Chapter 3

Route Windows C6 and C7: Farringdon Station and Liverpool Street Station
3 Route Windows C6 and C7: Farringdon Station and Liverpool Street Station

3.1 Introduction

Overview

3.1.1 Three amendments are proposed within Route Windows C6 and C7.

Amendment 1: Amendment of crossover location and construction method (Route Windows C6 and C7)

3.1.2 The main ES describes the construction of a crossover, required for operational reasons in the central section tunnels, positioned to the east of Aldersgate Street, in Route Window C6.

3.1.3 Stakeholder concerns were raised in relation to the environmental impacts associated with the original crossover and the Farringdon crossover worksite in Aldersgate Street. As a result, additional engineering studies were undertaken to consider options for relocating the crossover and possible alternative construction methods.
3.1.4 An alternative location to the east of the original crossover, to be constructed using a different methodology and using different permanent structures underground, has been identified. Whilst the crossover remains within Route Window C6, the worksite for construction is within Route Window C7. This is shown on Map C6/C7(ii) of the AP2 ES mapping volume (AP2a).

3.1.5 Additional land and powers are required to enable the construction of the crossover, hence the need for an Amendment of Provisions.

Amendment 2: Amendment of Finsbury Circus worksite boundaries, layout and access points to reduce the impact on trees (Route Window C7)

3.1.6 Since deposit of the main ES, additional work has been undertaken on the access and layout of the Finsbury Circus worksite in relation to the trees within Finsbury Circus gardens. Following consultation with stakeholders, a new layout and access position has been identified that reduces the impact on the trees. This requires an additional area of land for the worksite outside the Bill limits. This is shown on Map C6/C7(ii) of the AP2 ES mapping volume (AP2a).

Amendment 3: Amendment of Sewer Diversion Location (Route Window C7)

3.1.7 The main ES describes the proposed diversion of a sewer that runs through the middle of Moorgate station, referred to as the Moorgate station sewer (Volume 2, Chapter 8, Section 8.9, paragraph 8.9.16). The proposed diversion takes the sewer southwards to connect into an existing sewer in Fore Street Avenue.

3.1.8 Since the submission of the Bill, British Telecom (BT) has designed, and is in the process of installing, a major telecommunication infrastructure route with a view to making the existing telephone exchange in Fore Street redundant. BT plans to undertake the duct installation by the end of 2006. These new cables and ducts would need to be diverted in order to effect the sewer diversion. Based upon the current understanding of these ongoing works, the duration of such a diversion is expected to be approximately two years. As a consequence, an alternative route for the diversion of the sewer has been developed.

3.1.9 The alternative diversion route will run through the existing Moorgate worksite in Moorfields. Parts of the diversion will extend outside of this worksite resulting in further excavation and reinstatement.
3.1.10 The sewer diversion is a scheduled work in the Bill and as such it has its own limits of deviation, consequently moving its position requires an Amendment.

3.1.11 This chapter sets out information for each of these Amendments as follows:

- Amendment 1: the original proposals for the crossover location and its construction as set out in the main ES and the revised proposals for the crossover and its construction;
- Amendment 2: the proposed amendment to the worksite at Finsbury Circus to reduce the impact on trees;
- Amendment 3: the original proposals for the sewer diversion as set out in the main ES and the revised proposals for the sewer diversion and its construction; and
- an assessment of any changes to the significant environmental impacts reported in the main ES.
Amendment 1: Amendment of crossover location and construction method (Route Windows C6 and C7)

3.2 Permanent Works

The Original Works

3.2.1 The original works include the construction of a rail crossover between Farringdon and Liverpool Street stations, beneath the Barbican. The provision of the crossover is to:

- ensure that Crossrail services can continue to run during emergencies and disrupted services;
- provide a location for reversing trains during the phased opening;
- provide a location for reversing trains when a tunnel is blocked;
- enable service recovery from a failed train; and
- allow a limited service to operate whilst a section of the tunnels is closed for maintenance.

