

TRANSPORT CONNECTIONS**CONTENTS**

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1 INTRODUCTION

The proposed surface access is configured to create the largest and most efficient passenger, employee and freight catchments for Thames Reach Airport while generating the greatest urban agglomeration benefits through the independent Metrotidal Tunnel system. Accordingly the following principles have been used for forming the new rail and road surface access networks:-

Metrotidal Tunnel principles:-

- transport links that result in the greatest agglomeration benefits
- links that provide minimum travel times, energy consumption and carbon audit
- optimum integration of the tunnel with food defence, tidal power and data storage
- optimum configuration for passenger and freight demands
- the shortest connections to existing arteries for creating new rail and road networks
- locations for uniting rail and road connections through a single immersed-tube tunnel
- the site, gradient and curvature constraints of the tunnel approaches

To serve Thames Reach Airport the Metrotidal Tunnel surface access should also:-

- have the capacity to serve both the agglomeration and aviation agendas
- provide the best catchments for the airport passengers, employees and freight
- provide rail-led surface access of between 60 – 80% of total demand
- make best use of existing rail and road networks
- make best use of counter-cyclical commuting capacity
- result in the minimum length of dedicated airport spur

2 COMPARATIVE PROXIMITIES, AIR-RAIL SUBSTITUTION AND CATCHMENT

Thames Reach Airport with the surface access provided by Metrotidal Tunnel will have a much larger catchment area and better connectivity for lower cost than expanding Heathrow, Stansted or Gatwick. The longer travel distance from northwest and west of London to the estuary location is more than made up by the more efficient travel times airside and landside when passing through the purpose-designed, new-build airport. So, to take Heathrow as an example, the apparent advantage of its relative proximity to Central London and for areas northwest and west of London is lost by the inefficient passenger transit arrangements within the airport system. For a fair comparison to be drawn between existing airports and a purpose-designed, new-build hub in the Thames estuary the surface access travel times to the various airport options should also include the average passenger transit times passing through the airports, landside and airside, to provide overall travel times. As a result the “comparative proximity” of a purpose-designed new-build solution is significantly better and the surface access catchment areas and net economic benefits are correspondingly increased. Thames Reach Airport, the closest new-build proposal in the Thames Estuary to Central London, emerges with a much better comparative proximity, catchment area and net economic benefit than Heathrow, Gatwick or Stansted. This was first demonstrated in 2003 by

the SERAS study access models, which found that Thames Reach Airport as then configured had a £2bn “comparative proximity” benefit.

Ten years later and the comparative proximity benefit of Thames Reach Airport is still better, this despite proposals to improve rail access to the existing airports. HS2 has been diverted from the shortest route between London and Birmingham to improve access to Heathrow but this still requires an 18km journey on the Heathrow Express route from a new station at Old Oak Common. The distance from Old Oak Common to Thames Reach Airport via HS1 and the Metrotidal Canvey-Hoo Tunnel route option is some 71km, or 70km via HS1 extended to Old Oak Common, so the net additional travel distance to the estuary location is 52-53km, resulting in an additional travel time of some 20 minutes from areas served by HS2 northwest and west of London. Despite proposals to expand and improve the capacity of Heathrow the dispersed arrangement of gates between widely separated main terminals and the two runway infields of the 3-runway option results in an inefficient airport configuration with higher travels times landside and airside compared with a purpose-designed, new-build solution. Similarly the rail hub on the Great Western Mainline proposed by Heathrow Hub, which is 17.4km from Old Oak Common, is 4.3km directly from the centre of T5 and some 5.5km on the connecting tracks with another 2.7km transit from T5 to T2 and a further 0.8km from T2 to the eastern satellite. Even with a modern mass-transit people-mover a distance of up to 9.0km between the train hub and the plane satellite will result in substantially longer average transit times than a purpose-designed system. At Thames Reach Airport, with a single, compact infield and passenger transit axis and an airport station directly beneath the CTA, the furthest satellite is 2.88km from the centre of the CTA station. The combination of a purpose-designed system for travel time efficiency with fewer stops and shorter average travel distance from CTA station to satellite results in savings of 20 minutes on average when passing through the airport system landside and 5 minutes airside, providing a 5 minute comparative proximity benefit after taking account of the longer journey east from Old Oak Common. If the route for HS2 did not go out of its way to help Heathrow the benefit of Thames Reach Airport would be even greater. With a site to the east of London close to HS1 the comparative proximity of Thames Reach Airport is very much better than Heathrow for all

areas east of a line from Leeds through London to Brighton, including northern Europe across to Paris, Brussels and Amsterdam.

The purpose-designed new-build solution in the estuary not only provides much better surface access travel times. With up to half an hour saved on passing through the airport system, gate-to-gate landside and taxiing airside, the transit-flight catchment radius for Thames Reach Airport is increased by up to 300 miles when compared with Heathrow. This distance embraces a majority of short haul flights in Northern Europe.

The rail network proposals serve Gatwick and Stansted as well as Thames Reach Airport, for passengers, employees and freight. While in principle it is advantageous to concentrate all demand into one estuary hub there are benefits from maintaining a degree of commercial competition, particularly for low-cost, point-to-point journeys, and from maintaining the system resilience provided by three airports. The contributions of Gatwick and Stansted to the proposed network would be proportionate to the benefits gained. Accordingly Gatwick would contribute to the Earlswood chord so the Medway Valley Line services can be extended from Redhill to Gatwick and Brighton and so air-rail substitution is provided from HS1 via Ashford. Stansted would contribute to the costs of the East Coast Continental Line and the Rye Power Station chord from the WAML in the first phase and to building HS3 from Hutton to Quendon in Essex, just north of the airport, in the optional high-speed phase.

In summary Thames Reach Airport close to HS1 has an air-rail and transit catchment extending into mainland Europe that cannot be matched by Heathrow, however good an HS1-HS2 link. The purpose-designed, new-build airport provides minimum connection times (MCTs) landside and airside some 20-25 minutes shorter than those of Heathrow. These combined benefits enable Thames Reach Airport to extend its surface access catchment to compete with Schiphol, Frankfurt and Charles de Gaulle. The purpose-designed, low MCT's of Thames Reach Airport allow passengers to arrive an hour before departure, in competition with the conventional two hours, while still leaving time for duty-free shopping before boarding. The exceptionally low MCT's offer passengers the choice of spending their time at

the airport or making a longer surface access journey. Hence Thames Reach Airport will extend into the catchments of the mainland European hubs. The shorter MCT's result in Thames Reach Airport providing shorter travel times than Heathrow, as the time saved within the airport system when put towards the surface access journey more than offsets the additional travel times from the northwest, west and southwest to the inner estuary location east of London. As a result Thames Reach Airport has a much better "comparative proximity" than Heathrow with a larger catchment area in Europe and in the UK.

3 LINE WORKS

3.1 HS1 and the Isle of Grain Line

3.2 TRAX- Central London Thames Reach Airport Express Services

3.3 Crossrail Plus Orbital

3.4 East Coast Continental Line with TfL Central Line

3.5 Lincoln Continental Line

3.6 Great Eastern Main Line

3.7 Medway Valley Line

3.8 Regional Rail Hubs

3.9 HS1 – HS2 Link

3.10 HS3

3.1 HS1 AND THE ISLE OF GRAIN LINE

Two new, east and west, high-speed, GC gauge, twin-track connections are provided to Metrotidal Tunnel and Thames Reach Airport from the existing HS1 route between Ashford and Ebbsfleet on the route of the Isle of Grain Line from Hoo Junction, one north from Knights Place under Shorne Ridgeway and one west from Pepper Hill Tunnel/Northfleet Green via

Claylane Wood/Thong to Hoo Junction. The existing Isle of Grain Line is dualled to GC gauge east from Hoo Junction to Metrotidal Tunnel and Thames Reach Airport.

