITAL PRECEDENTS

GROWTH FROM URBAN AGGLOMERATION



LONDON UNDERGROUND CIRCLE LINE 1884



LONDON OVERGROUND 2007

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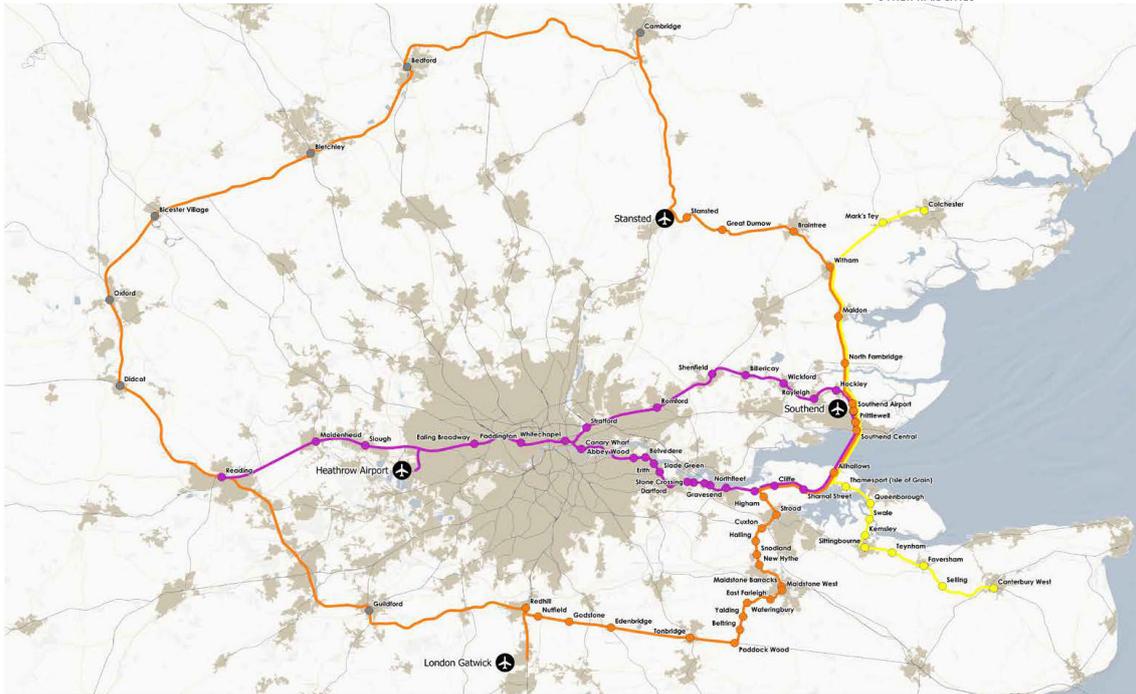
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For the Metrotidal Thames Orbital, the prototype for the generic system, an 8km throttle flood defence system and seawalls across the lower estuary replace proposals for a flood defence barrier across the Thames at Purfleet that would require 106km system of sea walls, sluices and gates downstream. Precedents for the connectivity and agglomeration benefits of the urban orbital railway are found in the Circle Line completed 1884 and the London Overground network of 2007. The benefits are also recognised by the current Transport for the South East (TfSE) “R25” rail orbital between Reading and Rochester, around the southeast and southwest quadrants of London, for which the Metrotidal Thames Orbital is the natural extension to the northeast quadrant, integrated with flood defence.

