ArupTransport

Tyne and Wear Passenger Transport Authority

New Tyne Crossing

Proof of Evidence on Engineering

by Richard James Thurlow, B.Eng., C.Eng., MICE, F.Cons.E, MIHT

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Ove Arup & Partners Ltd
Central Square, Forth Street, Newcastle upon Tyne NE1 3PL
Tel +44 (0)191 261 6080 Fax +44 (0)191 261 7879
www.arup.com

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1. INTRODUCTION

1.1 Richard Thurlow will say:

1.2 I am a Civil/Transport Engineer, holding a Bachelor of Civil Engineering degree from Liverpool University. I am a Member of the Institution of Civil Engineers, a Fellow of the Association of Consulting Engineers, a member of the Institute of Highways and Transportation. My expertise lies in the transportation field, in which I have 30 years' experience.

1.3 I am a Director of Ove Arup & Partners Ltd (Arup) having worked for Arup since 1976, and currently I am the leader of the Newcastle Office of Arup.

1.4 Prior to this I spent many years in the Arup Transport office in the Midlands, latterly as a Director, being involved in and managing transport projects in a number of disciplines, including:

- Director for Transport Projects in the Middle East
- Initial studies on the widening of the M1 Motorway
- Audit of the Black Country Spine Road
- Road and Bridgeworks in Africa, Hong Kong, and Continental Europe

1.5 Since May 2001 I have been the Project Manager of the New Tyne Crossing. I am responsible for the overall management of the Arup consortium's advice to the Tyne and Wear Passenger Transport Authority (TWPTA) for the Preliminary Design and Procurement of the New Tyne Crossing.

Scope of Evidence

1.6 My evidence covers the following issues:

- Background to the Arup Consortium and various studies carried out since our appointment in November 1999;
- An overview of the Reference Design, including the new tunnel, the associated highways and other facilities.
- The influence on the design of mitigating environmental effects
- A resume of the procedure for the appointment of the concessionaire and his responsibility for design development.
- An indicative programme for the design and construction of the works.
- Information on capital costs and safety issues
- A review of the assumed method of construction

2. BACKGROUND, TWA ORDER AND CONCESSION

Appointment of Consortium

2.1 Other witnesses, primarily John Miller, the Engineer to the Tunnel, will provide evidence to the Inquiry on the previous work and published studies that led to the appointment of the Arup Consortium in 1999.

2.2 In summary, the 1991 Cross-Tyne Studies (Phase 1) produced by the MVA Consultancy, concluded that without at least one further river crossing there would be insufficient highway capacity by the end of the 1990's. The 1992 Cross Tyne Study (Phase 2) considered four locations for a new crossing (Walker, St Lawrence, St Anthony's and St Bede's). The TWPTA were provided with a "decision tree" to assist them in making the choice for the preferred option. As a result the St Bede's option was recommended for further consideration.

2.3 In the absence of public funds to undertake the construction works, in 1995 the TWPTA appointed Hambros Bank Ltd, the Babtie Group, Steer Davies Gleave, Freshfields and Chesterton (referred to as Hambros) to conduct a feasibility study into a new crossing of the Tyne at St Bede's, to be funded through a Private Finance Initiative (PFI).

2.4 The New Tyne Crossing PFI Feasibility Study Report (CD35) considered a range of bridge and tunnel options at St Bede's and reported on the technical and financial viability of each with specific relevance to the funding processes. The principal options considered were as follows:

- Fixed bridge
- Opening bridge
- Immersed tube tunnel
- Bored tunnel

2.5 The report concluded, "On the basis of risk transfer, project specific requirements, and environmental impact, a tunnel option appears the most appropriate option. On the basis of whole life costing and construction risk there appears to be a significant benefit in an immersed tube as opposed to a bored tunnel. Therefore the immersed tube tunnel option has been taken forward as being the most suitable option for a PFI solution to the need for a new crossing" (page 30). In 1996, based on the study of Hambros et al, the TWPTA decided to promote an immersed tube tunnel at St. Bede's, as the preferable option for a new crossing of the Tyne (the New Tyne Crossing).

2.6 In order to progress the proposal through the statutory procedures, and through the process of competitive bidding to award a concession, the TWPTA sought to engage advisors to carry out the work necessary to obtain approval under the Transport and Works Act 1992 (TWA). The advisors were also to advise on the appointment of a concessionaire to carry out the detailed design, construction and to manage the operation of the new and existing vehicular tunnels as well the existing pedestrian and cycle tunnels during the concession period.

2.7 In 1999 the Arup consortium was appointed as the advisors to the project. The consortium consists of:

- Arup – lead advisor and project manager of the team carrying out the planning and engineering work necessary to obtain approval under the Transport and Works Act 1992

(TWA), including the Environmental Impact Assessment. Also specialist advisers on town and country planning policy, traffic, noise and vibration, air quality, nature conservation, contaminated land, hydrogeology (including surface water), and waste arising and disposal.