Components

HS1-Hoo Junction:	Knights Place chord
HS1-Hoo Junction:	Northfleet Green/Claylane Wood/Thong chord
Hoo Junction-Tunnel and Airport:	Dualling of the Isle of Grain Line

Connections

Central London
Ebbsfleet
Ashford
Europe: Lille, Brussels, Paris

Passenger Region Served

Central and West London
Kent
North Europe

Freight Connection

Mainland Europe – Thames Estuary and East Coast Ports

Comment

The Isle of Grain Line is dualled for fast express rather than full high-speed service, as high-speed operation would not significantly reduce the travel times for trains slowing to pass

through Metrotidal Tunnel or stopping at the Airport. Eurostar and Javelin class trains provide direct services to the airport from St. Pancras International, Lille, Brussels and Paris, along with indirect services by interchange at Ebbsfleet and Ashford. HS1 extends the Thames Reach Airport catchment into Europe with Lille 1 hour 15minutes and Brussels 1 hour 45 minutes from the airport.

Programme and Phasing

The airport opens with the existing Javelin-Class services from St. Pancras International stopping at Ebbsfleet to pick up HS1 passengers from the Continent. These together with the Metrotidal Tunnel and TRAX services provide sufficient capacity for passengers and employees in the first years of airport operation while the two high-speed chords from HS1 to Hoo Junction are completed. This allows the construction team that duals the Isle of Grain Line to advance a continuous programme of phased works for subsequently opening the two high-speed chords from Hoo Junction including the tunnel under Shorne Ridgeway. The passenger capacity on HS1 from Ebbsfleet into Central London is increased in due course by restricting freight operations to the night hours and then directing non-airport passenger and freight demand through Metrotidal Tunnel on new connections to the north and east. For increasing the capacity of HS1 see the HS1-HS2 Link below.

3.2 TRAX

Direct Thames Reach Airport Express (TRAX) services between Central London and the airport are provided from St. Pancras International and Liverpool Street Stations, Waterloo International and Victoria Stations, Fenchurch Street and London Bridge Stations. St. Pancras International and Liverpool Street Station TRAX services make use of the HS1 mainline to Ebbsfleet. The Liverpool Street Station services can be switched to the LTS Basildon Line via Pitsea and Metrotidal Tunnel if HS1 reaches full capacity. Waterloo International and Victoria Station TRAX services make use of the former CTRL route to Southfleet and join the new

high-speed chord to Hoo junction without connecting with the HS1 mainline. Fenchurch Street also provides services on HS1 via Barking with these also switched to the LTS Basildon Line via Pitsea and Metrotidal Tunnel if HS1 reaches full capacity. London Bridge Station TRAX services use existing lines to Hoo Junction, so they also avoid using the HS1 mainline. In this way full use is first made of HS1 to provide Central London express services for the airport allowing time to upgrade existing lines for accommodating higher capacities, if required.

Connections

St. Pancras International

Liverpool Street Station

Waterloo International

Victoria Station

Fenchurch Street Station

London Bridge Station

Passenger Region Served

Central London

Northwest and West England

Central England

Wales

South West England

Comment

The Central London termini provide connectivity for the northwest, west and southwest of England for the first few years from the airport opening, to be supplemented in due course by the Regional Rail hubs described below.

The TRAX services provide the following approximate travel times:-

Terminus	Distance (km)	Direct Service (minutes)
St Pancras International via HS1 Ebbsfleet/Thong	63	24
Liverpool Street via HS1 Ebbsfleet/Thong	60	32
Liverpool Street via Pitsea	58	42
Fenchurch Street via HS1 Ebbsfleet/Thong	60	32
Fenchurch Street via Pitsea	58	42
London Victoria via South Bromley/Thong	66	44
London Waterloo via South Bromley/Thong	67	44
London Bridge via Dartford	56	44

While some journeys seem long once the 20-25minutes landside and airside benefits are taken into account Thames Reach Airport has a much better comparative proximity to Central London than Heathrow.

If HS1 reaches full capacity additional express through-services from Liverpool Street and Fenchurch Street would be provided on the twin-track LTS Basildon Line where the following four stations can be upgraded with new lines:-

West Horndon	2 through-lines on agricultural land south of the existing platforms
Laindon	1 stopping line and platform south of the existing platforms
Basildon	2 stopping lines and platforms either side of the existing embankment
Pitsea	2 through-lines on the north side of the existing tracks

These works if required would not arise until later in the century when growth in the population to the east of London may warrant the upgrades with or without an airport.

3.3 CROSSRAIL PLUS ORBITAL

The eastern limbs of Crossrail to Shenfield in Essex and Abbey Wood in Kent are linked through Metrotidal Tunnel to create a high-capacity “Crossrail Plus” orbital system serving the Thames Estuary region. Crossrail has 24 trains per hour (tph) on the Central London tunnel splitting at Whitechapel into 12tph on the eastern limbs north and south of the Thames with the frequency of trains diminishing to 6tph beyond Gidea Park on the north-eastern limb to Shenfield and to 6tp on the south-eastern limb to Abbey Wood at off-peak times. As with existing commuter rail services the trains will run mostly empty in one direction during the morning and afternoon peaks. The orbital system makes use of this counter-cyclical commuting capacity to accommodate a growing population without increasing Central London congestion. The works include a relatively modest investment for the 25kvolt upgrade of the North Kent Line and some capacity improvements when required together with new rolling stock for the additional extent of the Crossrail services between Shenfield and Abbeywood. The line will improve connectivity for a large existing population while supporting substantial commercial and residential development, enabling growth to spread across the whole Thames Estuary region rather than being concentrated in Central London. The Crossrail Plus service via Metrotidal Tunnel brings Central London within one-hour of the airport, providing a stopping service for airport passengers and employees.

There are currently three principal options for connecting the eastern limbs of Crossrail to form the Crossrail Plus orbital through Metrotidal Tunnel that also serves the airport:-

- 1 to the east via the Metrotidal Hadleigh-Allhallows Tunnel
- 2 to the west via the Metrotidal Canvey-Hoo Tunnel passing east of Northward Hill
- 3 to the west via the Metrotidal Canvey-Hoo Tunnel passing west of Northward Hill

The first route, submitted to the Airports Commission in July 2013, results in a through-station and highway under the airport on an orbital that passes to the east of Canvey Island.

The second route is the one shown on the Metrotidal webpage since 2008, with the multimodal corridor from the Canvey-Hoo Tunnel turning east around Northward Hill.

The third route is one developed earlier for Metrotidal Tunnel, with the multimodal corridor from the Canvey-Hoo Tunnel passing west of Northward Hill. This most direct route has come back into play as a result of translating the two long runway configuration for the airport further west where it can be served by a single short multimodal spur from the tunnel orbital. This provides a shorter journey to the airport with fewer stops from Central London and allows non-airport demand to bypass the airport on an orbital that is some 12km shorter than the first route.

Metrotidal Canvey-Hoo Tunnel with the southern approach passing west of Northward Hill results in the following travel distances:-

	km
Reading- Whitechapel	66
Crossrail Plus Orbital Whitechapel-Whitechapel	110
Airport Spur	5
Shenfield to Thames Reach Airport	32
Abbey Wood to Thames Reach Airport	41
Liverpool Street to Thames Reach Airport (North Orbital)	65
Liverpool Street to Thames Reach Airport (South Orbital)	57

The Crossrail Plus orbital first makes use of the existing twin-tracks from Shenfield to Billericay with two new lines and platforms provided at Billericay Station to separate the new Crossrail Plus services from the existing Southend Victoria services. East of Billericay new twin-tracks turn south from Barrenleys Wood to bypass Wickford via Nevendon and cross the A127 to pass the Burnt Mills Industrial Estate, North Benfleet and Bowers Gifford before descending into the Thames basin where they turn either east to run beside the existing C2C tracks into South Benfleet for the Metrotidal Hadleigh-Allhallows Tunnel, or south to cross Canvey Island for the Metrotidal Canvey-Hoo Tunnel.