METROTIDAL THAMES + MEDWAY + R25 ORBITALS

COMPLETED BY THE INTEGRATED SEA REACH LINK

- METROTIDAL R25 ORBITAL
- METROTIDAL THAMES ORBITAL + CROSSRAIL
- METROTIDAL COASTAL
- OTHER RAIL LINES

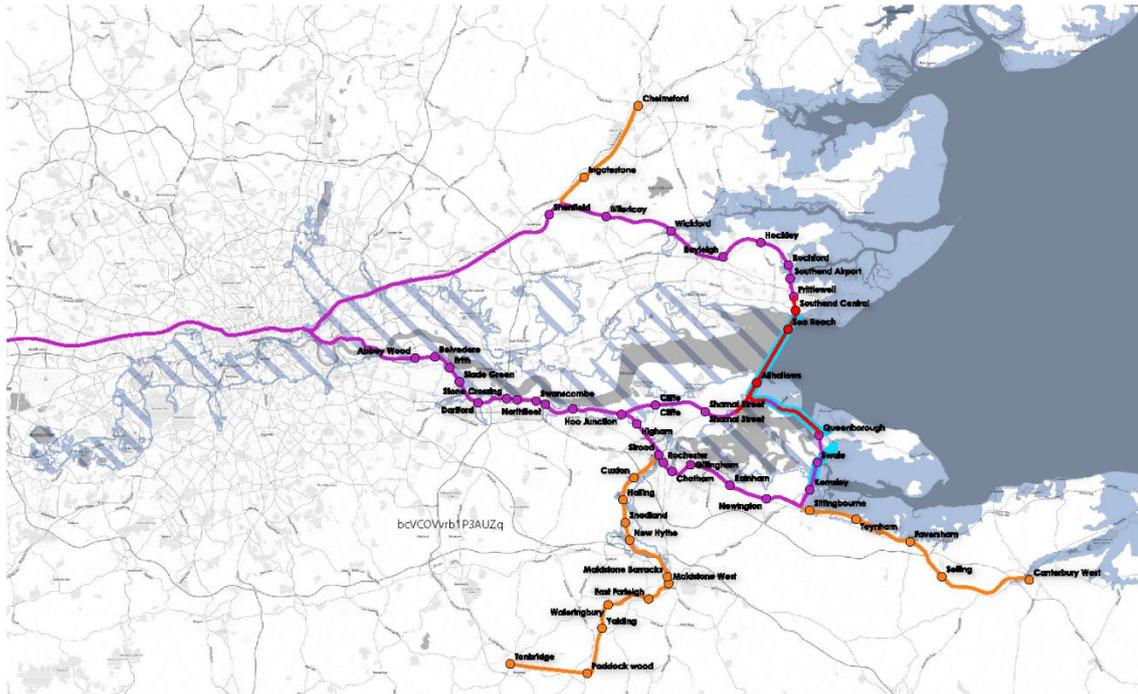


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Just 12km of new rail link across the Lower Thames Estuary creates a 132km orbital from Central London, formed from the eastern limbs of Crossrail, the C2E Crossrail Extension to Ebbsfleet and the Medway HIF project that re-opens the Hoo Peninsula in Kent to passengers. In Essex just 23km of re-opened line and 26km of additional new line, combined with existing twin-tracks and the forthcoming East West Rail link between Oxford and Cambridge completes a 454km twin-track R25 rail orbital of Greater London, East and Southeast of England.

