The different types of site

We require two types of construction sites.

**Main tunnel sites** are needed at the start or end point for a tunnel drive, where a TBM would be launched or received.

- **Main tunnel drive sites** are where a TBM is lowered into the ground and commences building the tunnel.
- **Main tunnel reception sites** are where a TBM is removed from the ground when the tunnel section is completed.

At **CSO sites** we need to build interception structures and a connection culvert to connect into the existing sewer and to take flows down to the main tunnel via a drop shaft. In some cases, the main tunnel is also constructed through the bottom of a CSO drop shaft.

We also need to make modifications to the existing sewerage system and at Beckton Sewage Treatment Works. Generally, the scale of works on these sites is significantly less than the CSO sites and main tunnel sites.

Connecting CSOs to the main tunnel

We need to connect CSO sites to the main tunnel so that the flows are directed into the main tunnel. This means we could store and transfer flows to our treatment works, instead of them discharging directly into the river. How we do this will vary between sites, depending on conditions.

We will need to build long or short connection tunnels to connect one or more CSO sites to the main tunnel. Connection tunnels are smaller in diameter than the main tunnel.

Sometimes the connection tunnels can join directly to the main tunnel, and sometimes we need to connect them to a shaft on the line of the main tunnel. This depends on the geology and depth.
The key element of work at CSO sites is the construction of a shaft, to transfer the flows from the existing sewer down to the tunnel. The shaft will be a concrete cylinder with an internal diameter ranging from six to 24 metres and 20-60 metres deep. The size and depth vary, depending on the amount of flow we need to transfer into the tunnel or the size of the connection tunnel. The depth of the drop depends on the level of the connection tunnel to take flows into the main tunnel.

To construct a drop shaft, we need to bring in concrete and remove material that has been excavated. We will also need to build structures, such as an interception chamber, valve chambers and connection culvert, to connect the drop shaft to the existing sewer. This may involve diverting utilities, such as gas, water and electricity. Sometimes, the existing sewer or utilities are in the roadway, so we would need to close part of the road while we do these works.

We will also need to build ventilation structures at CSO sites to allow air in and out of the shaft. At two sites, we need to build a long connection tunnel:

- At Dormay Street we are proposing to drive a long connection tunnel to the drop shaft at King George’s Park, and then in the other direction to the shaft at Carnwath Road Riverside. This is called the Frogmore connection tunnel.
- At Greenwich Pumping Station we are proposing to drive a long connection tunnel through the drop shafts at Deptford Church Street and Earl Pumping Station to the shaft at Chambers Wharf. This is called the Greenwich connection tunnel.

Once we have finished all of the works, we will complete the finishings on our new structures and landscape each site. Construction at CSO sites will typically take two and a half to three and a half years. It will be longer at a limited number of sites.

**Key elements of the works at a CSO site with short connection tunnel**

- Drop shaft
- Connection culvert
- Existing overflow to river
- Valve chamber
- Interception chamber
- Short connection tunnel
- Main tunnel
- Existing overflow sewer
- Blackfriars Bridge Foreshore
- King Edward Memorial Park Foreshore
- Earl Pumping Station (connection tunnel)
- Deptford Church Street (connection tunnel)

<table>
<thead>
<tr>
<th>Type of connection tunnel</th>
<th>What</th>
<th>Where</th>
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| Short                     | Shorter in length and connects CSO drop shaft to main tunnel. The CSO site is also used to ‘drive’ the short connection tunnel to the main tunnel. In our preferred scheme, the short connection tunnels are up to 350m long. | - Hammersmith Pumping Station  
- Barn Elms  
- Putney Bridge Foreshore  
- Falconbrook Pumping Station  
- Cremorne Wharf Depot  
- Chelsea Embankment Foreshore  
- Heathwall Pumping Station  
- Albert Embankment Foreshore  
- Victoria Embankment Foreshore. |
| Long                      | Longer in length and links several CSO drop shafts together before connecting to a shaft on the main tunnel. Some CSO sites are also used as drive sites for the long connection tunnel. In our preferred scheme, our long connection tunnels are greater than 1km long. The activities that take place on connection tunnel drive sites are the same as main tunnel drive sites but on a smaller scale. | - Connection tunnel from King George’s Park, through Dormay Street, to the main tunnel shaft at Carnwath Road Riverside. Dormay Street is used to drive this long connection tunnel in both directions.  
- Connection tunnel from Greenwich Pumping Station, through Deptford Church Street and Earl Pumping Station to the main tunnel at Chambers Wharf. Greenwich Pumping Station is used to drive this long connection tunnel. |
| Not required              | No connection tunnel is necessary as the main tunnel or long connection tunnel runs through the bottom of the CSO drop shaft. | - Blackfriars Bridge Foreshore  
- King Edward Memorial Park Foreshore  
- Earl Pumping Station (connection tunnel)  
- Deptford Church Street (connection tunnel). |