3.2.2 The crossover was to be located beneath Defoe House of the Barbican (see Map C6/C7(i) of the AP2 ES mapping volume (AP2a)).

The Revised Scheme

3.2.3 The revised scheme proposes an alternative location for the required crossover. The crossover remains beneath the Barbican but is located approximately 270 m to the east, underneath the lake between Gilbert House to the west and Willoughby House to the east (see Map C6/C7(ii) of the AP2 ES mapping volume (AP2a)).

The revised scheme does not result in any change to permanent above-ground structures, however the crossover is located in a different position under the Barbican, and since it will be constructed using a different methodology there will be different permanent structures underground.
3.3 Temporary Works

The Original Works

3.3.1 To construct the original crossover, a temporary shaft and adit were to be constructed from a worksite in Aldersgate Street. Using this adit, excavation of the crossover cavern would then be undertaken using sprayed concrete lining techniques. Once the work on the cavern was complete, the temporary adit and shaft would be backfilled. The original works are shown on Map C6/C7(i) of the AP2 ES mapping volume (AP2a).

3.3.2 The programme for these works was approximately 39 months, preceded by approximately 19 months of utility diversions to enable the works to take place.

3.3.3 The shaft in Aldersgate Street required a number of utility diversions as enabling works. These were the diversion of the sewer in Aldersgate Street as described in the main ES and the diversion of electrical, telecommunications and water services as set out in Chapter 15 of the SES2.

The Revised Scheme

Overview

3.3.4 The revised scheme removes the need for the Farringdon crossover worksite, the Aldersgate shaft sewer diversion worksite and the associated utility diversions described in the SES2. In its place, the revised scheme will utilise the extended worksite at Finsbury Circus (Amendment 2) to construct the crossover cavern, in addition to its original planned use as a worksite for construction of the Liverpool Street station tunnels.

3.3.5 The revised crossover will also require a small worksite to construct a small temporary shaft for delivery of materials to the crossover construction at Moor Lane. The works to Moor House shaft required for the original scheme will need to be undertaken earlier. The construction of the shaft in Moor Lane will require some local utility diversions. The scheme will require the removal of additional amounts of excavated materials from the Finsbury Circus worksite for the crossover. This material would originally have been removed through the shaft in Aldersgate Street.

3.3.6 In order to mitigate the impacts associated with predicted settlement at the Barbican, a hierarchy of mitigation options has been established, which are no more extensive than those that would have been adopted for the original scheme. The first option that would be utilised is compensation grouting from the temporary access tunnels required to construct the crossover. This is the preferred mitigation option. However, at this stage, prior to detailed design being undertaken, it is also possible that grout shafts within the sub-surface car parks may be required and have therefore been assessed.
Options proposed to mitigate impacts associated with predicted settlement at the Barbican

3.3.7 **Option One — Compensation Grouting from the Access Tunnels (the Preferred Option):** In order to mitigate impacts associated with predicted settlement at the Barbican, it is proposed that compensation grouting would be undertaken from the access tunnels used to construct the crossover cavern. This is a technique by which the small ground loss arising from the tunnelling process is replaced by material (grout) pumped into the ground at carefully predetermined locations.

3.3.8 **Option Two — Sub-surface Grout Shafts:** If detailed design shows that compensation grouting from the access tunnels is not likely to be sufficient on its own, up to four sub-surface grout shafts will be required. It is likely that two will be located within the basement of the public car park accessed from Silk Street. A third will be located in the basement car park at the junction of Willoughby House and Andrewes House. The car park is a half basement below the street level in Moor Lane and there are numerous options for the position of this shaft, either to the east or west or between the Willoughby House columns. The final location will be dependent upon the confirmed pile layout and depth for Willoughby House and Brandon Mews. The car park has access from ramps in either Fore Street or Moor Lane. The fourth grout shaft will be located in the basement car park immediately to the west of Andrewes House and the southwest of Gilbert House. The car park is a full basement level below Fore Street, and approximately level with the bottom of the lake to the north. The car park has access from the ramp in Fore Street.

