CROSSRAIL INFORMATION PAPER

D24 – TUNNELLING DURATION AND CONSTRUCTION STRATEGY

This paper sets out the proposed Crossrail tunnel construction strategy and duration.

It will be of particular relevance to those in the vicinity of the proposed Crossrail tunnels.

This is not intended to replace or alter the text of the paper itself and it is important that you read the paper in order to have a full understanding of the subject. If you have any queries about this paper, please contact either your regular Petition Negotiator at CLRL or the Crossrail helpdesk, who will be able to direct your query to the relevant person at CLRL. The helpdesk can be reached at:

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Information Paper

D24 – TUNNELLING DURATION AND CONSTRUCTION STRATEGY

1. Introduction

1.1 Crossrail requires the construction of 21km of twin bore running tunnels with a 6m internal diameter.

1.2 The central running tunnels link the surface rail routes at Royal Oak Portal with stations at Paddington, Bond Street, Tottenham Court Road, Farringdon, Liverpool Street, Whitechapel and the Isle of Dogs and connect to surface rail routes at Victoria Dock Portal to the east and Pudding Mill Lane Portal to the north east near Stratford.

1.3 The other Crossrail tunnel runs from the North Woolwich Portal, which is to the east of Custom House Station, under the River Thames to Plumstead Portal ("the Thames tunnel").

2. Running Tunnel Construction

2.1 Crossrail running tunnels are larger than those on the existing London Underground Network as they are designed to accommodate the standard surface rail rolling stock. The volume of excavated material is 120% more than generated by the excavation of an equivalent length of conventional tube tunnel.

2.2 To minimise the environmental impacts of construction of the running tunnels in terms public acceptance of the noise, dust and traffic Crossrail have developed a revised tunnelling strategy (see Information Paper D8, Tunnel Construction Methodology). It avoids the need for launching tunnel boring machines (TBMs) from the Hanbury Street Shaft site within the Spitalfields area.

2.3 The revised strategy allows the excavated material from the running tunnels to be removed from the running tunnel work sites as follows:

- by rail at Royal Oak Portal using the Great Western Main Line;
- by rail from the Pudding Mill Lane Portal using the Great Eastern Main Line;
- by barge from the Limmo Peninsula Shaft; and
- from the Plumstead Portal by road to Manor Wharf where it is transferred to barges.

2.4 The direction of tunnel drives with the revised strategy are shown in Annex A and comprise:

- two TBMs from Royal Oak Portal to the west end of Farringdon Station (6.16 km);
- two TBMs from the Limmo Peninsula Shaft in a western direction to the east end of Farringdon Station (8.30km);
- two drives from the Limmo Peninsula Shaft in an eastern direction to Victoria Dock Portal (0.93 km) constructed by one of the above TBMs;

• two TBMs from Pudding Mill Lane Portal to Stepney Green (2.72 km) or vice versa; and

• two TBMs from Plumstead Portal under the River Thames to the North Woolwich Portal (2.64 km).

2.5 The revised tunnelling strategy is based on using the following types of closed faced tunnel boring machines:

• earth pressure balance machines (EPBMs) for construction of all the running tunnels within the central London area; and

• slurry machines for the tunnel drives from Plumstead Portal to the North Woolwich Portal.

2.6 These machines are considered best able to deal with the ground conditions expected.

2.7 The TBMs will be designed, manufactured and operated in accordance with the Crossrail Materials and Workmanship Specification which will define “best practice” for the project. The tunnel construction methodology for the running tunnels is described in Information Paper D8, Tunnel Construction Methodology.

2.8 The revised tunnel drive strategy provides an optimum construction programme, maintaining the integration between the running tunnel drive programme and the station works programme. It also offers a construction programme which is compatible with the project strategy for opening for passenger service (see Information Paper D15, Implementation and Staging).

