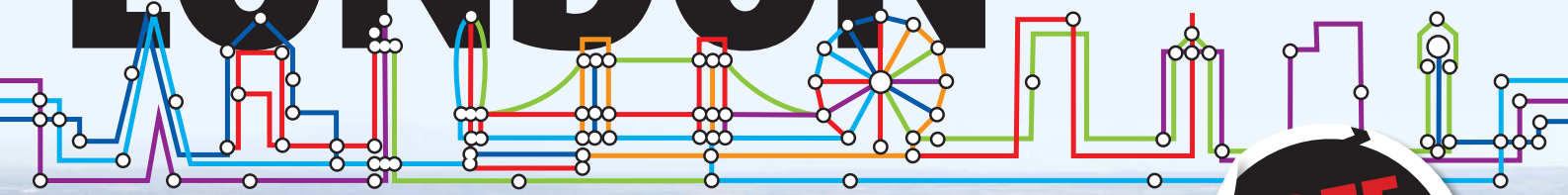


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LONDON SPECIAL



JACK BOSKETT/RAIL

Welcome

2017 will be as big a year as any for London's railways, and the pace of change must not slacken if they are to adequately cater for the capital's continuing economic and population growth.

We therefore begin this supplement by focusing on Transport for London's capacity-enhancing Deep Tube Upgrade Programme, and the 250 new trains it will need, for the capital's deep Tube lines, in a contract worth up to £2.5 billion.

The successful bidder is expected to be announced in the autumn, and Hitachi and Bombardier both describe to *RAIL*'s Richard Clinnick the benefits of their joint bid, and the considerable clout that the collaboration between these international manufacturers could bring to this exciting new project for London Underground.

Next we turn to the £14.8bn construction of Crossrail, now in the final preparation stage for the phased introduction of services from May. *RAIL* goes behind the hoardings at

Tottenham Court Road for a glimpse at the station fit-out, while also catching up with Matthew Steele who heads the Network Rail teams preparing the route's surface sections to the east and west of London.

London is also due to welcome an all-new railway on its Overground network at Barking Riverside, and also at Euston, which is the planned terminus of High Speed 2 from its initial phase in 2026.

HS2 construction is due to begin later this year, so Stefanie Browne looks at how the existing station could be redeveloped, and Richard Clinnick reports from Barking.

Of course, new or extended lines require new fleets of trains and the depots to handle them, so *RAIL* gives the final word to Taylor Woodrow, which demonstrates its extensive track record in bringing new and redeveloped maintenance and stabling facilities online.

PAUL STEPHEN
Assistant Features Editor, *RAIL*

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Managing Editor: Nigel Harris
Assistant Editor: Richard Clinnick
Contributing Writers: Paul Stephen, Stefanie Browne
Production Editor: Mike Wright
Art Editor: Charles Wrigley
Sub-Editor: Richard Hampson
Managing Director: Tim Lucas

ADVERTISING

Account Director: Julie Howard

Capitalising on pedigree

Bombardier's **PETER DOOLIN** and **MARTIN RENNOLDSON** explain to **RICHARD CLINNICK** why partnering with Hitachi Rail Europe to bid for London Underground's Deep Tube Upgrade Programme was a logical choice

Bombardier has a fine pedigree when it comes to London. An impressive number of train services operating into and within the city use trains built by Bombardier in Derby, supporting the assertion that investment in the capital also benefits the rest of the country. Chiltern, c2c, East Midlands Trains, Gatwick Express, Great Western Railway, Great Northern, Greater Anglia, Southern, Southeastern, Stansted Express, Thameslink and TfL all use trains manufactured by Bombardier.

Transport for London, in particular, is a key customer for Bombardier, which recently delivered the final S-Stock unit of a 192-train order for London Underground. Consisting of 1,403 cars, the delivery of the sub-surface line fleet, which operates on the Circle and District, Metropolitan and Hammersmith & City Lines, was one of the largest UK rolling

stock projects ever delivered and followed hot on the heels of the delivery of the new fleet of Victoria Line trains.

Both are achieving exceptional levels of reliability, with the Victoria Line trains now recording 100,000-plus miles between failures. Meanwhile, the 'S8s' of the sub-surface fleet have achieved 70,000 miles between failures, while (according to Bombardier) the 'S7s' have reached a peak of 200,000 miles.

This year the first Class 345s will enter traffic on the TfL Rail route, set to be the Elizabeth Line, heralding the launch of the brand new prestigious East-West London commuter service.

The development of the Aventra product platform, which formed the basis for Bombardier's offer for this train delivery programme, took several years and



Bombardier has delivered into traffic the first electric trains specifically for the Great Western Main Line. Class 387/1 Electrostars entered service between London Paddington and Hayes & Harlington last September, and these will be extended to Maidenhead in May before eventually running across the Thames Valley. JACK BOSKETT/RAIL.



London Overground has been transformational for many routes around the capital, and the three-car Class 378s first delivered by Bombardier in 2008 have had to be extended to five-car trains. On January 28, 10 378220 arrives at London Euston. JACK BOSKETT/RAIL.

£20 million of investment in product development, including use of virtual reality equipment to visualise and test the design with customers.

Peter Doolin, Bombardier Vice President, Project Management and Head of Elizabeth Line and London Underground Projects, believes that passenger and driver environments are significantly improved as a result. Explaining the approach to the train's evolution, he says: "We used an integrated team approach. For example, with regard to the interior, we sat down with the design consultants nominated by TfL - Barber and Osgerby - as well as our own internal industrial design house, our train functional design team, our manufacturing specialists and our maintenance team. When combined with our chosen suppliers, it ensured that we came up with a brilliant product."

Cross-functional team co-location has been key to the entire development of

Aventra. And having physically sat alongside the train system designers and all the support functions. Doolin has now moved his office to the production line.

He explains: "I was seated with the design teams initially, and the guys on the (manufacturing) floor are very surprised at how quick the process to build the first train has been.

"We are using considerable new technology in the design phase, with the virtual reality equipment proving to be really useful. It enabled us to create a design that was 'user friendly' to the manufacturing and maintenance teams as we worked concurrently with our supply chain."

So far, five Class 345s have been built for type testing and the first production line train is undergoing trials on the main line, even recently running into Liverpool Street station.

The trains, says Doolin, are "going well",

and this success is being reflected in further orders for Aventra. Contracts are in place with London Overground for 45 four-car Class 710s to enter traffic from next year, while 89 five-car and 22 ten-car electric multiple units are on order for Greater Anglia, with deliveries beginning in 2019.

“ The virtual reality equipment enabled us to create a design that was 'user friendly' to the manufacturing and maintenance teams.”

Peter Doolin, Vice President Project Management, Bombardier

And the company is looking to further capitalise on its reputation in London by bidding for the Deep Tube Upgrade Programme (DTUP, previously known as New Tube for London), this time working in a joint venture with Hitachi Rail Europe (HIRE).

DTUP requires 250 trains for the Piccadilly, Central, Bakerloo and Waterloo & City lines, with the first planned to enter traffic in 2023 on the Piccadilly Line. The new-generation trains and resignalling will enable a 60% increase in line capacity, to peak services of at least 33 trains per hour (tph) with the first capacity uplift in 2026-27. The new trains on the Bakerloo Line will create a 25% increase in line capacity and, with new signalling, enable a 27tph peak service by 2029. On the Central Line they will increase line capacity by 25% (to 33tph) by 2033. Finally, on the Waterloo & City Line there will be a 50% increase in line capacity - achieved through remodelling of the track layout →



► at Waterloo, a bigger fleet and new signalling to enable a 30tph peak service level by 2034.

Doolin says that the reason for joining forces with Hitachi was simple: "Hitachi builds very reliable trains in Japan and is also becoming a strong train manufacturer in the UK, so there is sound logic in our teaming up for this mega-project."

The presence of more than one UK facility certainly offers benefits to a major rolling stock delivery schedule. HRE has also highlighted the advantages of access to two facilities in the UK in terms of creating resilience to a joint programme on this scale, with both sites committing to consistency of product design and quality.

Bombardier Group Account Director Martin Rennoldson says: "I think partnering gives us several key strengths. There's added confidence because the risk is shared. Joining forces brings increased financing, and greater resilience and capability. And this will be crucial, because this project will necessitate the manufacture of a lot of trains in a demanding and significant programme."

"The requirement is for an innovative train. It's to have air-cooling, which will be a first for the deep Tube. It must be energy-efficient, regenerate electricity and carry more passengers than current trains. We have a strong pedigree in these areas."

"Another key aspect is the huge emphasis on reliability. We have invested in the Train Zero test facility at Derby, and HRE also have a demonstrable commitment to intensive reliability testing, so we feel the combination would be better than anything ever seen before."

A Victoria Line train arrives at King's Cross on February 2. The Bombardier-built trains on this line already operate a high-frequency service, and this will be extended to 36 trains per hour in the near future. JACK BOSKETT/RAIL.

Doolin explains the concept of Train Zero: "We took the principle from the aircraft industry, where advance testing of system integration is clearly crucial. Train Zero has been running for nearly two years and gives us a major advantage in pre-build system integration of the ever-more complex products. The investment was around £2m for the facility."

Train Zero effectively allows Bombardier to test the integration of each and every system before they are fitted to the train, well before the train physically exists, so that any conflicts can be eliminated at a much earlier stage. It is through this process that the company believes it can meet the increasing demands on performance that potential fleet buyers are now seeking.

The Class 345 Aventra trains are a perfect example of the advantages offered by Train Zero. They are fitted with highly complex signalling equipment. Conventional Automatic Warning System and Train Protection Warning System is installed, as well as European Rail Traffic Management System Level 2, for use on the Great Western Main Line to Heathrow.

The trains also have Communications Based Train Control for use in tunnels. This has involved many partners using the numerous items of test equipment and simulators to ensure the trains will work correctly 'out of the box'.

Says Doolin: "We are now seeing the benefit that can be gained by the investment

in Train Zero. It is a unique facility for UK train supply and it is critical in enabling the production of the highly reliable trains the customer's business model demands. We have also invested in excess of £15m in a brand new test facility in Derby which, combined with our on-site test track, further develops our in-built product reliability."

The Government appears keen for the UK to be prominent in any bid for new trains, with a view to supporting not only the train manufacturers, but also the supply chain. Similarly, Transport for London's policy is that any contract should not just benefit the capital, but also the rest of the country. This certainly applies to the Crossrail project, both in the construction of infrastructure, train manufacture, and all associated supply chains.

Investment in new rolling stock projects also has discernible knock-on benefits for the longer-term maintenance market.

For example, the Aventras for the Elizabeth Line will be based at Old Oak Common, a depot being built by Taylor Woodrow for Bombardier in west London, on the site of the former Great Western Railway, British Rail and (latterly) EWS facility.

"It is a huge, highly impressive, modern facility - some 30% of the energy needs will come from renewable sources," says Doolin. "There are currently over 300 people working on site during the construction phase."

He says one of the key innovative aspects of the Crossrail project is 'Responsible

Procurement,' explaining that this "is about recruitment and workforce training, and the need to feed that through to the supply chain; we need to support the small and medium-sized enterprises (SMEs). We ran the *Made in Britain* campaign, and have had working sessions with the Welsh Government to get their suppliers involved."

