London Borough of Greenwich

Greenwich Council

Greenwich and Woolwich Foot Tunnels

Feasibility Study for Refurbishment

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Hyder Consulting

London Borough of Greenwich

Greenwich Council

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1 Summary

This report, commissioned by Greenwich Council, describes the proposals for the refurbishment of the foot tunnels beneath the River Thames located at Greenwich and Woolwich.

The Greenwich and Woolwich Foot Tunnels were originally constructed to the design of Sir Alexander Binnie in 1902 and 1912 and are 371 and 504 m long respectively and 3.3 metres in diameter. The tunnels are 15 metres beneath the River Thames. The tunnels were constructed from shafts built in cylindrical steel caissons from where they were driven in Greathead Shields in compressed air beneath the river and lined with cast iron rings. The tunnels and shafts are lined with concrete and faced with white ceramic tiles and the inverts are paved. Access to the tunnel is provided down the shafts either by spiral stairs or by lift. Each shaft is capped with a circular top works building constructed of brick, stone and reconstituted stone masonry with a glazed roof and a cupola of either cast iron or timber, which houses the lift motor room. The tunnels are Grade II listed buildings.

The tunnels are to be refurbished to meet the following objectives:

- Improvement in the environment for tunnel users;
- Provide improvements where possible in access for the disabled in accordance with the principles set out under the DDA;
- Extend the service life of the two tunnels as infrastructure assets;
- Conservation of the heritage structures;
- Presentation of the structures both visually and in the provision of interpretation.

These objectives are to be met by carrying out works as follows:

- Initially the tunnel is to be the subject of inspection, investigation and assessment to determine the overall condition and the extent of the works in detail;
- Water management to restrict and control the influx of ground and river water by injection and drainage of the complex;
- Replacement and repair of areas of the tiled lining;
- Replacement of the paving and kerbs in the Woolwich Tunnel and repairs to the kerbs and paving in Greenwich Tunnel;
- Repair and repainting of steelwork in the shafts and top works buildings;
- Repair and replacement of damaged or weak brick, stone and reconstituted stone to the top works buildings;
- Installation of new glazing to the domes of the top works buildings and refurbishment of the cupolas;

- Installation of a new cable management system to support and supply tunnel lighting, CCTV, public address and other electrical supplies and services in the crown of both tunnels;
- Refurbishment of the lifts to improve reliability and efficiency and to provide for operation by users 24hours per day;
- The installation of improved communication systems, including CCTV, public address and help points, together with remote monitoring and control from a new control room;
- The installation of new electrical and mechanical systems and services and new lighting throughout to include feature lighting around the topworks;
- Completing the refurbishment in time for the rehearsals for the 2012 Olympics.

2 Introduction

The foot tunnel at Greenwich provides a pedestrian link beneath the Thames between West Greenwich, in Cutty Sark Gardens and the Isle of Dogs, in Island Gardens. The foot tunnel at Woolwich provides a similar link between Woolwich and North Woolwich next to the Woolwich Ferry. The Greenwich and Woolwich tunnels were built in 1902 and 1912 respectively, of broadly similar design and construction, to a design by Alexander Binnie and Partners. Both tunnels served a similar function, allowing people living in Greenwich and Woolwich to reach the Milwall Docks and Royal Docks respectively, without relying on ferries.

This report presents the findings of the desk and feasibility study for the refurbishment of the two tunnels commissioned by Greenwich Council.

2.1 Description of the tunnels

The Greenwich and Woolwich tunnels are approximately 371 m and 504 m in length respectively, at a depth of approximately 15m below the Thames and have an internal diameter of 3.3 m. The tunnels have shafts at each end, which provide access either by a spiral staircase running down the internal face of the shaft or by a centrally located lift.

Fig. 2.1 View of the north top works building on top of the shaft to Woolwich Foot Tunnel. Note that, the south Greenwich Foot Tunnel building is shown on the cover sheet.

The shafts were constructed by sinking steel caissons with a shoe on the bottom edge. The bottom of the caisson was plugged with concrete and the inside of the caisson was lined with concrete faced with white ceramic tiles. Steelwork constructed within the shaft provided support to the spiral staircase and the lift shaft. The spiral staircase is manufactured with cast iron treads and landings and spans between the steel stringers on the shaft wall and the lift shaft.

Fig. 2.2 View up part of the spiral staircase at Greenwich.

The lifts in the Greenwich tunnel were first installed in 1906, but the Woolwich tunnel was provided with lifts from the outset. The lifts were replaced in 1992 with the present lifts designed and manufactured by Express Lifts. The new lifts retain the original timber lining from the earlier lifts. The lifts are approximately hexagonal in plan.

The lift motor rooms serving the lifts are located on floors above the lift shafts in the top works buildings. These buildings comprise a cylindrical single storey red brick structure with stone and reconstituted stone dressings and are roofed with domes. The Woolwich buildings have separate entrances for the stairs and the lift, one of which is provided with a porch of cast iron, steel, timber and glass. The Woolwich buildings are provided with windows, where Greenwich has none. At Greenwich the fully glazed hemispherical domes have radial steel frames and are surmounted by small cast iron cupolas. The domes at Woolwich are generally similar, but are smaller and flatter, only partially glazed and provided with timber cupolas.

The tunnels were driven from the foot of the shafts and slope down beneath the river. The tunnels have bolted cast iron linings, which are internally lined with concrete and are in turn faced with white ceramic tiles. At the foot of the tiles a stone kerb has been provided, which at Greenwich is of granite and at Woolwich sandstone. The inverts to the tunnels are filled with concrete, which surround various services. The tunnel floor laid on the invert is of York Stone in the Greenwich tunnel and of pre-cast concrete slabs are granolithic faced in the Woolwich tunnel. The Woolwich tunnel has received more than one application of a non-slip coating.

Fig. 2.3 View through Greenwich Foot Tunnel.

A bomb falling on the Isle of Dogs foreshore in September 1940 breached the Greenwich tunnel. Temporary repairs to the tunnel were executed during the war years and involved placing a cast iron lining of smaller, 2.4 m, diameter within the bore of the tunnel over a length of approximately 20 m. The cast iron lining was left exposed.

Fig. 2.4 View of 'temporary repair' to Greenwich Foot Tunnel showing the exposed cast iron lining.

Services through the tunnels comprise power, lighting, CCTV, water, ventilation and drainage. The tunnels also carry some other services. Power for the tunnels systems is provided from both ends giving a degree of redundancy in the event of failure. Lighting is by discharge tube units each alternately powered from the two power supplies and fitted with emergency lighting units. A total of 14 fixed CCTV cameras are provided in the Greenwich tunnel, with slightly fewer in the Woolwich tunnel, and are capable of being monitored by the lift operators. The images from the cameras are recorded on site and records are kept for 30 days. There are hydrants, providing a water supply within the tunnel for maintenance and emergencies. Forced ventilation is provided from fans located in the shafts ducted into pipes located in the invert from where air is discharged via a duct in the crown at Greenwich or via discrete ducts at Woolwich. Both tunnels are provided with drainage sumps at their lowest points and with pumps to clear any accumulation of water. These pumps are relatively modern.

2.2 Refurbishment of Greenwich and Woolwich Tunnels

The refurbishment of the tunnels is divided into several areas and disciplines as follows:

- Access and Way Finding;
- Structural and civil engineering;
- Lift (vertical transportation) engineering;
- Communications and control systems;
- Mechanical and Electrical Engineering.

It is noted that, in considering the above, there is significant interaction between the disciplines.

2.3 Function of the Feasibility Study Report

The function of the feasibility study report will be to present for consideration the works required in the refurbishment of the two tunnels to achieve the objectives below and to make recommendations for the works. In each area described above the advantages and disadvantages of undertaking different levels of work and different approaches to the work are to be considered. These options are to be considered with respect to the following:

- Extending the life of the infrastructure provided by the tunnels;
- Major maintenance and repair;
- Improving the condition and quality of the tunnels to enhance the experience of the tunnel users;

- Environmental impact of refurbishing the tunnels;
- Health and safety of undertaking the works with the tunnels continuining in service and the implications of closure during the works;
- Programming and construction of the works for completion in time with the Olympic timetable;
- Assessing the cost of refurbishment the various options and the means by which these works might be delivered;
- Drawing conclusions and making recommendations for the options to be adopted and the actions to be taken to deliver the project.

3 Conservation

The buildings of both the Greenwich and the Woolwich Foot Tunnels are Grade 2 listed. The top works building of the Greenwich Foot Tunnel is located close to the Cutty Sark and is within the World Heritage Site of Maritime Greenwich.

The proposed refurbishment of the two foot tunnels will require listed building consent.

3.1 Listed Building Consent

Works on the fabric of the tunnels or within the curtilage of the tunnels will require listed building consent unless they constitute essential maintenance and are a like for like replacement of the existing. Notwithstanding this, it is prudent to consider initially that, all works will require listed building consent and to consult with the conservation officer of the London Borough of Greenwich and English Heritage at the earliest opportunity.

It is noted that, whereas the granting of listed building consent is a power delegated to local authorities in general, the London Borough of Greenwich cannot grant listed building consent for a structure in which it has an interest. For the works on the tunnels listed building consent will be granted by the Government Office for London based upon advice and recommendations given by English Heritage and the conservation officers. In each case the tunnels cross the boundaries of the London Borough of Greenwich into the adjoining boroughs of Tower Hamlets and Newham with respect to Greenwich and Woolwich respectively. Hence, it will also be necessary to keep both these authorities informed and to seek the agreement to the works of the conservation officers for these two boroughs. Owing to the peculiar nature of obtaining consent for works on these buildings, the normal criteria with respect to granting consent and the associated time periods no longer apply.

3.2 Philosophy and Approach to Conservation

The conservation and restoration of the tunnels requires the adoption of an appropriate response to the demands for a functional asset of historic importance and in the case of Greenwich located within a World Heritage Site. The principles to be adopted in relation to the works are, where possible, firstly works shall cause the minimum intrusion into the fabric of the tunnels; secondly works shall constitute an ‘honest repair’; and the works shall be reversible where they constitute an alteration. A further tenet for the works will be that materials and fittings introduced into the tunnels will be in character with the tunnels and the age of the tunnels.

4 Access and Way Finding

Access to the tunnels is by diverse routes. The entrances to Greenwich tunnel are located as noted in the Cutty Sark Gardens and the Island Gardens, from where the tunnel crosses the river at a slight angle. The entrances to Woolwich tunnel are quite different being located in the return in the nearby leisure centre in Woolwich and on the reserve in the centre of Pier Road in North Woolwich. The latter is a result of historic development as the entrance to the tunnel once sat next to the ferry terminal in Woolwich at the side of the access road and in North Woolwich sat on the footway on the north side of the road opposite the ferry terminal. The original ferry terminal was moved with the introduction of the present ferries in the 1960’s.

Access and way finding is about several criteria summarised as follows:

- The provision of signing from key locations to the tunnels;
- Provision of access for the disabled (DDA);
- Fire strategy;
- Passive way finding and presentation.

4.1 Survey of tunnel use

The results of the survey of tunnel use are included in Appendix 1 to this report. The surveys are made from counts of the users observed on the CCTV records.

Users of the tunnels come into three principal groups, which may be summarised as use for the following:

- Work or business use, including commuting;
- Domestic purposes, including shopping, etc.;
- Leisure and tourism.

The Woolwich Tunnel is heavily biased towards the work, business and domestic users, whereas the Greenwich Tunnel is spread across all three. In the case of Greenwich, Canary Wharf appears to be the destination for a high proportion of users, but at weekends the use would appear to shift to towards visitors to Greenwich.

A survey of tunnel use taken over a period of 4 days at the end of October 2007 indicated daily use of the tunnel of about 2000 a day rising to over 3000 at weekends for Greenwich and less than 2000 a day falling to over 1000 a day at weekends for Woolwich. Cyclists represented 10% of on weekdays at Woolwich falling to 5% at weekends and at Greenwich up to 30% falling to circa 10% on Sunday. At Greenwich on weekdays peaks occur morning lunchtime and evening and at weekends use is high from late morning to early evening. At Woolwich a similar pattern can be seen with steady use through out the day at weekends with a small peak in the morning. Cyclists appear to follow similar patterns with the exception of Greenwich where cyclists outnumber pedestrians circa 2 to 1 during the morning peak northbound and similarly during the evening peak southbound, suggesting a heavy bias towards commuters at these times. The figures quoted represent a snapshot taken outside the full tourist season, but are expected to be reasonably representative.

It is noted that, the only alternative route for cyclists is provided by the Woolwich Free Ferry as the DLR does not permit bicycles.

Further surveys are to be made over the forthcoming Easter period over a similar period of time. In addition this new survey will identify disabled users, where possible.

4.2 Signing

The existing signing has been reviewed and new signs have been proposed for each of the approaches to the tunnels. These approaches are as follows:

- Pedestrian Directional Signage – Greenwich North Side;
- Pedestrian Directional Signage – Greenwich South Side;
- Pedestrian Directional Signage – Woolwich North Side;
- Pedestrian Directional Signage – Woolwich South Side;

This signage extends to Mudchute and West ferry to the north; Greenwich Station and the entrances to Greenwich Park to the south of Greenwich Tunnel; Albert Road, Pier Road and King George V Station to the north; and Woolwich Arsenal Station and the streets radiating from the ferry on the south side of Woolwich Tunnel.

4.3 Disabled access

The tunnels are at this time accessible to the disabled, but there are several limitations upon access, not least the length of the tunnels, which will prove beyond the range of some disabled people. For this group the DLR will provide an alternative means of crossing the river at Greenwich and in the future at Woolwich from 05.30 until 00.30. At this time the alternative method of crossing the river at Woolwich is provided by the Woolwich Free Ferry from 06.00 until 20.00 daily.

The provision of lifts at each shaft and in each tunnel, with level access from the outside, has resulted in the tunnels inherently providing a degree of access to the disabled. The lifts have not been designed for disabled access and there are deficiencies both within the lift cars and on the landings. In part a deficiency arises from the limitations on times during which the lift is available. Making the lifts available at all times would significantly improve access for the disabled. These particular issues are discussed in greater detail in the section on lift engineering.

Once within the tunnel the 1 in 15 gradient of the Greenwich tunnel and the initial 1 in 17 slope at the south end of the Woolwich tunnel exceed the recommended 1 in 20 slope for wheelchair access. Although the Woolwich tunnel more nearly meets the requirements overall, the length of the slopes in both tunnels would require the provision of landings. Notwithstanding this, departures from standards have accepted ramp gradients of up to 1 in 10. Thus the tunnels might be expected to be capable of being accessible to wheelchair users, albeit with some difficulty.

For the disabled the spiral staircases do not provide a viable means of escape in the event of an emergency. The only means of escape would under these circumstances be the lifts or stair climbers, which would require that the appropriate provisions be made. The normal requirement would be for the provision of a safe refuge for the wheelchair users and carers. The estimated peak number of tunnel users of 200 suggests that up to 6 disabled people could be in the tunnel at one time. A refuge for this number of wheelchairs and people would be substantial and there are no locations within the tunnels or shafts adequate to provide such a refuge. Notwithstanding this, the most likely emergency would be fire, which would be restricted to the lifts and lift motor room as the tunnel is and can be made to be very low risk. Thus the tunnel could provide an adequate safe location under these circumstances, although smoke would be a potential residual hazard and would therefore need to be dealt with at source i.e. with in the infrastructure of the top works buildings.

It is with respect to the disabled that the greatest concerns are raised in the event of fire. Thus there is a need to develop a fire strategy for the tunnel, for which gaining the agreement of the London Fire and Emergency Planning Authority (LFEPA) would be desirable.

To fully comply with current regulations and legislation for disabled access would require major works, which are considered impractical as they would amount virtually to reconstruction of the tunnels. However, the tunnels do provide a level of access for the disabled, albeit not fully complying with the current requirements of DDA. This non-compliance is not unusual in historic structures and nearby examples include Flamstead House, part of Maritime Greenwich, where access for the disabled is not possible to the Octagon Room. This example is relevant only in the context of tourism and leisure, but much of the historic road and rail transport infrastructure of London is similarly not accessible to the disabled at this time.

4.4 Provisional Fire Strategy

The purpose of this section of the report is to provide a provisional fire safety strategy for the Greenwich and Woolwich foot tunnels. The fire strategy will need to be further developed in conjunction with Greenwich Council and the relevant fire officers and issued as a separate report.

The tunnels are manned during the hours 07:00 to 19:00 Monday to Friday five days a week; however, the tunnels are open for public access 24 hours a day 365 days a year.

In order to understand the likelihood of a fire in the tunnels we have identified the risk and analysed the potential for harm to the public using the tunnels, as well as the damage to the structure. Currently, there is no automatic detection for fire at either of the two foot tunnels. Any means of detection relies either on the operators reporting an incident, when on duty or the general public reporting an incident

This section provides a provisional strategic review of the risk of a fire within the foot tunnels and the areas within the tunnel were the risk is at the highest; see Table 1.

The basis is for the safe evacuation and means of escape for ambulant persons and facilities for the evacuation of non-ambulant persons.

The areas of risk considered are:

The entrance to the foot tunnels at street level including the lift motor rooms above the lift cars and the stairs between street level and the foot tunnel.