Works at main tunnel drive sites

There are four key activities at main tunnel drive sites:

Shaft construction
We need to build a shaft, which is a concrete cylinder with a 25-30m diameter about 40-60m deep. The size and depth of each shaft vary depending on:
- the size and depth of tunnels that need to be connected into the shaft
- the hydraulic structures that need to be constructed in the shaft.

Tunnelling preparations
Before we begin tunnelling, we need to prepare the site and bring a tunnel boring machine (TBM) to the site, assemble it, and lower it into the bottom of the shaft.

Driving the TBM
The TBM is used to build the tunnel from the drive site to the reception site. Precast concrete segments are lowered into the shaft by a crane and delivered to the TBM by a train within the tunnel. The segments are then fixed together to create the circular tunnel wall. Material excavated by the TBM is taken out of the tunnel by a tunnel wall. Material excavated by the TBM is delivered to the TBM by a train within the tunnel using concrete segments. As it excavates it also transports material back to the site.

Lining the tunnel
Once the tunnel is in place, we would construct an internal (or secondary) lining inside the concrete segments installed by the TBM. This would give additional strength to the tunnel. We would also need to make grout on site. Grout is a mixture containing cement, sand, water and other additives, which is used to fill the small gap between the outside of the tunnel segments and the soil around it. This minimises any risk of the ground above the tunnel moving or ‘settling’. The component parts of the grout would be stored on site.

TBM decommissioning
When the TBM arrives at the reception shaft we will disassemble it and lift it out of the shaft. We will then remove it from the site.

Key parts of a TBM

What is a tunnel boring machine?
A tunnel boring machine (TBM) excavates a circular tunnel using a rotating cutterhead, while simultaneously creating a tunnel wall using concrete segments. As it excavates it also transports material backwards via a conveyor belt or pump, which is progressively extended as the machine moves.

Build

Works at main tunnel reception sites

At a main tunnel reception site there are three key activities that would take place:

Shaft construction
We need to build a shaft, which is a concrete cylinder with a 15-20m diameter about 30-65m deep. The size and depth of each shaft vary depending on:
- the size and depth of tunnels that need to be connected into the shaft
- the hydraulic structures that need to be constructed in the shaft.

Lining the tunnel
Like main tunnel drive sites, we will construct the secondary lining of the tunnel from the main tunnel reception sites.

Our main tunnel reception sites also have other functions. For example, Acton Storm Tanks is a main tunnel reception site but it is also a CSO site. Chambers Wharf is a reception site for the TBMs that have to come from Kirtling Street and Greenwich Pumping Station, and it is also used as a main tunnel drive site to drive the main tunnel to Abbey Mills Pumping Station.

Conveyor to take excavated material back to the drive site

Ventilation system

TBM cutterhead

Tunnel segments constructed behind the TBM

Tunnel segments delivered to TBM
Phase two consultation preferred tunnel route and sites

- Acton Storm Tanks
- Hammersmith Pumping Station
- Barn Elms
- Putney Bridge Foreshore
- Dormay Street
- King George's Park
- Carnwath Road Riverside
- Falconbrook Pumping Station
- Cremorne Wharf Depot
- Chelsea Embankment Foreshore
- Kirtling Street
- Heathwall Pumping Station
- Albert Embankment Foreshore
- Victoria Embankment Foreshore
- Blackfriars Bridge Foreshore
- Shad Thames Pumping Station
- Chambers Wharf
- Earl Pumping Station
- Deptford Church Street
- Greenwich Pumping Station
- King Edward Memorial Park Foreshore
- Bekesbourne Street
- Abbey Mills Pumping Station
- Beckton Sewage Treatment Works

Site types:
- Main tunnel drive site
- Main tunnel reception site
- CSO site
- Short connection tunnel drive site
- Long connection tunnel drive site
- System modifications

Main tunnel
Connection tunnels
Lee Tunnel (under construction)
A typical construction site

All of our construction sites will be different, depending on their surroundings, the type of site and the methods of construction to be used. The site layouts will also vary throughout construction as the activities change. There are different ways to construct shafts and tunnels. The methods that we use will depend on the size and depth of the shaft, as well as the ground conditions at the site.