3. Station Tunnel Construction

3.1 The stations within the central area are all underground. Bond Street Station, Tottenham Court Road Station, Farringdon Station, Liverpool Street Station and Whitechapel Station all have mined platform and passenger tunnels constructed using sprayed concrete lining (SCL) techniques. These are linked to the surface station concourses and entrances with escalators and lifts for people with reduced mobility. Paddington and the Isle of Dogs Station are to be constructed from the surface as cut and cover structures i.e. from ground surface.

3.2 Crossrail has undertaken a comprehensive study to arrive at these arrangements and has developed a strategy for the safe implementation of the works. The systems and procedures Crossrail will have in place for the installation of sprayed concrete linings are detailed in Information Paper D23, Sprayed Concrete Lining.

3.3 Stations will be constructed from sites located on the surface that are generally incorporated into the station surface works. This construction work is supported, where required, by additional work sites as detailed on the plans deposited with the hybrid Bill. The material arising from excavation of the 5 tunnelled stations, namely

Bond Street, Tottenham Court Road, Farringdon, Liverpool Street and Whitechapel will be removed by road.

3.4 The plan is to have the SCL station platform tunnel primary lining completed in advance of the arrival of the running tunnel TBMs. This will allow the tunnel boring machinery to be slid through the completed platform tunnels and re-start the running tunnel drive to the next station. The TBMs will be serviced from the tunnel work sites listed in section 2.3 above, which are on the periphery of the central area. This will reduce the level of Crossrail generated construction traffic within central London to a practical minimum.

4. Construction Strategy

4.1 This revised tunnelling strategy has been made possible following a major review of the proposed construction programme, which was started in mid-2005. In particular, it is no longer the case that pre-tunnelling enabling works will be carried out before Royal Assent. This has allowed a construction programme to be developed that integrates these enabling works with the main civil engineering works for the central area stations and at the TBM launch sites.

4.2 This has allowed programme critical station works to commence at a relatively earlier time in the construction programme, taking them off the project critical path. It has also made it possible to gain access to start certain running tunnel drives earlier thereby making longer drives possible. The longer drives in turn allow a modest increase in the average rate of tunnelling.

4.3 This is supported by recent experience of tunnelling in London and the developments in the design, manufacture, reliability and performance of TBMs which can now deal with a greater range of ground conditions and drive longer tunnels. Taken together, the revised tunnelling strategy, with fewer longer drives, has been adopted without affecting the overall construction duration.

4.4 The revised construction programme maintains the objectives of balancing the costs of constructing the project in the shortest time possible against the increased risks and the duplication of manpower and construction equipment that a shorter programme period would cause.

4.5 Taking into account the above considerations, the revised strategy enables Crossrail to be constructed within the overall eight year timeframe with simultaneous tunnelling from four different sites.

4.6 Construction of the running tunnels is essentially a linear process. It involves, in turn, the excavation and support of the tunnels, clean out and removal of temporary facilities, followed by the installation in separate operations of the first stage trackbed, the track-form (rails and fixings), walkways, pipework and cable brackets and then the railway systems (see Information Paper D8, Tunnel Construction Methodology).

4.7 Tunnelling operations will be carried out on a 24 hour, 7 day week basis, allowing for both planned and unplanned stoppages; maintenance and replacement of equipment; extension of conveyors and service railway; slowing of TBMs through areas of importance in central London; and removal of obstructions where and if necessary. Tunnelling continuously has a beneficial effect on the control of ground movements (for further information please see Information Paper D11, 24-Hour Working).

5. Types of TBMs

5.1 The type of TBM proposed and the tunnelling rates adopted are based on the ground conditions (see Annex B), the length of the tunnel drives, and the location of the drives with respect to surface structures and their sensitivity to settlement. The following average tunnelling rates have been adopted for planning purposes for the construction programme.