For the Metrotidal Hadleigh-Allhallows Tunnel route, at South Benfleet the B1014 Ferry Road underpass, station and associated road access are replaced by a new low-level 4-track, 4-platform station for interchange between the new services and existing C2C services. Ferry Road is reformed above the new station as an esplanade overlooking Benfleet Creek and reconnected to the Canvey Road Bridge. With the transport corridor and station enclosed by cut-and-cover construction, the existing barrier formed by the C2C tracks and station is removed and South Benfleet is reconnected to its historic tideway by an esplanade overlooking Benfleet Creek. On the south side of the estuary the new station at Kingsnorth provides direct access to the new industrial estate and in due course a park and ride facility for the airport. At Cliffe the old station site can be re-opened or a new site formed west of the existing road bridge.

For the Metrotidal Canvey-Hoo Tunnel the Crossrail Plus orbital descends from North Benfleet to be joined by a branch from the LTS line east of Pitsea and merges with extensions from the A130 and A13 to cross East Haven Creek and descend into the tideway by the Lobster Smack Inn on Holehaven. Here there is an option for a Canvey Riverside Station, not shown on the maps. On the south side the corridor turns beneath the high-pool of the tidal pumped-storage system and for environmental reasons continues across the marshes within a cut-and-cover tunnel before the tracks turn west to join the Isle of Grain Line and the highway heads south to skirt around the Lodge Hill estate and join the A289 beside the Royal School of Military Engineering.

The completed Crossrail Plus orbital has either 15No. or 14No. stations north and south from Whitechapel to Thames Reach Airport before returning on the opposite side of the estuary:-

North Orbital

Whitechapel

Stratford

Maryland

South Orbital

Whitechapel

Canary Wharf

Custom House

Forest Gate	Woolwich
Manor Park	Abbey Wood
Ilford	Belvedere
Seven Kings	Erith
Goodmayes	Slade Green
Chadwell Heath	Dartford
Romford	Stone Crossing
Gidea Park	Greenhithe
Harold Wood	Swanscombe
Brentwood	Northfleet
Shenfield	Gravesend
Billericay	Cliffe
<i>South Benfleet</i>	<i>Kingsnorth: For the Hadleigh-Allhallows orbital</i>
Thames Reach Airport	Thames Reach Airport

The Metrotidal Canvey-Hoo Tunnel provides a Crossrail Plus orbital that is some 12km shorter with two fewer stops than the Metrotidal Hadleigh-Allhallows Tunnel, saving up to 10 minutes travel time on the orbital for journeys that bypass the airport. The travel distances to the Central Terminal Area of the airport for the alternative tunnel routes are similar from the north but some 1.5km shorter from the south for the Metrotidal Canvey-Hoo Tunnel. A range of issues determine the relative merits of the alternative routes, including the lengths of tunnel, ability to bypass the airport, airfield configuration, flood storage operation, effects on the tideway and mitigation of impacts on the Northward Hill RSPB Nature Reserve. For the shorter Metrotidal Canvey-Hoo Tunnel under the tideway the multimodal corridor is shown enclosed by a cut-and-cover tunnel, to pass Northward Hill and protect the approach from flooding.

Passenger Region Served

Crossrail Plus provides the principal catchment for passengers and employees from Central London through the eastern metropolitan areas, South Essex and North Kent to Thames Reach Airport. The station connections and high-frequency orbital service provide indirect services for passengers and employees from Essex, Kent, Suffolk and Norfolk.

Programme and Phasing

Crossrail Plus can open as a separate service between Shenfield and Abbey Wood for integration with Crossrail services in due course though this introduces the delay of interchange. In addition to the orbital stopping service the integration of the Crossrail and Crossrail Plus routes opens the opportunity to run express through-trains on the eastern limbs to reduce the orbital travel times and the journey times between Central London and the airport. A typical Express Crossrail Plus orbital service would call at all stations from Central London to Stratford and Abbey Wood and then provide a fast orbital service in the East as follows:-

Express Crossrail Plus Orbital Services from Whitechapel

North Orbital

Connecting services

Stratford	LUL and Network Rail GEML + WAML
Romford	Network Rail Upminster Line
Shenfield	Network Rail GEML+ Southend Victoria Line
Thames Reach Airport	ECCL + Medway Valley Line

South Orbital

Connecting services

Abbey Wood	Network Rail Southeastern (SE)
Northfleet/Ebbsfleet Intern.	HS1 + SE Javelin services + Network Rail North Kent Line
Thames Reach Airport	ECCL + Medway Valley Line

Subject to track capacity and service priorities two new through-lines may be required at the following stations in order to provide the Crossrail Plus express services:-

- Billericay (as already proposed for separation of the Southend Victoria Line services)
- Cliffe
- Northfleet
- Swanscombe
- Greenhithe
- Stone Cross
- Slade Green
- Erith
- Belvedere

Land is available beside these stations to accommodate the through lines with modest third-party property impacts.

The fewer stops reduce orbital travel times to bring Central London within an hour of Thames Reach Airport. Accordingly Crossrail Plus compliments the fast rail access from West and Central London provided by the direct TRAX services.

Comparative Proximity

If we take Canary Wharf as an example the distance and number of stops of an all-stops service on Crossrail to Thames Reach Airport is 52km and 13No. stops and to Heathrow 35km and 12No. stops. The additional stop and 17km would take around 10 minutes additional travel time. However with 20 minutes saved landside within the airport system Thames Reach Airport still has an 10 minute comparative proximity benefit, before taking into account the 5 minute airside benefit. With the comparative proximity benefit taken into

account the travel times to Heathrow and Thames Reach Airport from the West End are the same for an all-stops service and quicker on the Crossrail Plus Express service.

The Crossrail Plus orbital supports the green-growth agenda by enabling the growing populations of South Essex, North Kent and metropolitan areas into Central London to travel conveniently and directly to and from the airport without compounding congestion on existing commuter radials into Central London. With the station connections to other networks and the high frequency of the orbital services, Crossrail Plus also provides convenient indirect services from the outer orbital and regional rail networks north and south of the estuary to and from Essex, Kent, Suffolk and Norfolk. As a result the Crossrail Plus service relieves pressure on the new TRAX services to and from West and Central London that would otherwise carry passengers and airport employees to and from these northeast and southeast quadrants via Central London to Thames Reach Airport.

3.4 EAST COAST CONTINENTAL LINE AND TfL CENTRAL LINE

The East Coast Continental Line (ECCL) connects the East Coast Main Line (ECML) at Stevenage with HS1 at Knights Place on the following lines to provide passenger, commuter and freight services between Edinburgh and the Continent via Metrotidal Tunnel and Thames Reach Airport:-

- | | |
|---------------------------------------|---------------------------------------|
| • Hertford Loop Line | Stevenage to Watton-at-Stone |
| • New Link | Watton-at-Stone to Ware |
| • Hertford East Branch Line | Ware to Rye House |
| • New Link | Rye House to North Weald |
| • Epping Ongar Railway | North Weald to Ongar |
| • New Link | Ongar to Hutton near Billericay |
| • Shenfield to Southend Victoria Line | Hutton to Billericay |
| • New Link | Billericay to Thames Reach Airport |
| • New Link | Thames Reach Airport to Knights Place |

Component		Length km	Land
New Link	Hertford Loop Line – Hertford East Branch Line	4.6	new
Hertford East Branch Line	Ware – Rye House	5.2	existing
Rye House Viaduct	Including approaches	3.5	new
New Link	Rye House Viaduct – Epping Ongar Railway	9.5	new
Epping Ongar Railway	Epping Forest – Ongar	6.7	existing
New Link	Ongar – Southend Victoria Line	12.7	new
Southend Victoria Line	Hutton – Billericay	6.0	existing

Passenger Region Served

- Northeast England
- Midlands
- Lincolnshire and East Anglia
- Kent
- Northern Europe

Programme and Phasing

The ECCL opens when required to relieve the TRAX services from Central London and improve connectivity for the Northeast, Midlands, Lincolnshire and East Anglia. An independent service can open between Stevenage and Thames Reach Airport for subsequent integration to provide through services from the ECML.