Main tunnel drive site

This is an illustration of a typical construction site for a main tunnel drive site. It explains the key components of the site. The site setup for a long connection tunnel drive site is the same as for a main tunnel drive site but on a smaller scale.

We will store precast concrete tunnel segments near the shaft so they are ready to be lowered down to the TBM. The segments are joined together inside the tunnel to form the circular tunnel wall.

The shaft is a circular, deep hole in the ground that is the entry point for the TBM. It is used to lower tunnel segments and to remove excavated material.

Where we are tunnelling in chalk, we will pump the paste-like ‘slurry’ out of the tunnel in a pipe to an excavated material processing area. At other sites, the excavated material will come out of the shaft by conveyor.

At main tunnelling sites we will provide limited parking to service the site and offices.

We will use a workshop and storage area to carry out routine maintenance on the TBM and other equipment on site, and to hold spare parts and tools.

At main tunnel drive sites and Greenwich Pumping Station connection tunnel drive site, we will house the gantry crane, shaft and segment loading bay in a shed to keep noise to a minimum during 24 hour working.

These tanks and buildings are for processing the excavated material removed from the tunnel. This shows the type of process we would require for slurry (material of fluid or paste-like consistency) that will be removed when we are tunnelling in chalk in the east.

At sites where we are not tunnelling in chalk, the excavated material processing will be a much smaller and simpler operation.

We need to provide welfare and office facilities for the engineers and construction staff working on the site. Welfare facilities include a room to eat meals, a first aid room, toilets and a room to wash.

Conveyors are used to load the excavated material onto the barge. We will cover these conveyors if our noise assessments show that we need to.

At sites where we are not tunnelling in chalk, the excavated material processing will be a much smaller and simpler operation.

*This illustration is indicative only and subject to detailed design by the contractor.
A CSO site in the foreshore
This is an illustration of a typical construction site for a CSO site in the foreshore. It explains the key components of the site. The site layout and some components will vary depending on methods of construction.

A temporary ‘cofferdam’ is constructed around the outside of the working area using sheet piles. The cofferdam stops water from coming into the site. The inside of the cofferdam is temporarily filled with material to create a safe working area. At the end of the construction period, the temporary area will be taken away and the smaller, permanent area will be left. This will be surrounded by a new length of river wall.

A drop shaft needs to be constructed to take the flows from the existing sewers down to the new tunnel. The method of construction of the drop shaft depends on the size, depth and ground conditions.

Cranes would lift materials into and out of the shaft.

We need to store material that is excavated from the drop shaft for short periods of time, before it can loaded into a barge or lorry for removal from the site. On sites in the east, where we will be excavating chalk, the area required for processing and handling excavated material is much larger.

Silos may be needed for storing cement and equipment to make concrete for construction of the drop shaft.

Containers are used to store equipment and spare parts.

This barge is sitting on a ‘campshed’, an area created on the riverbed for barges to rest at low tide. At high tide, the barges float and can be taken away.

We need to provide welfare and offices facilities for the engineers and construction staff working on the site. Welfare facilities include a room to eat meals, a first aid room, toilets and a room to wash.

*This illustration is indicative only and subject to detailed design by the contractor.
An inland CSO site
This is an illustration of a typical construction site for a CSO site away from the river*. It explains the key components of the site. The site layout and some components will vary depending on methods of construction.

Silos may be needed for holding concrete that can be sprayed onto surfaces. This is likely to be used to construct short connection tunnels in the west.

Containers are used to store equipment and spare parts.

We need to store material that is excavated from the drop shaft for short periods of time, before it can be loaded into a lorry for removal from the site.

Cranes would lift materials into and out of the shaft.

We need to construct a drop shaft to take the flows from the existing sewers down to the new tunnel. The method of construction of the drop shaft depends on conditions.

Precast concrete segments, which are used to build the walls of the drop shaft.

Related documents
Project information papers
- Odour
- Managing construction
- Design
- Site selection
Site information papers

*This illustration is indicative only and subject to detailed design by the contractor.

For further information see our website: www.thamestunnelconsultation.co.uk or call us on 0800 0721 086.
Phase two consultation (Autumn 2011)