Doolin is clearly passionate about the subject, and his enthusiasm is palpable. "It's about providing opportunities for young people, and that is fantastic. We have engagement with schools, which is all about creating jobs and future careers."

"We have 250 suppliers around the Derby area and we are invested in them."

"We support equality and diversity. This is the first big rolling stock project to adopt responsible procurement and it has been so rewarding for the team to be able to work on this."

Old Oak Common is also at the forefront of job creation in London, he says.

"The project will have up to 50 apprentices there. Twenty are starting in Derby this year. Given the nature of our work, we hope they have a job for life if they want it."

Bombardier has been involved in delivering trains and building depots around London for years. And the experience has led to some interesting tales.

"I remember delivering the Overground

“The trains will be state of the art with a very open and welcoming passenger environment.”

**Peter Doolin,
Vice President Project Management,
Bombardier**

Class 378s," says Doolin. "The passenger ridership on these routes has hugely exceeded the original estimates. The new air-conditioned trains, supporting TfL's reinvigorated routes, generated massive new customer demand. We originally supplied three-car trains, which were extended to four-cars, and last year we supplied a further car to integrate as a five-car unit. They have transformed parts of London, and I am sure the Elizabeth Line will have the same effect."

He compares the impending entry into traffic of the new Aventras with that of the S-Stock.

"The same thing will happen. When we introduced the Sub-Surface Line (SSL) trains people would wait to travel on one of the new vehicles. The Elizabeth Line is a new route, and it will be very efficient and enjoyable to use. The trains will be state of the art with

a very open and welcoming passenger environment - they will certainly vastly improve the customer travel experience."

Doolin highlights that over the past five years, Bombardier has built 3,400 vehicles for various customers in and around London. "That is extensive experience, and we are very, very familiar with what is required."

Bombardier is also working for London Underground, installing Automatic Train Control (ATC) as part of the transformation of the Circle, District, Hammersmith & City and Metropolitan lines. This involves fitting S-Stock trains with Thales equipment, and when it's fully in use it will increase peak-hour capacity on the four lines by 33%.

Currently there are two prototype trains at Old Dalby test track undergoing trials, while other trains are being moved to London ready for testing. Doolin says: "We have three trains at any one time. It is quite an intensive programme and we are working with LU to ensure we do not affect the current high level of performance they are experiencing with the existing fleet. We have planned and taken a lot of the time to test the trains on the test track at Derby and then at Old Dalby."

"Bombardier is a provider of solutions to London Underground. We are unique in that we design, build and maintain trains in the UK, delivering services to our customers that last the whole lifespan of a project."

Add this considerable experience to a partnership with Hitachi, and this makes the combination a force to be reckoned with. ■



An S-Stock train arrives at Royal Oak on February 2, bound for Barking on the Hammersmith & City Line. The trains were delivered from 2009, and reliability on some sets has reached 200,000 miles per failure. They were the first London Underground trains to be fitted with air-conditioning. JACK BOSKETT/RAIL.

Best of both worlds



Hitachi and Bombardier are set to form a formidable alliance, but how will it work? Hitachi's **NICK HUGHES** and **BARRIE COTTAM** talk to **RICHARD CLINNICK**

London has always been important for Hitachi Rail Europe (HRE). It's where its first European rail office opened, where its first fleet served during the 2012 Olympic Games, and now where its global headquarters is based. This focus on the capital has been enhanced by its joint venture with Bombardier to bid for the Deep Tube Upgrade Programme (DTUP).

Hitachi, like its DTUP bid partner, boasts several fleets that are (either currently or in the near future) playing vital roles in transporting commuters to the capital. By the end of the decade, HRE will have provided almost 200 new trains, moving people into more than a third of London's major stations, including the important hubs of Paddington and King's Cross.

In addition to its flagship Javelin fleet, the next wave of Hitachi trains to start serving the capital will be the Intercity Express Programme (IEP) Class 800s for Great Western Railway, in the autumn. They will be followed next year by IEPs on Virgin Trains East Coast, and after that by a new fleet of AT300 bi-mode vehicles for Hull

Trains. With new, high-performance trains offering significantly increased capacity, the prospects for improved commuting into the capital from other parts of the UK are looking good.

Hitachi's first major breakthrough in the UK market came in the form of the prestigious contract to supply the Javelin Class 395 dual-mode high speed commuter trains, which were to become a symbol of the success of the London 2012 Olympics.

Delivered in 2009, with a preview service six months ahead of schedule, the 29 six-car trains operate at speeds of up to 140mph on the HS1 route to Ebbsfleet and Ashford International stations in Kent, as well as linking to Stratford International and St Pancras in central London. In addition to providing the fastest domestic service in the UK under the HS1 25kV AC overhead lines, the trains overcame the challenge of operating dual mode with 750V DC third rail.

HRE Sales Director Nick Hughes explains: "The Javelins were a complex design. They're dual voltage and run on old and new infrastructure, and the design had to

be spot-on. Working a test period into the delivery schedule was vital, and Hitachi's approach is not to over-commit, but to ensure that everything works prior to entry into service."

This is borne out by the results. Today the trains carry up to 40,000 people per day - 275,000 per week. Reliability is 99.7% availability for the morning start of service. During the 2012 Olympics, the fleet ran for 120,000 miles without a failure.

This service has also proved transformational along its route from central London to Kent, with Hughes highlighting the social impact that the trains' introduction has had. Reliability and speed of services from Kent into London has encouraged commuter confidence, reflected in the boost in house prices along the route.

"Ashford is now a mere 37 minutes commute to London via HS1, bringing huge economic benefits in the seven years the route has been open. It has encouraged growth and investment across Kent and helped power London's economy by bringing commuters more efficiently to their jobs in

A Southeastern Class 395 enters Stratford International on February 2. The order for 29 six-car dual-voltage 140mph electric multiple units was the first contract Hitachi Rail Europe won for rolling stock in the UK. JACK BOSKETT/RAIL.

to increasing capacity on the rail network, a key concern in a capital that is expanding at an exceptional rate. London's population grew at twice the rate of the UK as a whole between 2011 and 2015, and could reach almost ten million by 2025, according to official figures.

The Hitachi fleets to be delivered for Greater Western and East Coast routes will play their part in generating much needed additional capacity for passengers travelling from further afield in the UK. IEP trains have one-third more seats for passengers compared with existing trains, with up to 652 seats for every full-length train. The delivery of 93 new trains for Great Western Railway will also help to deliver up to 40% more capacity between the West Country and London during morning peak times. Hitachi is confident these new trains will have a significant impact in offering additional capacity, as well as improving comfort for passengers.

And while it doesn't involve the supply of trains, HRE's Traffic Management System will play a crucial role in increasing services on the £6.5 billion Thameslink project, with Hitachi systems controlling trains through the 'core' between Blackfriars and St Pancras International.

Hughes explains: "We will be introducing Tranista. It is a Japanese system. It will enable Thameslink to provide a significant increase in the number of trains through one of the busiest sections of track in the country. Teams of people in Japan are working on it, in collaboration with our UK project team."

Hughes says the system is scheduled to be operational by early 2018, with testing already under way.

"We are working closely with Network

Rail, Govia Thameslink Railway and Siemens," he says, adding that HRE is also part of the industry board collaborating on the Digital Railway.

"This technology offers not only an increase in the throughput of trains, but in the event of an issue can automatically configure routes for the best options, so that trains will continue to run," he says.

"We think this technology has huge potential for the entire national network. What excites me is the core capacity. Projects to improve it have been planned for years, but never been achieved. This is a high-profile project that has to be done right."

He adds that a demonstrator of the system has been installed in Network Rail offices.

Cottam says: "Getting people used to it is crucial. It's a real-time system, and operators aren't used to the level of functionality that this brings."

Its introduction, Hughes explains, positions HRE very closely to the Digital Railway through the Early Contractor Involvement programme.

"We are very much part of Network Rail's digital plans," he says. "David Waboso [NR's Group Digital Railway Managing Director] has engaged with us and the supply chain to identify what's needed. There will be a presentation at the end of March to the industry [on the future of railway signalling in the UK], and we'll be supporting that."

Hughes highlights that HRE's acquisition of Ansaldo STS enables it to offer a range of European Train Control System (ETCSs) that can be introduced in the UK.

"Part of Ansaldo STS is working on the communications-based train control (CBTC) for Glasgow Metro. It is a small system, but it uses very similar technology to London Underground equipment, plus it's proven and certified," he says.

So, why has Hitachi decided to join forces with Bombardier to bid for DTUP?

Hughes explains that both Bombardier and HRE had already pre-qualified for the contract to build the new deep Tube trains, →



Hitachi Rail Europe bi-mode 800001 stands at Peterborough during a test trip. The Class 800/801s will also enter traffic on the East Coast Main Line from next year, serving London King's Cross as part of the Intercity Express Programme introduction. ALEXANDER CROMARTY.

A member of Hitachi Rail Europe staff at work at Newton Aycliffe. The company is committed to recruiting staff from across the UK, including people new to the industry and apprentices. HITACHI.

but felt that they had very clear joint strengths. "Bombardier and Hitachi working together, and the opportunities that would bring, was a highly attractive proposition in terms of the technologies we could offer," he says.

Cottam adds: "This would work out well for both companies, with each of us playing to our strengths."

If successful, the project would involve the supply of up to 3,300 vehicles across the four lines. Says Hughes: "London Underground is an important global reference customer. From a supplier perspective, Hitachi has a significant presence in Tokyo, while Ansaldo [which the Japanese parent company bought in 2014], has a formidable record in mass transit. Put these together and add Bombardier's significant experience and it is a compelling combination."

Hughes says the company is also very excited by the impetus to the UK industrial



strategy that could emerge from the alliance. "We see it as making sense for the UK rolling stock market as a whole, supporting 4,000 jobs across both Newton Aycliffe in the North East and Derby in the Midlands

throughout the next decade. Then there is the supply chain. Both companies underpin a significant UK presence, and therefore this would see us engaging with firms up and down the country. The trains would be identical, and the customer would not be able to tell the difference between a train built in Derby or Newton Aycliffe.

"It's important to get the design right. The project is calling for the next-generation metro trains for London. That is what excites me."

Cottam adds: "The testing will be very, very thorough. The supplier rightly has to guarantee very high levels of reliability. Our offer aims to bring the Priestmanngoode [design consultant] vision to life."

He is referring to the initial concept design released by Transport for London, back in 2014. The brief was to combine Priestmanngoode's vision for the train with TfL's specification, thereby creating something that remained true to the heritage of London Underground's iconic design, while still delivering the requirements of a 21st century underground network.

This programme is different to other LU projects. It will be the first time deep Tube trains have had air-cooling, and the reliability required from the start is roughly the same as S-Stock trains are delivering now, seven years after they first entered traffic.

Says Cottam: "There is a particular feel to the train. As well as achieving a high level of reliability from day one, it must also live up to TfL's vision."

The deal is not just about trains, however. Infrastructure is just as key to the upgrade. Says Cottam: "You need to control the systems, and that is where Tokyo's experience comes into play. We have to see the opportunities to use technology to make people's travel experience better."