Comment

The route from Billericay to Knights Place is the same as that for the Crossrail Plus orbital. The ECCL completes a route between Edinburgh and Brussels via Metrotidal Tunnel and Thames Reach Airport, with the following benefits:-

- new north-south UK rail capacity and connectivity for passengers and freight
- direct rail services from the North to a new hub airport in the Thames Estuary
- through services to Northern Europe for passengers and freight
- a shorter route that avoids the congestion of Central London
- additional capacity that avoids the congestion of Central London
- an extension of the passenger and employee catchment area for the airport
- new freight services between the North, Midlands, Southeast and Europe
- integrated with the Crossrail Plus orbital for the Thames estuary region

Metrotidal Tunnel with the ECCL, West Anglia Main Line (WAML), Great Eastern Main Line (GEML) and Medway Valley Line (MVL) provides shorter routes from Cambridge, Ipswich and Gatwick/Crawley that avoid inner London congestion so these areas will also be brought within the one-hour catchment of the airport using conventional rail services. The ECCL provides further relief for the TRAX services for West and Central London that would otherwise carry ECML and WAML passengers between Central London and Thames Reach Airport

Works for the ECCL can also include re-opening of the TfL Central Line from Epping to North Weald to add to counter-cyclical commuter capacity and generally improve connectivity for the north east quadrant of London.

3.5 LINCOLN CONTINENTAL LINE

“Lincoln” as the line incorporates the Great Northern and Great Eastern Joint Railway between Doncaster and Cambridge that opened in 1882 and passes through Lincoln. “Continental” as this line working in tandem with the East Coast Continental Line opens an alternative route for rail freight services between Edinburgh and Europe, via Metrotidal Tunnel, Thames Reach Airport and HS1, to provide the following benefits:-

- new north-south rail capacity and connectivity for passengers and freight
- relieves congestion on the existing WCML, Midland ML and ECML
- diverts freight from the ECML to liberate additional capacity for passengers from the North to a new hub airport in the Thames estuary via the ECML and ECCL
- extends the northern catchment for the new air-rail hub
- alternative freight through-services between the North and Europe
- compliments the new Felixstowe-Nuneaton freight line and the Varsity Line
- integrated with the Crossrail Plus orbital for freight to the Thames estuary region

Component	Length km	Status
East Coast Main Line		
• Edinburgh – Doncaster	329	existing
Great Northern and Great Eastern Joint Railway		
• Doncaster – Spalding	120	existing
• Spalding – March	32	re-opened
• March – Cambridge	49	existing
West Anglia Main Line		
• Cambridge – Rye House Power Station	58	existing
East Coast Continental Line		
• Rye House Power Station to ECCL	2	new chord

From the new chord by Rye House Power Station the Lincoln Continental Line then follows the same route as the East Coast Continental Line through to Metrotidal Tunnel and Thames Reach Airport.

Programme and Phasing

The Lincoln Continental Line takes slow freight movements off the ECML, thereby liberating capacity for passenger services from the North to the Continent via Metrotidal Tunnel and Thames Reach Airport. The growth in overall north-south capacity opens the way for additional passenger services on the East Coast Continental Line between the Northwest, Midlands and Thames Reach Airport, either via interchange at Stevenage or direct through-services. The additional freight services on the Lincoln Continental Line merge with the WAML passenger services south of Ely and Cambridge. The WAML line between March in Cambridgeshire and Rye House Power Station forms part of Network Rail's Route 5 and is already programmed for capacity and gauge improvements. The passenger and freight services then merge with the East Coast Continental Line Services via the Rye House chord. The twin-track line from here to the Thames Estuary region is sufficient for anticipated demand. Exceptional growth in demand for passenger and freight through-services for the Thames Estuary Region, Thames Reach Airport and the Continent would be eased by the opening of HS3; see below.

The 34No.level-crossings between Doncaster and Spalding would be reviewed for replacement by bridges if and when required. The 32km Spalding to March line that closed in November 1982 is re-opened to avoid a western loop through Peterborough including a flyover at Werrington that had been mooted to separate freight from the congested ECML. In 2009 Network Rail considered re-opening the line for freight services associated with the new Felixstowe-Nuneaton Line but the cost/benefits at the time were presumably marginal. Now with a broader remit for freight on the Lincoln Continental Line to the ports of the Thames Estuary, Thames Reach Airport and through services to the Continent, and the liberation of

additional passenger capacity on the ECML the benefits are greater. There have been encroachments on the Spalding – March line since 1982 that would require the purchase and clearance of up to 32 dwellings, these being mostly in Little London, Spalding and nearby at Cowbit. A new viaduct could carry the line across the canal and adjoining new roads through Little London, or a new rail bypass west of Cowbit and Spalding could be provided as an alternative to avoid the house purchases and urban disruption. The track bed, bridges and viaducts of the former line need reconstruction and there are four commercial sheds and other minor temporary buildings to remove along with a short stretch of road to be diverted. The re-opened line would include bridges to replace 11No.level-crossings if and when required. New twin-tracks on easy curves would pass west of Whitemoor Prison and cross the sidings to complete the re-connection to March. The 23No.level-crossings between March and Newport would be reviewed for replacement by bridges if and when required.

Passenger Region Served

- Northeast England
- Midlands
- Lincolnshire and East Anglia
- Kent

Comment

The Lincoln Continental Line gathers freight demand from the Northwest and Midlands via the following western branch lines:-

Branch	Length km
Leeds - Doncaster	47
Sheffield – Gainsborough via Retford	52
Derby and Nottingham to Sleaford	79
Leicester to March via Melton Mowbray	108
Oxford to Cambridge via the Varsity Line	125

Leeds – Doncaster and Sheffield – Gainsborough are existing routes. The Leicester to March branch is already being upgraded as part of the Felixstowe-Nuneaton freight route. The Oxford to Cambridge Varsity Line is being planned. These north-western branches provide freight routes to the southeast that avoid using the congested East Coast Main Line. The western cross branches to the East Coast and Lincoln Continental Lines result in a new UK rail network with the following principal north-south lines and west-east links:-

North-South Main Lines

- West Coast Main Line
- Midland Main Line
- East Coast Main Line
- East Coast Continental Line
- Lincoln Continental Line

West–East Links

- Liverpool – Lincoln
- Holyhead – Sleaford
- Nuneaton – Felixstowe
- Oxford – Cambridge (the Varsity Line)
- Great Western Main Line

The new Lincoln Continental Line and its western branches connected to the Metrotidal Tunnel system and HS1 also provide new way leaves for communications, data and utility networks. South Essex, Kent and the Thames estuary region are some of the driest and most populated areas in the UK, where desalination plants are already required to provide secure supplies. There is potential for a north-south trunk main on the route of the Lincoln Continental Line between Northumbrian Water and Southern Water, with connections from Yorkshire Water, Anglian Water and Thames Water, to provide new, secure water supplies for the Southeast and the Thames estuary region.

3.6 GREAT EASTERN MAIN LINE

Direct services for passengers and freight from East Anglia and the Haven Ports to the Thames Estuary region, Thames Reach Airport and the Continent are provided by opening a new chord from the Great Eastern Main Line and Shenfield to the Southend Victoria Line.