METROTIDAL THAMES + MEDWAY ORBITAL



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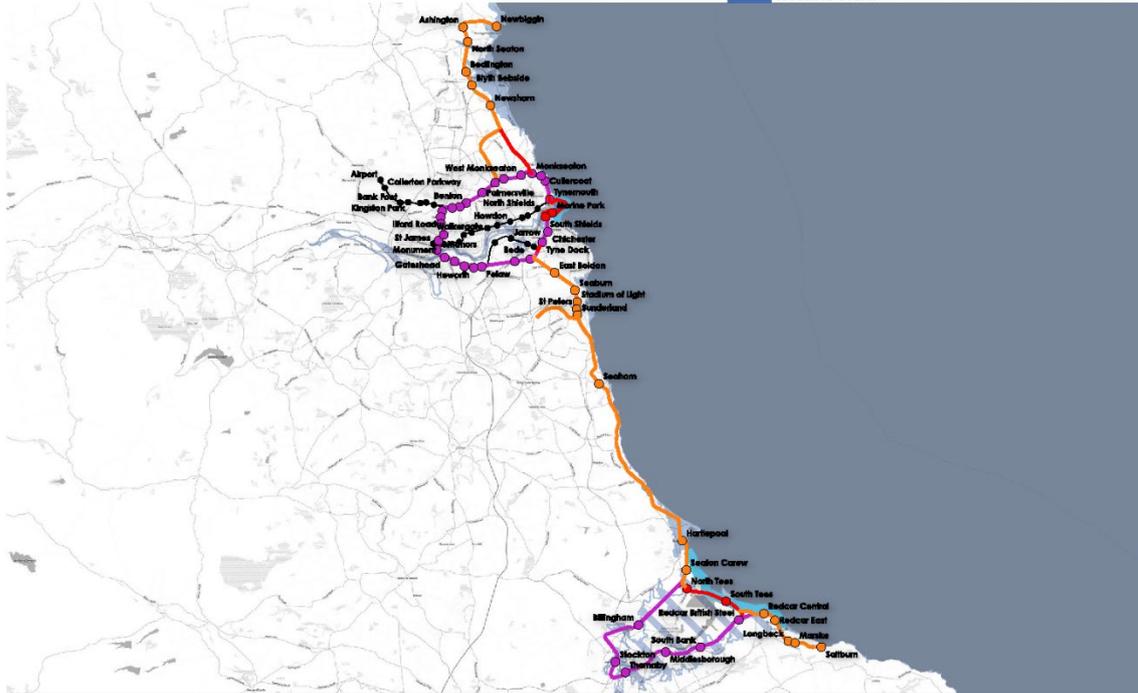
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Similar benefits can be provided for the Medway Estuary where a 2.7km throttle and 5.5km of new railway link replace a managed retreat programme that requires the sacrifice of 14.5sq.km and the raising of 52.5km of sea walls. The combined Metrotidal Thames and Medway Orbital makes use of the same line over the Hoo Peninsula, providing significant distance and journey time savings for coastal journeys across the estuaries. For example, Southend to Sittingbourne, a current journey of some 115km taking 122 minutes with four changes, in part using HS1, becomes a direct journey of 28.3km taking 25 minutes. This forms part of the Metrotidal Coastal route between Colchester and Canterbury, replacing a current route of 180.6km using HS1 through Stratford International with a direct journey of 108.9km through the Sea Reach and Medway throttle flood defence systems.

METROTIDAL TYNE-TEES COASTAL

COMBINED TYNE AND TEES COASTAL 97.2KM

- 2050 FLOOD RISK
- 2050 PROTECTED AREA
- FLOOD DEFENCE LINE
- URBAN ORBITAL
- URBAN COASTAL
- NEW METROTIDAL RAIL
- FLOATING SOLAR