The bottom of the lift as it merges with the foot tunnel.

The foot tunnel and the sump pumps.

Following on as a strategic document, produced on the basis of available guidance and discussions with interested parties, this document will set the requirements for;

- Means of warning and escape
- Fire spread and control
- Controls and Fire Brigade facilities

This section will not offer full details of all works involved to achieve these requirements. Details of the actual work involved in realising the requirements of this strategy will appear in detailed fire discipline specific design outputs as a result of a detailed fire safety strategy.

4.4.1 Fire Risk

In order to access the risk of a fire or incident both tunnels have been divided into three discreet areas as outlined above. We have analysed each of these areas, and for the purpose of this report we have identified the level of risk to each location.

Greenwich and Woolwich Foot Tunnels		
Location	**Risk**	**Management of the Risk**
The entrance to the foot tunnels at street level.	The entrances are considered low risk. The structure is steel and brickwork	Provide automatic fire detection in the entrance area.
The lift car The motor rooms above the lift cars	Medium risk. Lift car and the lift motor room has combustible materials.	Provide automatic detection in the lift car. Provide automatic detection in the lift motor rooms.
Stair case linking street level to tunnel level	The staircases are considered low risk the structure is predominately steel and brickwork.	Provide automatic detection in the staircases.
Tunnel and area adjacent the lift entrance	The tunnel and the area adjacent to the lift car are considered low risk the structure is predominately steel, concrete and tiles.	Provide manual call point in the tunnel at the foot of the shafts.
Tunnel area near the mid point and the sump pump and controls.	The tunnel is considered low risk the structure is predominately concrete and tiles.	Provide manual call points in the length of the tunnel and engineer the pump assemblies to minimise fire risk.

Table 1

This provisional review of the risk will/should be developed in detail as part of the fire safety strategy.

As a result of this review it considered that it will be necessary to further develop this study and identify what actions would be required to safely evacuate the tunnels see Table 2.

4.4.2 Evacuation of the tunnel

This evacuation strategy is based upon the premise that a new control room is to be provided in the Greenwich tunnel area, and the surveillance is 24 hours a day 365 days a year or the control room will be manned when the tunnel is open.

For the benefit of this section we have stated that the:

- Lifts will automatically park at the bottom of the lift shaft; this is subject to further discussion on the merits of where the lift will park;
- Passengers in the tunnel will be advised to evacuate by the public address system via the entrance taking them away from the fire;
- In order for the public to clearly understand which route they are required to exit by, this will be carried out by way finding lighting or some other proven method.

Location	Detection and Evacuation Procedure
The entrance to the foot tunnels at street level.	Fire at the entrance will detected via the automatic detection system and reported to the control room. The operators will evacuate the public by the public address system and call the emergency services. Passengers in other parts of the tunnel will be advised to evacuate by the public address system via the other entrance. Lifts will automatically park at the bottom of the lift shaft and passengers will evacuate via the other entrance.
The lift car The motor rooms above the lift cars	Fire in the lift car and/or the motor rooms will detected via the automatic detection system and reported to the control room. The operators will evacuate the public by the public address system and call the emergency services. Passengers in other parts of the tunnel will be evacuated by the public address system via the other entrance. Lifts will automatically park at the bottom of the lift shaft and passengers will evacuate via the other entrance.
Stair case linking street level to tunnel level	Fire in stair case will detected via the automatic detection system and reported to the control room. The operators will evacuate the public by the public address system and call the emergency services. Passengers in other parts of the tunnel will be evacuated by the public address system via the other entrance. Lifts will automatically park at the bottom of the lift shaft and passengers will evacuate via the other entrance.
Tunnel and area adjacent the lift entrance	Fire in the area of the pumps (centre of tunnel) will be detected via the manual system and reported to control room. The operators will evacuate the public by the public address system. Passengers in other parts of the tunnel will be evacuated by the public address system via both entrances. Lifts will automatically park at the bottom of the lift shaft and passengers will evacuate via the other entrance.

Table 2

4.5 Presentation

Presentation of the tunnels is included under the heading of 'Access and Way Finding' as the presentation of the tunnel strongly influences the use of the tunnel. Presentation has numerous facets, not least of which are the cleanliness, standard of maintenance and general appearance of the tunnels as seen by the general public. Presentation in the context considered here is involved with attracting people to the tunnels, providing passive way finding, providing interpretation of the tunnels and encouraging ownership.

The aspects of presentation discussed here are as follows:

- Retention and enhancement of the lighting to the domes;
- Enhancement of lighting to the masonry of the top works buildings;
- Illumination of the approaches to the tunnels;
- Placing Greenwich Tunnel within the World Heritage Site of Maritime Greenwich;
- Providing interpretation of the tunnels as part of the built environment and within a historic context.

4.5.1 Cutty Sark Gardens

The south entrance to the Greenwich Foot Tunnel is located within the Cutty Sark Gardens, which since 1954 have housed the composite hulled tea clipper the Cutty Sark. The Cutty Sark is arguably the most famous ship in the world, ranking above the HMS Victory and the SS Great Britain, and together the surrounding gardens forms part of the World Heritage Site of Greenwich. The Cutty Sark although only part of the World Heritage Site is internationally renowned and annually receive many thousands of visitors from around the world. The Cutty Sark has reputedly received some 15 million visitors since undergoing the first restoration in 1954 and opening to the public.

The entrance to the tunnel is clearly visible from numerous points around the gardens and not least from the port bow and side of the Cutty Sark. The tunnel is visited by many who are themselves visitors to Greenwich, rather than those commuting to work or otherwise involved in domestic tasks or trips. The Cutty Sark Gardens highlight the need for presentation and interpretation of the facility to a high standard commensurate with the tunnels surroundings.

4.5.2 Lighting

Exterior lighting within the dome, the exterior of the buildings and the approaches is probably the most obvious aspect of presentation, but will be evident only for part of the time. On the other hand the interior lighting is visible at all times and has a strong bearing on people's perception of the tunnel.

For the Greenwich Tunnel the illustration used on the Greenwich website shows the top works building in the Cutty Sark Gardens with the dome highlighted by green lighting within. This view will be familiar to many and is repeated on the north entrance in the Island Gardens. Standing on either embankment the link between the two buildings is obvious and a degree of passive way finding is provided. In daylight a similar level of passive way finding is provided by the inter-visibility between the two buildings and their identical appearance. It is strongly recommended that, this lighting be maintained and possibly enhanced to provide a clearer signature.

The Woolwich Tunnel also has a degree of inter-visibility between the two sites, albeit obstructed when the ferries are against the canting brows. The domes to the top works buildings are not fully glazed and in addition are flatter than those at Greenwich. Providing feature lighting to the domes may enhance the presentation of the Woolwich Tunnel, particularly if this is to be combined with re-glazing. The north entrance is clearly visible to those approaching from Pier Road, but the south is obscured to any approaching along the south embankment.

Below the glazed domes typically the tunnel buildings are provided with some lighting attached to the walls, with about 8 bulkhead lights around the perimeter of each. These lights are circular on Greenwich and rectangular on the south building of Woolwich, with none on the north. These lights might be enhanced to improve the visibility of the buildings and it is recommended that this approach be further investigated. However, the top works are listed buildings and any significant visible alteration needs to be carefully considered. Thus it may be preferable to provide lighting to highlight the masonry around the perimeter at ground level in the form of uplighters, which in turn may be let into the paving.

In the same way the approaches to the tunnel entrances through Cutty Sark and Island Gardens need to be considered as although acceptable during daylight hours they become less tenable after dark. There is general lighting around the Cutty Sark Gardens in the form of lamp columns with double luminaires, but there is little on the Island Gardens approach. It is recommended that, this lighting be reviewed and consideration be given to its enhancement, possibly by the use of uplighters set into the ground to minimise the impact on the site. This lighting will need to be considered in the context of proposals for the lighting of the Cutty Sark following completion of the reconstruction work.

At Woolwich the requirements are somewhat different with street lighting being provided, but, whereas this is acceptable on Pier Road, on the south bank there is a need to consider and provide enhanced lighting to create a comfortable environment. Thus, this should be the subject of further investigation.

Lighting within the tunnel must also be considered in the context of presentation, providing lighting of a quality and level commensurate with the location. General lighting levels need to be brought up to those currently acceptable and recommended for subways in prestigious areas and there is a need for transitions in lighting levels to be provided at the entrances. These transitions can be varied in level to match ambient conditions. The intention being to create lighting levels at all times that provide confidence to tunnel users.

The opportunities for lighting are discussed in more detail in the chapter on mechanical and electrical engineering.

4.5.3 Interpretation

The two tunnels provide a unique opportunity and considerable scope for the provision of interpretative information on several interrelated topics in the context of the locations of Greenwich and Woolwich:

- The history of the Thames from fishing villages to commercial docks;
- The history of transport on and across the Thames;
- The development of docklands;
- The building of the tunnels;
- The story of the tunnels and the damage suffered during World War II.

Greenwich provides the more extensive sites for interpretation panels as there are external areas, spaces within the top works buildings and the cladding that will be placed in the bomb damaged section. The smaller buildings at Woolwich may provide some opportunities, together with the areas immediately adjacent to the buildings. In both cases interpretation panels might also be fixed to the tunnel or shaft walls near to the lift entrances.

The interpretation of the tunnels provides the opportunity to inform visitors and the local community alike and to increase interest in the tunnels. The development of the interpretative material might involve local civic societies as well as more academic organisations such as the National Maritime Museum depending on the topic being considered. It is observed that, the Institution of Civil Engineers may be interested in making a contribution to the interpretation, as may Binnie, Black and Veach as successors to the original designers of the tunnels.

5 Structural and Civil Engineering Elements

The structural and civil engineering aspects of the works of refurbishment are quite diverse owing to the different structural forms and the range of materials incorporated into the two tunnels. Each principal area is discussed in terms and the requirements for the inspection and investigation of the two tunnels are set down.

5.1 Tunnels

The tunnels suffer from a range of problems that differ quite significantly between Greenwich and Woolwich, thus the two tunnels are generally discussed separately.

Within both tunnels there is a need to incorporate a new cable management system, which is discussed separately from the refurbishment of the interior of tunnel.

5.1.1 Greenwich Foot Tunnel

The most obvious defect in the Greenwich Foot Tunnel is the crazing to the glazed surfaces of the estimated 200,000 ceramic tiles lining the barrel from kerb to kerb. Combined with this there are numerous tiles and patches of tiles from which the surface has spalled in part or over the entire surface. Other defects include the accumulation of calcite deposits where water has percolated through and patches covered in coatings, apparently to obscure defects. The defects along the crown, which include breakage and corrosion of the cast iron duct and spalling and breakage of the hollow tiles either side of the duct are discussed separately under the heading of the cable management system below.

The feasibility of the refurbishment of the tunnel lining can be considered from practical, aesthetic and historic standpoints. The possible approaches are summarised below:

- Do nothing, but clean the tunnel lining;
- Carry out a programme of repair and replacement of damaged and defaced tiles, combined with the cleaning of the whole of the tunnel lining;
- Strip out the existing ceramic tile lining to the tunnel and install a new tiled lining using modern ceramic tiles to match the original lining;
- Strip out the existing ceramic tile lining to the tunnel and install a new enamel or polymer coated sheet metal or polymer sheet lining;
- Install a new enamel or polymer coated sheet metal or polymer sheet lining over the existing tiles.

The last solution has several virtues as it is the easiest to implement and can also be adapted to act as a drainage membrane conducting any water percolating into the tunnel to the kerb level. Such a lining can be easily maintained if damaged, can be used to carry other information and can be used to obscure services such as cables. The lining would be out of character with the tunnel historically and would detract from the heritage of the site. Placing the lining within the present envelope of the tunnel also has the disadvantage of reducing the interior space within the tunnel. Removing the tiles entirely to maintain the present envelope would be extremely costly both in time and funds resulting in a protracted closure of the tunnel to the public, which also mitigates against replacing the whole of the tiled lining.

Do nothing at the other extreme leaves the tunnel with a poor ethos of neglect, although structurally the tiles do not contribute to the stability of the tunnel and cleaning can be expected to be effective in improving the overall appearance. Even with the do nothing option it will still be necessary to develop procedures and processes that can at least stabilise the damaged areas and offer some improvement. At the crudest level this would be the use of coatings, but past performance has not been good.

The intermediate approach of combining cleaning with spot repairs offers the best opportunity of minimising the closure of the tunnel to the public, whilst executing an honest repair and satisfies the heritage criteria. Adopting this procedure damaged tiles will be cut back and new tiles will be inserted. The area of damage will need to be assessed by inspection, but it is suggested that where the face of a tile is more than simply crazed it will be replaced.

Within the bomb damaged section of the Greenwich Tunnel different criteria clearly exists as the original cast iron lining remains exposed. The presence and appearance of this section can be said to reflect the heritage of the tunnel and important historical events. On the other hand, from the perspective of tunnel users this section is relatively dark owing to the many corners and niches of the lining and has a poor ambience. Tiling to make this area match the remainder of the tunnel will reduce the internal diameter still further and may as a result have a negative impact. The alternative is to install enamel or polymer coated sheet lining, which can be attached directly with screws into the ribs of the cast iron segments, causing the minimum intrusion into the envelope. With a lining only at this section there is an opportunity to use the surfaces to carry interpretative information, possibly including the history of the tunnel and information about the ‘temporary repair’.

Within the tunnel at Greenwich the kerbs on either side are of granite and the floor is of York stone, both of which are generally in reasonable condition. Work on these elements will be restricted to local repair and replacement with materials selected to match the original and will be designed to be an honest repair. Metalwork in the form of covers and gratings are not in such good condition and will need replacement. The covers will be selected to match current standards, but will be of cast or malleable iron in character with the age of the tunnel.

5.1.2 Woolwich Foot Tunnel

Woolwich Foot Tunnel, as noted above, has quite different problems to Greenwich. The tiles are not crazed and overall are generally in better condition, thus cleaning and local repairs with new tiles provides the most efficient and economic solution. In Woolwich the real areas of concern are the floor and kerbs.

The floor is, as noted, of pre-cast concrete slabs, which have received at least two applications of a non-slip coating. The coating has been eroded and has left the worn surface of the slabs exposed. It is not clear why the coating was applied over what appears to be a granolithic substrate. It is apparent that the floor requires fully resurfacing to meet acceptable presentation and serviceability standards.

The kerbs in Woolwich are of sandstone, with a drip detail formed in the top edge. The kerbs are face bedded leaving the bedding exposed along the top edge to cause accelerated weathering owing to water and salts being introduced into this plane of weakness. Given the deterioration of the kerbs it is apparent that the kerbs are close to the end of their useful life, with the probability that weathering will accelerate in the near future. The problem of the weathering of the sandstone may have more than one cause that will be identified by petrographic examination. What is quite apparent is that the kerbs need to be replaced. Given the status of the tunnel, the replacement will need to be an honest repair and like for like. The deviation from this approach will be that the sandstone will be selected to be durable in the environment of the tunnel, will be naturally bedded as opposed to face bedded and will be bedded in lime mortar as opposed to Portland cement mortar.

To remove the kerbs and install new kerbs it will be necessary to cut back the paving along each side of the tunnel. Given this degree of disruption it is considered that paving throughout the length of the tunnel should be replaced as part of the same exercise. The replacement paving will need to be selected to provide an appropriate walking surface in character with the structure. It is unlikely that York Stone as used in Greenwich will be selected, but the finish to any pre-cast concrete slabs will need to be carefully considered.

5.2 Cable management system to tunnels

In both Greenwich and Woolwich Tunnels there is a need to accommodate the services and associated cables that are to be installed as part of the refurbishment of the communications, controls, mechanical and electrical systems. At this time, these services are accommodated in steel conduits mounted on the surface at the crown of the tunnels. These conduits are severely corroded and are at the end of their useful life, with some having already been replaced or superseded. As part of the refurbishment it is suggested that a single cable management system is designed and installed to contain the cables and support the lights, the cameras, the public address system and any other associated equipment.

The most appropriate location for these services remains the crown of the tunnel. In Greenwich the crown is occupied over most of the length by the cast iron ventilation duct, to either side of which are hollow tiles. The removal of the duct and the cutting back of the adjacent tiles to the cast iron tunnel lining provides an adequate space for the services to be accommodated, together with any future provisions that might be reasonably considered.

The cable management system is envisaged as pultruded fibre reinforced phenolic resin polymer sections. These will comprise an upper section forming an inverted 'U' with a closure panel fitted flush with the soffit. The closure panel will support the equipment which will be directly mounted or recessed into the soffit panels. Lighting units can be surface mounted, partially or fully recessed into the duct to give optimum performance and ease of maintenance. As the basic material is black or brown it will be coated to provide an acceptable finish. Systems of this type are gathering increasing acceptance owing to their durability, freedom from maintenance and ease of handling, being considerably lighter than steel. In the United Kingdom these system can be produced by Exel Composites in Runcorn and Pipex in Plymouth or from Europe supplied by Fiberline in Denmark.

The cable management system of the Woolwich Tunnel will be similar to the Greenwich Tunnel. The lifting of the floor in Woolwich does offer the opportunity to replace the service ducts and pipes within the invert, which will confer a longer life and greater reliability upon these facets of the infrastructure.