Describing Hitachi's commitment to the UK, Hughes explains: "We are investing significantly in supporting our products here.



Newton Aycliffe is a serious investment."

And the site is already yielding results. Currently, the IEP trains and the Class 385 trains for ScotRail are being built at the North East facility, but they will soon be joined by Hull Trains and TransPennine Express AT300 fleets.

Says Hughes: "The order book is full until the end of 2019. Also, we took on a 27½-year maintenance deal for IEP that has daily availability targets. To support this, we are building depots at Doncaster and Stoke Gifford, which will employ around 350 people. We are also upgrading facilities, such as at North Pole [the former Eurostar depot in west London]."

This was redeveloped by HRE between August 2012 and December 2014, with Volker Fitzpatrick as the principal contractor. Two new connections were created to link the depot to the Great Western Main Line.

Overall, HRE invested £46 million in the depot, which was last used by Eurostar in 2007. It currently employs around 30 people, and HRE's aim is to employ at least one additional apprentice per year once it is fully operational.

"The investment in this and other depots around the country reflects Hitachi's long-term approach to doing business," says

Passengers stream from a Class 395 Javelin at Stratford International on February 2. The Southeastern trains entered traffic in 2009, six months earlier than planned. They move thousands of commuters, reliably, into St Pancras International, operating on both HS1 infrastructure and the older third-rail network. JACK BOSKETT.

Hughes. "The Japanese way is to make an enduring commitment that will generate returns for the business in the long term, as well as benefit the communities they work in."

The approach to North Pole depot, in Ealing, is no different. Hitachi has refurbished its main shed, which is some 400 metres long with a six-track facility for light maintenance and cleaning. Its repair shed, which will be used to carry out major repairs, is approximately 200m long with four tracks.

North Pole also has a maintenance facility, wheel lathe, bogie drop, extensive storage and the capability to use mobile booth and filtration techniques to carry out paint repairs.

The upgrade to the depot and its modern equipment means that it can be the centre of maintenance for the Great Western IEP fleets in London. And being the first IEP depot to be properly established by Hitachi, it means that North Pole will act as what Hughes calls a "knowledge hub" for other depots maintaining the IEP fleets. He says there is a regular flow of staff visiting the depot, in

order to learn from North Pole's experience.

These depots are also creating a lot of opportunities for new staff. Hughes explains: "Hitachi is recruiting 900 new people to work in maintenance. We are also keen to recruit additional electricians and technicians. We're acutely aware that we need to invest in people. Long term projects, such as the 27½-year maintenance deal for IEP, gives job security."

Cottam adds: "There's a long-term requirement for maintenance over the life of a fleet, and to support these programmes you need an experienced and skilled workforce."

Hitachi is taking the view that it needs to encourage development of the next generation of engineers and rail workers. This is why it is supporting the Enjoyment to Employment programme with the London Transport Museum, a scheme that aims to turn childhood enthusiasm into adult achievement in the sector, with a view to addressing the industry skill shortage.

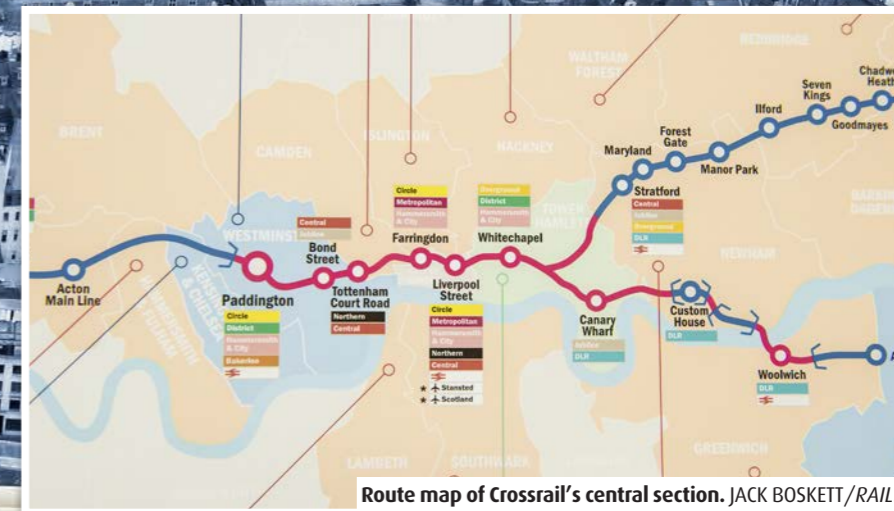
With both companies dedicated to ensuring Britain's rail heritage has a sustainable future, through their respective commitments to skills development, technology and the local supply chain, Hitachi and Bombardier have strong synergy in their business aspirations. Cottam concludes: "In joining forces for this bid our goal is to be able to give the customer the very best of both companies. That has to be an unbeatable offer." ■

“As well as achieving a high level of reliability from day one, it must also live up to TfL's vision.”

Barrie Cottam, Business Development Manager, HRE

From this summer, Hitachi Rail Europe's Intercity Express Programme trains will enter traffic on the Great Western Main Line from London Paddington. The multi-billion-pound deal for the trains has performance-related targets for each day, with HRE paid only if the exact number of trains specified are available. There are several IEP sets undergoing testing on the main line ahead of service, as is the HRE way. Carrying Great Western Railway colours, 800004 stands in London Paddington. IAIN C SCOTCHMAN.

West End Story



PAUL STEPHEN heads below London's busy Oxford Street to deliver a progress report on the construction of Crossrail's Tottenham Court Road station

All RAIL photography: PAUL STEPHEN. Artist's impressions supplied by Crossrail

An aerial view of Tottenham Court Road station, looking south towards Covent Garden and Leicester Square. Oxford Street runs from left to right, while Centre Point Tower dominates the middle of the picture. Tottenham Court Road Tube station is the triangular building in the highlighted area mid-picture, and is surrounded by the construction site for the Crossrail station's eastern ticket hall. Its western ticket hall, on Dean Street, is just out-of-shot to the right, and on the other side of Soho Square. CROSSRAIL.

Regular readers of *RAIL* will no doubt already be extremely familiar with the rapidly changing face of Tottenham Court Road station, as it continues to be readied for its first Crossrail services in December 2018. Of course, by that time the route's name will also have changed to the Elizabeth Line.

Such is the rapid pace of construction, which began with tunnelling in 2012, it is the third time in just 12 months that *RAIL* has been invited below ground there, having been shown around by apprentice technical engineer Zoe Conroy in February 2016 (*RAIL* 796), and then again by track engineer Juliet

Murray in May (*RAIL* 803).

For anyone who missed it, it is worth repeating the scale of transformation the area is currently undergoing, as more than £1 billion is invested in a new subterranean Crossrail station and rebuilding the existing London Underground station next door.

Tottenham Court Road will be one of Crossrail's busiest stations when complete, as an estimated 200,000 passengers a day either head for London's West End, or interchange with the Northern or Central lines.

The footprint of the new station stretches over 200 metres underground from a new plaza by Centre Point Tower on Charing

Cross Road, running westwards and immediately adjacent to Oxford Road, beneath Soho Square and on to Dean Street.

It will boast two new ticket halls - a western ticket hall on Dean Street, which has been designed to look subdued and with a cinematic ambience to reflect the local night-time economy, and an eastern ticket hall by Centre Point Tower at St Giles Circus, which will be bright and well-lit to provide contrast. It is also here that an integrated ticket hall will be opened to provide an interchange with Tottenham Court Road Tube station, which will be six times bigger than it is now.

RAIL was granted access to the entire site

on January 27 to take photographs from roughly the same position as a pre-selected range of artist's impressions. By presenting them here, side by side (see pages 54-55), it is easy to see how the station will look when it is handed over to Transport for London in summer 2018, but also how close Tottenham Court Road is now to completion.

Western Ticket Hall Site Manager Brian Keene was *RAIL*'s guide of the station fit-out, which is being led by contractor Laing O'Rourke. Only limited access was available to the station's two running tunnels as they are currently in the possession of ATC - a joint venture comprised of contractors from

Alstom, TSO and Costain.

ATC is completing the trackwork through the 26 miles of tunnels that form Crossrail's central section, and has accomplished over

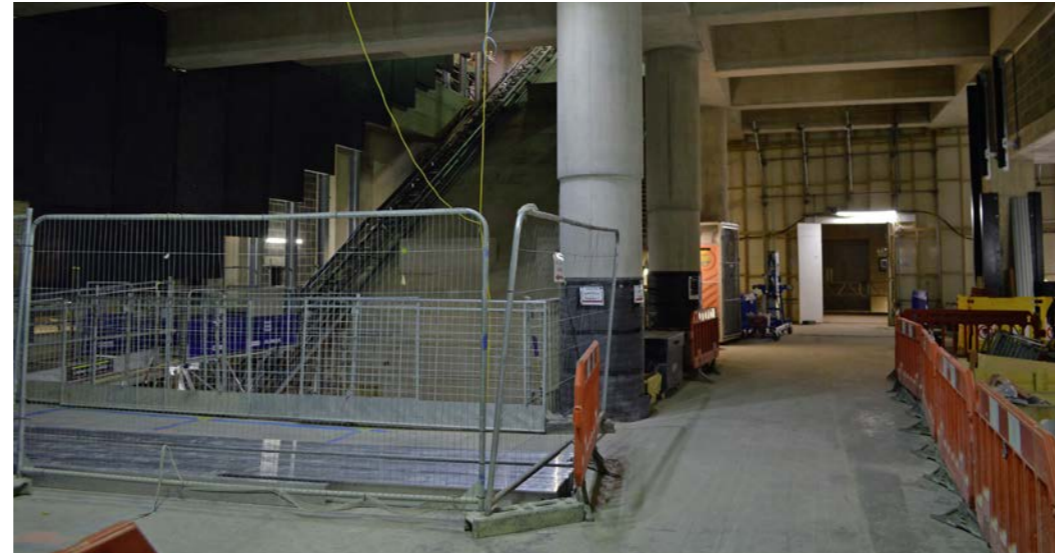
“ The western ticket hall on Dean Street has been designed to reflect the local night-time economy.”

70% of this task so far. It is also erecting the overhead conductor rails that will deliver power to Crossrail's new fleet of Avenra trains currently being built by Bombardier. Finally, it will install the signalling, before testing and then commissioning the line.

The station has been very deliberately future-proofed with passive provision made for the proposed arrival of Crossrail 2. Space has been left to retrofit extra escalators, and interconnecting passages have been built wider than needed. There is also extra room to extend the length of platforms in future, should Elizabeth Line services themselves needed to be lengthened. ▶



The eastbound platform, looking in the direction of Farringdon. The two platforms at Tottenham Court Road are 240m long and the only curved ones on Crossrail, which is necessary to avoid London Underground's Central and Northern lines. The wooden hoardings were dismantled shortly after *RAIL*'s visit on January 27 so that contractors from Knorr-Bremse could erect the platform doors, as shown in the artist's impression.