Component	Length km	Land
New chord between GEML and Shenfield Victoria Lines	1.16km	new

Passenger Region served

Essex, Suffolk and Norfolk

Comment

The modest investment for a short new twin-track chord opens a range of new services that avoid congestion on the GEML between Shenfield and Liverpool Street Station. The line extends the airport catchment for passengers and employees from the northeast quadrant of London across East Anglia and along the East Coast to the Wash.

3.7 MEDWAY VALLEY LINE

The Medway Valley Line is extended east from Strood to Thames Reach Airport via the North Kent and Isle of Grain Lines, and west from Tonbridge to Redhill using existing track or, with the option of a new chord between South Nutfield and Salfords via Earlswood in Surrey, south to Gatwick Airport and Brighton.

Component	Length km	Land
New chord between Lower Higham and Hoo junction	2.0	new
New chord between South Nutfield/Salfords and Earlswood	3.0	new

Comment

The Medway Valley Line extends the airport catchment for passengers and employees around the southeast quadrant of London and across to Gatwick and the South Coast without using the congested lines of Central London. This relieves pressure on the new TRAX services for West and Central London that would otherwise carry passengers and employees to and from the southeast quadrant of London and surrounding areas to the airport and enables the southeast region to accommodate growth in population.

The new chord between South Nutfield and Salfords via Earlswood in Surrey benefits Gatwick Airport by improving rail surface access from the east and by opening an HS1 continental air-rail substitution service for Gatwick via interchange at Ashford. Since the main benefits of the Medway Valley Line for Thames Reach Airport are already provided by a connection to Redhill there is a case for Gatwick to bear the cost of the new chord to extend the service to Gatwick and Brighton. The benefits to Gatwick and Thames Reach Airport are not those of a virtual hub as the transfer times would be far too large. The benefits arise from the improved rail surface access to both airports for passengers and employees.

3.8 REGIONAL RAIL HUBS

To relieve pressure on the Central London termini and provide faster through-journeys, a system of regional rail hubs within one-hour's travel time of the airport is developed as the airport capacity increases; clockwise around London:-

Regional Rail hub	Main Line served	Distance to airport (km)
Stevenage	East Coast Main Line, with East Coast Main Line	83
Cambridge	West Anglia Main line, with Lincoln Continental Line	119
Cambridge	West Anglia Main Line via HS3 (see below)	95
Ipswich	Great Eastern Main Line	106
Ashford	HS1	62
Gatwick	South Coast Railway	101
Woking	South West Rail	99
Reading	Great Western Main Line via HS1	124
Watford Junction	West Coast Main Line via HS1	90

The Regional Rail Hubs are located on main lines with local line junctions, to provide subsidiary rail catchments for direct services to the airport on through-trains that avoid the Central London termini.

Comment

The Regional Rail Hubs relieve congestion at the Central London termini and avoid the need for another Cross-London rail tunnel. For Reading airport services there are two alternative routes to the GWML/Old Oak Common/HS1 route, one via Clapham Junction and the former CTRL route and another via Guildford and Redhill. Neither are fast but they already exist, enabling substantial works elsewhere to be postponed, and the travel times are offset by the comparative proximity benefits of Thames Reach Airport. This also applies to the other regional rail hub services so that while some journeys may be up to an hour, once the comparative proximity benefit is taken into account the longest equivalent journey is forty minutes. As a result Thames Reach Airport has broadly similar comparative proximity to Heathrow from regions to the west of London and very much better proximity for regions to the north, south and east of London.

3.9 HS1 - HS2 LINK

Metrotidal Tunnel and Thames Reach Airport provide greater benefits at lower cost than an expansion of Heathrow supported by HS2. The most useful service provided by HS2 would be a true high-speed link between HS1 and HS2 to extend the benefits of HS1 beyond London and as a corollary provide quicker access from the northwest and west of England to Thames Reach Airport and Europe. The HS1-HS2 link would take the form of a tunnel from the existing HS1 tunnel beneath the North London Line at Islington west under the West Coast Main Line tracks to Kensal Green and thence rise under Old Oak Common to connect with the Great Western Main Line, the West Coast Main Line and in due course HS2 heading northwest to follow the M40 as recommended by Mark Bostock. Services from the Regional Rail Hubs at Watford Junction and Reading would have airport through-trains stopping only at Stratford International for Central London connections via Crossrail. Accordingly the new tunnel does not require expensive station works at Old Oak Common, Euston or St. Pancras International as the Regional Rail hubs send through-trains under the capital to the airport. Extending HS1 from Islington to Old Oak Common, without connections or station works at St. Pancras International, Euston or Old Oak Common should be a priority for connectivity to the northwest and west of England, before the construction of HS2.

The current safety requirement that high-speed trains run three minutes apart in the tunnels sets the capacity of HS1 and the HS1- HS2 link at 20tph. A key benefit of the Crossrail Plus and TRAX services is that they postpone the time when HS1 reaches this 20tph capacity. The HS1 trains already run at lower speed in the tunnels and with further developments to signalling and other rail equipment there may be scope for raising the frequency from 20tph up to 30tph to postpone the need for additional tracks. Only the St. Pancras International TRAX service has to use HS1 as subject to an additional ten minutes travel time (from 32 to 42 minutes) the Liverpool Street TRAX services can be run via Pitsea. As the St. Pancras International and the faster Liverpool Street TRAX services via Ebbsfleet merge on HS1 at Dagenham and diverge just east of Pepper Hill Tunnel to the Northfleet Green/Claylane

Wood/Thong chord for Hoo Junction the first capacity decision for upgrading HS1, as an alternative to switching the Liverpool Street TRAX services via Pitsea, would be 4-tracking HS1 from Dagenham to just beyond the Pepper Hill Tunnel, this requiring new twin-track Thames and Pepper Hill Tunnels beside the existing tunnels. While this is expensive the land is available and the work is much cheaper than a Central London tunnel.

In the meantime with the services and high costs of HS2 and the upgrade of Heathrow under review there is a strong case for considering the East Coast and Lincoln Continental Lines combined with Metrotidal Tunnel and Thames Reach Airport as the better and cheaper alternative for new north-south rail capacity and connectivity, for passengers and freight, enabling the Midland ML, WCML and GWR to be used for access to the new estuary hub from the northwest and west via the Regional Rail Hubs and classic rail connections.

3.10 HS3

Metrotidal Tunnel under Thames Sea Reach opens a route for “HS3” a high-speed link from Knights Place on HS1 to Stansted Airport, East Anglia and the Northeast, with or without Thames Reach Airport. The route under Sea Reach includes the integration of the flood-storage defence system and tidal power generation, which in turn helps to reduce the cost of the tunnel connection and offset the energy demands, thereby enabling green-growth i.e. economic growth without a corresponding increase in carbon audit.

To demonstrate the case for HS3 via Metrotidal Tunnel it is useful to look at alternative routes for a connection from HS1 to Stansted Airport, East Anglia and the Northeast. An existing route for passengers and freight could be provided via Stratford International and Stratford London by linking services on HS1 and the West Anglia Main Line resulting in a journey from HS1, say on the Medway Bridge, to Stansted Airport of 98km. However the West Anglia Main Line is not high-speed or GC gauge. At present trains on HS1 do not stop at Stratford International and the Stansted Express from Liverpool Street stops at Tottenham Hale not

Stratford London. If stops and interchange were arranged there is the problem that the low-level platforms of Stratford International are some 350m from the high-level platforms of the West Anglia Main Line at Stratford London. This too can be solved but results in a delay that is compounded by the relatively slow journey north on the West Anglia Main Line to Stansted Airport. With a connection between HS1 and the West Anglia Main Line at Stratford high-speed trains might continue north to provide an express service but again the route north is slow and results in a 98km journey. Some freight already follows this route but the trains via Barking contribute to congestion on the inner London lines.