5.3 Shafts

The shafts of both tunnels exhibit evidence of water percolation, damage to tiles and are generally comparable to the tunnel linings. The shafts at Woolwich seem to be more severely affected. With the exception of the severe leakage in the North Woolwich shaft the process and procedures for repair will follow generally similar lines to the repairs for the tunnels. In the North Woolwich shaft it may be necessary to break out the lining to effect a repair to the pipes embedded in the shaft wall.

A particular issue in relation to the shafts is the flow of water into the lift pits. This appears to have increased in recent years as the tiled floors beneath are no longer visible. A combination of measures is proposed to reduce inflow and manage water ingress, which measures are discussed elsewhere in this report.

5.3.1 Steelwork and metalwork to shafts

The metalwork in the shafts is extensive as it includes the stringers to the staircases, the stairs, the floor giving access to the lift at ground level and the steelwork surrounding the lift shafts. Much of this steelwork being within the structure has not suffered severe corrosion, but where the metalwork has been wetted by the influx of ground water corrosion has developed and has become severe. Numerous areas on the stringers are affected and have been distorted by the build up of corrosion products or in the worst cases have become perforated. Following investigation the source of the damage will be rectified and methods of repair will be developed. It is observed that, many early steels are not readily weldable and embrittle following heat treatment, but it is often possible to develop welding procedures that will provide a satisfactory welded repair.

5.4 Domes and top works buildings

The four domes are the items cited in the listing of the tunnels. The defects of these structures might best be described as weathering. Given the extent and nature of the works on these structures it is probable that during the works they may be encapsulated to create a weather proof enclosure and contain dust and lead.

5.4.1 Masonry of top works buildings

The masonry of the top works buildings comprises a mixture of stone, reconstituted stone and brick. These will be the subject of repair, conservation and restoration. These works are summarised as follows:

- Brick work – match existing bricks and source replacements, match existing mortar and develop a suitable mortar, cut out damaged bricks and inappropriate plastic repairs and set in new brick or brick slips;
- Stone masonry – match existing masonry and mortar and piece in or replace masonry components;
- Reconstituted stone – investigate unweathered areas of reconstituted stone and precast decorative units and develop and apply a matching cementitious coating to refinish weathered units.

5.4.2 Steelwork and metalwork to top works buildings

The steelwork including the ribs supporting the domes has been covered by the roofs and is appears generally to be in satisfactory condition. However the steel work is embedded into the brick masonry at several locations, where it will be necessary to subject it to careful examination as there is a risk of corrosion damage. The lift motor room floor will also be subject to some changes for which it will need to be assessed. However, it is envisaged that alterations and repairs will be relatively minor.

The cupolas surmounting the domes have always been exposed and difficult to access. The actual condition of the cast iron of Greenwich and the composite of materials at Woolwich is difficult to assess until full access is achieved. It must be anticipated that a range of skills will be used, including steelwork repairs, carpentry, cold repairs to the cast iron and painting.

5.4.3 Glazing and roofing to domes

The present glazing to the domes relies upon the existing glazing bar system, which is of some age, uses aluminium components on timber battens in combination with steel supporting members and frosted Georgian Wired Glass. The whole is single glazed and provides weather protection to the lift motor rooms. The arrangement does not provide any protection against heating by solar gain, hence, the domes suffer from severe green house effects.

The existing arrangements result in the lift motor rooms being subject to extremes of temperature, hence the plant and equipment is provided with both heating and cooling equipment to improve reliability. Costly failures and periods during which lifts have been out of service have been attributed to the operating conditions.

Improving the thermal efficiency of the domes results immediately in a reduction in the energy required for heating and ventilation and enhances the reliability of the systems. The glazing and the roofing also restricts access to the structure for maintenance and repair during the refurbishment, particularly any works associated with the cupolas. Thus, it is clearly evident that, replacing the glazing will allow the works overall to progress with greater certainty and to create an environmental gain by reducing the power required to achieve a stable environment.

The double glazed panels will incorporate Pilkington K glass to achieve the maximum improvement in thermal efficiency. Double glazing also uses toughened glass, which may be expected to improve resistance to damage.

The roofs on the domes at Woolwich will be stripped and the area of glazing will extend to the full extent of the dome, which will both improve the thermal efficiency of the installation and allow for the inclusion of lighting in the dome to improve the presentation of the tunnel.

During the refurbishment long term maintenance of the glazing will also be considered to fulfil responsibilities under the CDM regulations. The scale of the Greenwich dome in particular makes maintenance access difficult and although cleaning from a mobile elevating work platform might possibly be considered, this will not be adequate for other operations, including replacement of damaged panels or repainting of the cupolas. A purpose built gantry on each dome will satisfy the need and owing to the frequent requirement to clean the glass can be justified despite the need for annual certification. These gantries will comprise lightweight aluminium frames with a lightweight grillage decking of fibre reinforced polymer.

5.5 Painting and corrosion protection

In civil structures the primary purpose of painting is to provide corrosion protection to metal work by excluding air, water and aggressive agents. The finish coat provides protection to the paint system against the effects of ultraviolet light and ozone, but also has a decorative function. It is reported that, the metalwork has not been subject to a comprehensive repainting programme, hence given the age of the structure it is anticipated that much of the existing paint will now no longer adhere strongly to the substrate or provide effective corrosion protection.

Modern paint systems applied to correctly prepared surfaces can be expected to have a life before over coating of up to 20 years with some maintenance work being carried out after 12 years. It is anticipated that these will be applied to all the accessible metalwork within the tunnel complexes. Selection of appropriate paint systems will need to respond to the different environments within the complex. Temperature for application is unlikely to be a significant issue, but tolerance to moisture and high humidity will be of significance at many locations. Many of the spaces will be enclosed and so care will be necessary in selecting products that do not contain hazardous agents such as iso-cyanates. Unfortunately this will preclude that group of moisture curing polyurethanes most suited to application in this environment. Surface tolerant systems based on epoxy resins are tolerant to relatively high humidity, but are not tolerant when the humidity passes the dew point. These two systems are the ideal maintenance painting systems and ways of using them may be developed, but the final selection of a paint system will be the subject of further development. It is observed that, glass flake, recently used on Westminster Bridge and Forth Rail Bridge, will not provide a solution in this case, as although providing a high build and long life, it is not readily applied effectively to detailed and small section steelwork.

5.6 Water management

The management of water ingress into the tunnels probably represents the most difficult area to address effectively. It is generally recognised that, excluding water from buried structural complexes is neither practical nor economic and that even in new works some percolation should be anticipated. The original designers recognised this requirement and incorporated a drainage sump at the deepest point of both of the tunnels from which water could be pumped out. The designers of the Woolwich Tunnel went a step further, possibly as a consequence of problems observed in the Greenwich Tunnel, and provided a drainage detail along the top of the kerbs on either side of the tunnel. The emphasis of the water problems differs between the two tunnels, but there are common factors.

Greenwich and Woolwich Tunnels both suffer from percolation of water into the shafts. In Greenwich there is a particular problem of water percolating into the lift pits, whereas in Woolwich water percolation into the north shaft through the wall is of particular concern. In the latter case there appears to be a link with pipes carried up the shaft walls within the lining. Within the tunnels, Woolwich has relatively few leaks when compared to Greenwich, where leaks near the crown are relatively common.

At this time remedial action is seen to be desirable in several areas, but particularly to protect the lift pits and associated equipment within the shafts, to resolve the heavy seepage in the north shaft at Woolwich and to displace percolation away from the crown in Greenwich. Although the quality of concrete fill to the pans of the cast iron linings is notoriously poor, it is the cast iron lining itself and more specifically the effectiveness of the rust caulking and the lead grommets that is at issue. Rust caulking, by its very nature, is quite hard and brittle and lead may also embrittle and crack with time. This failure may have been prompted by the bombing during the Second World War as the docks and dockland in general represented a primary target. Indeed it is surprising that the two tunnels do not exhibit greater evidence of damage.

The water of the Thames is tidal, which results in the water at Greenwich and Woolwich being saline and liable to be aggressive to the metalwork of the tunnels. The tidal range of the Thames is in excess of 7.5 m, which together with the static head of about 15 m imposes pressures on the tunnel and shaft of over 1.5 to 2 bar.

Historically the Thames was highly polluted, although over the last 40 years the water quality in the river has improved considerably. During these early years the tunnels would have been subjected to a wide range of both organic and inorganic chemical agents liable to cause damage to the materials of construction. These agents will have been carried in solution, hence, would percolated into the tunnel.

Other aggressive agents will have been derived from the geology of the site and will include sulphates.

The combination of these chemical agents with the water pressure acting on the buried and submerged structure will have caused deterioration of the materials of construction and opened up drainage paths along lines of weakness in the construction. These problems are particularly evident in the shafts and lift pits. In the Greenwich tunnel they are also evident throughout the bore, but considering the age of the tunnel the problems are not seen at this time to be extreme. Percolation and the associated chemical attack are problems that tend to accelerate with time as paths are opened up and greater volumes of the aggressive agents are admitted.

The design and the undertaking of remedial works for these facets of the refurbishment will need to be informed by the condition of the materials and the extent of the defects. Thus detailed surveys, inspections and investigations will be required, which are described below.

5.6.1 Grouting and leak sealing

Water percolation is a consequence of there being an available water path or permeable materials within the components of the structure. The purpose of leak sealing and grouting is to attenuate the paths and to reduce permeability, recognising that achieving a waterproof structure is untenable. Grouting is a process commonly using cementitious materials in suspension to fill voids. The type of grouts used as the voids become smaller in size within the material changes in character to become less viscous. Low viscosity grouts tend to be polymer resins and are no longer cementitious. These will penetrate cracks as small as 0.2 mm wide.

The process of closing leaks in the crown of the Greenwich Tunnel will be the subject of trial but it is anticipated that low viscosity resins will be employed, possibly introduced by vacuum impregnation. The injected zone provides protection to the overhead services as well as improving the appearance and character of this highly visible zone.

Leak sealing within the tunnel will also form part of the general repair process in areas where damaged tiles are being replaced, with the opportunity being taken to seal the substrate to the repair area as part of the procedure.

The shafts will be subject to generally similar procedures with respect to tile repairs, although it is noted that, in some zones of heavy percolation works may prove to be more extensive. These problems will be identified as areas to be grouted are flushed, giving a clear indication of the probable magnitude of the repair and its extent. Within the shafts these procedures will commence at the bottom, pushing up the shaft. Investigations into heavy leakage in the shaft walls may require consideration of more intrusive works, for example the removal and replacement of existing pipes and conduits with the wall or their closure by grouting and substitution.

The problem of sealing leaks at the level of the lift pits may be more deep seated as the plug of concrete will have been placed into the base of the caisson possibly with the caisson flooded. The base of the caisson is also founded into the sands underlying much of the area and saturated. Given the potentially poor quality of this concrete plug grouting either within the mass of the concrete or below the foundation level may be the most effective approach.

5.7 Material and other investigations

The civil and structural engineering works require a detailed knowledge of the construction, extent and severity of defects and the materials of which the tunnel is comprised. The record drawings of the tunnels appear generally to be quite comprehensive in their coverage of the components of the tunnels, although there are areas of construction where details are less thorough. The first piece of the investigation will be to compare the records to the tunnels as built. This would involve carrying out what would normally be described as an inspection for assessment.

The inspection for assessment would include the following:

- Verify geometric data for all primary components;

- Verify details of construction and types of materials of components, principal dimensions and residual sections of materials;
- Inspect and record extent and severity of defects.

Having confirmed the accuracy of the record of the distribution of the materials throughout the tunnel it will be necessary to ascertain their characteristics, properties and condition. The materials may be divided into two primary groups, which may be described as metalwork and geomaterials. There is timber and glass, which will also need to be considered, but apart from some minor investigations, do not need to be investigated in great detail at this time.

With respect to certain aspects of the complex it is anticipated that it will be desirable to undertake a structural assessment similar to that carried out for bridges. This will form the last stage of the investigation and will be used as the basis of the design for structural remedial works, particularly where the residual section of structural components has become depleted.

A list of the materials and a summary of the investigation of each of the materials is presented below.

5.7.1 Metalwork

Metalwork may be divided into the following groups and investigations, in addition to visual and geometric inspections described above, are as follows:

- Structural Steelwork to floors, beams and trusses supporting landings, machine rooms and glazing within top works buildings and domes, investigate paint, remove tokens for micro-etch and carry out hardness surveys;
- Structural steelwork to caissons, investigate residual thickness, carry out micro-etch, chemical analysis and hardness on disc samples recovered by diamond coring to recover tile and concrete samples;
- Paint, survey of all exposed metalwork to ascertain residual condition of the paint, adhesion to the substrate and the presence and estimated quantities of lead in the paint.
- Cast iron linings, investigate residual thickness of pans of tunnel lining by drilling following removal of core through tile and concrete lining, using core bit recover disc sample for micro-etch.

Drilling and coring through the caisson and the tunnel lining will cause a breach and allow an influx of water. The smaller hole through the tunnel lining can be readily plugged by tapping a thread into the hole and inserting a plug. The larger hole through the caisson will be sealed using a drain type expanding plug before filling the hole with concrete.

The cast iron to the stairs will be investigated only by visual examination. Whilst carrying out the inspections of the metalwork any evidence of fractures or similar linear defects will be recorded and will then be subject to further inspection using magnetic particle or ultrasonic methods.

The results of the investigation will be used in the assessment of the capacity of some components and in the determination of the methods for repair. For example with respect to the structural steelwork the combination of results will be used to ascertain whether the materials can be welded or whether cold repair methods should be adopted i.e. bolting and riveting.

5.7.2 Geomaterials

Geomaterials are that group of materials having a direct geological origin that include cements concretes, reconstituted stones, bricks, ceramics and tiles and building stones. The tunnels include a variety of these materials, which will be the subject of petrographic examination of materials recovered as cores. These materials include the following:

- Cements, possibly including limes, used in concretes, brickwork and tiling;
- Concretes lining the caissons forming the shafts, forming the plugs to the caissons at the base of the shafts, lining the tunnels and used to fill the inverts;
- Bricks forming the top works buildings, which include Staffordshire blue brick as well as the more common red Wealden brick;
- Tiles forming internal surfaces to top works buildings, shafts and tunnels, which may be on either a terra cotta base or a refined yellow London brick earth base;
- Reconstituted stones forming dressings to the top works buildings;
- Building Stones, including lime stones, sand stones and granites.

Petrographic examination allows the condition of the microstructure of the materials to be examined for evidence of the presence of deleterious actions. The examination can also be used to identify deficiencies in the properties of these materials arising from inherent characteristics, arising from treatment in manufacture or from the presence of aggressive elements surrounding the component. Historically the waters of the Thames have proved very aggressive to concrete, resulting in significant loss of strength at many locations.

The cores and hand samples recovered from the tunnels may also be used to make an assessment of the strength of the materials.

5.7.3 Other materials

As noted other materials include wood and glass. These materials will be assessed principally by visual inspection, but it is anticipated that the glazing to the domes will be replaced. Where the glass is to be retained it is observed not to be of great age, hence the only concern will be the presence of any damage to the glass and the condition of the supporting materials. The timber will be examined for evidence of decay and the condition of any coatings will also be reviewed.

6 Lift Engineering

6.1 Lift cars

Aesthetically the lift cars which are 'Listed' are the same, wooden panels to the front and side walls other features of the interiors are bronze finish Car Operating Panels, TV Monitor displaying persons in the tunnel,

The car operator panel in each car is located on the left hand wall when looking from inside the car towards the lobby. They include Door Open, Door Close , Alarm , Operator pushes, Auto/Attendant key switch, Tunnel and Ground Call, Car overload LED's.

Fig. 6.1 Car Doors

6.2 Machine room

The machine room is located directly above each lift shaft and is entered via a stairway

The Express Lifts gearbox and motor is mounted on steel bedplates and whilst these machines have not been subject to excessive wear there are oil leaks emanating from the gear box and it was also evident that oil seals had been changed.

The lift controller is the Express ETQ 100 which is now obsolete. The direct drive system utilising Thyristor control technology is no longer the preferred system in the lift industry for this type of application.

The lifts position is controlled by an encoder that is situated on the over speed governor.

There is an emergency special hand winding facility that was developed for these lifts that enables one person to move the lift should there be catastrophic failure of the drive and this system must be part of the modernisation.

The lighting in the motor rooms are poor and do not comply with the current 200 lux standard

There is inadequate heating or ventilation in the motor rooms especially an issue at Greenwich as the glass dome acts as greenhouse effect on extreme temperatures during the year. Lift control systems have generally a temperature operating band of between 5 degrees Centigrade to 40 degrees Centigrade and therefore a system should be installed to maintain this requirement.

6.3 Door system and landings

The doors are power-operated four panel centre opening doors utilising an Express belt driven system. All locks, skates and door closure devices are Express equipment. The escutcheon plate (door release) is located in the top section of the left hand fast speed landing door and is of a triangular design.

Electronic 2D safety edges are fitted to the car doors to initiate door reversal in the event of an obstruction.

The landing doors are surrounded by steel full-depth architraves.

The obsolete belt operated door operator was slightly noisy and would certainly benefit from adjustment, but the landing doors have acceptable gaps between panels of up to 6mm.

The landing fixtures are not D.D.A compliant.