The platform-level concourse beneath the Dean Street entrance, this time turned 180 degrees from the vantage point in the image (bottom

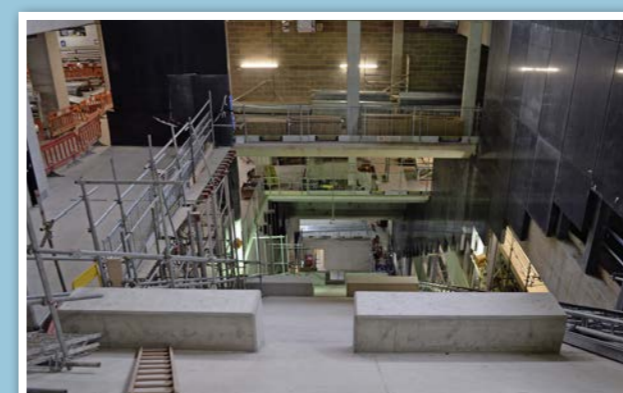
left). The colour scheme is already well established with dark-coloured cladding already in position on the walls in the escalator shaft.



The western station entrance and ticket hall at street level on Dean Street. The lights above the escalator shaft have already been installed.

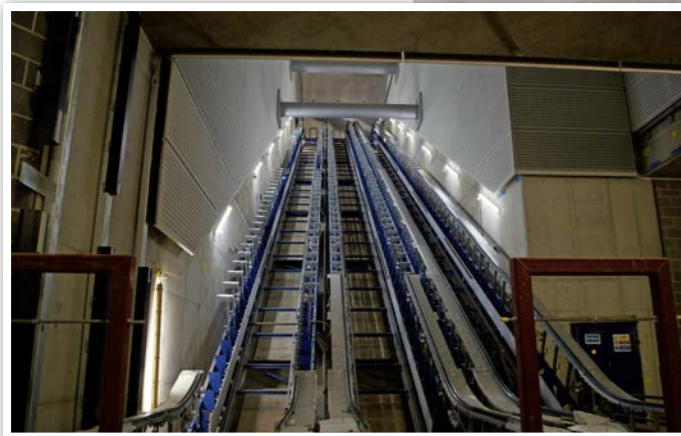


The platform-level concourse from the station's Dean Street entrance. The lights being installed here have been designed to resemble stage lights, acknowledging the nearby West End's many theatres.



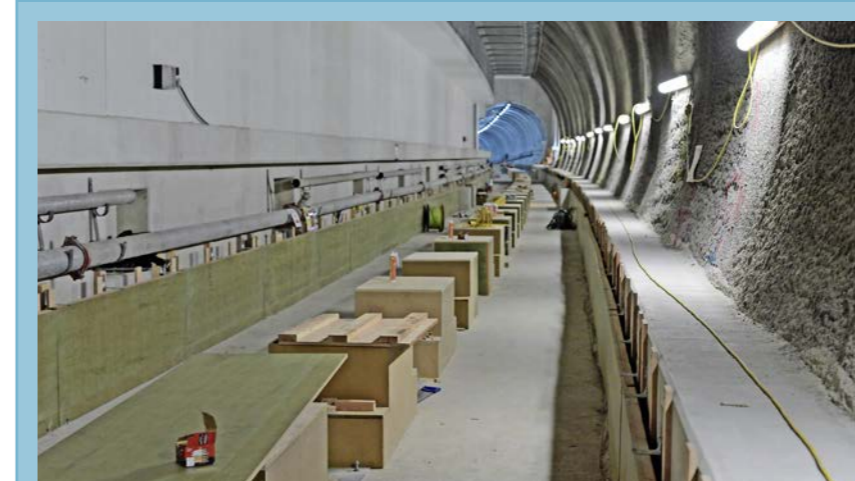
The escalators leading down from Dean Street (western) ticket hall. Above them, a sequence of screens will display digital artworks by Turner Prize-winner Douglas Gordon. Weighing 42 tonnes each and being 47m in length, they will be the second longest escalators on the TfL network, as only the escalators at Angel Tube station are longer.



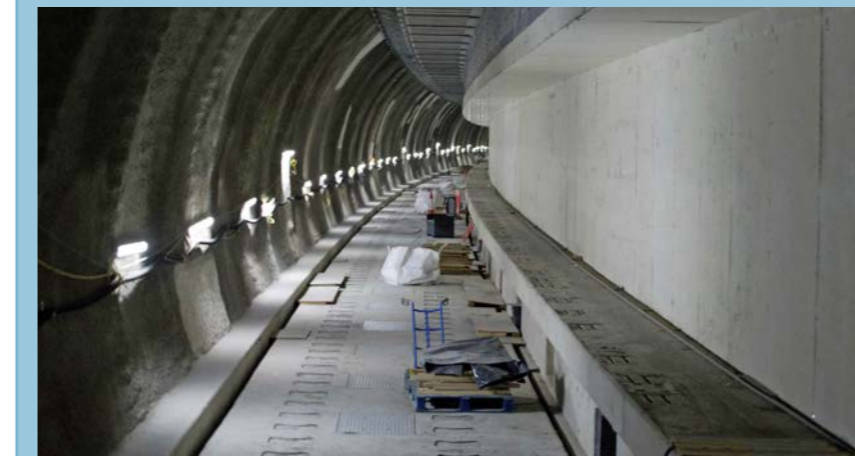


The view from the top and bottom of the escalators leading from St Giles Circus (eastern) ticket hall. Noise-cancelling cladding has already been fitted to the walls. All escalators at Tottenham Court Road are being installed by Otis, and the lifts by Kone.

“ Space has been left to retrofit extra escalators, and interconnecting passages have been built wider than needed.”



Before and after the concrete pour that formed the station's floating slab track. These images are taken from opposite ends of the eastbound platform at Tottenham Court Road, with the first shot captured during RAIL's last visit in June 2016. The wooden boxes mark where hydraulic jacks were placed to lift the slabs into position once they had set. 1.97km of floating slab track is being laid between here and Bond Street to reduce vibration, due to the proliferation of hotels, theatres, recording studios and editing suites.



SUPPLIER CASE STUDY - FUJITSU



In order to successfully carry out the physical construction of Crossrail's central section, Crossrail Ltd had to align itself with a number of tier

one information technology partners, including Fujitsu.

Crossrail Ltd outsourced its entire IT infrastructure, including desktop devices, data centre services and helpdesk support, and so Fujitsu was appointed to manage other IT suppliers and ensure the project was getting value for money.

Its teams of engineers were tasked with providing data capture and maximum availability of mission-critical information and IT support in a constantly changing environment, while it was also essential that construction workers would always be able to access a vast repository of construction plans and data on the move, underground and at any time of day.

Fujitsu demonstrated its commitment to helping Crossrail achieve its ambition to leave a skills legacy, by providing sponsorship and other support for the UK Tunnelling and Underground Construction Academy (TUCA) opened in September 2011 at Aldersbrook, East London.

Fujitsu's Client Managing Director for Transport Russell Goodenough (pictured) now thinks that much of the best practice that emerged from Crossrail can, and should, be transferred to other major infrastructure projects, such as the forthcoming construction of High Speed 2, which is set to receive Royal Assent imminently and begin later this year.

He tells RAIL: "We would like to mirror lots of pieces of Crossrail for HS2, such as the IT system we provided for its training academy. It shows our commitment to the skills agenda and the redevelopment of London's East End, and is a shining example of what an IT company can do for the wider rail industry."

"Crossrail has an awful lot of good practices that HS2 can only benefit from, as the next generation and progression of digital technologies. The IT industry has learned a lot from Crossrail, the London Underground and the Olympics (in 2012) about building at speed and giving surety of delivering critical IT infrastructure."



Tottenham Court Road station's western entrance on Dean Street, looking south from the road's junction with Oxford Street. The artist's impression shows the view from the opposite direction, looking north and back towards the location of the photographer.



Crossing the line

Network Rail's **MATTHEW STEELE** describes to **PAUL STEPHEN** how he and his team pulled off a few Christmas miracles of their own

2017 started well for Network Rail in its delivery of Crossrail's surface sections, which bookend the central tunnelled portion by stretching east alongside the Great Eastern Main Line and west along the Great Western Main Line.

That's because during ten days of blockades beginning on December 24 2016, more than 4,000 NR workers and subcontractors completed £45 million-worth of engineering in outer London, Berkshire and Essex.

The surface works are now 80% complete, to facilitate the phased introduction of services across the Crossrail route, which starts with Shenfield-Liverpool Street in May. The entire route will be fully open by December 2019, when services will run all the way through to Heathrow and Reading at its western end.

Starting with the western section, there was a significant concentration of work at Paddington station itself, as NR is not only upgrading the Great Western Main Line to Reading to accommodate Crossrail services, but also for the introduction of a new Intercity Express Programme fleet in July.

Infrastructure was also needed to enable the introduction, on January 1, of new Class 387 electric multiple units operated by Great Western Railway between Paddington and Hayes & Harlington.

During the Christmas blockade all GWR services were forced to terminate at Ealing Broadway, while the Heathrow Express was suspended to allow NR to put in overhead line equipment (OLE) above Platforms 1 and 2, and lengthen Platforms 12 and 13.

Sections of Paddington's main footbridge had to be raised to provide added clearance for OLE equipment, and a road bridge had to be strengthened above the station throat.

"To put wires above Platforms 1 and 2, a very old footbridge had to be removed, redesigned to allow better clearances and put back in exactly the same position," explains Matthew Steele, Crossrail Programme Director at NR.

"On Christmas Eve, [Secretary of State for Transport] Chris Grayling came out to Paddington to see the crane lift out the old footbridge and then put it back, which you could obviously never do with trains running.

"We also worked on a road bridge where we had to cut sections out and put new ones in, which is quite intrusive and, again, it can't be done with trains running. This was the most disruptive time for passengers, when we had to shut Paddington for six days and

turn everything around at Ealing Broadway. Once it re-opened, we needed the GWML relief lines for a further four days, giving us the ten-day blockade."

Moving slightly further west, and a ladder-type junction and requisite signalling was installed at Old Oak Common. This was to connect the Crossrail lines with the new depot and sidings that have been built there to stable and maintain Crossrail's Bombardier fleet of Aventras.

Then at Acton, a new diveunder was fully commissioned following a four-year construction sequence to provide grade separation between the Crossrail lines and the junction between London's largest aggregates yard and the GWML. Building the diveunder required the excavation of 48,000 tonnes of spoil, while the aggregates yard had to be moved approximately 20 metres to the north, track by track, in order to create sufficient space.

Next, at Hayes & Harlington, a junction was remodelled in order to connect a new eight-car bay platform that now accommodates GWR's new half-hourly Class 387 EMU services to Paddington.

Further grade separation has been provided at Stockley, where the final stages were completed over Christmas to bring into use a flyover at Heathrow Junction. Then it was the turn of Maidenhead, where another significant concentration of engineering took place.

"The biggest site for us on Crossrail west was at Maidenhead," adds Steele. "We put in 11 sets of new points and resignalled it ready for most of the Crossrail services that will eventually head this way, and will turn there. Some will go through to Reading, but not many, so there's a big turnback facility there, a new layout and new sidings."