Options proposed to mitigate impacts associated with predicted settlement of the railway lines beneath the Barbican

3.3.9 The London Underground (LU) Metropolitan, Circle, and Hammersmith & City lines, and Thameslink railway tracks are located in a concrete box structure underneath the Barbican and above the crossover, and it is predicted that this box will also be affected by ground movements. Like the surface structures, a hierarchy of mitigation options has been established. The first and most likely of these is re-levelling of the tracks within the box; the second is structural strengthening measures to support the tracks.

3.3.10 Finally, as a precautionary measure, it is also possible that the lake within the Barbican complex will be temporarily drained to install a flexible liner to safeguard the LU infrastructure below, and then refilled and stocked.
3.4 **Construction of the Revised Works**

**Overview**

3.4.1 A new access shaft will be constructed within the northern part of Finsbury Circus worksite to allow access to the crossover and for the removal of excavated materials.

3.4.2 A plan of the adit and crossover cavern is shown below:

![Diagrammatic location of access tunnel and cavern](image)

3.4.3 From the new access shaft a new 5 m diameter access tunnel will be required at approximately 25 m depth, running 365 m from shaft to cavern, to facilitate the construction of the crossover. The proposed works involve the construction of a barrel vault roof to the crossover prior to excavating the internal cavern core.
Section through crossover cavern

3.4.4 The access tunnel will be backfilled after the construction of the crossover is complete.

3.4.5 Construction will also require an additional worksite at Moor Lane to accommodate a temporary ventilation shaft and a shaft for delivery of materials such as concrete to the tunnel and use of the existing Moor House shaft earlier than originally proposed. The Moor House shaft has already been constructed as part of the Moor House development and is currently capped off at basement level. The proposed works will break out the existing cap over the shaft and construct a dedicated emergency escape route to street level through the retail unit that is currently located above the shaft. This work was required for the original scheme, but is to be undertaken earlier under the new proposals.

Duration of the Works

3.4.6 The construction of the crossover will take approximately 3.5 years to complete, 3 months longer than that required for the original proposal, although the revised scheme avoids the need for the 19 month programme of utility works required for the original scheme. The programme for the crossover works is shown on the following page, together with the programme for the Liverpool Street station construction works (as set out in the main ES) and utility diversions in the vicinity of Finsbury Circus (as set out in the SES2). For clarity, other utility diversions within Route Window C7 are not shown on the programme, but are provided in full in the SES2.
### Programme for Farringdon crossover, Liverpool Street station and utility diversions in the vicinity of Finsbury Circus

<table>
<thead>
<tr>
<th>SITE</th>
<th>ACTIVITY</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Finsbury Circus Worksite</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Site setup</td>
<td>2 months</td>
</tr>
<tr>
<td></td>
<td>Temporary access - shafts &amp; tunnels</td>
<td>17 months</td>
</tr>
<tr>
<td></td>
<td>Canopy - barrel vault</td>
<td>14 months</td>
</tr>
<tr>
<td></td>
<td>Cavern construction</td>
<td>10 months</td>
</tr>
<tr>
<td></td>
<td>Backfilling and finishing</td>
<td>7 months</td>
</tr>
<tr>
<td></td>
<td>Moor House Worksite</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Access for construction of emergency escape</td>
<td>6 months</td>
</tr>
<tr>
<td></td>
<td>Moor Lane Worksite</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Site setup and shaft sinking</td>
<td>3 months</td>
</tr>
<tr>
<td></td>
<td>Site operation</td>
<td>22 months</td>
</tr>
<tr>
<td></td>
<td>Running Tunnels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eastbound Tunnel Boring Machine Transit</td>
<td>2 months</td>
</tr>
<tr>
<td></td>
<td>Westbound Tunnel Boring Machine Transit</td>
<td>2 months</td>
</tr>
<tr>
<td></td>
<td>Liverpool Street Station -</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Finsbury Circus &amp; Moorgate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Worker Enable Works</td>
<td>12 months</td>
</tr>
<tr>
<td></td>
<td>Station Construction</td>
<td>44 months</td>
</tr>
<tr>
<td></td>
<td>Liverpool Street Station (West) Utility Diversions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stage 1 - Diversion of utilities from Moorgate and Moorgate into surrounding roads</td>
<td>11 months min 18 months max</td>
</tr>
<tr>
<td></td>
<td>Stage 2 - Diversions in Moorgate</td>
<td>4 months min 6 months max</td>
</tr>
<tr>
<td></td>
<td>Stage 3 - Jointing and cable pulling, some within Finsbury Circus</td>
<td>9 months min 35 months max</td>
</tr>
</tbody>
</table>