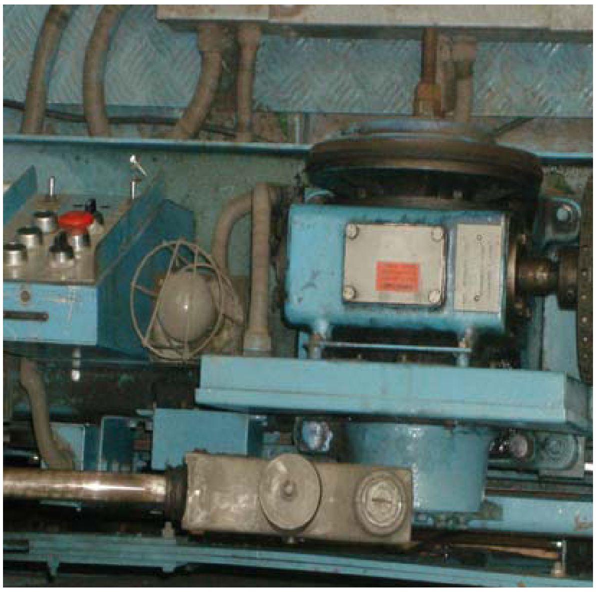

Fig. 6.2 Door Operator

6.4 Car top

The lift car top control box used by the service engineer to drive the lift from the top of the car during service is in working order and the emergency stop can be reached from the landing to gain control of the lift, but is not compliant with current standards.

Fig. 6.3 Top of Car Maintenance Control Unit

6.5 Lift shaft and pit

The lift shafts are circular in construction and are lit by bulkhead fittings connected in conduit, currently they do not produce an acceptable level of lighting.

Located in the pits of each shaft are energy dissipation spring buffers, four for the lift car and three for the counterweight. The governor tension device is also in the pit together with a counterweight guard.

There is concern as to the water ingress in the lift pits and this needs addressing immediately as it is causing severe corrosion of the spring buffers. Lift shaft corrosion is also a major concern and must be part of any structural remedial works.

Figs. 6.4 & 6.5 Lift Pit Water Ingress   Shaft Corrosion

6.6 Special features

There is a facility for the lift drivers that when they finish their working shift to park the lift via control box (see photograph) between floors to prevent vandals accessing the lift car.

Fig. 6.6 Lift parking control.

6.7 Reliability of existing lifts

The lifts were installed by Express Lifts, however Apex Lifts have been the incumbent maintenance company since September 2007.

The analysis of their records over this period indicates call backs on the Greenwich Lifts totalling 22 and on the Woolwich Lifts as 9. It should be stressed that a number of the calls at Greenwich were false calls however further analysis shows majority of the genuine calls were related to door locks, safety edges and controller issues and this data has been considered when compiling the modernisation strategy.

6.8 Shortfalls against current codes of practice.

The following items although not exhaustive were noted during the inspection and clearly indicate there are shortfalls against current guidelines.

- No functioning intercom between the inside of car and machine room.
- No alarm device located within the lift shafts to allow emergency release of person working in the shaft.
- Car emergency lighting was not ascertained.
- No three way Lift well lighting switching.
- Car interior not DDA compliant.
- Landing fixtures not DDA compliant.

6.9 Modernisation performance objectives

After assessing the condition of the existing lift installations against the required performance criteria of a further fifteen years acceptable service life, it is recommended a comprehensive modernisation be undertaken

The details in Appendix 4 describe the specification and brief that should be used to agree an acceptable scope of works and installation programme with a lift contractor to modernise the existing lifts.

The objective of this modernisation works is be to align the lifts with current health and safety expectations, improve reliability and reduce the risk of component obsolescence.

7 Communications and Controls

7.1 Introduction

A visual survey of the Greenwich and Woolwich tunnels was carried out on the 15th November 2008; the survey was carried out accompanied by Mr. Jeff Horsman from Greenwich Council.

The emphasis of the survey was to appreciate and understand what is currently provided in the Tunnels in relation to the communication and surveillance systems. This was to include, but not limited to;

- Current CCTV surveillance systems.
- Current emergency telephone systems (help points for the public)
- Existing telephone systems
- Existing ''leaky feeder'' cable installed in the Woolwich tunnel.

It is the intention of Greenwich Council to replace and enhance the existing systems to provide a safer and reliable public thoroughfare and understand the magnitude of the costs in upgrading/extending the existing systems.

7.2 Current systems

7.2.1 CCTV system

A CCTV system is installed at Greenwich and Woolwich and provides images of the following areas of the tunnels.

- The entrances at both sides of the Thames,
- The lift cars and to a certain extent the staircases down to the tunnel
- The foot tunnel.

As funds become available additional cameras have been installed in the stair case from street level down to the foot tunnel.

The images are viewed from within the lift car on a single monitor. The images are selectable and the images are recorded locally on tape.

The images at Greenwich are in general of a reasonable quality, Woolwich are not as good a quality. It is considered that the images would not meet the requirements detailed by the Home Office Scientific Development Branch (HOSDB) for recognition in any litigation, a copy of which is available at the end of this section.

7.2.2 Telephone systems

The lift cars are fitted with a telephone, allowing the lift operator to communicate with the management, emergency services or the maintenance organisation.

7.2.3 Leaky feeder system

A leaky feeder cable has been installed in the Woolwich tunnel, allowing communication between hand held radios in the tunnel and the surface.

7.3 Proposals

Greenwich Council has intimated that they would prefer to provide a central monitoring position for Greenwich and Woolwich Tunnels located at Greenwich, probably in the Cutty Sark Gardens car park. This would allow the lifts to be no longer manned and operated by the users. Thus the lifts would then be in operation 24 hours a day

In order to provide a high degree of security to the public, Greenwich Council are considering what systems could be provided to the public a high level of confidence in their safety. This level of security and confidence is currently achieved by London Underground Limited (LUL) at their stations by the provision of CCTV, Help points and public address systems. Considering these outline proposals and using a knowledge of LUL systems it is proposed that a similar arrangement be provided.

Following these principles, combined with a control centre manned 24 hour a day would provide the monitoring for the mechanisms by which this security and confidence can be achieved. The elements fulfilled by the control centre are as follows:

- Monitoring CCTV for both tunnels on video wall of the images transmitted from Greenwich and Woolwich;
- Monitoring and direct connection to help points to render assistance to the public, linked to the CCTV system;
- Provide a safe and secure location for recording the CCTV images, and the means of playback of an incident;
- Provide an access point into the public address system in order to make live announcements;
- Monitoring the fire alarm systems at both tunnels;
- Permitting access to input information into the public visual displays;
- Monitoring lift status to ensure the public lifts are operational and to assist in planned maintenance routines of the lifts;
- Receiving calls from lift telephones;
- Monitoring the status of the sump pumps for both tunnels;

- Providing a control and command centre in the event of an incident;
- Providing additional security for the Cutty Sark Gardens and the Cutty Sark.

7.4 Equipment Costs

The order of costs has been estimated to be is £360,000 (three hundred and sixty thousand pounds). In order to assess the magnitude of costs for the work involved, the following assumptions have been made:

- All existing equipment is redundant and will be replaced by new. As part of the detailed design, but this statement will be revisited as it may be possible that some of the existing equipment will be suitable for reuse;
- The cost below for the design, installation and commissioning of the systems;
- The costs are inclusive of staff training, both technical and operations;
- The cost does not include the cable management systems or other third party provisions i.e. fibre optic or other dedicated lines.

8 Mechanical and Electrical Engineering

The mechanical and electrical services to the tunnel include:

- Lighting;
- Power;
- Water supply;
- Ventilation.

These services are essential to the safe use of the tunnels, their maintenance and presentation.

8.1 Lighting.

The tunnels have no natural light, except in the top works buildings, and therefore the user needs to feel safe with the minimum levels of illumination needs to be maintained at all times. The existing lighting levels within the tunnels are not in compliance with today's standards which are summarised below.

Location	Day		Night	
	E	E min	E	E min
Subways				
Open			50 lux	25 lux
enclosed	350 lux	150 lux	100 lux	50 lux

Table 8.1 Abstract of BS5489-1:2003 Table 4 Lighting levels for subways, footbridges, stairways and ramps.

The current illumination levels within the tunnels fail to achieve the night time values for any area.

8.1.1 Design lighting level

It is proposed that the lighting levels within the building entrance, head of the stairway and upper level lift access points (threshold area) be maintained in accordance with the table above with transition down the stair way to a normal level of 150 lux during the day and 100 lux during the night time. These tunnels are of relatively small cross section and it is felt that to maintain 350 lux level may cause glare discomfort to the users if maintained at the high level throughout.

Lighting external to the building needs to emphasise the entrance domes on both sides of the river. The current thinking is to use up-lighters set in the ground around the entrance domes to compliment the illumination within the glazed domes. This, in conjunction with the signing and enhancements to the street lighting proposals provides a comprehensive ''entrance'' to the tunnels. The level of street lighting on the approach through the Cutty Sark Gardens will be decided upon as and when the latest proposals for presentation of the Cutty Sark are known, but at other locations the levels of lighting will be commensurate with current standards and practice for London. The minimum level of lighting should be no less than adjoining areas and meet the appropriate standards specified in BS 5489-1:2003.

8.1.2 Lighting level control

It is proposed that external lighting level control be provided for the threshold areas and the control should respond to daylight intensity should be incorporated in the entrance buildings.

Energy saving by the use of PIR along the length of tunnel will be used to reduce lighting levels during non occupied periods. The illumination level would then increase to normal level night or day level in a 'wave' surrounding a solitary user. Day and night lighting levels would be set by reference to external sensors.

The stair way lighting will form a transition between the lighting level at the entrance and the lighting level in the tunnel to assist the users to accommodate the varying lighting levels.

The lift motor room internal lighting shall be improved to the minimum requirement of 200 lux as described in the section on lift engineering. The dome lighting will be retained to identify the location of the building from across the river.

8.2 Drainage

8.2.1 Refurbishment of drainage pumps and controls.

The existing tunnel drainage pump system will be adapted to use submersible pumps with float level controls, and will include means of reporting levels and alarms to the new control rooms. At Greenwich the existing pumping main will be reused following an inspection, although it may prove necessary to clear and line the pipe. At Woolwich the main will be replaced. The control gear will be replaced.

All the drainage intakes within tunnels will be examined and repaired or replaced as necessary. The drainage water is considered to be substantially clean seepage as the Thames is now clean, but in the past water seeping into the tunnel would have been polluted.

The lift shaft pits will be provided with submersible pumps set in a sump and fitted with float switches to enable any shaft leakage water to be routed to the main tunnel sump before being pumped to the surface, sump alarms will be connected to the new control room.

8.2.2 Refurbishment of gravity drainage

Roof drainage for the domes and drainage of the areas outside the entrances will be examined, and refurbished as necessary. Special attention will be paid to down pipes embedded in the masonry and the integrity of the gutters will be assessed.

The foul drainage to the tunnel head buildings and the mess room will be inspected for integrity and the facility will be refurbished to meet current welfare requirements. It is noted that there are no public facilities associated with the tunnels.

8.3 Water Supply system

The water supply pipe-work will be inspected, tested and any necessary repair or replacement will be carried out to ensure that no leaks persist and materials meet current standards. In the Woolwich Tunnel the water main will be replaced throughout. In the Greenwich Tunnel the main will be tested and cleaned and lined if necessary. It is currently assumed that there will be no provision of fire fighting hydrants within the tunnel that would necessitate an increase of flow capability on the system. The water supply is to be provided purely for welfare and cleansing. It is observed that the mains within the tunnel are subject to an additional pressure of up 2 bar owing to the depth of the tunnels.

8.4 Environmental controls

A temperature controlled environment will be provided for the lift motor controllers within the domes, which will be in addition to the insulation provided by reglazing. The area subject to temperature control will be decided in consultation with the lift equipment manufacturer to establish the location, extent, overall heat dissipation and ambient working temperature of the equipment.

The need for forced ventilation to the tunnel is to be assessed further as part of the detail design, however it is considered that the existing system at Greenwich and Woolwich are less than effective. It is suggested that the system at Greenwich will be replaced and the space reutilised for electrical services. A similar approach will be adopted for Woolwich tunnel.

It is noted that there are options for the replacement of the ventilation system, but that the location of fans in the domes will be ineffective owing to the probable losses through the shafts and entrances. This results in a duct of some size with a cross section in excess of 0.5 m^2 being required taken well into the tunnel. The alternative of using small jet fans is not considered acceptable in this environment. Overall the tunnel appears to naturally ventilate quite effectively and it is concluded that forced ventilation is unlikely to be sufficiently effective to justify the installation and maintenance costs and the liability. There may from time to time be a requirement for extracting fumes and dust during maintenance, which can be best effected by portable plant.

8.5 Electrical services

The existing ventilation at Greenwich is to be removed and the space used for electrical services, a similar approach for Woolwich tunnel is to be further developed. A similar provision will be made in the crown of the tunnel at Woolwich.

The space once occupied by the ventilation system will support a new electrical service containment designed to suit the tunnel aesthetics and provide for:

- Lighting to the proposed level
- Location for CCTV cameras
- Location for the PAVA loudspeakers
- Containment for cables for lighting, CCTV, PAVA, help points and power

The choice of materials for the containment will meet the current fire regulations. Revised distribution arrangements for electrical systems will be included at the incoming locations for the mains. Although the two power supplies overlap through the length of the tunnels, they will not be duplicated to the extent where the lifts have a duplicated power supply.

Electrical service sockets for washing and cleaning will be fitted adjacent to the proposed help points within the tunnels. These will be 110V socket outlets with locking covers. Conventional 13 Amp sockets will be fitted for use of test equipment in the upper areas of the domes.

Dedicated lighting circuits will be provided for the dome feature lighting. Power supplies for external lighting of approaches and the perimeter to the buildings and of the buildings architecture will be provided.

Security for non–public areas will be provided by appropriate closures and contacts on all doors and gates and their status reported to the new control room. Security contacts for the main gates to the tunnel entrances will be provided but the gates will remain manually operated.

9 Environment, Health and Safety

The Environmental Assessment Form is included as Appendix 2 and the Initial Designers Risk Assessment is included as Appendix 3, where it is accompanied by details of the client's responsibilities under the Construction Design and Management Regulations 2007. The environmental and health and safety issues discussed below and outlined in the appendices represent a preliminary over view. As the project progresses, these documents will remain live to encompass any environmental and health and safety matters that may from time to time be encountered.

9.1 Environmental issues

Environmental issues can be considered from several different aspects in the context of the two tunnels. These are summarised as follows:

- Heritage issues relating to the status of the tunnels as listed buildings;
- Heritage issues arising from the location of the south entrance of Greenwich Foot Tunnel within the curtilage of the World Heritage Site of Maritime Greenwich;
- Energy savings that can be achieved from a review and improvements to the operation of the tunnel;
- Environmental savings achieved through selection of materials and processes in the refurbishment;
- Disposal of waste materials, including recycling of materials and disposal of contaminated materials;
- Prevention of contamination or damage to the River Thames.

9.1.1 Heritage and conservation

The issues relating to heritage are discussed in section 3 above, but are identified here as conservation and heritage are considered to have environmental impact. In this context it is noted that, the proposed works adhere to established principles for works of conservation and heritage.

9.1.2 Reducing the energy demands of the tunnels

The works on the tunnels will be designed to achieve several improvements and savings with respect to energy. These are summarised as follows:

- Installation of new AC motors and controllers for the lifts reduces the power demand; although the lifts will be working longer hours with more daily cycles the improvements are expected to represent some overall gain or at worst no increase in the use of electricity;

- Replacing the glazing to the domes with double glazing incorporating Pilkington K Glass; significantly reduces the temperature variation within the lift motor room and significantly reduces the demand for heating and cooling, leading to savings in electricity;
- Improvements to lighting and additional controls; although light levels will be higher than at present, the use of PIR systems to respond to people using the tunnel will result in savings in electricity use particularly during off peak and night hours.

9.1.3 Pollution and environmental impact of the works

Pollution and environmental impact overlap with several of the aspects of health and safety, particularly with respect to noise, dust and hazardous materials. Environmental concerns relate to the disposal of lead and any other hazardous materials that might be encountered, their segregation from other waste arising from the works and their transport and disposal at licensed tips.

The River Thames is also of concern as the works will need to be designed to prevent any risk of pollution to the water course.

9.2 Health and safety

It is noted that in considering some of the environmental issues already identified, numerous health and safety issues are also brought to light. The designers risk assessment identifies as particular risks in the works to be considered the following:

- Lead based paints;
- PCBs in electrical equipment;
- COSHH assessment of new materials, including paints, resins, etc.;
- Noise;
- Contaminated soils and silts;
- Flooding.

Noise is a particular issue in relation to the tunnels as any noisy work will be amplified and at such times the public will be excluded and individuals working in the tunnel will need ear defenders. Exclusion of the public will be essential during numerous operations including preparation of the steelwork for painting owing to the presence of lead.

Special concerns arise from the submerged nature of the two tunnels as there are risks of breaking out materials within the tunnels and possibly opening up a pathway for the influx of water. It would be expected that, the influx of water would carry with it significant quantities of soils and silt. Despite the River Thames now being clean the soils and silts of the river bed can be expected to retain many of the pollutants that the Thames once carried. Although regarded as a comparatively low risk, a comparable event did occur in 1968 during the refurbishment of the Old Blackwall Tunnel when an opening between the caisson and the tunnel was found resulting in an influx of an estimated 1000m^3 of gravel, sand and silt.