The final package of work delivered to the west was GWML West Outer Electrification

PRINCIPAL CONTRACTORS

Crossrail East
Costain
Alstom

Crossrail West
Carillion
Balfour Beatty
Alstom
Taylor Woodrow



Overhead line adjustment work takes place near Shenfield. These are some of the 4,400 workers deployed by Network Rail to work on Crossrail's eastern and western surface sections during a ten-day blockade in December 2016. CROSSRAIL.

from Heathrow Junction to Maidenhead. The final wires were erected on Christmas Day ready for energisation during the first half of this year.

Meanwhile, on Crossrail's eastern surface section, engineering was completed at 13 different locations on the Great Eastern Main Line, including gauging work ahead of the first TfL-run services, beginning in May. The Christmas work programme also kicked off a series of rolling blockades that take place until May, and which has resulted in rail replacement bus services running between Liverpool Street and Shenfield at weekends.

“It will be a completely modern, reliable route that will handle a much higher frequency of trains.”

Matthew Steele,
Crossrail Programme Director, NR



JACK BOSKETT/RAIL



Steele adds: "Infrastructure work took place near the tunnel portal at Pudding Mill Lane, which is now ready for connection, while our other really big site was at Shenfield. Eleven new sets of switches and crossings went in and overhead line adjustments were made. This also marks the start of a small series of blockades until May, while we put the final layout in there ready for the start of Crossrail."

"We've shut two of the lines between Brentwood and Shenfield during some weekdays, but we need access to all the main lines at weekends to bring in the cranes and engineers' trains so that key infrastructure work can continue."

"Some of these jobs are things the railway has needed for years. The GEML has never been remodelled, and the signalling is old, so we are completely resignalling it and putting in new OLE. It will be a completely modern, reliable route that will handle a much higher frequency of trains."

With 4,400 people working on sections of track also being used by 250 machines plus 74 engineering trains bringing everything in from ballast to track panels, the need for robust safety protocols over Christmas was paramount.

And with so many resources deployed on so many projects and over such a short space of time, the scope for things to go wrong was considerable. Steele also needed the ability to recover the overall timetable in the likely event that individual pieces of work overran, in order to avoid a ripple effect and a delay in reopening the railway.

Steele says his engineering teams rehearsed this scenario for six months prior to the blockade, while their experience came to the fore to secure a safe and punctual handover of the line.

Meanwhile, Ealing Broadway became the GWML's temporary terminus during the closure of Paddington. Carefully formulated procedures had been put in place there to

avoid any repeat of the severe overcrowding that occurred at Finsbury Park station in December 2014, after engineering overruns at King's Cross resulted in all East Coast Main Line services terminating at the small suburban station.

"In terms of how we ran the work, we used control rooms. On the west we had a



Aerial views of Acton dive-under (above) and Stockley flyover (below). Both have now been fully commissioned. CROSSRAIL.



top level control room that fed through to one at Maidenhead, one at Stockley and one at Old Oak Common. They each had to formally report every six hours what they had achieved and what issues they'd had, so we could make sure they were on track.

"We also made contingency plans, and focused primarily on Ealing Broadway,

where we were turning HST sets. That station isn't designed for that, so we worked very closely with GWR to make sure we were bringing sets in and out as quickly as possible, and managing passenger flows through the station. We took the time to learn from Finsbury Park, and planned what we'd do to collectively respond if something happened. This included, for example, turning trains around at Reading instead, where there is more room to bring in buses and taxis and look after people.

"As it happened the railway was reliable

throughout. We'd put maintenance teams in strategic locations, so if there were problems they could fix them quickly."

He adds: "Because they've been doing it for four years, this team has learned how to deal with problems safely and effectively. "Things do go wrong, but our sub-contractors and our own teams deal with them. They're highly trained and know what to do, but we have contingency plans if there's a problem."

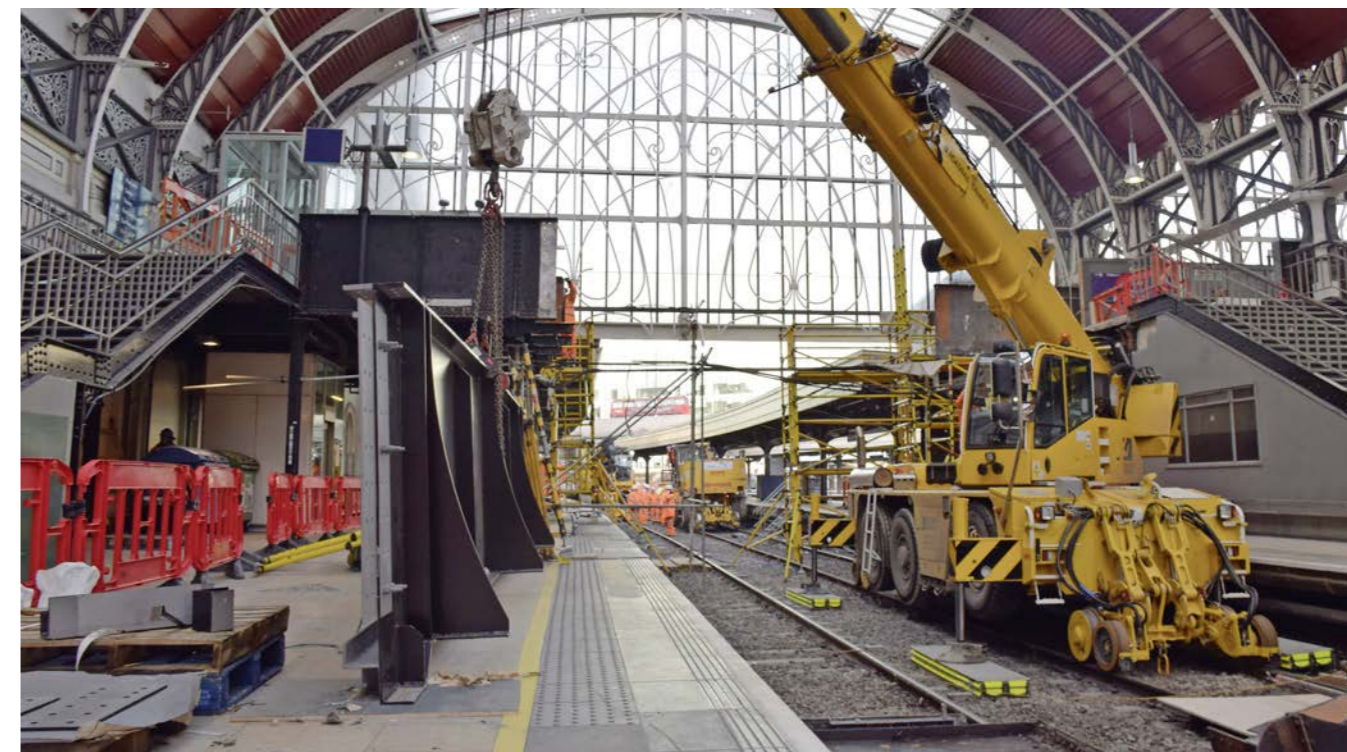
More blockades are planned for Easter and next Christmas, though on a much

smaller scale. Shenfield station will be handed over in May, when the first Crossrail services start, while work, including platform lengthening, will continue at other stations along the GEML.

With all the major infrastructure works now completed to the west, Steele says the focus will shift to making stations ready to accept Crossrail services, and the energisation of the OLE between Heathrow Junction and Maidenhead in May. Once this is completed, GWR's Class 387 EMU services from Paddington can be extended from Hayes & Harlington to Maidenhead.

Finishing works and commissioning is also required at both Old Oak Common and Pudding Mill Lane. ■

A rail-mounted Kirow crane was brought in during December 2016 to raise the footbridge above Paddington's platforms 1 and 2. Five of the seven Kirow cranes in the UK were used on the Crossrail programme during the last Christmas engineering blockade. CROSSRAIL.



Down by the riverside



DB Cargo 60054 passes Renwick Road, near Ripple Lane, on November 25 2015, with the 1112 Tilbury-Margam steel train. From here, the proposed 0.9-mile new railway to Barking Riverside would be constructed. ANTONY GUPPY.

Will TfL be able to bring its 'Midas touch' to the new Barking Riverside development? **RICHARD CLINNICK** looks at the continuing success story

London's Overground network is a success story for the capital that has transformed the fortunes of the areas of the city it serves.

In 2007, Transport for London took over the Silverlink routes around the city that relied upon 30-year-old electric multiple units (EMUs) and 20-year-old diesel multiple units (DMUs). Both fleets had seen better days, and they served routes that were down at heel.

It's hard to imagine, but the North London Line was proposed for closure by Beeching in 1963, and although that was saved, following a campaign, Grant Aid was removed in the 1980s. The railway did manage to keep open some intermediate stations, but passenger numbers remained low.

Its reputation changed in the late 2000s when TfL took over management of the line. New trains replaced old units, first

the EMUs, then the DMUs. Stations were re-staffed and before long passenger numbers rocketed. This was replicated on other routes; the demand was so high that the Bombardier-built Class 378s had to be upgraded from three-car to five-car trains.

The vision of a London Orbital railway was first presented in 2005, during a dark period for the UK's railways. Parts of what are now the LO network were, at the time, part of either the national network (in terms of being run by other operators), such as parts

“ Without the railway, the full potential of Barking Riverside will not be achieved.”

of what is now the South London Line, or the London Underground system (the East London Line). Defunct parts of the capital's railway network were later reopened (the line to Broad Street as far as Shoreditch) to match demand, as TfL set about transforming the capital's railway network.

It's been a success. Since TfL took over the management of London's railways nearly ten years ago, passenger numbers have risen by some 400%. Sixty-five new trains have been delivered, and already one of the two fleets (eight two-car Class 172/0s) is to be replaced by four-car trains, after TfL ordered 45 Class 710 Aventras from Bombardier, as it seeks to transform the fortunes of routes it took over running from Abellio Greater Anglia in 2015.

It is these new trains, due in traffic next year, that will prove key to TfL's latest plans.

Already there have been extensions to the system via the East and South London Lines,

and now plans are in place for another extension, which could be running in four years' time, subject to various approvals.

Transport for London wants LO to run to Barking Riverside. To do this, a new railway needs to be built to allow LO trains terminating at Barking to be extended to the new development next to the Thames.

The extension, says TfL, forms part of its vision of "creating better rail services in London to meet the needs of the city's rapidly growing population, and to support new jobs, homes and economic growth."

A public inquiry has already been held, while three separate consultations have been completed. It is expected that a Transport and Works Act Order (TWAO) application submitted in March 2016 will be approved by the Secretary of State for Transport later this year.

The 2½-mile extension is designed to

WHAT IS BARKING RIVERSIDE?

According to TfL, it is part of the London Riverside Opportunity Area. Two years ago, the Greater London Authority (GLA) adopted an Opportunity Area Planning Framework (OAPF) for the London Riverside area. This set out how more than 26,000 new homes and 16,000 new jobs would be delivered to the city. It is a new joint venture between the GLA (49%) and London & Quadrant New Homes (51%). The collaborative project was reworked following the sale of former partner Bellway Homes' shares to L&Q.