**NOTE:** Liverpool Street Station worksites are assessed in the main ES (February 2005) and utilities are assessed in the SES2 (January 2008).

**KEY:**
- **Farringdon Crossover Works**
- **Transit of Tunnel Boring Machines**
- **Liverpool Street Station Works in Finsbury Circus**
- **Utilities Works Minimum Duration**
- **Utilities Works Maximum Duration**
3.4.7 It is considered likely that construction of the crossover access works will commence one year in advance of the main construction works in Finsbury Circus gardens (for construction of the Liverpool Street station platform tunnels). As detailed construction planning progresses, it is possible that construction may commence earlier than this date (up to two years before main construction start) or up to one year later than this date (concurrent with main construction start). Regardless of the construction start time, it is likely that there will be some overlap with the enabling works programme set out in the SES2 and with the existing three and half year construction programme for Liverpool Street station as set out in the main ES (Volume 2, Chapter 8, Section 8.9, paragraphs 8.9.15 to 8.9.26).

3.4.8 The existing Moor House shaft will be required earlier than originally proposed to provide emergency escape during construction. This will require the retail unit that is currently located above the shaft to be relocated approximately 12 months earlier to enable the installation of the emergency escape. The site will be required for a six month period to undertake the works.

3.4.9 Compensation grouting will commence at the start of the crossover cavern construction and will continue for the duration of the works with a further year of intermittent grouting activities to address residual settlement.

3.4.10 If required, construction of the sub-surface grout shafts would take approximately two months each and will be carried out during the daytime. Again, compensation grouting will occur for the duration of the works (approximately three years), with a further year of intermittent grouting activities. The grouting will be a 24 hour activity, by necessity.

Construction Plant

3.4.11 The construction plant will be as reported in the main ES (Volume 2, Chapter 8, Section 8.8, paragraph 8.8.24).

Worksites

Finsbury Circus Worksites

3.4.12 The Finsbury Circus worksite is the main access for the construction of the crossover and for the removal of excavated material from the temporary access tunnel and crossover cavern. The layout of the worksite has been amended to accommodate the additional shaft. The only change to the worksite boundary results from an Amendment to reduce the impact of the construction works on trees within Finsbury Circus gardens (see Amendment 2 below).

Moor Lane Worksites

3.4.13 An additional worksite is required within Moor Lane to accommodate the temporary ventilation shaft and a shaft for delivery of materials such as concrete into the temporary access tunnel leading from the Finsbury Circus worksite to the cavern. This worksite is located in the eastern half of Moor Lane as shown on Map C6/C7(ii) of the AP2 ES mapping volume (AP2a).
Aerial view looking north along Moor Lane

*Moor House Worksite*

3.4.14 The works at Moor House will not require any additional worksite area to those identified in the main ES. The works will be undertaken within the retail unit, but will not require any additional area outside this boundary, although there will be a requirement for deliveries to the site.