10 Cost Programming and Procurement

10.1 Programme

The project is to be delivered in time for the 2012 Olympics based primarily in the Lea Valley, but also extending down into Greenwich. The programme for the Olympics actually sets an earlier date than this with a need for the works to be completed by July 2011 in time for the rehearsals. The time to complete the project on site is judged to be 2 years owing primarily by the restricted access and the confines of the tunnels. Thus it is envisaged that, the works will need to commence on site no later than the beginning of July 2009. To achieve this programme there are a series of activities to be completed, which are summarised as follows:

- Design the refurbishment works;
- Consult with conservation officers and English Heritage and obtain listed building consent for the works;
- Prepare tender documents;
- Advertise in the Official Journal of the European Union (OJEU) for contractors wishing to pre-qualify for tendering for the refurbishment contract, issue pre-qualification questionnaires, review and report on submissions, interview prospective tenderers and recommend list of selected tenderers;
- Invite tenders.

It is noted that some items of equipment required for the refurbishment will need a lead time of 6 months for delivery, thus adequate time must be given for the timely delivery of these items. Hence, although works will start no later than July 2009, it may be desirable for the contractor to be appointed before that date. The alternative is for these materials to be ordered separately and supplied to the contractor for incorporation into the works.

It has been noted that, much of the works will require the tunnels to be closed. At Woolwich, once the DLR between Woolwich and North Woolwich enters service in 2009, full closure of the tunnel for the duration of the works is considered feasible. The special character of Greenwich makes closure at any time undesirable, but it seen as the only way of effectively progressing with the works. Thus for Greenwich, with some works being carried out during overnight closures, full closures will be necessary from October through to April of the following year i.e. 2009 to 2010 and 2010 to 2011. This provides 2 six month periods of possession during which major works can be carried out.

Thus the key dates are summarised as follows:

- Commence inspections investigations and assessments – April 2008;

- Commence design and preparation of tender documents – May 2008;
- Prepare draft OJEC notice – April 2008;
- Issue questionnaires to interested contractors – July 2008;
- Prequalify contractors – September 2008;
- Issue tender documents – November 2008;
- Tender documents returned – January 2009;
- Tender report – February 2009;
- Appoint contractor – April 2009;
- Commence works on site – July 2009;
- Complete works and handover – July 2011.

The activities within the inspection, investigation and assessment phase of the project are described in Section 5.7 above. These activities will be undertaken by Hyder Consulting assisted by Sandberg and Geomaterials Research Services. The term contractor for Greenwich Council will attend on the investigation and provide all the resources to breakout, diamond core and drill and cut cast iron and steel as necessary to facilitate the investigation works.

10.2 Procurement

The contract will be multi disciplinary and will involve a range of trades that include the following:

- Structural steelwork repairs and replacement;
- Painting;
- Grouting and injection;
- Concrete, brick and stone masonry repairs and restoration;
- Installation of duct work and pipes;
- Electrical installations;
- Lift engineering;
- Communications and controls.

The most appropriate way of handling and organising the complex interaction of all these trades is to let a single contract for the whole of the works to a main, probably civil, engineering contractor. The form of contract will be taken from the range of New Engineering Contracts (NEC) and will be selected to provide the diversity and controls necessary in a multi-disciplinary contract.

10.3 Cost

Although a detailed estimate cannot be produced until the design is progressed much further, it is apparent that, programme and site constraints will dictate the cost of undertaking these works. Thus a simple engineering cost will give little real measure of the true cost. A project of this type, located in inner London also carries a further multiplier, which depending on the site will be between 1.6 and 3 times. Taking this into account, together with the duration of the works, it is judged that the cost of executing the contract will be of the order of £10.5 million. This assumes the civil and structural works will represent of the largest part followed by the lift engineering, mechanical and electrical engineering and finally the communications and control. Within the figure is included a contingency of 20%, which is judged to be reasonable for the two tunnel complexes of this age. The current estimates are laid out in Table 10.1 below. As the design progresses it is to be hoped that the scale of the contingency can be reduced.

		Design (£k)	Tender (£k)	Super-vision (£k)	Works (£k)	Contin-gency (£k)	Sub-total
Preliminaries and mobilisation					1100	220	1320
Civil and Structural Eng.	Tunnel	110	45	444	3500	819.8	4918.8
	Shaft				280	56	336
	Lift pits				200	40	240
	Topworks buildings				1140	228	1368
	Ancilliary steelwork				240	48	288
Mechanical and Electrical Eng.		30	10	15	400	91	546
Lift Eng.		30	9	19	800	171.6	1029.6
Communications Eng.		21	25	12	400	91.6	549.6
Architecture and Presentation	Landscaping and interpretation	20		20	600	128	768
	Lighting	40					40
Investigation and testing	Painting and Metallurgy	30				6	36
	Petrography	35				7	42
Summation		316	89	510	8660	1687	**11482**

Table 10.1 Estimated cost of refurbishment

An overview of the cost of maintaining and running the tunnels has been prepared and is presented in Table 10.2, which is based on the information available at this time. This should not be considered to be complete or precise, but is indicative of the scope and magnitude of the costs.

	Item		£/unit	£
Staff[1]	Salary/wages	-	-	300,000
Term contractor	Man days	400	500[2]	200,000
Replacements	Bulbs	2,500	15	37,500
Power[3]	kWh	1,800,000	0.04	72,000
Contingency[4]	-	-	-	60,000
Total	**£669,500**			

Table 10.2 Estimated annual costs.

Notes:
[1]The sum for salary assumes 6 to 8 people receiving average wages with an on cost of 2 times and an addition for management costs.
[2]Man days are assumed to be nights and rates are increased to take account of anti-social working times.
[3]Power is estimated for lighting only as the power consumption of the lifts cannot be readily estimated.
[4]The contingency sum is included to cover unforeseen costs i.e. vandalism, breakdowns, etc.

11 Conclusion and Recommendations

It is concluded that the works to be carried out to refurbish Greenwich and Woolwich Foot Tunnels are as follows:

- Inspection, investigation and assessment to determine the overall condition and the extent of the works in detail;
- Prepare and issue an OJEC notice as soon as possible to select suitably qualified contractors;
- Water management to restrict and control the influx of ground and river water by injection and drainage of the complex;
- Replacement and repair of areas of the tiled lining;
- Replacement of the paving and kerbs in the Woolwich Tunnel and repairs to the kerbs and paving in Greenwich Tunnel;
- Repair and repainting of steelwork in the shafts and top works buildings;
- Repair and replacement of damaged or weak brick, stone and reconstituted stone to the top works buildings;
- Installation of new glazing to the domes of the top works buildings and refurbishment of the cupolas;
- Installation of a new cable management system to support and supply tunnel lighting, CCTV, public address and other electrical supplies and services in the crown of both tunnels;
- Refurbishment of the lifts to improve reliability and efficiency and to provide for operation by users 24hours per day;
- The installation of improved communication systems, including CCTV, public address and help points, together with remote monitoring and control from a new control room;
- The installation of new electrical and mechanical systems and services and new lighting throughout to include feature lighting around the topworks;
- To complete the refurbishment in time for the rehearsals for the 2012 Olympics, the works are to commence on site no later than July 2009, which requires the inspection commence in April 2008 and tender documents be issued in November 2008.

Appendix 1

Survey of users of Greenwich and Woolwich Foot Tunnels

Greenwich Foot tunnel

DATE :

		25/10/2007					26/10/2007				
		North-bound ped	North-bound cyc	South-bound ped	South-bound cyc	Hr Total	North-bound ped	North-bound cyc	South-bound ped	South-bound cyc	Hr Total
00:00	01:00	6	0	11	1	18	6	0	0	3	9
01:00	02:00	3	1	2	1	7	7	1	3	2	13
02:00	03:00	2	0	0	0	2	2	0	5	1	8
03:00	04:00	1	0	1	1	3	0	0	0	1	1
04:00	05:00	2	1	0	0	3	1	1	1	0	3
05:00	06:00	1	8	0	1	10	1	5	0	0	6
06:00	07:00	6	31	3	6	46	7	19	4	6	36
07:00	08:00	15	102	7	5	129	12	70	8	4	94
08:00	09:00	82	137	21	22	262	28	112	20	14	174
09:00	10:00	56	40	18	4	118	10	41	15	6	72
10:00	11:00	29	8	53	9	99	22	9	21	2	54
11:00	12:00	30	6	50	5	91	28	7	64	4	103
12:00	13:00	76	5	84	0	165	39	9	99	5	152
13:00	14:00	131	3	77	22	233	74	8	78	13	173
14:00	15:00	100	14	84	5	203	121	8	80	13	222
15:00	16:00	99	5	63	14	181	95	7	84	10	196
16:00	17:00	97	13	54	29	193	101	13	60	33	207
17:00	18:00	46	11	35	95	187	93	14	52	94	253
18:00	19:00	29	33	26	109	197	48	16	45	87	196
19:00	20:00	19	8	33	46	106	18	9	32	32	91
20:00	21:00	15	1	11	23	50	17	2	25	13	57
21:00	22:00	7	5	7	11	30	20	1	30	6	57
22:00	23:00	3	2	1	10	16	13	0	13	6	32
23:00	00:00	7	0	2	4	13	15	1	4	1	21
	Totals	862	434	643	423	2362	778	353	743	356	2230

		27/10/2007					28/10/2007				
		North-bound ped	North-bound cyc	South-bound ped	South-bound cyc	Hr Total	North-bound ped	North-bound cyc	South-bound ped	South-bound cyc	Hr Tota
00:00	01:00	24	0	13	2	39	13	2	6	1	22
01:00	02:00	22	3	7	0	32	34	3	23	2	62
02:00	03:00	11	0	2	0	13	2	0	5	0	7
03:00	04:00	3	1	3	1	8	5	0	0	0	5
04:00	05:00	3	1	1	1	6	1	0	0	0	1
05:00	06:00	0	2	2	0	4	7	2	3	0	12
06:00	07:00	1	6	1	2	10	3	3	5	1	12
07:00	08:00	6	9	7	1	23	5	7	11	0	23
08:00	09:00	4	5	13	10	32	6	3	11	3	23
09:00	10:00	24	10	28	8	70	24	5	40	9	78
10:00	11:00	31	8	94	8	141	95	9	108	11	223
11:00	12:00	81	10	110	16	217	64	12	172	26	274
12:00	13:00	102	14	247	22	385	94	8	116	11	229
13:00	14:00	162	21	192	10	385	93	4	113	5	215
14:00	15:00	173	17	157	14	361	120	11	116	7	254
15:00	16:00	220	13	162	18	413	191	25	101	9	326
16:00	17:00	199	5	136	17	357	151	9	50	9	219
17:00	18:00	190	11	68	7	276	102	5	40	9	156
18:00	19:00	77	1	44	15	137	26	2	17	1	46
19:00	20:00	40	5	37	5	87	15	0	8	2	25
20:00	21:00	17	8	23	2	50	13	2	2	3	20
21:00	22:00	29	0	15	1	45	6	1	1	2	10
22:00	23:00	6	2	12	0	20	19	0	3	0	22
23:00	00:00	19	1	11	2	33	7	0	4	0	11
	Totals	1444	153	1385	162	3144	1096	113	955	111	2275

Woolwich Foot tunnel

DATE :

		25/10/2007					26/10/2007				
		North-bound ped	North-bound cyc	South-bound ped	South-bound cyc	Hr Total	North-bound ped	North-bound cyc	South-bound ped	South-bound cyc	Hr Total
00:00	01:00	2	0	18	0	20	8	0	11	0	19
01:00	02:00	1	0	2	0	3	0	0	1	0	1
02:00	03:00	0	0	0	0	0	0	0	0	1	1
03:00	04:00	1	0	1	1	3	0	0	0	0	0
04:00	05:00	7	1	7	0	15	8	2	7	0	17
05:00	06:00	25	7	23	1	56	20	10	6	0	36
06:00	07:00	55	11	44	3	113	51	10	62	5	128
07:00	08:00	59	13	67	4	143	64	23	69	4	160
08:00	09:00	87	19	45	2	153	72	13	62	1	148
09:00	10:00	33	2	33	3	71	46	6	31	2	85
10:00	11:00	37	3	25	1	66	22	2	48	2	74
11:00	12:00	20	0	26	1	47	36	3	36	1	76
12:00	13:00	56	3	34	1	94	33	2	51	2	88
13:00	14:00	33	1	72	0	106	53	1	64	3	121
14:00	15:00	39	0	30	1	70	46	2	45	6	99
15:00	16:00	42	3	75	1	121	37	2	41	3	83
16:00	17:00	54	0	43	13	110	53	3	69	9	134
17:00	18:00	60	8	89	10	167	49	5	55	14	123
18:00	19:00	52	8	70	16	146	60	1	34	8	103
19:00	20:00	33	0	64	9	106	39	0	39	4	82
20:00	21:00	32	1	46	5	84	45	1	49	3	98
21:00	22:00	23	1	35	8	67	32	1	30	3	66
22:00	23:00	9	1	20	1	31	22	1	29	1	53
23:00	00:00	18	0	18	1	37	12	2	30	0	44
	Totals	778	82	887	82	1829	808	90	869	72	1839

		27/10/2007					28/10/2007				
		North-bound ped	North-bound cyc	South-bound ped	South-bound cyc	Hr Total	North-bound ped	North-bound cyc	South-bound ped	South-bound cyc	Hr T
00:00	01:00	9	0	21	0	30	8	0	16	0	2
01:00	02:00	3	0	2	3	8	7	0	4	0	1
02:00	03:00	0	0	1	0	1	2	0	4	0	6
03:00	04:00	6	0	1	0	7	2	0	3	0	5
04:00	05:00	7	0	2	0	9	8	0	2	0	1
05:00	06:00	23	3	16	0	42	14	0	18	0	3
06:00	07:00	27	5	24	2	58	33	1	32	2	6
07:00	08:00	26	2	52	2	82	19	3	31	0	5
08:00	09:00	18	1	38	1	58	49	1	39	1	9
09:00	10:00	21	4	26	1	52	70	1	34	1	1
10:00	11:00	40	1	67	3	111	90	5	66	0	1
11:00	12:00	47	4	48	4	103	54	3	43	1	1
12:00	13:00	34	0	51	4	89	26	1	35	2	6
13:00	14:00	36	5	37	2	80	26	0	29	0	5
14:00	15:00	33	4	62	0	99	15	1	35	1	5
15:00	16:00	40	2	35	1	78	28	1	28	1	5
16:00	17:00	41	1	28	4	74	27	4	27	1	5
17:00	18:00	38	4	40	4	86	15	2	30	2	4
18:00	19:00	48	0	22	0	70	27	0	38	0	6
19:00	20:00	27	1	32	3	63	33	0	33	1	6
20:00	21:00	28	0	40	0	68	32	0	22	1	5
21:00	22:00	23	1	21	1	46	21	0	17	0	3
22:00	23:00	18	0	14	0	32	18	0	17	4	3
23:00	00:00	8	1	17	0	26	2	0	6	0	9
	Totals	601	39	697	35	1372	626	23	609	18	12

Appendix 2

Project environmental assessment of Greenwich and Woolwich Foot Tunnels

Hyder Consulting	**PROJECT ENVIRONMENTAL ASSESSMENT WORKSHEET**	
	Project Title Greenwich and Woolwich Foot Tunnels	Project Code LN01084

Project Director Geoff Hilling	Team Member completing assessment (if not PD) William Day/ Eleni Antoniades

Client Greenwich Council

	N/A	Yes	No
Client accepts Project Environmental Management? *(If "No" please state reasons. Section 2-4 can be omitted but good practice to complete)*		■	☐
Partners accept Project Environmental Management? *(If "No" please state reasons)*	☐	■	☐

1. PROJECT DESCRIPTION

11.1.1 Brief description of project

The project will involve the refurbishment of the civil, structural, mechanical, electrical, communications and lift engineering aspects of the Greenwich and Woolwich Foot Tunnels beneath the River Thames. It is an objective of the project to ensure that the refurbishment is carried out with a minimal impact on the environment during both the design stage and construction stage of the project.

Job involves:

Initial study (feasibility / ~~pre-feasibility~~ / site investigation)	■
Design	■
Tender Document Preparation (Sub-contractors)	■
Construction Supervision	■
Operational Supervision	☐
Decommissioning	☐
Monitoring / Surveys	■
Management Advice	☐

Environmental Requirements of Brief

	Yes	No
Environmental Impact Assessment	☐	☐
BREEAM Assessment	☐	☐
Environmental Management Plan	☐	☐
Other Environmental Requirements *(Please specify)*	☐	☐
CEEQUAL Assessnent	■	☐

If "yes" to any, refer to outputs where relevant in section 2

An EIA is not required for this project. However, it is recommended that a CEEQUAL (Civil Engineering Environmental Quality Assessment and Award Scheme) is carried out for this project as there are a number of environmental issues and sustainability issues associated with the project.