Originally, the plan was to extend the Docklands Light Railway (DLR) from Gallions Reach to Dagenham Dock via Barking Riverside. DLR consulted stakeholders a decade ago regarding the possible route options, but costs of £700 million were deemed unaffordable, and the then-Mayor of London Boris Johnson dismissed the proposal in 2009.

Undeterred, TfL explored other options to serve the planned development. Extending LO trains from Barking to a new terminal seemed the best solution, so a new plan was formed.

In December 2016, TfL announced that three companies had been shortlisted to build the extension - Balfour Beatty, Carillion plc and a VolkerFitzpatrick-Morgan Sindall joint venture.

At the announcement of the shortlist, Jonathan Fox, TfL's Director of London Rail said: "The Barking Riverside extension is key to regenerating this part of East London, helping to support up to 10,800 new homes, along with new jobs and improved facilities for the local community. The London Overground network has helped regenerate other parts of London by providing a frequent, reliable and high-standard rail service, and this rail extension will help Barking Riverside to grow and develop."

serve a new station at Barking Riverside, in the heart of a large development that will transform this part of East London.

The extension includes 0.9 miles of new railway. It will serve what TfL claims is the largest housing development in East London, where planning permission is in place for the construction of up to 10,800 new homes, subject to various conditions relating to the railway.

Additionally, retail outlets and healthcare, community and leisure facilities will be built, and TfL says that without the railway, the full potential of Barking Riverside will not be achieved.

As part of the conditions of the application for the new homes, no more than 1,500 can be built before a TWAO is granted, and no

The shortlist was announced after TfL had placed a notice with the Official Journal of the European Union (OJEU) last July.

Funding is already in place. The scheme will cost £263m, of which £172m is being provided by the developers of Barking Riverside, a joint venture between the GLA and London & Quadrant. The remaining £91m will come from TfL.

This model of third-party funding is something that Network Rail is investigating as it looks to get the best value for other possible extensions. However, the concept is not new to the capital. Indeed, the £14.9 billion Crossrail project is partly funded in this manner, with the City paying a percentage of the construction costs, justified by the benefits it will reap from the new railway.

The extension will connect with the Gospel Oak-Barking (GOBLIN) line, which is being electrified ahead of the introduction of new Class 710 Aventras from next year. GOBLIN links with the NLL, creating onward connections across the city. This route is already busy, carrying commuters and leisure travellers throughout the day, and the addition of Barking Riverside will likely ensure that the new four-car '710s' will remain well patronised.

With the TWAO expected to be approved this year, it is hoped construction will begin very soon after, with the goal of trains serving Barking Riverside by 2021.

There are already calls for another extension to Thamesmead, in the east of the city, in the hope that London Overground's magic can work there, too. The emphasis on getting LO's involvement in this massive development is a testament to its success.

more than 4,000 are permitted before the railway opens.

Operationally, the extension would be capable of accommodating four trains per hour in each direction. They would run along the existing Tilbury Loop, sharing the tracks with c2c trains. After passing under the existing Renwick Road bridge, they would turn onto the new infrastructure, heading south to a new station in the middle of the new development.

The extension would also provide a transport link to Barking, creating an onward connection to the employment powerhouses in Central London, the Isle of Dogs and Stratford. Connections would be possible at Barking for the Hammersmith & City LU line and c2c into Fenchurch Street. ■

Assessing connectivity in the capital

If you live in a busy city, car ownership becomes a less and less attractive option, particularly in places like London where the parking charges are high, there is a congestion zone and traffic is often chaotic. So public transport is essential and, more than that, effective connectivity.

That word, 'connectivity', does not just describe transport infrastructure being available. It also encompasses how well the places are linked together; how frequent and efficient buses and trains are, for example.

In the capital, Transport for London measures connectivity across the city, with specific aims:

- To identify places that may benefit from transport improvements;
- To understand the likely impacts of plans for new routes, stations or roads;
- To identify the most suitable locations for medical and other services, so that people can reach them easily;
- To understand what parts of London are suitable for developing more houses and offices;
- To recommend whether different locations need more or less car parking.

But how, exactly, is connectivity measured in a meaningful way?

For a start, TfL assesses not just what connections are like now, but what they will be like in the future under different

STEFANIE BROWNE explains how Transport for London calculates its figures when mapping out the future of London's public transport network

scenarios, such as with an increased population and an improved transport network.

Three different types of assessment are used. The first is PTAL (Public Transport Access Level), which essentially rates a location based on its proximity to public transport and also how frequent services are. The second is travel time mapping. This presents, in a graphical format, how long it will take to travel from a particular place to another, or how far it is possible to travel from the location in a given amount of time.

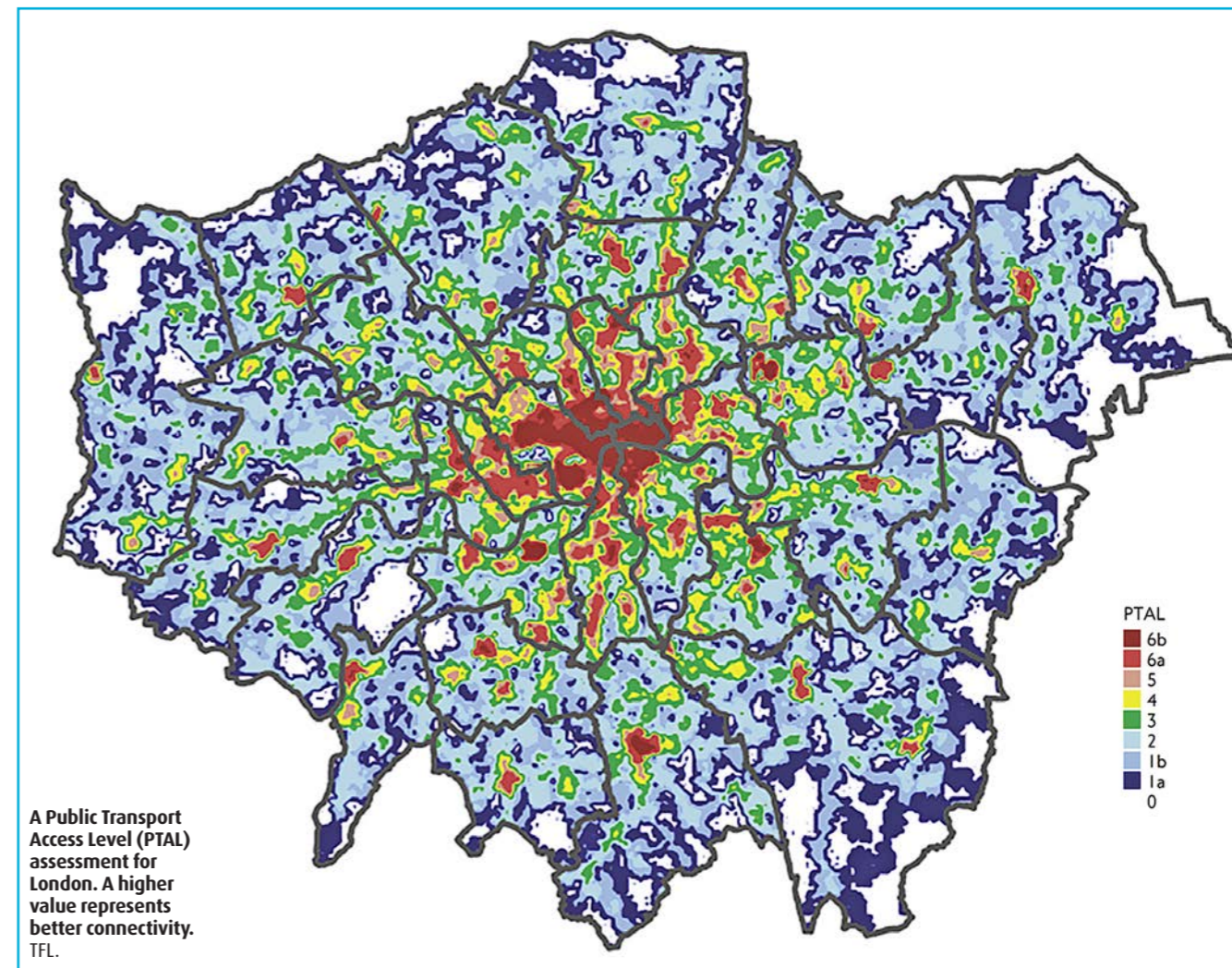
TfL assesses not just what connections are like now, but what they'll be like in the future under different scenarios.

The last type is a catchment analysis, which describes how many workplaces, or different types of services, are available within a certain travel time from a chosen location.

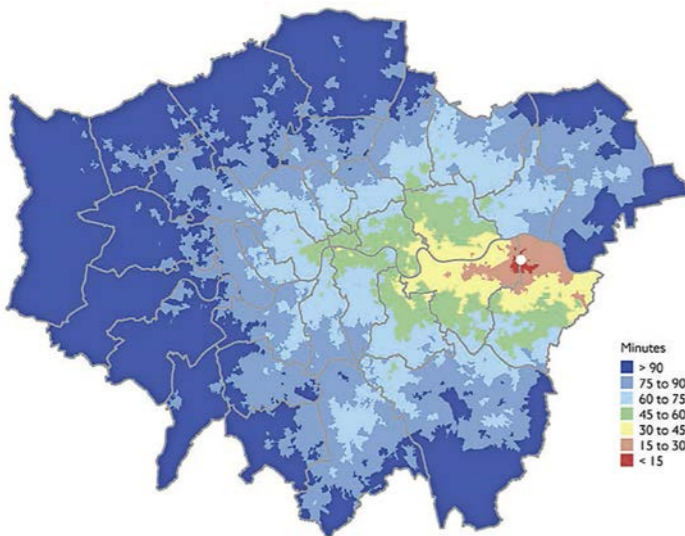
PTAL is essentially a scoring system. The higher the value a place is given, the better its connectivity, and vice versa, ranging from zero to six. So what factors can give a location a higher PTAL score? It could be that it is only a short walk from the nearest stations or bus stops; short waiting times for transport at those places; or major rail stations nearby.

What PTAL does not take into account is the destinations that can be reached, or negative factors such as overcrowding.

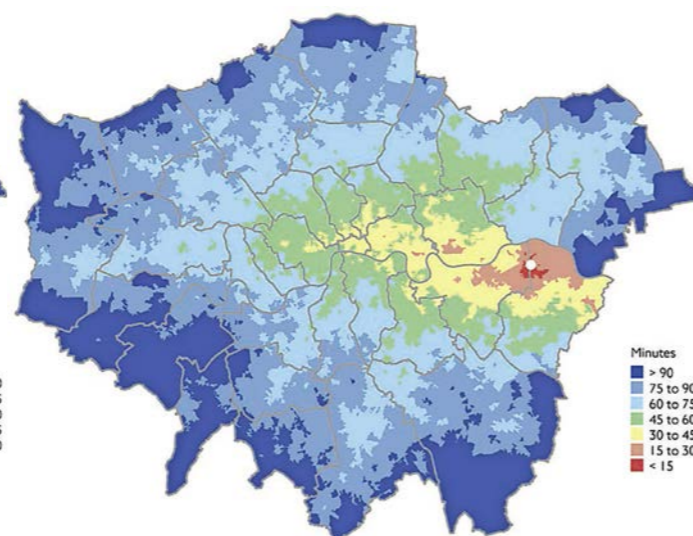
This information is only useful if it goes on to mean something in reality and, for London planners, PTAL is a key tool. The capital has an overall strategic plan (known as the London Plan) which sets out economic, social and environmental goals up to 2031. This plan uses PTAL as a key factor in determining the desire for housing in different parts of London, based on the theory that places with good public



A Public Transport Access Level (PTAL) assessment for London. A higher value represents better connectivity.
TfL.