Amendment 2: Amendment of Finsbury Circus worksite boundaries, layout and access points to reduce the impact on trees (Route Window C7)

3.5 Permanent Works

3.5.1 Amendment 2 does not result in any change to permanent works as stated in the main ES.

3.6 Temporary Works

The Original Works

3.6.1 The original layout of the Finsbury Circus worksite can be seen on Map C6/C7(i) of the AP2 ES mapping volume (AP2a).
The Revised Scheme

3.6.2 The northern access point to the Finsbury worksite has been moved approximately 20 m to the west to avoid a mature London plane tree on the perimeter of the gardens. This requires an extension of the worksite boundary to the west to accommodate the new access points. The southern access point to the worksite has also been moved approximately five metres to the west to avoid a mature oak tree. This has not required any change to the worksite boundary.

Amendment 3: Amendment of Sewer Diversion Location (Route Window C7)

3.7 Permanent Works

3.7.1 Amendment 3 does not result in any change to permanent works as stated in the main ES.

3.8 Temporary Works

The Original Works

3.8.1 The sewer that runs through the middle of the station was to be diverted southwards to connect into an existing sewer in Fore Street. These works required a worksite in Fore Street Avenue, known as the Moorgate station sewer diversion worksite. The original works are illustrated on Map C6/C7(i) of the AP2 ES mapping volume (AP2a).

The Revised Scheme

3.8.2 The alternative diversion route that has been developed will run through the existing Moorgate worksite, although the connection works at the southern end will extend out of the southern most part of the Moorgate worksite. This area has already been identified as a utilities worksite within the SES2 utilities assessment for other utility diversions. The diversion will be constructed as part of the station box either inside or along the outside.

3.8.3 The Moorgate station sewer worksite on Fore Street Avenue will no longer be required for the sewer diversion. This is shown on Map C6/C7(ii) of the AP2 ES mapping volume (AP2a). However, there are a number of other utility diversions that still need to be undertaken in Fore Street Avenue. These have been assessed as part of the SES2 on utilities.
3.9 Construction of the Revised Works

Overview

3.9.1 The alternative diversion route that has been developed will run through the existing Moorgate worksite. A permanent gravity diversion will be constructed with the sewer being intercepted in a new chamber in the basement of 21 Moorfields. The route of the diversion will pass through or around the Moorgate station shaft and rejoin the existing sewer at the southern end of Moorfields (see Map C6/C7(ii) of the AP2a ES mapping volume (AP2a)).

Duration of the Works

3.9.2 The construction programme and working hours remain unchanged from the original scheme presented in the main ES (Volume 2, Chapter 8, Section 8.9, paragraph 8.9.15).

Construction Plant

3.9.3 The main construction plant to be used at the worksites will remain unchanged from that identified in the main ES (Volume 2, Chapter 8, Section 8.9, paragraph 8.9.21).

Worksites

3.9.4 The works will be within the Moorgate worksite, although the connection works will extend out of the southern part of the Moorgate worksite as identified in the main ES (Volume 2, Chapter 8, Section 8.9, paragraphs 8.9.22 to 8.9.26). This is illustrated on Map C6/C7(ii) of the AP2 ES mapping volume (AP2a).

3.10 Mitigation and Residual Impacts

Overview

3.10.1 The proposed amendments do not change the conclusions as set out in the main ES with respect to air quality, contaminated land, community or socio-economics. The temporary significant impacts of the revised scheme are illustrated on Map C6/C7(iii) of the AP2 ES mapping volume (AP2a).

Impacts on Landscape, Townscape and Built Heritage

Baseline

3.10.2 The full baseline assessment can be found in the main ES (Volume 2, Chapter 8, Section 8.8, paragraphs 8.8.34 to 8.8.41 and Section 8.9, paragraphs 8.9.27 to 8.9.30).

3.10.3 The Finsbury Circus worksite is within a townscape of high quality and high sensitivity to change. It is within the Finsbury Circus Conservation Area and an area designated by English Heritage as Parks and Gardens of Special Historic Interest. There are a number of Grade II and Grade II* listed buildings around the Circus.

3.10.4 The new worksite in Moor Lane is within a townscape of moderate quality and moderate to high sensitivity. It is adjacent to the Grade II listed Barbican, which includes its boundary walls and gardens.