2. ENVIRONMENTAL ISSUES IN DESIGN / ADVICE

Materials

What materials are being used / recommended (local supply, aesthetics)? ***Concrete, Cementitious materials, Stone, Glass, Steel and Polymers***

Can quantity of materials in design be reduced? ***The volumes of all new materials will be kept to the minimum consistent with retaining the integrity of the works.***

Can materials already on site be reused? ***As far as practical the existing fabric will be retained.***

Can recycled / reclaimed materials be used / recommended? ***Recycled materials will not be incorporated in the permanent works, except that metals may include the use of scrap in production. In the temporary works and processes recycled materials may be used i.e. recycled glass as an abrasive for steelwork preparation.***

Energy Use (construction and operation)

Can the design reduce the energy use in:

- Construction (e.g. using locally sourced materials, minimising movement of waste)? ***It will be recommended that any bricks, cements and concrete products to be used in the construction stage of the project should be produced locally***
- Operation (e.g. energy efficient buildings)?
- ***The dome houses the lift motor equipment. The dome currently overheats as heat is absorbed through the glass causing the liftmotor equipment tofail. Cooling systems would be required to prevent overheating, which would lead to a high energy use. The refurbishment will recommend re-glazing the dome to reduce the need for cooling , reducing excess heat generation and reducing the overall energy use of the structure.***
- ***Lighting is present through the 500 metres length of the tunnel. The lighting will be assessed as part of the project with the aim of improving the efficiency and quality of the lighting. The use of energy efficient lighting, which will be controlled, will be designed to minimise energy consumption, with higher efficiency and improved quality.***

Water Use (in construction and operation)

Could grey-water recycling be included in the design (e.g. about rainwater collection from roofs)? ***N/A***

Could any wastewater treatment include biological systems? ***N/A***

Are drainage / run-off issues being considered? Scope for pollution control and Sustainable Urban Drainage Systems (SUDS)? ***N/A***

11.1.2 Waste Generation (in construction and operation)

What wastes will be generated?

The waste generated will include metals, concrete, stone, brick and ceramics. Potentially contaminated material will include lead contaminated blasting abrasives used to removed paint. There may also be asbestos (which will be confirmed by an asbestos survey) and there may also be possible light fixtures and light bulbs (light bulbs may be re-cycled) . In accordance with the Waste Framework Directive, there will be a requirement for the material to be processed prior to disposal. Processing can include separation into waste streams. The material will then need to be sent for recycling if possible or disposed of at a suitably licensed landfill site .

Can any waste be reused in design / on site? *No, but it will be possible to recommend that the material generated is recycled or re-used off site.*

Site Selection

Is site location predetermined? ***Yes***

Greenfield / brownfield / existing developed site? ***Existing site.***

If site not determined, can brownfield site use be specified? ***N/A***

Can land-take be minimised? ***No additional land will be taken up as works are within existing envelope.***

Likelihood of contamination issues on site? ***Lead in existing paint coatings is the only anticipated contaminant, but checks are to be made for the presence of asbestos.***

Any areas of environmental sensitivity (archaeology, residential, wildlife, water, landscape etc):

- On-site? ***Grade II listed buildings. The design will take the listing into consideration. Consultation will be undertaken with the three local authorites planning department and will be required with English Heritage in order to ensure that the character of the structure is not altered by the refurbishment. Consent for the works will be given by the Government Office for London. All refurbishment will have to be sympathetic to the character of the structure.***
- In surrounding areas? ***Greenwich Tunnel south entrance is located within the Maritime Greenwich world Heritage Site. The River Thames is adjacent to and above the site.***

Can reduction or mitigation of impacts be included in design / advice? ***The philosophy of design will lean***

11.1.3 Construction Works

Is an environmental management plan a requirement of any Hyder prepared tender documents?***Yes***

11.1.3.1.1.1 **Does the contractor have an environmental management plan for any works?**This will be a

Transport

Is there provision in the design to provide for or improve sustainable forms of transport? ***Yes, the project encourages pedestrian use and accommodates cyclists.***

Can access to public transport be improved?***One aspect of the project is to improve links with public transport . This includes improving signs to Dockland Light Railway and over ground railway stations.***

Can footpaths, cycle-ways, bus routes/lanes, light railway be included in the design? ***Links with these***

Noise / Air quality

Will the project lead to (directly or indirectly) emissions of noise / vibrations or air pollution? ***Yes***

Is there scope in the design to reduce these emissions or their impacts? ***The contract will require the contractor to minimise any emissions or pollution.***

Lifecycle

Have end of life options been considered? ***No***

What are the end-of-life options? ***As listed buildings end of life options have not been considered, as it is anticipated that the structures will be the subject of further refurbishment at some time in the future.***

Is there any flexibility in design to update/extend etc rather than rebuild? ***The emphasis of the project is to refurbish an existing facility and provide it with an extended life.***

Can the life-span be extended by more durable design, or by forecasting to predict future requirements? ***The intended design life will be 120 years in line with normal highway structure design criteria***

Client

Does the Client have an Environmental Policy? ***Yes***

Does the Client operate an Environmental Management System? Yes (ISO 14001)

If "No", would the Client consider developing an Environmental Management System?

3. ENVIRONMENTAL ISSUES IN PROJECT ACTIVITIES

11.1.4 Transport

Will project require travel (additional to staff commuting)? ***Yes***

Is there potential to use public transport for travel? ***Public Transport is the Preferred Option in Inner London. Site visits can be carried out using public transport***

Paper Use

Does the project involve submission of a report / reports? ***Yes***

Is there potential to submit all / some copies of report(s) in electronic format? ***Where possible all drafts will be electronic and only prime documents will be paper. General communications will be electronic***

4. SUMMARY OF ISSUES IDENTIFIED WITH POTENTIAL FOR IMPROVEMENT (for which Review Form should be completed)

The client has stated that it is their wish that the project should as far as practical have the minimum environmental impact. In addition the energy use of the refurbished tunnels where practical shall be minimised. Lift, lighting and ventilation are the primary energy users and will be reviewed and designed to be as efficient as is practical within the operational constraints. It is also recommended that a CEEQUAL is carried out for this project to recognise the environmental and sustainability merits of the project.

If issues are considered significant, would Client consider specialist environmental input as additional work?	Yes	No
	☐	■

5. SIGN OFF

Agreed by		Name	Signature	Date
A	Project Director			
B	Office Environmental Manager			

Form to be stored in relevant Project file, and copy submitted to Office Environmental Manager.

Appendix 3

Hazard record and designers risk assessment

HEALTH & SAFETY HAZARD RECORD

Hyder Consulting	**Project Title** Greenwich and Woolwich Foot Tunnel Refurbishment	**Project Code** LN01084

Assessment Coverage:

Feasibility study.

1. Scope of Commission and Assessment of Coverage:

The scope of the commission includes the design of the full refurbishment and presentation of two foot 3.3 m diameter tunnels and their associated buildings beneath the River Thames located at Greenwich and at Woolwich. The bolted cast iron lined bored tunnels constructed at Greenwich in 1902 and Woolwich in 1912 were driven between shafts sunk in steel caissons on either bank. Interior finishes are ceramic tiles on concrete with either stone or precast concrete to the invert. Lifts and spiral staircaes in the shafts provide access to the tunnels. The shafts are capped with brick and masonry buildings with glazed domes enclosing the lift motor rooms. In addition to design, tender documents are to be prepared, tenderers are to be selected through the OJEC process and prequalified and following tender and appointment of a contractor, the works are to be supervised.

2. Brief Description of the Works:

The works include repairs and refurbishment of the linings, floors and stairs of the interior of the tunnels and shafts, together with all structural steelwork and the top works buildings; the refurbishment of the lifts; installation of new communications systems, together with the establishment of a new control room; and the refurbishment and replacement of all M&E services within the tunnel. In addition the works are to include improvements to signing and the presentation of the two listed buildings with respect to interpretation and lighting.

3. Key Risk Reduction measures taken during design process:

The complex is to be the subject of a detailed investigation described in the feasibility study. In addition to the investigation of the materials the complex will be the subject of an inspection and assessment.

The inspection will be the equivalent of a principal inspection and an inspection for assessment as undertaken for highway structures in accordance with the Design Manual for Roads and Bridges (DMRB). The assessment will be based on the record information, the observations of the inspection and the findings of the investigation works and will comprise both numerical and qualitative assessment in accordance with the requirements of the DMRB.

An Approval in Principal (AIP) will be prepared for the assessment and for the design of the works. The design will be subject to a Category 2 check in accordance with the requirements of the DMRB.

The design of the works is to be based on the principle of minimum intrusion, which will reduce the risk of the integrity of the tunnel being breached.

4. Significant Project Specific Hazards Remaining:

There are several project specific hazards that cannot be eradicated from the project, which are summarised as follows:

- Possible breaches in the integrity of the tunnel lining or caisson walls leading to flooding cannot be predicted;
- Proximity of existing river walls of unknown detail, origin and age to works areas;
- Small diameter tunnels create physical restriction of site;
- Tunnels extend communication paths owing to length and limited entrances only at extreme ends;
- Shafts and Grade II listed lifts restrict access;
- Site divided into two areas (Greenwich and Woolwich) remote from each other, necessitates duplication of some essential services;

	# HEALTH & SAFETY HAZARD RECORD	
	Proiect Title Greenwich and Woolwich Foot Tunnel Refurbishment	**Proiect Code** LN01084

- Proximity of public to works and presence of public in works areas i.e. pedestrian areas, Cutty Sark Gardens and highway abut top works buildings and public access will be required through Greenwich Tunnel during peak tourist season.

The hazards and risks are described and considered in greater detail in the H&S Design Risk Assessment where the consequences of the above hazards are expanded.

5. Specific Construction Requirements

Tunnel closures will be permitted at Woolwich without restriction following opening of the DLR at Woolwich.

Tunnel closures at Greenwich will be restricted to the period from October to April.

6. Means by which significant hazards conveyed to contractors and others:

The health and safety plan, to be included as part of the tender (contract) documents, is to identify the site specific risks associated with the two tunnels and outlined above and in the Design Risk Assessment. The results of the inspections, investigations and assessments will be made available to the tenderers for inspection at tender stage and copies will be provided to the contractor.

Date of Review	05 March 2008

Assessed by:

Name ---------------------------------- Signature --- Date --------------------

Reviewed by:

Name ---------------------------------- Signature --- Date --------------------

	Health & Safety Design Risk Assessment			Project Code/Doc No: LN01084	
Hyder Consulting	Project Title: Greenwich and Woolwich Foot Tunnel Refurbishment	Assessor (Name): William Day	Assessor (Signature):	Date:	Revision: 1

Ref	Activity & Hazard	Level of Risk	Design Input to Eliminate or Reduce Hazards, and Hazards Remaining	Residual Hazard?
1	Flooding and/or influx of bed material following breaking out of lining materials or intrusion into fabric.	Low	Inspection of tunnel prior to completion of design to ascertain possible extent of defects and design of works to minimise intrusion into fabric. Hazard remains, but is subsequently moderated by method of working. Although the probability of this hazard being encountered is low the consequences of its occurrence are catastrophic.	Low
2	Collapse of river walls (particularly at Greenwich owing to proximity of shafts and recorded bombing on foreshore) owing to loading by construction plant and/or materials.	Moderate	Inspection and assessment of works site prior to completion of design and restriction of areas and magnitude of imposed loadings to be permitted. Require additional assessment for cranes and similar large invisible imposed loads. Although of low probability the consequences of a river wall collapse are potentially catastrophic.	Low
3	Cramped working conditions create conflict between trades and operations taking place within tunnel.	High	Design works and programme to allow for sequential operations and avoiding concurrent operations.	Moderate

Ref	Activity & Hazard	Level of Risk	Design Input to Eliminate or Reduce Hazards, and Hazards Remaining	Residual Hazard?
4	Cramped working conditions and enclosure exacerbate normal hazards.	High	Noise and dust suppression will be necessary throughout the works, but in addition works shall be designed to utilise methods that moderate noise and dust emissions e.g. diamond cutting with flushing water to suppress noise and dust and wet blasting to metals to suppress dust.	Yes
5	Extended communications path and restricted section create potential for excessive manual handing operations.	High	Design where practical to minimise transport of bulk waste or new materials. Design works utilising materials and processes permitting loads to be divided into small parcels and use lightweight materials e.g. substitute plastics and polymer composites for metal components where practical.	Yes
6	Capacity of lifts restricts size and weight of plant and equipment that can be utilised and rates and methods of transport of materials increasing manual input and hazards arising from using hand tools and small plant.	High	As 5 above. Design works to be executed by tools and equipment that reduce normal hazards.	Yes
7	Remote sites with 4 principal nodes increase normal hazards.	Moderate	Identify minimum requirements (by reference to ACOP and other standards and regulations) for site provisions at each node of project i.e. parking, storage, welfare and communications.	No
8	Interaction with general public during execution of works creates risk to workforce from possible assault and risk to members of public from construction operations.	High	Specify requirement for site security on 24 hour basis, including CCTV surveillance. Specify provision for information boards. Specify requirement for marshalling of public by security personnel whilst works are occurring when public access is permitted and in other public areas.	Yes

Ref	Activity & Hazard	Level of Risk	Design Input to Eliminate or Reduce Hazards, and Hazards Remaining	Residual Hazard?
9	Structural collapse of existing components, floors, stairs, etc.	Moderate	Inspection and assessment of works site and structural elements prior to completion of design and restriction of areas and magnitude of imposed loadings to be permitted. Require additional assessment for all plant and similar large invisible imposed loads. Restrict storage on existing structural components, floors, stairs, etc.	No
10	Disease from rats, needles, pigeons and other biohazards associated with an inner city area.	High	Identify requirements for site management and hygiene by reference to ACOP and regulations.	Yes
11	Contact with silts and contaminated materials.	Moderate	Identify potential hazards associated with areas of contamination.	Yes

Appendix 4

Design brief and specification for lift refurbishment

Description of the proposed lift engineering works

Retained equipment

The following equipment is to be retained and reused as part of the modernisation, subject to compliance with statutory tests on all lifts: -

- Car & Counterweight Guides & Brackets
- Counterweight Frames and Filler Weights
- Pit Steelwork
- Shaft Fascias
- Car Slings, including the platform
- Car wall panels and ceilings

All existing equipment not being retained is to be completely removed and disposed of by the lift contractor in accordance with any relevant legislation regarding waste disposal. Certificates verifying the safe and proper disposal of such waste are to be provided and copies are to be included in the Owners Manual.

Removal of redundant equipment

Redundant components are to be removed. All associated equipment should also be removed and distributed safely off site by the lift contractor. A specialist LEIA affiliated company is to be appointed to complete the removal e.g. Lift Out.

Prior to any works being undertaken, the selected company is to prepare a detailed plan that includes Risk Assessments, Method Statements, etc.

The lift contractor should ensure as far as practical, there is no imminent danger to the general public or work personnel when works are completed and will request works by others to ensure this. Signage is to be used throughout the project.

The lift contractor is to provide all necessary protection and hoardings for the duration of removal using e.g. hardwood floor panels, sheets, etc. The lift contractor is to make good any damage caused by the removal of the lifts on completion.

Any cutting or grinding is to be by prior agreement only. Equipment dismantling is to exclude these items.

Particular requirements

To select suitable equipment to modernise the existing lift installations in accordance with the requirements of this specification, to comprise of everything necessary to design supply, install, set to work, commission and test the ‘traditional traction lifts’. Design all specialist and propriety equipment associated with the lift installation to allow the correct operation

The works are to comply with all current British and European Standards, Codes of Practice, Regulations and Best Practice.

Modernisation design parameters

All materials supplied and works carried out are to be the best of their respective kinds in accordance with the specification. All such materials and work are to comply with the relevant British and European Standards Codes and recommendations as far as any existing building constraints allow.

Where specific British and European Standards are referred to these are to be deemed to refer to the current edition of such Standards and to include as far as practicable any amended standard requirements, which may become current before the date at which the work is carried out. Substitution for specified or approved materials is to only be permitted by prior written permission.

Ensure all proposed equipment, plant, and machinery meets the design duty, quality standards, and fits within the space available. Ensure manufacturers, suppliers, trade contractors, etc., are informed of all relevant information to enable all materials, services, installations, etc. to be properly co-ordinated and interconnected.

Authorisation is granted for copies of all relevant sections of this specification to be copied and forwarded to manufacturers, suppliers and trade Contractors for information purposes.

Reference documents

The Lift installations are to fully comply with the current edition (including amendments) of each of the following documents: -

BS ISO 18738 Lifts (Elevators) – Measurement of lift ride quality

BS IOS 7465 Passenger lifts and service lifts – guide rails for lifts and counterweights

BS463-2 Specification for sockets for wire ropes. Metric units

BS 5655 Lifts and service lifts – all relevant parts

Part 11 1989: Lifts and service lifts. Recommendations for the modernisation of electric lifts in existing buildings

BS 12385-5 Stranded steel wire ropes Part 4: Specification for ropes for lifts

BS ISO 4190 1999 - Lift Installation Part 1: Class I, II, III AND VI Lifts

BS ISO 4190 2001 - Lift Installation Part 2: Class IV Lifts

BS 7255 2001 Edition Code of practice for safe working on lifts

BS 7671 Requirements for electrical installations - IEE wiring regulations

BS 8300 Design of buildings and their approaches to meet the needs of disabled people – code of practice (DDA)

BS EN 81/1 1998 – Safety rules for the construction & installation of electric lifts

BS EN 81/10 System of EN 81 Series of Standards

BS EN 81/28 Remote alarms on passenger lifts and goods passenger lifts

BS EN 81/70 Accessibility to lifts for persons including persons with disabilities

BS EN 81/80 Rules for the improvement of safety of existing passenger and goods passenger.