Travel times by public transport to Abbey Wood without Crossrail. TfL.



Travel times by public transport to Abbey Wood with Crossrail. TfL.

transport are more suitable for development. It is also used in the Plan to work out how much parking is needed for residential areas. The rationale here is that the best way to encourage people to use public transport is to provide fewer parking spaces in areas where public transport is good. Those areas that are less well-connected by public transport 'enjoy' more parking.

PTAL is only one way of measuring connectivity though, and alone it cannot provide a full picture of an area's connections. Travel time mapping is an additional method that assesses how long it takes to travel between one particular place and all other places. This information is then presented using a range of colours.

A simplified map of London's streets and public transport is split into a few thousand zones, representing all the places that people travel to and from.

Each individual zone may contain a few hundred houses and buildings (smaller zones are used for more densely populated areas). It is then estimated what routes people are likely to take when travelling between the zones, whether it be by car or public transport. An estimate of the travel time can then be calculated.

Travel time mapping is used in a similar way to PTAL, to describe a level of connectivity in an area where transport improvements are being considered. For example, it is a useful method for understanding the impact that Crossrail could have on travel times (see diagrams).

The final type of assessment used is catchment analysis. This essentially assesses the area that is influenced by the level of

connectivity in a particular place. So if a location provides a service, such as a school, hospital or shop, then most of its students, patients and customers will come from within the 'catchment area'. The idea behind this is that the better connected a place is, the larger its catchment area will be. This is calculated by plotting destinations that can be reached by public transport from a particular location, and within a certain length of time.

It is then possible to see how the area changes when you introduce new transport routes or stations, for example. It is also a useful tool to help businesses identify possible new premises. It could even be used to calculate how many jobs are available within a 60-minute commute from a particular house.

The three methods allow for a complete picture to be created of how well any location is connected, based on proximity to transport, travel times to other locations and what locations can be reached within a specified time. This kind of information is critical when it comes to planning transport investment in London and understanding the positive effects it could have on local areas.

HOW CAN I USE THIS INFORMATION?

Anyone can access the connectivity planning tools on the Transport for London website through WebCAT. You put an address or co-ordinates into the calculator and a bespoke map will appear. You can even see how the location is likely to have changed in 2021, or even 2031, based on estimates.

WebCAT is used by professional planners and is frequently updated with new features to make it more useful. Visit <http://bit.ly/TfLWebCat>

More than just a station...

Whoever HS2 Ltd picks to transform Euston station will face some big expectations, writes **STEFANIE BROWNE**

Constructing a new railway has less to do with track and trains, in the planning phase, than it does about the reasons for the new line and the knock-on effects it could have on the areas in its vicinity. The knowledge that new infrastructure could have a transformative appeal to local communities can be the difference between a good idea and a brilliant one.

And nothing is predicted to have quite such a transformative effect on Britain as HS2. Whatever your opinion of the project, in many quarters communities and businesses are already preparing for anticipated prosperity.

At HS2's planned terminus in Euston, redevelopment of the station and its surrounding area is one of the biggest development opportunities in central London. The current station is one of the busiest in the capital, with more than 70 million people using it every year (40 million to travel and a further 30 million who shop, eat or board the Underground there).

In early February, HS2 Ltd began

looking at options for appointing a Master Development Partner (MDP) for the project of redeveloping the station and its surrounding area. Though a formal procurement process is not intended to begin until the spring, it provides an opportunity for the development community to offer their views. But what is the vision for Euston so far? What do they intend to create?

HS2 Ltd explains: "We want to create a Euston that provides a great experience for the community, travellers, businesses and

“ Our aim is to generate economic development (including new jobs and homes) above and around the station.”

HS2 Ltd



An artist's impression of Euston's southern entrance. HS2 LTD.

visitors. Our aim is to generate economic development (including new jobs and homes) above and around the station and throughout the wider area, as well as to connect people and places across national and high-speed rail networks, London Underground and other surface transport."

That sounds like a plan for much more than just a modern updated station.

Situated in the heart of Camden, Euston

has not been a popular choice of terminus for everyone and the local council has been in heavy opposition from the start (see panel, page 69), making it even more important that redevelopment of the area leaves a positive legacy. It's a vibrant part of London and becoming even more so, with many creative industries located there. University College London and its hospitals, The Francis Crick Institute, the Wellcome

Trust and the Turing Institute are all based around the area.

And it is helped by the recent regeneration of neighbouring areas such as King's Cross, which is now a far cry from its outdated past. But space in the area is limited, which means opportunities for further development are rare, giving Euston a real opportunity to grow and regenerate a wider area.

The site HS2 Ltd intends to develop

EUSTON STATION BUILDING HISTORY

Opened in July 1837, Euston was the first intercity station in London and the terminus of the London and Birmingham Railway. The original station building was built by William Cubitt, with two platforms (one for departures and one for arrivals). It quickly grew in popularity and, over the next 60 years or so, a further 13 platforms were built.

There is little left of the original station - in the early 1960s it was decided that the station needed to be bigger. The only way to do this was to demolish the Great Hall and the iconic Euston Arch (which has been a subject of dispute ever since).

The new building opened in 1968, following electrification of the West Coast Main Line.

stretches to around 53 acres (21 hectares), including the new HS2 terminal, Network Rail main line station, the station approaches north along Park Village East and the adjacent NR freehold lands. It is all only approximate at this stage until designs for the area are finalised.

Original plans for redeveloping Euston were drawn up back in 2007, before the station was even chosen as the terminus for the new high-speed railway. At the time, its redevelopment was mooted due to capacity constraints which make the 1960s station unfit for the long-term. Since the decision in March 2010 that HS2 would terminate there, the plans have had to change, to move from a reconstruction to a whole redevelopment.

In September 2015, the Government submitted plans to Parliament for developing Euston station, encompassing 11 new high-speed platforms to be built in two stages

THE VIEW FROM THE PRIMARY LANDOWNER: SYDNEY & LONDON PROPERTIES

Sydney & London Properties (SLP) is the only landowner on the current 12-acre Euston station site, other than Network Rail.

SLP owns The Euston Estate, which comprises the four large office buildings sited on Euston Road, fronting the station. The company has long had a desire to develop the local area, even before HS2 was set to arrive there, and it is eager for comprehensive regeneration.

"In our view, the scheme put forward by the local authorities was not sufficiently aspirational to achieve what could be achieved over the top of the station at Euston," Chief Executive Richard Anning tells RAIL.

"Our perception is that a more widely diverse scheme to provide a higher level of employment and residential

accommodation could be achieved, in order that this area of London has significant rejuvenation."

Anning points out that the adjacent communities and wards are considered as some of the most deprived in Camden (if not in London), and that the ability to use the redevelopment potential at Euston to rejuvenate this whole area is something that must be seized and achieved.

"We've seen smaller schemes in the past, such as the excellent scheme at King's Cross, but that was really built around the users of the station, with ancillary offices and residential accommodation. One wouldn't consider King's Cross to be an integrated scheme covering the whole of the area.

"The potential at Euston is phenomenal. Perhaps it's fair to say we're a little

bit more aspirational in what could be achieved than the current statutory plan."

HS2 Ltd, Camden Council and Government for London decided in conjunction with the Department for Transport to set up a board specifically for the redevelopment of Euston station (the Euston Station Regeneration Board). That board is seeking a master planner, to review what could be undertaken over and around Euston station and to then move on or make observations upon the existing statutory plan.

Says Anning: "It's fair to say that the Government and the other public stakeholders acknowledge that even though the current plan is only two years old, it needs to be readdressed in light of the specific HS2 scheme and what could potentially be achieved for greater

rejuvenation of the borough."

This is further enhanced by HS2 Ltd's decision to appoint a Master Development Partner (MDP, see main story) for the area. Anning says there are two distinct elements to the redevelopment that would be covered by the MDP.

"One is the procurement of a transport network and transport interchange. The second, which is equally important for ensuring value for money, is what can be put on top and around the transport 'box' to achieve maximum contribution to the public purse."

This is what HS2 Ltd is currently seeking consultation on from the development community. It is not yet clear whether there will be one MDP that provides both the transport and over-station developments, or two separate parties.

Says Anning: "With our partners Argent, who did King's Cross, and RELATED, which is an American developer that is currently developing over live rail tracks in Manhattan, we will be submitting a bid to be the development partner along the lines of whatever they choose, whether it be one contract or two contracts."

Does Anning believe that HS2 is positive for Euston?

He is tentative, but responds: "HS2 is the catalyst which is providing the impetus for the redevelopment for the existing station as well. It is accepted by everybody that the existing station is not fit-for-purpose. So the redevelopment of the station at Euston is good for Camden and the community. I don't know that you can then extend that to say that an HS2 station at Euston is good for the

community per se, because it's just one of the transport modes going into a redeveloped station."

Is he positive, however, that a more ambitious vision might now be achieved for the area?

"I believe there is probably a greater consensus between the public stakeholders to achieve something at Euston than there ever has been in the past, when you start putting in TfL, Network Rail, HS2, Camden, Government for London and DfT.

"That's a lot of public stakeholders that have to get thinking 'in the round' rather than their own individual position in the consortium. There is a desire to do this properly now, I believe. I'm sounding far more positive than if you had spoken to me a year ago."

➔ (causing less disruption to the rest of the station and the surrounding community than if they were all built at once), while leaving 11 platforms still in place in the current station for the existing rail network. The plans include underpinning support structures that will allow for potential development above the station and improved London Underground facilities.

The two stages of the development would split into:
 ■ Six new high-speed platforms and a concourse to the west of the station to support the opening of HS2 Phase 1 in 2026.
 ■ Five further high-speed platforms and a concourse to support the opening of Phase 2 in 2033.
 But not everyone is convinced that the



The current public space outside Euston station. JACK BOSKETT/RAIL.



An artist's impression of an HS2 train inside a new Euston station. HS2 LTD.

WHAT ABOUT THE LINK BETWEEN HS2 (EUSTON) AND HS1 (ST PANCRAS)?

The question comes up frequently - if you site the HS2 terminus at Euston, what are you going to do about connectivity to High Speed 1? It's a controversial topic because at one stage it was likely that there would be a link between HS2 and HS1, then the idea was scrapped. And as recently as last year, many of us thought the idea would come back again. So why are there no plans for a link?

Lord Adonis, the Secretary of State for Transport who announced HS2 back in 2009, gave a compelling answer to that very question in the House of Commons on January 10.