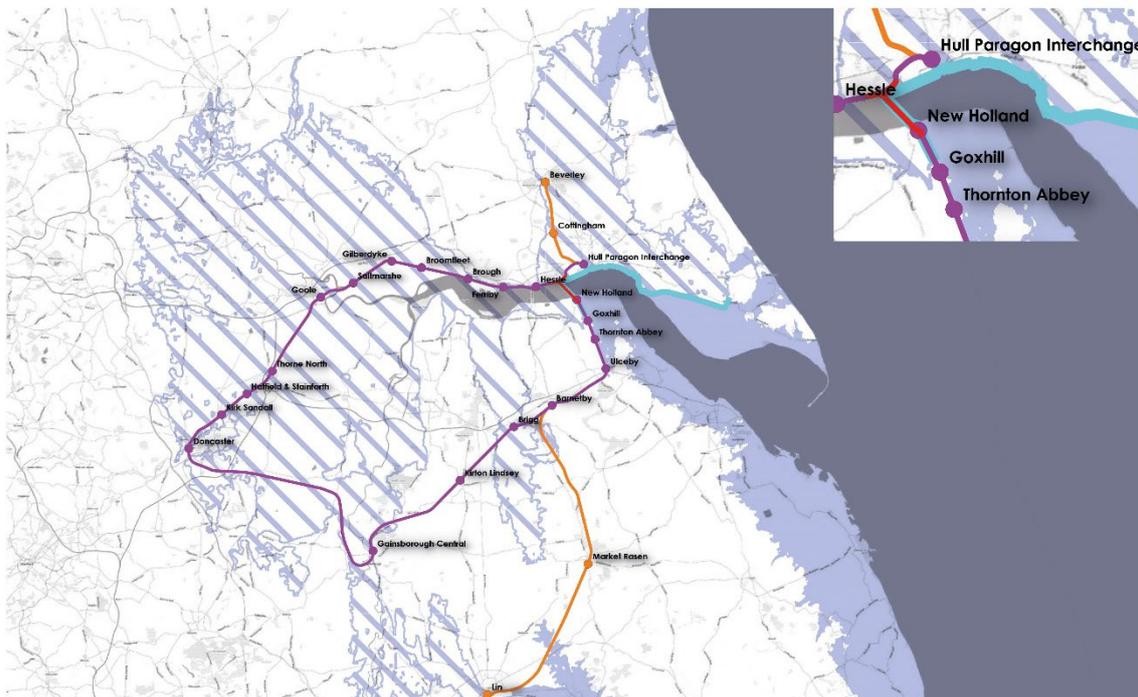
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METROTIDAL HUMBERSIDE ORBITAL (OPTION D)

NEW RAIL LINE 4.2KM + FLOOD DEFENCE LINE 33.2KM + URBAN ORBITAL 160KM

- 2050 FLOOD RISK
- 2050 PROTECTED AREA
- FLOOD DEFENCE LINE
- URBAN ORBITAL
- URBAN COASTAL
- NEW METROTIDAL RAIL



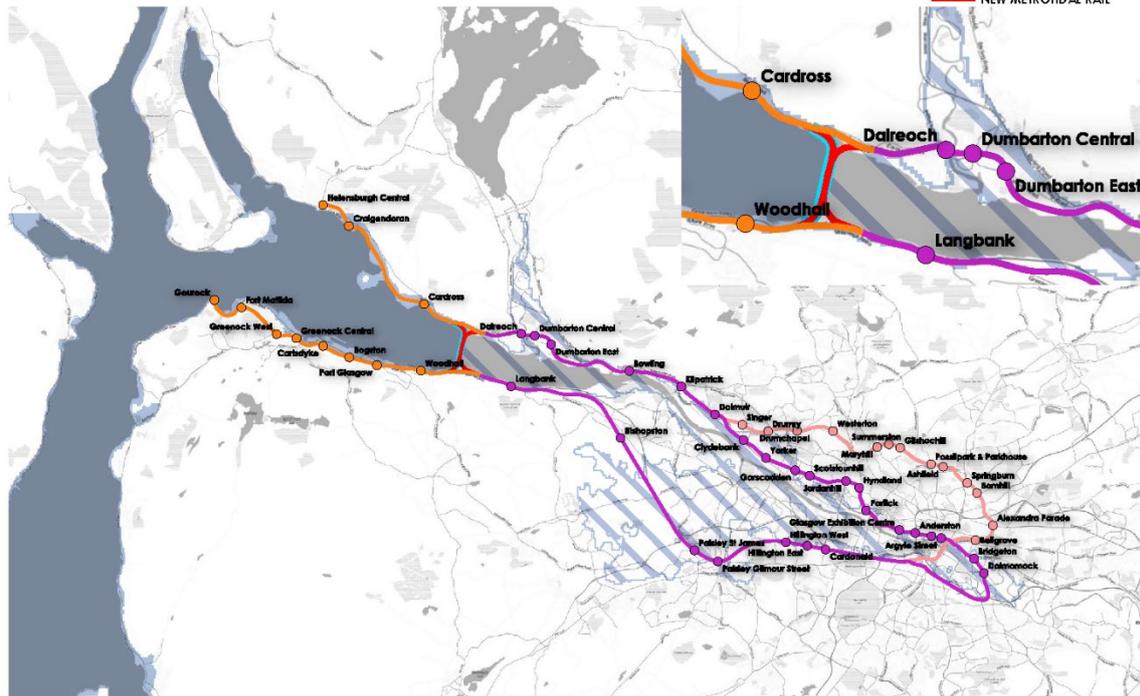
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The Metrotidal Urban Orbital, developed from the Thames and Medway cases, is readily applied around the UK as part of the levelling-up policy of investment and opportunity between the North and South. Tyneside, Teesside, Humberside and Clydeside are all strong applications where a short new flood defence line and rail link protects a large flood risk area while uniting large estuary and coastal communities around efficient urban orbitals.