BS EN 627 Specification for data logging and monitoring of lifts, escalators and passenger conveyors

BS EN 12015 Electromagnetic compatibility – product family standard for lifts, escalators and passenger conveyors - emission

BS EN 12016 Electromagnetic compatibility – product family standard for lifts, escalators and passenger conveyors – immunity

BS EN 13015 Maintenance for lifts and escalators - rules for maintenance instructions

BS EN 50214 Flexible cables for lifts

BS 5655-10 Specification for the testing and examination of lifts and service lifts

ISO 7465 Passenger lifts and service lifts – guide rails for lifts and counterweights

CIBSE Guide D - Vertical Transportation Systems in Building

SAFed Safety Assessment Federation - Lift Guidelines

HSE Provision & Use of Work Equipment Regulations (PUWER) 1998

HSE Lifting Operations & Lifting Equipment Regulations (LOLER) 1998

HSE Health and Safety at Work Act

HSE The Workplace (Health, Safety and Welfare) Regulations 1992

CDM Regulations 2007

COSHH Control of Substances Hazardous to Health Regulations 2002

LPC Loss Prevention Council Rules

DETR Building Regulations 2000: Approved Document M – Access and Facilities for Disabled People

The Factories, Shops and Offices Act 1990

The Environmental Protection Act

The Electricity at Work Regulations 1989

All details are to be to the satisfaction of the local Building Control Officer.

Modernisation system requirements

Description of Modernised Lifts

2 Passenger Lifts North and South Greenwich Foot Tunnels

2 Passenger Lifts North and South Woolwich Foot Tunnels

Special requirements

The following items are listed throughout the specification and are referred to as 'special requirements'.

1. Refurbish the existing motor room lighting to produce all normal (200 lux) and emergency lighting (50 lux) and shaft lighting to produce all normal (50 lux) and an acceptable emergency lighting level. The small power to the lift shaft and motor room is also to be refurbished. This is to comprise of twin fluorescent light packs, with 3-hour standby supply positioned to provide the lux levels required for both normal and emergency. The small power is to consist of twin socket outlets positioned to serve each lift. Provide these sockets with RCD protection, where required. Top and bottom shaft light fittings to be provided with emergency backup.
2. Connect the lifts to the main building fire alarm system and ground to a designated level upon receipt of a signal.
3. All electrical equipment located less than 1m above the pit floor shall be protected to IP67
4. All existing wiring shall be renewed and trunking or tubing will be adapted to suit the new installation.
5. Replace existing parking control panel with new ensuring key switch is the same and engrave faceplate as appropriate. New controller is to be interfaced with this unit.
6. Carry out building alterations to the shaft front walls to accommodate new push stations and landing indicators then make good once completed.

7. Ensure all works comply with the standards set out in this document, such as DDA, etc.

8. Each lift car is to be provided with a hands free emergency intercom system that is to connect to the security room in the event of lift failure. The system is to have the facility to dial three locations using an autodial system, the last being the lift maintenance contractor's 24-hour, call out centre.

9. Provide all MCB distribution panels with sufficient circuits to suit the lift systems. Provide sufficient spare ways for future use.

Lift machine room

The following items are referred to as general requirements for the lift machine rooms.

1. Provide all small power and lighting to each machine room and space. Provide both 240v sockets and 110v sockets.

2. Ensure all lift motor rooms and installed equipment has the necessary notices, warnings, and instructions, regarding working restrictions, operation, maintenance and safe access.

3. Provide encapsulated as fitted wiring diagrams and a purpose-made painted steel rack fitted to the lift motor room walls. These racks are to store the lock release key, brake release bar and any other specialist tools required.

4. Detailed instructions, regarding the moving of the lift in an emergency are to be fixed to the machine room wall, adjacent to each machine. Danger notices are to be securely fixed to the access door of the lift machine room. Details of the machine and motor will be permanently displayed as required by BS EN81/1.

5. Steel constructed cupboards are required in each lift motor room for the storage of lift related items. Steel pocket racks are to be provided to store reports for each lift. Heavy-duty full-length rubber mats for the prevention of electric shocks are required at all accessible points around control panels and electrical equipment.

6. Each lift motor room will be provided with at least two plastic covered HSE approved electrical shock notices fixed in prominent positions.

7. The existing lifting beams in the machine rooms are to be re-tested and certificate produced. Each beam is to be marked with the safe working load (SWL) in kg in a clearly visible location.

Modernisation control requirements

Control System Description

Microprocessor based control systems are to be provided for all lift operations and perform all the necessary functions to ensure proper and safe lift operation and group supervisory control, based upon the Variable Voltage Variable Frequency drive control principal. The controls are to be housed within a dedicated lift motor room located above the shaft and connected to lift equipment using serial transmission cable networks.

The control panel is to be provided with remote emergency operation from a changeover switch and directional push buttons, used in conjunction with the audible floor level indicator to drive the lift on slow speed in the event of a lift malfunction and passenger trapping.

The systems are to be designed for re-programming and modification with the minimum shut down period to limit disruption to the lift service. It is to be possible to interrogate the microprocessor based control system operating functions, by means of access test points on the controller boards, by using a portable diagnostic instrument.

The current operation of the lifts is via lift drivers but the new strategy is to run the lifts without lift drivers and monitor and possibly operate the lifts remotely. A lift BMS system is to be installed in a remote area dictated by the client this system must have facility to operate the lift isolate.

Include for full provision of operating instructions and training for building management staff in the release of trapped passengers and general house keeping, to ensure the lift remains in service.

Control operation

The microcomputer based control system is to perform all of the functions of safe lift motion and lift door control. The system is to perform car operational and group supervisory control and each main function, namely traffic demand calculations, permanent car position control, car motion control and door operating control, is to be individually supervised by a set of processors.

The controller cabinet containing memory equipment is to be properly shielded from line pollution, and incorporate positive ventilation and air filtration. The transmission of all information between car and controller cabinet is to be carried out serially.

When the independent service switch in the car-operating panel is actuated, that lift is to disconnect from the landing buttons and operate independently only from the car buttons. The doors are to open on arrival at a floor and close when constant pressure is applied to one of the destination buttons.

Provide a connection point within the lift motor room and connect the lift to the main building fire alarm system to return lift to the main floor lobby on receipt of a fire signal. If the fire alarm has been activated at the main floor lobby, the lift is to return to the level above or another predetermined level. Also provide a manual override rotary switch for the lift to prevent this operation during testing. The activation of the switches in the 'ON' position is to be identified on the lift management system.

Upon activation of a fire alarm or manual recall key switch, regardless of position or direction, the lifts are to stop the doors are to remain closed and the lift is to return to the designated level. All registered calls are to be cancelled. On arrival at the main access level the cars are to initially park with the doors open, then close after a predetermined period and remain operational from the car door open button only.

Under this condition the cars are to remain inoperative until the control system is reset to its normal mode by the deactivation of the fire alarm or key switch.

Control panels

The control panels are to be of the totally enclosed industrial type supplied as a complete assembly by the manufacturer of the installations. The panels are to consist of switch and distribution gear fabricated on channel or angle iron frames specially made for this purpose, complete with all mechanical and electrical fixings, interconnections and accessories to form a complete assembly. The panel is to be complete with all fuses (to be of the HRC type) and all steelwork is to be given a priming coat of paint and two finishing coats.

Provide all electrical interlocking as necessary to ensure that the relays and contactors operate in proper sequence. Ensure all relays, contactors and safety-switching devices comply with the appropriate British Standards including 'the conditions for use of electric safety devices' BS 5655: Part 2. Protect the primary winding of the transformer by an HRC fuse in the live supply line.

Upon resetting any changeover switch to the 'NORMAL' position, the associated lift returns to normal operation with car control push buttons and all landing call push buttons becoming fully operative.

A copper earth bar is to be incorporated within the panel and all switchgear is to be bonded to the earth bar. Provision is to be made for bonding all outgoing armoured cables to the earth bar. A main earth terminal is to be provided. Check all connections after the panel has been installed.

Ensure full compliance with British Telecom requirements.

Protect the DC control circuit by a single pole miniature circuit breaker of the electro-magnetic type, giving instantaneous overload protection with a current of 50% above its full load rating, and having a free handle with clear indication of whether the circuit is open or closed. If the control circuit is AC then the voltage must be 110v or less.

Car operating panels

All lifts are to be provided with a new single, car-operating panel in the side of the car, containing a digital display car position and direction indicator, destination floor buttons, service and safety buttons, intercom system, voice annunciation unit and key switches. The operational buttons are to be located between 900mm and 1200mm in each panel above the car floor, located centrally to the car. The buttons are to be micro movement stainless steel and contrast against the finish of the car-operating panel. Statutory signage is to be engraved on each panel.

The destination buttons are to illuminate when operated and each button are to be provided with a tactile indication of its respective floor. The service and safety buttons are to comprise an alarm button, a door open button, a door close button and an independent key switch. The safety buttons and colour are to comply with DDA BS EN81-70.

All car-operating panels finishes are to be as per architect instruction but with secret fixings and the panels are to not deflect when buttons are pressed.

Landing control, indicator stations

Provide each lift landing with a call station adjacent to or central to the lifts, comprising up or down direction buttons for terminal floors and dual direction buttons for intermediate levels. Each button is to confirm call acceptance by illumination and chime (with adjustable volume), and is to contrast against the finish of the call station. The operational buttons are to be located between 900mm and 1100mm as per DDA EN81-70.

All call stations and indicator panels are to be constructed from 12-gauge stainless steel, flush mounted with secret fixings and the panels are to not deflect when buttons are pressed. The apertures for buttons and indicators, etc, are to be laser cut. Each landing call station is to be fitted with a raised tactile numeral corresponding to the level served, below the buttons.

Landing indication

Provide an LCD EN81-70 compliant digital display unit per lift mounted at high level adjacent to the lift doors at every level. These panels are to indicate direction of travel, the floor levels and the levels being served by the lift.

Lift landing is to be provided with lift arrival gongs to chime the direction of travel with either one or two chimes. The volume of the gongs is to be adjustable on site.

Voice annunciation

Provide the lift car with voice annunciation as per EN81-70 to advise persons with sensory impairments the condition of the lift i.e. going up, doors closing, etc. The units are to have the facility to provide emergency messages i.e. lift returning to ground floor and the voice are to be pre-recorded BBC Style English Female. The speaker units are to be discretely mounted behind the car operating panels at high level with equally spaced perforations for sound transmission.

Provide an audio frequency induction loop system as per EN81-70 within each lift car to assist hard of hearing passengers to hear the voice messages.

Limit switches and over travel devices

All the current shaft switching and wiring is to be removed and tubing or trunking to be adapted to suit the new installation.

New shaft switching and encoding system is to be installed to suit the new control systems. The new system shall be able to bring the car to a stop at the terminal levels independent of the regular operating devices in the car. Automatic terminal limit switches are to be provided for the lift together with an ultimate limit switch fitted and arranged to operate in the event of either one of the terminal switches failing to operate.

The terminal and ultimate limit switches are to be so arranged that the operation of each is to bring the car to rest from full contract speed without the car or balance weight striking the buffers. The operation of the ultimate limit switches is to cause a relay in the control panel to trip and this must be reset manually before the lift can again operate under normal control.

Terminal stopping and shaft ultimate limit switches are to control at least two separate and independent contactors in the controller, two of which are to be closed to complete the motor and the brake circuits for each direction of travel, unless the ultimate limit switch opens the motor and brake circuits and its contacts are directly opened mechanically.

Maintenance controls

Car top control stations – Provide new Control Station to comply with current regulations

Shaft limit switches – Provide a maintenance limit switch at the head of every lift shaft to operate with the car top control station to stop the car when moving in an upward direction not less than 1.8m below the top of the lift shaft, or first striking point. Ensure that it is not possible, by the operation of the maintenance controls, to move the lift car beyond this upward limit or beyond the bottom terminal floor limits.

Pit stop switches and socket outlets – Mount a new 'STOP' switch, operated by a mushroom-headed button, in the lift pit, in a convenient and readily accessible position from inside and outside the shaft, for the use of the Maintenance Engineer.

Configure such buttons such that, when operated, they 'lock-off' the contacts of the switch, and isolate the lift from operating. Ensure that it is not possible to re-start a lift until the ‘stop’ switch is manually re-set.

Provide an integral 13 Amp 3-pin socket outlet and configure the electricity supply for this socket outlet independent of the lift car supply, with a residual current circuit breaker.

Fire alarm mode

Provide an automatic control facility for the lifts such that in the event of activation of the fire detection and alarm system a signal is received at the lift controller is to cause the lifts to complete the current operation, cancel all calls and automatically return to the bottom of the shaft.

Modernisation drive requirements

Drive system description

The new drive system is to comprise an AC geared drive machine, electro mechanical brake and traction sheaves; all designed specifically for heavy lift duty at 180 to 240 starts per hour. The AC drive machine is to be provided with closed loop variable speed operation using the variable speed control principle. Variable Frequency drive controllers for the drive motors are to be mounted within each microprocessor control panel.

For each journey the lifts make, a velocity curve is to be computed to provide a very smooth and fast journey with accurate levelling. The control system is to compare the actual speed with the computed speed, and make adjustments to the drive system to reduce any errors. Acceleration, full speed run, deceleration and levelling are to be fully controlled.

The lifts are to be provided with automatic self-levelling devices to bring the lift car level within the floor landing tolerance regardless of load or direction of travel. The automatic self-levelling devices are to correct for over or under travel and rope stretch within defined parameters and is to be generally 3mm and no more than 6mm.

Levelling device

The lifts are to be provided with automatic self-levelling devices to bring the lift car level within the floor landing tolerance regardless of load or direction of travel. The automatic self-levelling devices are to correct for over or under travel and rope stretch within defined parameters and are to be no more than 6mm. The normal levelling tolerance is to be less than 6mm in any direction.

Construction

The new AC motor is to be flange mounted, using high tensile steel, machined fitted bolts and the new drive sheaves are to be of the disc pattern selected to ensure a design life of a minimum of 20 years. The drive sheave is to be machined steel and provide sufficient traction to hoist the lift cars whilst maintaining the hoisting ropes for a period of not less than 10 years.

The new drive unit is to be mounted upon isolation pads as part of the lift construction to prevent transmission of noise to the surrounding structure.

Electro mechanical brake

The drive motor is to be provided with a compression spring applied, solenoid released electro-mechanical brake, operating at direct current from control panel rectifiers. It is to be rated at a minimum of 180 and 240 cycles of operation per hour.

The brake shoes are to be self-aligning and a detachable emergency release lever is to be fitted, which is to release the brake only while manual pressure is applied. The brake is to be located between the Motor and gear and the brake is to only be used for parking and emergency stopping. The motor speed is to be reduced electrically in all instances. The brake must be capable of stopping the car whilst carrying 125% load at full speed.

Hoist ropes

The hoist ropes are to be replaced. The hoist ropes are to comply with BS: 6970 and their construction is to be ordinary lay. The suspension rope clamped anchorage device is to permit and indicate equalisation of tension (e.g. long screwed shank eyebolts and a matched set of compression springs).

Effective precautions are to be incorporated to prevent ropes leaving their respective grooves or objects lodging between grooves.

Lift car platforms and frame

The existing car platform and frame will be retained.

Guide shoes and rails

The guide shoes were inspected and were found necessary replace sliding guide shoe liners at the top and bottom of the car and counterweight.

The guide rails are to be retained, adjusted and reused. The distance between guides for the required car dimension is to be –0mm and +1mm. The tolerance of accuracy of angular alignment is not to exceed +/- 1mm. The vertical tolerance for the passenger lift is not to exceed +/- 1mm over any 5000mm length. Horizontal deflection is not to exceed 1 to 2mm under full loading conditions.

Guides and their fixings are to withstand the application of safety gear mechanisms when stopping a fully loaded car and sole plates are to be fitted to the base of all guides in the lift pits. The guide securing clips are to be of mild steel and be so designed that rotary movement of the clip does not release the guide.

Bond the guide rails at the base of each shaft in accordance with the latest Edition of the IEE Wiring Regulations by means of multi-stranded PVC insulated copper cable and bolted connections to local earth pit by others.

Counterweights

The car counter balance weights are to be retained and rebalanced. The weights are to be tied down into position and the whole assemblies are to be re-painted yellow.

Energy Dissipation Buffers

The existing car and counterweight energy dissipation buffers are to be replaced. As the buffer sole plates have been subjected to water contamination the existing plate is to be replaced and protected with appropriate corrosive protection paint.

Safety gear and over speed governor units

The safety gear is to be retained but stripped down and a complete system test carried out.

All lift cars are to be fitted with new over speed governor units to include a mechanical setting to enable the system to be tested at contract speed. The centrifugal governor will consist of a sheave, flyweights and a rope-clamping device. If the lift over speeds, the flyweights are to move outwards and strike a release mechanism to cause the rope-clamping device to grip the governor rope. The governor must grip and hold the governor rope with a force of 300N or twice the force required to engage the safety gear.