Baroness Randerson wanted to understand the reasons why plans for a link between HS1 and HS2 had been dropped. She said that, while she acknowledged the practical and costly difficulties of having a link, there are "huge practical difficulties associated with the proposed - and very costly - Euston development, but that does not seem to have deterred the Government or HS2 Ltd". She asked: "Why were the original plans to link HS1 to HS2 dropped and, importantly, could they be taken up again if demand was at such a level that that would be justified, and what firm plans exist for the trek along Euston Road?"

Adonis answered first by separating the two issues. The first being through trains from Paris to the Midlands and

further north. The second being the "lamentable" connections between Euston and St Pancras.

On the first point he said: "The economic case for running through services from Paris and Brussels to Birmingham, Manchester and Leeds is very weak indeed."

He continued: "Although HS1 has been a great success in engineering terms and has played a useful part in linking two of Europe's great cities, it is way off all the projections of traffic between London and the continent. I do not think it is yet even at half the level of the projections of what the traffic should have been. There is still only one service an hour between London and Paris for most of the day. Often, those services have quite light loads."

Adonis said it was "important to be frank about this because everybody pays lip service to the benefits of linking HS1 and HS2".

"On the face of it, it seems absurd that there is not a connection between the two, but because the service would be so intermittent - with the best will in the world, only a few trains a day would run on that service - I very much doubt it would be taken up in any big way. While we have cheap airlines that offer very frequent services to Manchester and Birmingham - both are highly successful airports, which are expanding and have significant capacity that they can make

available for flights to the continent - it is unlikely that such a line would be viable."

So what about the trek along Euston Road?

Said Adonis: "Although this degree of work has not yet been done, my assumption with the planning of Crossrail 2 is always that it will be possible to use it also as a pedestrian tunnel, with a travelator for getting from Euston to St Pancras.

"The transport planners are not wildly keen on that idea because it will add to the cost of Crossrail 2 and they want a more limited scheme that has access only for transport users. But it's obvious that if you have a Crossrail 2 station serving the two stations, and you have this underground link, putting in a simple travelator and making it possible for people to connect between the two stations underground must be sensible."

He finished: "It has to be said that, at the moment, this issue still does not have a satisfactory resolution... Passengers cannot be expected to put up with the current state of connectivity between Euston and King's Cross St Pancras. It should be incumbent on the Government, the mayor, TfL and HS2 to see that there are better links for that period between the opening of HS2 at Euston and the completion of Crossrail 2. As I say, that is the only long-term solution to this issue."

LOCAL ASPIRATIONS FOR EUSTON

Up to 14,100 new jobs

Up to 3,800 new homes

Up to 280,000m² new commercial floor space



The site HS2 Ltd is seeking to transform, by sourcing a Master Development Partner. HS2 LTD.

CAMDEN COUNCIL OPPOSITION

Ultimately, Camden Council is opposed to HS2 as it is currently proposed. However, if HS2 is going to happen, the council seeks to make the case that proposals for the area should maximise the community benefits and regeneration opportunities.

The main areas of Camden Council's opposition to the new railway are based on the negative impacts on residents and local businesses, such as homes being demolished, traffic increasing, loss of open space and the potential impact on air quality. The council sought assurances to address these and has secured more than 100 separate assurances from HS2 Ltd consisting of measures to protect the local area.

Camden Council made representations at the House of Lords Select Committee in September 2016 to stress how important it is for the redevelopment of Euston main line station to be integrated with plans not just for HS2, but also for Crossrail 2 (which is relevant for connections with HS1 - see separate panel, opposite).

The local authority's argument for further change is that a comprehensive redevelopment would minimise disruption to the area and also create the opportunity for 2,200 new homes and 16,000 jobs through over-site development.

current Government plans for the area go far enough to delivering the regeneration so desired by local communities (see panel, page 66).

Despite its opposition to HS2, Camden Council joined forces with the Greater London Authority and Transport for London to produce the Euston Area Plan (EAP), which is a long-term planning framework for the area up until 2031, regardless of whether HS2 goes ahead or not.

Since then, in November 2016, the parties began work on a Planning Brief for the Euston station and railway tracks area. The idea is to provide detail on the external station design and potential over-site development that were first set out in principle in the EAP, with the intention of informing the next phase of HS2 Ltd's design work for the station. It is expected that initial proposals will be published in the spring, with a formal consultation to follow in early 2018.

It isn't currently clear exactly what the area around Euston and its station will look like once HS2 opens, or beyond that but it's obvious that people in the local area aspire to something that provides the kind of regeneration that goes well beyond even that experienced by the likes of King's Cross. ■



The new nine-road Elizabeth Line depot at Old Oak Common will be brought into use later this year. TAYLOR WOODROW.

END-TO-END EXPERTISE

Depot projects: Building from scratch or upgrading existing facilities - it's all in a day's work for Taylor Woodrow. JEZ HASKINS and FRED GARNER tell PAUL STEPHEN how it's done

London's population continues to grow at the rate of two Tube trainloads of people per week, and the capital's rail network must constantly evolve to meet this increased demand through new high-capacity train fleets and new lines. The Elizabeth Line, due to open in 2018, will be the capital's first new railway for decades.

Extra route miles and more technically advanced rolling stock demands a key but often overlooked component - upgraded depot facilities that meet not only the maintenance and cleaning requirements of new trains, but also the operational requirement of increasingly frequent timetables. They must also offer a safe and efficient working environment for the maintenance teams that are based there, and for the drivers who bring trains in and out.

Additional depot facilities can be created in two ways that each pose different, but similarly demanding, challenges for experienced contractors like Taylor Woodrow to deliver. Building new depots is a multi-disciplinary task combining design, construction, civil engineering, railway systems and operational expertise. On the other hand, modifying or upgrading an existing depot, with its existing and often decades-old infrastructure, adds complexity

Taylor Woodrow is steeped in experience of delivering both. On the new-build side, it was tasked in 2014 with building a new facility at Old Oak Common to service the Elizabeth Line's new fleet of Bombardier-built Aventras. Meanwhile, the company's ability to upgrade existing facilities has been demonstrated at Ealing Common and Upminster depots, which required upgrading in advance of the replacement of D78 stock on the District Line with S-Stock, from 2015.

Taylor Woodrow directors Jez Haskins and Fred Garner oversaw both infrastructure projects and the development of robust strategies needed to tackle the unique challenges they posed.

Starting with the District Line, the main challenge was that the S-Stock trains were longer, heavier and had a different kinematic

envelop (the space occupied by a vehicle when in motion, including tilt, sway, track cant, etc) to the lower capacity trains being withdrawn. They also required more power and had vastly different maintenance regimes to their predecessors. Haskins says that the easiest option would have been to build new purpose-built sites, but the lack of suitable locations meant Taylor Woodrow would need to work with existing depots at Upminster and Ealing Common, located at opposite ends of the line. What's more, London Underground required both depots to maintain a level of functionality for existing stock during the build sequence.

"While some depots may lend themselves to a sequence of knock-down and rebuild while maintaining suitable levels of functionality, the cost of such an approach

is often prohibitive to LU in these days of tighter budget constraints," he tells RAIL. "So LU had to look to how it could upgrade its existing facilities to make them fit for 21st century trains. What was most satisfying is that works at both depots were carried out with minimal disruption to the LU depots' operational teams and that we have been able to transform the existing depots, in structures built more than 70 years ago, into state-of-the-art facilities."

Work began in 2011, and the scope of the contract included design, groundworks, new and extended buildings, new permanent way and depot mechanical and electrical services, including power upgrades and depot signalling. Specialist equipment was also needed to maintain the S-Stock, such as overhead craneage and a synchronised jacking system built by Pfaff-silberblau.

At Upminster, stabling capacity was expanded at the start of the build sequence to enable new trains to be housed alongside the existing D78s, as the latter were phased out and eight sidings were installed on reclaimed land within the depot's existing footprint.

The maintenance shed was then divided with a full-height acoustic barrier running along its entire length to keep two roads open for continued maintenance, while the Taylor Woodrow team worked on the other

side, converting the other six roads to four. The building was then underpinned by engineers to increase its strength, while the team also managed noise, dust and vibration levels in order to limit disruption to adjacent and ongoing train maintenance.

At Ealing a similar process was followed, and Taylor Woodrow was able to occupy the eastern Acton end of its three sheds while leaving all the roads into the western Ealing end fully functioning.

Five roads in the yard were equipped with new train arrestors, trip cock lights and walkways for the stabling of S-Stock and D-Stock trains together. The shed roofs and inspection pits below the rails were extended at the Acton end to accommodate longer S-Stock trains, while synchronised heavy lifting jacks were installed on road one, capable of lifting an S-Stock train in its entirety. Five roads were reduced to three, and the remaining two roads equipped with fixed platforms for internal and external cleaning. Finally, traction power was upgraded and all stabling roads received extended walkways, modified conductor rails and new trip cock lighting.

The majority of the civil, permanent way and traction power works on the stabling roads outside the sheds were undertaken during weekend possessions to further minimise disruption.

Over in west London, adjacent to the main line approach into Paddington, Taylor Woodrow's new-build project at Old Oak Common for TfL and Bombardier is being gradually brought into use over the course of 2017, following the completion of construction of its Operations, Maintenance and Control (OMC) building. The depot has nine roads in the maintenance building and 33 external sidings. Its scale is impressive and the depot will be equipped with a wheel lathe, two-road bogie drop, train washing facilities and extensive workshops, stores, offices and drivers' accommodation. It also has impeccable green credentials and its deployment of renewable energy systems,

including solar panels and ground source heat pumps, deservedly earned it RAIL's National Rail Award for sustainability in September 2016.

Garner adds: "We really hope that other clients in the sector take a look at what can be done with green energy sources in the depot environment, and we believe our work at Old Oak Common is at the leading edge in this field."

"It is very rewarding to see the project enter its final stages, and over the course of 2017 we have several key milestones to achieve. We will first give access to MTR Crossrail, who will operate the Elizabeth line on behalf of TfL, to start the fit out of their office space, and then over the summer commission signalling and traction power along with our main line connection to allow a test train to access the depot. Finally, external sidings will be brought into use with the OMC building as units start to arrive from the Bombardier production line in Derby.

Garner describes the biggest challenges of the project as co-ordinating the design of around 30 different subsystems, and then guiding it through a rigorous assurance process with TfL as Bombardier's client. It is also necessary to co-ordinate the works with Network Rail, concerning the connection to the main line, which is just 1¼ miles from Britain's eighth busiest station - Paddington.

He concludes: "Old Oak Common is hemmed in between the Grand Union Canal to the north and the existing Great Western Main Line depot approach roads to the south. It's been a challenge to fit in all the necessary cables, pipes and underground tanks, but the team has worked incredibly well to solve a number of perplexing challenges in the critical throat area of the depot."

"Our team enjoys the challenges provided by this type of environment, however, and I know it will give them a great feeling of satisfaction, when they travel on the new trains, to know they've played their part in making it happen." ■



New hydraulic jacks at Upminster depot can lift an entire S-Stock train. TAYLOR WOODROW.



“ We have been able to transform the existing depots, in structures built more than 70 years ago, into state-of-the-art facilities. ”

Jez Haskins, Sector Director, Taylor Woodrow



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