The most direct route from HS1 to Stansted Airport would head north from the Medway Bridge and Knights Place near Cobham in Kent to pass under Shorne Ridgeway and the Thames and emerge to head north across Bulphan Fen following the route of pylons and take the shortest, straightest, fastest route from Hutton near Shenfield to Stansted Airport. This route, 61km from the Medway Bridge to Stansted Airport station, has the advantage that it passes under the Thames on the same alignment as the DfT road-only Option C (LTX C) thereby enabling a multimodal immersed-tube tunnel to be used as investigated for "Metrotidal 2" in 2008. With chords in each direction to the London Tilbury and Southend Line the route provides convenient HS1/GC gauge connections into the Port of Tilbury and London Gateway Port. The route being new and straight also enables a high-speed GC gauge line to be extended to Stansted and north to the West Anglia Main Line near Quendon in Essex for further extension north in due course. However the location of the tunnel under Gravesend Reach would not be suitable for the integration of flood storage or tidal power and has difficult geological conditions for the construction of a flood barrier across the tideway. A barrier here would be downstream of the Port of Tilbury and consequently introduce an impediment to shipping. Another issue is the length of rail tunnel required. Knights Place is a high-point on the route of HS1. For HS3 to head north from here to descend under the Thames the track has to start descending not far north of the Medway Bridge, to pass under Knights Place in a tunnel that continues all the way under the Thames to emerge in Thurrock, with an overall length of some 10km. The current consultations are for the short road-only Option C hypotenuse between the A2 west of Knights Place and the M25 near North Ockendon. To

fulfil the Kent County Council Dover-Midlands agenda that seeks to guide HGVs out of the county on the most direct route available there will need to be an expensive and controversial extension of the hypotenuse from the M2 to the M20 by Maidstone to relieve the A229. Kent CC have already expressed their view that a similar extension to the hypotenuse would be required north through Essex to the M11 near Harlow. So the full LTX C road hypotenuse is more controversial and expensive than suggested by the current consultations. The counter argument is that with the HS3 rail freight connection under the Thames the traditional Dover – Midlands HGV route that is driving the Kent M20-M25 hypotenuse agenda becomes less important and will experience less growth than rail freight via the Thames estuary and East Coast ports, with more TEUs moving on the rail freight routes between them and the Midlands in due course. On this basis the case for the shorter LTX C road-only hypotenuse might be sustained if it is accompanied by rail and becomes the multimodal immersed-tube Metrotidal 2.

So we return to a route for HS3 that follows the Crossrail Plus orbital from HS1/Knights Place through Metrotidal Tunnel to Hutton near Shenfield and then follows the shortest, straightest fastest route north, this route being 74km from the Medway Bridge to Stansted Airport via the shorter Metrotidal Canvey-Hoo Tunnel route. Apart from the turns to approach the tunnel the route is quite straight and can be high-speed with GC gauge through to Stansted and the West Anglia Main Line near Quendon as for the multimodal LTX C. Similar GC gauge rail freight connections are provided for the Thames Estuary and East Coast ports though not quite so direct as Metrotidal 2 for London Gateway and the Port of Tilbury. An advantage is that the cost of this route is shared by the Crossrail Plus service so that it generates wider agglomeration benefits for the Thames estuary region with, or without, an estuary hub airport. A key point is that HS3 is optional, as the East Coast Continental Line between the ECML at Stevenage and HS1 at Knights Place already provides the connectivity required to open the estuary airport.

North of Stansted Airport the high-speed route for HS3 follows the curves of the M11 to Cambridge then the straight route northwest of the A14, to diverge east of Huntingdon and

join the East Coast Main Line just east of RAF Alconbury. From here the East Coast Main Line already follows a straight course north so that a high-speed upgrade on to Peterborough is relatively straightforward. The high-speed trains would then continue north of Peterborough on the existing ECML tracks to the Northeast and Edinburgh. The result is a much shorter route between Edinburgh, the Northeast of England and Europe that avoids the diversionary route of HS2 first west to Birmingham then back east into the congestion of Central London and the commuter belt. Accordingly, though only express speed north of Peterborough, HS3 provides a competitive service to HS2 at a fraction of the cost.

Where the M11 passes close to the West Anglia Main Line near Great Chesterford a connection is provided between HS3 and the proposed Lincoln Continental Line, enabling the Regional Rail Hub at Cambridge to use the shorter high-speed route to Metrotidal Tunnel and Thames Reach Airport instead of the WAML/Rye House Power Station chord and East Coast Continental Line. The classic rail route south from Cambridge continues to provide connections for freight thereby liberating capacity on HS3 and the ECML for the high-speed passenger services.

The West-East passenger and freight connections from Leeds, Sheffield, Derby/Nottingham and Leicester to the East Coast Continental Line and Lincoln Continental Line, together with high-speed operation of HS3 south from Peterborough provide a cheaper alternative to HS2 that relieves congestion on the West Coast Main Line and Midlands Main Line and opens a shorter route between the Northwest and Europe as well as between Edinburgh, the Northeast and Europe, via Metrotidal Tunnel and Thames Reach Airport.

4 ROAD WORKS

With a target of between 60-80% of transport growth and surface access capacity provided by rail the requirement for new road connections and existing road upgrades for the Tunnel and Airport agenda is reduced.

An outer orbital route across the estuary is completed from the south by extending the A289 to the tunnel either along the A228 for the Metrotidal Hadleigh-Allhallows Tunnel route or across Lodge Hill for the Metrotidal Canvey-Hoo route with an intermediate option of the road turning east around Northward Hill to the Canvey-Hoo Tunnel. The extended A289 is upgraded from D2 to D3 when required. From the north side a D2 extension of the A130 is carried on a flyover across Sadlers Hall Farm roundabout and follows Canvey Way to cross Canvey Island and enter the tunnel. The A13 between Orsett and Pitsea is upgraded from D2 to D3 when required. An upgrade of the Pitsea flyover is avoided by providing a new D2 branch of the A13 east from Vange Wharf following the LTC tracks east to where they converge with the extended A130 to cross East Haven Creek and Canvey Island to enter the Tunnel. An alternative A13 upgrade would provide a new D2 highway from the A1089 junction west of Orsett, through Mucking and south of Stanford-le-Hope to the London Gateway and thence under Holehaven Creek to Metrotidal Tunnel. This might be phased starting with a tunnel from Canvey Island to Manor Way.

Provision of the D2T2 multimodal Metrotidal Tunnel allows the expensive and disruptive LTXC proposals to be dropped with the solution at Dartford being LTXA in due course if no other road capacity were provided. However the provision of a new D2 East London Crossing between the A406 and A2016 is already a priority with or without a Lower Thames Crossing or Thames Estuary Airport and this too will relieve both the Blackwall Tunnel and the Dartford Crossing. A combination of the D2T2 Metrotidal Tunnel and the D2 East London Crossing will double the capacity of road connectivity across the estuary downstream of the Blackwall Tunnel, allowing the DfT/LTX proposals to be dropped while providing a much better spread of new capacity for growth across the whole estuary region from Central London to the Nore.

Investment in due course is switched to improving the connections to the A130/M2 outer orbital route rather than increasing lane capacity on the eastern half of the M25. In summary Metrotidal Tunnel enables the LTX proposals to be dropped and avoids the need for another lane upgrade around the eastern half of the M25.