The over speed governor for the car safety gear is to activate when the speed is equal to or greater than 115% of the contract speed. The over speed governor for the counterweight safety gear is to activate at a speed not more than 10% greater than the speed at which the car safety gear is operated.

Provide each governor with an electrical cut out switch that removes the power from the lift motor and applies the brake, before the safety gear is activated, set at 115% of contract speed.

Trailing cables

Replacement trailing cables are to be provided for control circuits, telephones, alarms, lighting, and socket outlets. Cables are to be in one length between the lift car and the control panel connection points. All trailing cables are to include 10% spare ways and be finished in black LSF sheathing.

Half way or intermediate disconnecting boxes are not to be used in the well or under the car. The cables are to be securely clamped at the halfway point and where they exit the well. Cables are to be terminated using copper

clamp type washers and all cables are to be adequately numbered and identified.

Modernisation equipment

Lift car ventilation

Natural ventilation is to be by apertures at low and high levels on the basis of not less than 1% of the floor area for free air space. Provide each lift with a new mechanical ventilation system operated from a maintained trickle charger and battery of three-hour duration. This ventilation system is to only operate when the lift malfunctions.

Emergency lighting

Test and if required provide a maintained emergency lighting system for each lift car. The emergency lighting unit is to be of the self-contained type with integral battery, charger and control circuit. The lamps for the emergency lighting are to be located and rated such that, in addition to general illumination of the car, the horizontal luminance over the car front is to distinguish the car threshold, the emergency intercom and the alarm button.

The battery for the emergency lighting is to have sufficient capacity to maintain the simultaneous operation of the emergency lighting and extract fan for at least three hours and the emergency signal for at least half an hour. Lead acid charging batteries are not to be used.

The emergency lighting unit is to be fed from the live side of the car light switch in the machine room. It is to automatically re-charge the battery upon restoration of the normal mains supply.

After the battery has been discharged for the specified duration, it is to be capable of again supporting the specified duration period following a re-charge period of not more than 14 hours. At the end of the specified duration period, the battery is to provide not less than 85% if its nominal voltage at 15° C with the normal load connected.

Provide a three way switch in the service cabinet to switch car lights on, off or test. In the test position the emergency lighting can be tested for as long as necessary to prove it is operation correctly.

Lift alarms

Replace existing emergency alarm bell operated by the lift car alarm push button of every lift, located at the ground floor level. Arrange for it to be served via a dry-battery back-up system suitable for at least 3-hours continuous operation.

Lift communications

Provide each lift car with an emergency intercom unit for connection to a 24-hour manned call out desk via an in built autodial modem capable of dialling a least three numbers, via a normal telephone system. Provide all associated wiring between the connection point in the lift motor rooms and the system mounted into the car operating panels.

The operation of the intercom and two-way voice link is to be clearly marked on the car-operating panel. Two-way communications is to be initiated by the continual pressing of the alarm button for more than 3 seconds. The alarm is to continue to sound whilst the button is pressed.

The lift intercom system is to link the car to the Lift Contractors call centre. The system is to have the ability to link all points as well as an all stations broadcast facility.

The car top and pit intercoms are to have two call buttons, one to call the Lift Contractors centre and one to call the LMR. The LMR call buttons are for maintenance purposes.

Appendix 5

Outline description of the control and communications systems

Description of the communications and control systems

Control room

The control room will provide the hub for the safe monitoring of Greenwich and Woolwich tunnels.

As with any design the control room has to be carefully thought through. The ergonomics are important especially if staff are required to spend extended times carrying out there duties. The control room must comfortably accommodate the numbers of staff working there, as well as providing messing and rest room facilities. There is a further requirement that must also be accounted for within the control room suite, which is the retrieval of evidence (CCTV) by authorities including the police.

Control and monitoring equipment

The control room will accommodate all switching equipment, telemetry control and multiplexing as the design requires operating all of the proposed systems.

The equipment and facilities to be controlled and monitored from the desk needing to be considerable, together with their layout to allow ease of working include:

- CCTV control and monitors;
- CCTV retrieval for incidents;
- Fire alarm system;
- Public address;
- Lift control and telephones;
- Help points;
- Lighting with manual override;
- Control and monitoring of sump pumps;
- Alarm monitoring.

CCTV control system

The controls for the CCTV cameras can be set by the operators but most modern systems can be configured for sequence switching for groups of cameras. A minimum of 5 sequence routines shall be provided upon commissioning.

The operator will be able to control the following:

- Switching of any camera to any monitor.
- PTZ camera control functions.
- Selection of preset shots.
- Control of digital recorder.
- Start/stop sequences.
- Compiling or modifying sequence routines (Administration Level Access).

The system will also facilitate the set-up and configuration of:

- Sequences or patrols.
- Password and Authorisation Levels.
- Preset shot positions.

All recording equipment will have their time/date generators locked to an 'off-air' master clock. This standard will be common to all the subsystems, requiring time and date stamping.

The speed of focus, zooms lens and manual iris functions shall be configurable.

The CCTV system shall have the facility for programmable non-dwell zone (for any frontage cameras that may be directly opposite hotel windows e.g. for privacy).

The system shall be capable of generating an alarm, if the synchronisation signal from any camera is 'lost'. The alarm shall be displayed to the operator, whether the particular camera is selected or not.

Control room monitors

The monitor location shall be to the recommended distances and optimum field of vision in accordance with good practice and the guidelines outlined by the P.S.D.B.

The minimum monitor screen size to be considered for inclusion into the design shall be 17" and will be of TFT technology.

Digital recording

In order to provide evidence of incidents it is proposed to record all images. A digital recording system is proposed and it should comply with the BTP Document for recommendations and specification guidance for digital recording systems for use within the jurisdiction of the British Transport Police.

A file size of typically 30kB using JPEG compression (ISO 10918) or similar would provide what is defined as “medium resolution” and would be sufficient for evidential requirements. However, the compression rate will be configurable to higher or lower ratios, the aim is to achieve storage of images for 31-days.

It will also be possible to configure the system to: record real-time, record in response to an alarm, record in response to video motion, or record based on a user-defined schedule.

A video authentication method will also be included to provide confidence that the video has not been altered.

The system shall facilitate a range of review features. These shall include as a minimum:

1 Search by time and date.

2 Search by alarm or events.

3 Search by camera number.

CCTV system

The current CCTV system provides a level of coverage to satisfy the current demands and as funds have come available the system is expanding to cover other key areas of the tunnels. In the proposals Hyder are aiming at extending what is already provided to provide better coverage/enhancement. With the addition of Help points this would provide a greater level of security for the public using the tunnel.

To increase the perceived level of security the CCTV system should be enhanced to provide a higher level of coverage throughout the foot tunnel. The areas of concern are with the lifts unmanned and the tunnel is not staffed.

The objective of the CCTV system is to provide a safer and a more secure environment for the public and staff. To successfully achieve this, the system must provide the following benefits:

1. Create and promote a safe and secure environment by:
   - Deterring crime and terrorism through its presence in all vulnerable areas of the tunnel.
   - Delivering sufficient levels of video information to help detect and record crime in progress throughout the tunnel.

- Delivering sufficient levels of video information to help detect other forms of non-criminal activity for crowd management (i.e. medical emergencies, crowd disturbances and safety issues etc.).

2. Capture and record the presence of any abnormal activity for evidential use with respect to:

   - Criminal activity.
   - Litigation claims.

The proposed enhancements of the CCTV system for Greenwich and Woolwich Tunnels will be designed to facilitate the specific requirements identified herein. The system will be continually monitored and will be capable of providing recorded information simultaneously from all of the areas requiring coverage, to the standards identified.

The system shall have the capability of being remotely monitored from the proposed new control room at Greenwich.

It is envisaged that the required level of detail can be afforded by the use of a combination of fixed or varifocal lens cameras.

To achieve these objectives, the CCTV system design must include careful consideration of:

- Camera Coverage and Performance.
- System Monitoring, Control and Associated Processes.
- Image Archiving and Retrieval.

Camera coverage

The outline design for Greenwich an Woolwich Tunnels can be found on drawing LN01084 - 001 and details the locations of CCTV cameras and other related equipment, the design is to ensure a coverage of 95% to 100% CCTV coverage by the use of fixed CCTV cameras, including a dedicated camera for each public help points, controlled entry/exit point as well as a CCTV interface(s) for each lift.

The design of the CCTV requirements for the tunnels will need to take cognisance of the existing CCTV system and ensure that the design is compatible in its electrical interfaces. In particular, the video outputs of the additional CCTV cameras/interfaces will be incorporated within a new/additional CCTV matrix located in the existing/new cabinet and controlled from the proposed new control room located at Greenwich.

In selecting camera locations the design shall adopt the recommendations made by the Home Office Scientific Development Branch (HOSDB) formally the Police Scientific Development Branch.

Four general observation categories have been defined, which are based on the relative size that a person appears on screen (figure 1). As part of the OR development, the user will be asked to decide which of these four categories best reflects the type of activity being observed. The CCTV installer will then be able to fit a suitable camera to meet the requirement.

Figure 1 Height based ‘levels of detail’

Monitor and Control: A figure occupies at least 5% of the screen height and the scene portrayed is not unduly cluttered. From this level of detail an observer should be able to monitor the number, direction and speed of movement of people, providing their presence is known to him; i.e. they do not have to be searched for.

Detect: The figure now occupies at least 10% of the available screen height. After an alert an observer would be able to search the display screens and ascertain with a high degree of certainty whether or not a person is present.

Recognise: When the figure occupies at least 50% of screen height viewers can say with a high degree of certainty whether or not an individual shown is the same as someone they have seen before.

Identify: With the figure now occupying at least 120% of the screen height, picture quality and detail should be sufficient to enable the identity of an individual to be established beyond reasonable doubt.

Coverage area	Coverage Required
<u>Entrances</u>	
All Entrances & Exits to the tunnel at street level.	To identify facial detail in line with HOSDB guidelines 120%. Staff entrances covered with door contacts where relevant.
All Entrances to restricted/staff areas.	

Coverage area	Coverage Required
Stairs & Walkway	
The stair access from street level to tunnel level	Crowd monitoring cameras to HOSDB 10%
Tunnel walkway	
All public lift entrances	
All public stair wells	
Tunnel frontage	General crowd monitoring views and tracking PSDB 5%

Table 2 Camera Coverage Requirement Specification

Camera specification

All cameras shall be fitted with appropriate lenses to meet the objective of total coverage. Camera coverage will be designed to ensure that all cameras installed are in the field of view of another camera, i.e. coverage overlaps.

The image pick up device used by the camera shall be of the interline transfer charge coupled device (CCD) type; they shall be of rugged design suitable for internal or external use.

The sensitivity of the cameras will enable a full video output (1 volt p-p) to be achieved for a scene luminance of 1 lux when used with an fl.2 lens or better this facility could be useful in areas of low lighting

Camera housings and location

The cameras within the tunnel will be housed in the service duct located in the centre of the tunnel. All other cameras will be installed in a manner, which will not intentionally cause damage to the structure.

The camera housing and brackets shall be to a B.S./RAL colour agreed with Greenwich Council and the final design of the bracket will be subject to approval of the Engineer.

The housing and mounting shall reflect the character and style of the location and other existing tunnel furniture.

The height of the camera shall be such that it will provide the optimum views, but will be as a minimum 2.4m above the FFL to the lowest point of the camera housing, with the exception of the tunnel CCTV cameras.

Public help points

Help points provide a further level of safety for the public. They provide in areas not manned by staff a method for the public to make contact to a manned centre in case of an emergency. Currently London Underground (LUL) are providing help points every 30 meters, so at any point in an underground station you are within 30 metres of summoning assistance. This is achievable on the underground as each station has a control room which is manned, currently; the Greenwich tunnel has no manned centre to accept/answer these calls.

In order to provide a means for the public to communicate with the control centre it is proposed to install passenger help points.

The use of help points on the London Underground and rail stations is common and provides reassurance to the public that help is at hand in case of an incident.

Eight help points are proposed for the tunnels;

- 0ne at each of the entrances, (two in total);
- Two in the staircase between street level and tunnel (four in total);
- Four in the tunnel.

In addition to the help points the lift cars will be fitted with lift telephones connected to the control room. It is proposed the help point units are a single button help point telephones, with the exception of the help points in the tunnel as these will be fitted with a manual point for operating the fire alarm system.

Each help point will be equipped with an induction loop, via an amplifier and loop cable contained in a plate box mounted directly above the help point to assist the public with hearing aids.

Each Help point will be cabled back to the control room for connection to a dedicated telephone line, In addition, a contact type output will be available from the Help Point, which will be cabled to the CCTV system, to trigger the switching of views / recording modes.

Help Points will be telephone line powered but the inductive loop will be locally mains powered.

Refuge points

The inclusion of refuge points for non-ambulant persons within the tunnels would require the installation of a refuge alarm call system in accordance with BS 5839 Part 9 (Code of practice for the design, installation, commissioning and maintenance of emergency voice communication systems).

The requirements to provide a refuge system for both foot tunnels has been considered, in order to provide a communication path between the refuge point and a manned control centre is possible using of the shelf equipment. Refuge points according to the requirements laid down you must establish secure locations within the structure to be able to withstand smoke/fire for a period. The current layout of the tunnels does not fit this scenario.

In order to meet the aims of the code we are proposing that the help points will provide part of this facility and with the use of LSOH cable provide a high level of availability in the event of an incident.

Intruder detection system / gate alarms system

Since the tunnels will now be unmanned it is essential that any security doors/areas are provided with detection to indicate to the control room staff of possible entry.

Therefore as part of the scheme a review of what areas doors should be alarmed will be required.

Additionally, if certain alarms are operated it will also operate the CCTV to record and alert the operator by means of displaying the image on a monitor.

The alarms will also have to be monitored for routine maintenance of equipment or staff entrance/exit will require the fitment of an electronic keypad to allow staff to pass without the alarm being activated.

Public address

Within the rail industry and especially on London underground the use of public address to provide a voice evacuation system connected to the fire alarm system is common place. Sub surface stations are generally known as Section 12 stations and are fitted with a public address system in accordance with BS5839 part 8.

In the event that the automatic fire detection system or a manual break glass fire alarm is activated the means of evacuation would be audible announcements broadcast over the loudspeakers for the tunnel(s) to be evacuated.

Other possible uses of the public address system are;

- Deter acts of vandalism by the operators making live broadcasts.
- Provide fixed announcements on a regular basis, for example ''Cyclists you are requested to dismount and walk through the tunnel'' No Smoking
- Deter other incidents within the tunnel that are being viewed on the CCTV system.

The public address would be controlled from the control centre during normal operating conditions. In the event of a fire being detected the system would automatically broadcast evacuation messages.

A preliminary fire strategy has been developed and dependent on the fire scenario passengers would be evacuated by laid down procedures, up to the intervention of the fire brigade controlling officer, who would take overall control of the situation.

Public address equipment

The public address equipment PAVA (public address voice evacuation) would be housed in three separate locations;

- Control centre for equipment to provide local microphone and keyboard/touch screen to provide the interface.

- Equipment cabinets at both tunnel locations to provide the amplifiers for the audio signals, interfaces to the control room equipment and interfaces to the fire detection system and monitoring of all external lines for faults.

The loudspeakers for the tunnels would be designed to fit in with the surrounding local conditions, within the tunnel the new service duct could be used to mount ceiling loudspeakers and the staircases would be discreetly installed within the roof space.

In addition to the loudspeakers ambient noise sensors (ANS) could be deployed to monitor the back ground level of noise in the tunnel prior to a broadcast be made, therefore, allowing the broadcast to be automatically louder than the background noise. This facility, with careful set up this may not be required.

All cabling to the loudspeakers would be in LSOH to ensure its fire dependency.

Public visual displays.

The use of visual information at the tunnel entrances would provide the public with up to date information on possible tunnel closures and providing visual alarm in the event of a fire.

The displays would be installed at street level in each of the entrances; the displays would controlled and operated from the control centre and would provide useful information on proposed planned shutdowns of the lifts, requesting cyclists to dismount (linked to the public address to provide a audible co-ordinated approach), No Smoking.

In addition, following operation of the fire alarm, the displays would display DO NOT ENTER signs, this would be flashing in order to attract the attention of the public.

Leaky feeder cable

Currently a leaky feeder cable is installed in the Woolwich tunnel. The intention is to provide this facility in the Greenwich tunnel as part of the works. Dependent on the material chosen for the cable management system the leaky feeder cable could be re used, however if this is not possible then the use of small stub antennas would be proposed.

We would also recommend that the system is capable of being used by The London Fire Brigade for any emergency situations. Further discussion will be required with the London Fire and Emergency Planning Authority (LFEPA).

Communication links

In order to link the Woolwich tunnel to the control centre at Greenwich it is essential to provide a back bone communication system.

This link will have to carry the CCTV images, voice, and control information. Currently this is being researched in to what can be provided and at what capital cost and the ongoing yearly costs.

Currently we are investigating this with BT.

One of the issues is the CCTV images on whether we transmit them as real time, requiring large band width or at say 12 frames a second requiring less bandwidth but a ‘’jerky’’ picture.