METROTIDAL CLYDESIDE ORBITAL

NEW RAIL LINE 3.1KM + FLOOD DEFENCE LINE 2.5KM + URBAN ORBITAL 64.1KM



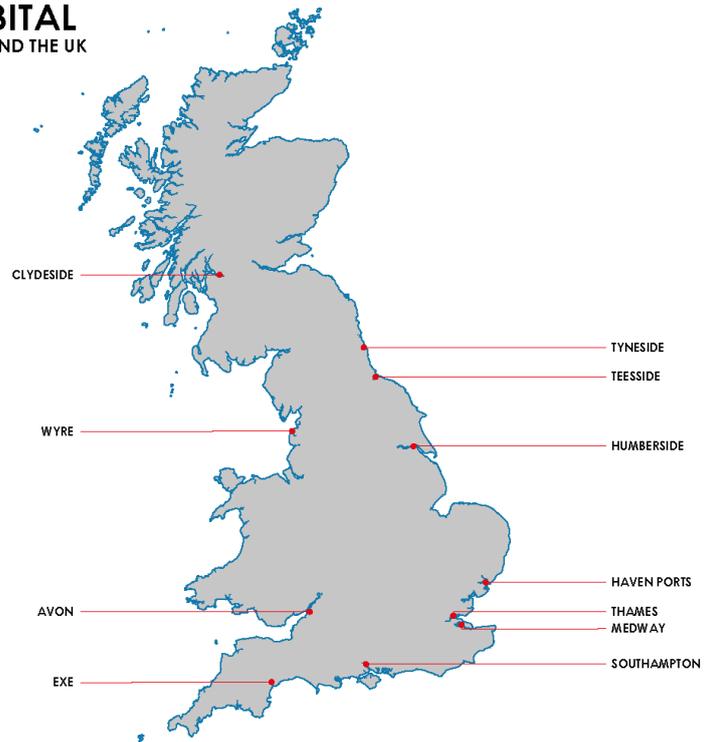
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Managed Retreat vs the Metrotidal Urban Orbital is a case for debate as part of the current 10-year flood defence review of the Thames and Medway estuaries and for the run up to COP26, the 2021 UN Climate Change Conference in Glasgow. Here the Clyde provides a useful demonstration, with a lower tidal range than many other UK urban estuaries but still some 3m with storm surges, where a relatively short flood defence line across the outer estuary protects a large urban area and improves urban and coastal connectivity.

METROTIDAL URBAN ORBITAL

EXAMPLES OF FLOOD DEFENCE THROTTLES AROUND THE UK



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Current investment policies for coastal flood defences, urban rail, micro-mobility, data connectivity, FFTP, freeports, the levelling-up of the North and the strengthening of the Union are all addressed with lower cost and carbon audit by the Metrotidal Urban Orbital and its application to urban estuaries around the UK. Further details of the Metrotidal Urban Orbitals are provided on the webpage

www.metrotidal.com.