5 SURFACE ACCESS CAPACITY

Set out below are the current facilities and capacity of Heathrow (LHR2) compared with those of three hub options being considered by the Airports Commission:-

- a third runway at Heathrow (LHR3),
- Heathrow Hub 2 long-runway configuration (HH-2LR),
- Thames Reach Airport 2-long-runway configuration (TRA-2LR)),

The figures are based on the following assumptions:-

- all options are assumed to operate for 9 hours at peak capacity and 9 hours at 75% peak when approaching their comfortably manageable peak capacity
- Thames Reach Airport can operate 24-hours, which is assumed to add another 6 hours at 40% capacity, equivalent to a 15% uplift in capacity, this mostly for long-haul, charter, freight and other night flights, which can be wholly accommodated on one long runway allowing the other to close for maintenance, the closed runway alternating each day
- Air-rail substitution of 5mppa at Heathrow and 20 – 25mppa for TRA
- Maximum load factor of 175, with a lower option of 150 illustrated for TRA

	LHR2	LHR3	HH-2LR	TRA-2LR
'000 s ATM's pa	480	740	920	1060
Peak ATM's per hour	90	128	160	160
Stands	174	248	310	310
Load factor	175	175	175	150 (175)
Mppa	85	130	160	160 (185)
Air-rail substitution	5	5	5	20 (20)
Total Mppa	90	135	165	180 (205)

For Heathrow, with 740,000 ATM's on three runways generating 130mppa, the assumed load factor of just over 175 is high and demonstrates the airport will again be squeezing out short haul flights as it approaches a capacity of only 130mppa. 700,000 ATM's is quoted as the more likely operational frequency, which then reduces capacity to 123mppa, still on a load factor of just over 175.

For Thames Reach Airport the 3 widely-spaced runway configuration will have a comparable capacity to the 3-runway configuration for Heathrow, uplifted by 15% for the 24-hour operation of the runways as outlined above allowing one to close each night for maintenance, resulting in 155mppa on a load factor of 175, dropping to 135mppa for a load factor of 150.

If for TRA we assume 60% O&D traffic and 80% surface access by rail, these deliberately being high estimates, then setting aside the air-rail substitution for now, the higher load factor provides 185mppa resulting in some 122,000 passengers travelling each way on the rail connections per day and allowing for reduced demand during night hours this resolves to some 6,700 passengers per hour each way at peak times.

Commuter movements for the airport employees are then added to the system. BAA quoted Heathrow as sustaining 75,000 jobs in 2011 when the number of passengers per annum was just less than 70m. With say a 15% improvement in productivity from an efficient new-build design, Thames Reach Airport with 185mppa may be expected to generate 172,000 jobs of which say a third, some 57,000, would be at ancillary developments around the airport where the employees commute directly to and from these outsourced locations, not the airport. This leaves 115,000 jobs generated by the full capacity of the airport resulting in flows of 6,300 commuters per hour each way at peak times, if commuting demand were to track passenger demand. However the employment pattern at the airport is likely to be arranged in three 8-hour shifts and while flexitime can be applied to reduce peak rates there will still be say double the rate of movement during the shift changes, resulting in a peak commuter rate of 12,600 per hour.

Accordingly a flow of 19,300 passengers and commuters for peak hours during shift changes is spread over the following services:-

Service	Train Capacity	tph
HS1		
St. Pancras Int. (+WCML +GWML)	750	4
Liverpool Street	1,500	2
Watford Junction	1,500	1
Reading	1,500	1
Woking	1,500	1
Ashford	750	1
Waterloo (+South West Trains)	1,500	2
Victoria	1,500	2
Fenchurch Street (Pitsea)	1,500	2
London Bridge (North Kent Line)	1,500	1
Crossrail Plus (North)	1,500	6
Crossrail Plus (South)	1,500	6
Stevenage (+ECML)	1,500	2
Cambridge	1,500	1
Ipswich	1,500	1
Brighton/Gatwick(+Southern)	1,500	1
On northern approach to airport via the tunnel		12
On southern approach to airport		22

Air-rail substitution is now added to the system. Services between the airport and the continent run on HS1 via the Knights Place chord with 1tph for Paris and 1tph for Brussels. UK air-rail substitution is provided by the ECCL/ECML or HS3 with 2tph via Stevenage or Cambridge. These services can be supplemented with direct continental services using through trains in due course. If we apply a daily demand profile to air-rail substitution of 9 hours peak and 9 hours at 75% peak with no service through the 6 night hours the 20mppa air-rail substitution equates to peak rates of 1,750 passengers per hour each way distributed on the following services, with interchange at the airport:-

Service	Train Capacity	tph
HS1 via Knights Place	750	2
ECCL (+ECML) or HS3	750	2

This results in the following peak demands:-

On northern approach to airport via the tunnel	14
On southern approach to airport	24

In due course urban growth in the east is assumed to require alternate trains on the Crossrail Plus orbital that bypass the airport, so that at peak demand there are an additional 6tph in each direction on the orbital between Shenfield and Gravesend.

Service	Train Capacity	tph
Crossrail Plus (North)	1,500	6
Crossrail Plus (South)	1,500	6

This results in a Crossrail Plus orbital service with 12tph in each direction and the following peak tph's:-

On northern approach to the tunnel	20
On southern approach to the airport	30

Finally there are the rail freight services of say 4tph through Metrotidal Tunnel. These can be directed to night time movements when peak airport capacities are reached on the southern approaches.

In summary 4-tracking of the Crossrail Plus orbital is not be required, except for when peak capacities are reached later in the century on the southern approach to the airport between Hoo Junction and the chord to the airport spur. For the western location of the airport this is only some 10 kilometres across the Hoo Peninsula, where the additional tracks can be accommodated easily without third party property impacts. Metrotidal Tunnel accommodates 20tph in each direction for which twin-tracks are sufficient, with freight running through the tunnel at night when peak capacities are reached late in the century.

This rail capacity review should be robust for the following reasons:-

- the peak runway capacity has been applied, which will allow over two decades of operating experience to be gathered to field emerging pinch points in the surface access system before they constrain demand.
- the contribution of a Sheppey Tunnel has not been taken into account
- the contributions of ferries on the Thames and Medway have not been taken into account
- 60% O&D traffic excluding air-rail substitution is a high percentage
- the actual percentage of rail use achieved is likely to fall below the maximum target of 80%

Road surface access capacity

Assessment of the road surface access capacity starts by assuming 60% O+D journeys of which only 60% use rail, the lowest percentage in the target range. The remaining 40% by road is distributed:-

- 34% car/taxi/limousine
- 6% bus and coach

The car/taxi/limousine mode generates an average of 1.8 passengers per vehicle, but most vehicles are empty in one direction, so for a peak airport capacity of 185mppa with 60% O+D traffic there are 103,000 road passengers per day generating 57,000 trips or some 3,200 trips per hour at peak times in each direction this being a high average as during the night hours surface access journeys are by road.

The bus and coach services are efficient and assuming an average of 40 passengers they generate a peak rate of some 10 vehicles per hour each way. The SERT and FASTRACK bus networks in South Essex and North Kent respectively would be linked and co-ordinated through Metrotidal Tunnels to provide an efficient service alongside other public and private, bus and coach operators.

The passenger traffic is assumed to spread equally north and south of the estuary resulting in 1,600 cars and 5 coaches passing through the tunnel each way during peak hours.

Airport employees are assumed to travel by the same mode shares:-

- 60% rail
- 34% car/taxi/limousine
- 6% bus and coach

The peak airport capacity of 185mppa generates 115,000 jobs on site and with 34% by car/taxi/limousine there will be some 1,600 vehicles per hour each way at peak times and 5 bus/coaches per hour at peak times each way. Combining airport passengers and employees we have:-

- 3,200 car/taxi/limousines per hour each way at peak times
- 10 bus/coaches per hour each way at peak times

Again the airport employees are assumed to spread equally north and south of the estuary resulting in the following peak rates for the combined passengers and employees travelling through the tunnel:-

- 3,200 car/taxi/limousines per hour each way at peak times
- 10 bus/coaches per hour each way at peak times

The airport manufacturing/logistics generates additional movement of goods and people between the airport and the outlying commercial and industrial zones that will require a separate assessment in due course though the distances are short and the additional loads on the two highways are likely to be modest.