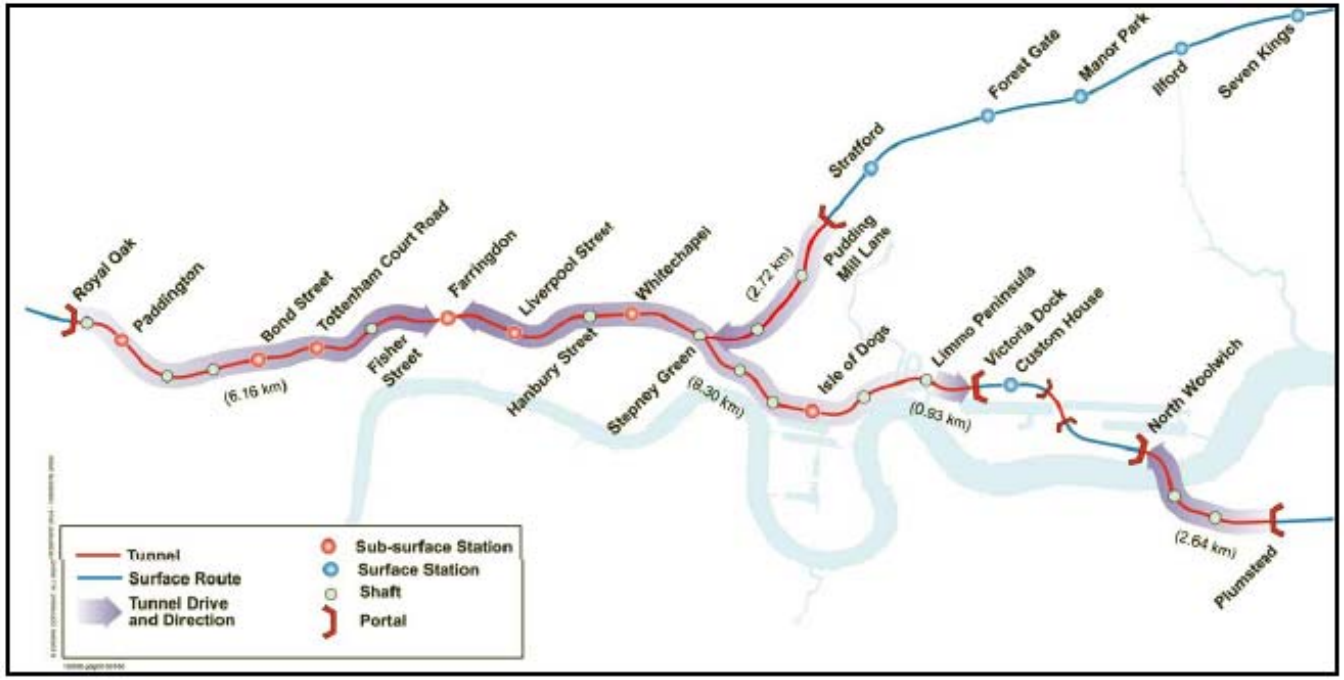
Tunnel Drive	TBM Type	Tunnel Drive Length (km)	Planned Average Tunnelling Rate (m/week)	Duration of tunnel driving (weeks)
Royal Oak portal to Farringdon Station	Closed Face Earth Pressure Balance Machine	6.16	90	68
Limmo Peninsula Shaft to Farringdon Station		8.3	90m/wk	92
Limmo Peninsula Shaft to Victoria Dock Portal		0.9	65m/wk	12
Pudding Mill Lane Portal to Stepney Green Shaft.		2.8	90m/wk	31
Plumstead Portal to North Woolwich Portal	Closed Face Slurry Machine	2.6	60m/wk	29

5.2 An eight week learning curve has been introduced at the commencement of the tunnel drives where typically 50 per cent of the advance rate is assumed, except for Royal Oak to Paddington where a tunnelling rate of 40m/week has been assumed.

6. Environmental Impact

6.1 The overall environmental impact of the revised tunnelling strategy is summarised in Information Paper D8, Tunnel Construction Methodology.

Annex A - Plan of Crossrail alignment showing direction of tunnel drives



Annex B - Tunnelling ground conditions