While the Thames Reach Airport demand will clearly be a commercial benefit for Metrotidal Tunnel a key issue for the integration of tunnel and airport is that the airport demand should not throttle the independent agglomeration benefits provided by the tunnel. The above estimate indicates that during peak airport demand there will still be spare capacity on the Metrotidal Tunnel highways to provide wider agglomeration benefits for the Thames Estuary region and beyond.

This road capacity review is robust for the following reasons:-

- Given the advantages and frequency of the rail services the actual realised proportion of rail use is likely to be greater than 60%
- Current trends are moving away from using private cars for Park-and-Fly or Kiss-and-Fly
- The proportion of bus and coach access can easily be higher than 6%
- No allowance has been made for the higher percentage of road surface access during the night hours when cars/taxis/limousines and night buses and coaches will exceed rail use, as there is less surface access demand for rail through the night and less traffic on the roads.

Phased airport capacity and surface access

The airport opens with a minimum start-up capacity and is then developed in phases to peak capacity with the surface access matching the demands for each phase. It is useful to look at the opening capacity of the airport and the associated surface access. The Thames Reach Airport long runway configuration can open with two runways in the east, forming a conventional widely-spaced pair pending extension of the runways, or with the northern long runway, either option providing 15-20% more capacity than optimum use of the existing runways at Heathrow, as a result of the purpose-designed, new-build benefits and the additional hours of operation. This provides Thames Reach Airport with an opening flight capacity of up to 100mppa plus say 5mppa air-rail substitution, for a much lower start-up cost.

As before if we assume 60% O&D traffic and 80% surface access by rail, these deliberately being high estimates then the 98mppa, setting aside the air-rail substitution for now, results in some 64,000 passengers travelling each way on the rail connections per day and allowing for the reduced demand during night hours this resolves to some 3,600 passengers per hour each way at peak times. The assessment then runs as before resulting in half the compounded passenger and employee demands on the various services. However a key

question is whether half the demands can be served by less surface access infrastructure from the outset to reduce the start-up costs.

A minimum surface access provision would be Metrotidal Tunnel carrying the Crossrail-Plus orbital with the new high-speed link between Ebbsfleet and Hoo Junction via Thong but without the ECCL/ECML, Medway Valley Line or Regional Rail services.

The opening peak demand of 3,600 passengers per hour in each direction might then accommodated as follows:-

Service	%	Passengers per hour
St. Pancras International (+WCML +GWML)	40	1,440
Liverpool Street	15	540
Fenchurch Street	5	180
Victoria	5	180
Waterloo (+South West Trains)	10	360
London Bridge	5	180
Crossrail Plus (North)	10	360
Crossrail Plus (South)	10	360

Similarly there will be up to 3,600 airport commuters per hour at peak times mostly distributed on the Crossrail Plus services:-

Service	%	Passengers per hour
Crossrail Plus (North)	50	1,800
Crossrail Plus (South)	50	1,800

There will be small percentages of commuting from the Central London termini to the airport but there is spare capacity for counter-cyclical commuting on these lines at peak times.

The airport passenger and commuter start-up demands are now compounded and the required numbers of trains per hour (tph) is estimated by applying appropriate rolling stock to each service on each line:-

Service	Passengers per hour	Train Class	Capacity	tph
St. Pancras Int. (+WCML +GWML)	1,440	395	340	5
Liverpool Street via HS1	540	395	...340	2
Fenchurch Street via HS1	180	395	...340	1
Victoria	180	395	...340	1
Waterloo (+South West Trains)	360	395	...340	2
London Bridge	180	395	340	1
Crossrail Plus (North)	2,160	345	1,500	2
Crossrail Plus (South)	2,160	345	1,500	2
Total				16
On northern approach to airport				2
On southern approach to airport				14

Air-rail substitution is now added to the system. For the start-up opening capacity of 5mppa indirect services can be run from HS1 via Ebbsfleet using Class 395 train sets. The 5mppa air-rail substitution equates to peak rates of 450 passengers per hour each way distributed on the route between Ebbsfleet and Hoo Junction via Thong requiring 2tph Class 395 trains.

With Crossrail Plus opening a service with 6tph each way the capacity available for urban growth to the east is 4tph:-

Service	Passengers per hour	Train Class	Capacity	tph
Crossrail Plus (North)	6,000	345	1,500	4
Crossrail Plus (South)	6,000	345	1,500	4

In summary the airport start-up has the following services:-

Service	Passengers per hour	Train Class	Capacity	tph
St. Pancras Int. (+WCML +GWML)	1,440	395	340	5
Liverpool Street	540	395	...340	2
Fenchurch Street	180	395	...340	1
Victoria	180	395	...340	1
Waterloo (+South West Trains)	360	395	...340	2
London Bridge	180	395	340	1
Crossrail Plus (North)	2,160	345	1,500	6
Crossrail Plus (South)	2,160	345	1,500	6
Total				24
On northern approach to airport				6
On southern approach to airport				18

As Crossrail is already designed to provide a 6tph service at off-peak times on the eastern limbs it should be possible to use them for opening a the Crossrail Plus all-stops orbital service to the airport without any through-lines or other substantial works at the existing stations, except perhaps for separating the Southend Victoria services through Billericay.

There is scope to consolidate the airport express services on fewer Central London termini from the outset in order to reduce the start-up costs and provide a more frequent service from

the chosen express terminal for the first phase of the airport opening. Accordingly, with Metrotidal Tunnel funded independently, the aviation market only has to fund the following services for the start-up capacity:-

- St. Pancras International airport express services
- Waterloo International and/or Victoria airport express services
- Liverpool Street Station airport express services
- Ebbsfleet International air-rail substitution services via HS1

These all making use of the new high-speed chord from Northfleet Green via Claylane Wood and Thong to Hoo Junction.

6 FREIGHT AND MANUFACTURING LOGISTICS

The East Coast and Lincoln Continental Lines with HS1 open new GC gauge freight connections between the UK and Europe via Metrotidal Tunnel and Thames Reach Airport. With this new international freight connectivity there is scope for a major new strategic rail freight interchange (SRFI) in the Thames estuary region at Thamesport on the Isle of Grain or the London Gateway Port, accompanied by the development of a new network of international air-freight manufacturing/logistics sites each with their own freight sidings and facilities:-

- Hoo Junction
- Kingsnorth
- Thamesport and Isle of Grain
- London Gateway Port, the Port of Tilbury and Basildon via Metrotidal Tunnel
- Thames Reach Airport and Stansted Airport via Metrotidal Tunnel
- Queenborough, Sheerness, Ridham Dock and Sittingbourne (subject to a separate Metrotidal (Sheppey) Tunnel)

Metrotidal Tunnel allows freight to be redirected from existing shipping and highway routes to the international rail and air-freight networks of HS1 and Thames Reach Airport. Greater use is made of freight capacity through the Channel Tunnel, with direct connections between the East Coast Ports (Felixstowe, Harwich International, Bathside Bay, London Gateway, Sheerness, Tilbury, Thamesport,) and the industrial heart of Europe. There is considerable scope for reducing road freight and eliminating unnecessary mode changes by directing freight through Metrotidal Tunnel between the English ports, major distribution centres in the Thames Estuary and the European freight network. London Gateway can also be connected directly to Metrotidal Tunnel by the alternative A13 connection.

The new twin-track chord near Shenfield between the Crossrail Plus orbital and the Great Eastern Main Line opens another, shorter freight route from the Thames Estuary to the Haven Ports that can be upgrade to GC gauge in due course. This route was examined as part of the London to Ipswich rail study (LOIS) by Essex County Council and others.