- Herbert Smith – specialist legal advice on TWA procedures and the Concession Agreement.
- KPMG – advice on funding and the structuring of the PFI /PPP package and the appointment of the concessionaire.
- Posford Haskoning –specialist advice on engineering for an Immersed Tube Tunnel, on water quality, river impacts, and marine ecology.
- Lamb and Edge – specialist advice on property matters.
- Reid Jubb Brown –specialist advice on landscape and cultural heritage issues.
- Northern Archaeological Associates - specialist advice on archaeological matters.
- Centre for Ecology and Hydrology - specialist advice on the impact of the proposal on fish.
- Bradley O'Mahoney – specialist advice on public relations.

Relevant Investigations

2.8 The advisor has carried out a number of investigations. These are summarised below.

2.9 The advisors were requested by TWPTA to review the Hambros' Feasibility Study. The review focussed on the possible changes to the underlying assumptions made in the Hambros Study and identified where further action was required to support or update those assumptions. The findings can be summarised as:

- **Finance** - while there had been changes in financial conditions, they were not to the extent that the Feasibility Study conclusions would be affected. No actions were recommended.
- **Traffic** - while there had been changes in traffic forecasting issues, they were not likely to undermine the assessments of the Feasibility Study. No actions were recommended.
- **Legal** - there were no legislative changes since the date of the Hambros report that would invalidate any of its substantive conclusions. Clarification of certain powers and jurisdiction was recommended.
- **Land and Property** - there had been no changes that invalidated the Hambros report's conclusions. No actions were recommended.
- **Planning** - there had been no changes which invalidated the Hambros Report's conclusions. It was recommended that options be evaluated on the basis of new planning policy, that regeneration and economic implications be analysed, and that the impacts of the construction and operation of the tunnel on local residents be evaluated.
- **Environment** - different methodologies and assessment methods would be used, but all options would be affected equally, and therefore the conclusions of the Feasibility Study were still valid. No actions were recommended.
- **Engineering** - There had been changes in the Port of Tyne Authority's requirements, which were likely to affect the physical layout and the costs. There were doubts on the scope of the work and hence on the capital costing of the preferred solution, which were considered to possibly cause subsequent financing concerns. There were doubts about the horizontal and vertical alignments, the resolution of which could possibly be problematic. There had also been changes in technical guidance that were considered likely to increase project costs.

2.10 A number of actions were recommended to address these matters. These were to:

- Resolve the interfaces with the existing tunnel on the north and south sides of the river
- Examine the effects of the Port of Tyne Authority's (PoTA) dredged depth requirements
- Assess safety issues
- Examine the options for building the tunnel elements in a dry dock

2.11 In addition to reviewing the Hambros Study, the TWPTA also wished to review a further range of immersed tunnel options, of which four were evaluated in greater detail:

- Option 1 - a new southbound two lane, one way tunnel, with operation of the existing tunnel as a two lane, one way northbound tunnel
- Option 2 - a new four-lane two-way tunnel for vehicles of reduced height, retaining the existing tunnel to carry two-way traffic of standard height.
- Option 3 - a new two-lane, two-way tunnel to carry A19 through traffic, leaving the existing tunnel to carry two-way local traffic
- Option 4 - as option 3, but with a new four-lane tunnel.

2.12 Each option was evaluated against assessment criteria derived from the Department of Transport, Environment and the Regions, New Approach to Appraisal (DETR NATA) methodology; these being environment, safety, accessibility and integration issues. Economic issues were not assessed at this stage, but financial aspects were. After an initial appraisal, Options 1 and 4 were considered further. It was advised that Option 1 should be adopted as the preferred scheme.

2.13 The reasons for this were:-

- There were no significant differences between all the options in respect of environmental, legal, property, planning or economic development issues.
- The major differences were almost wholly related to the cost implications and the financial viability of the scheme, and safety.
- Option 4 could not be financed solely from tolls, i.e., costs would fall on the public purse. Even at maximised toll levels, there would be insufficient income to meet operating costs and service commercial debt funding.

2.14 Although Arup was appointed to progress the immersed tube option, our advice to the TWPTA had been that it would be prudent to review the bored tunnel option. In the light of these recommendations the TWPTA requested Arup, in August 2000, to also examine a bored tunnel option in greater detail than had been done before, and undertake a direct comparison of its effects with those of an immersed tube.

2.15 In order to facilitate the confirmation of TWPTA's decision on the choice between the two tunnelling options (bored and immersed, both carrying a new two-lane southbound carriageway and converting the existing tunnel to two-lane northbound) a comparison was made between the two for consideration by the TWPTA. This comparison was first made in April 2001 and subsequently revised, (using more recent capital cost data), in February 2002.

2.16 The following issues discussed are summarised in the table below:

TABLE: 2.16: SUMMARY COMPARISON OF IMMERSED TUBE AND BORED TUNNEL

ISSUE	IMMERSED TUBE	BORED TUNNEL
FINANCIAL		
80th % percentile Capital Cost (2Q 2000) recalculated Feb 2002	£138.9million	£162.5 million
Present Value Costs (PVC)	£141 million	£168 million
Present Value Benefits (PVB COBA style)	£255 million	£219 million
Net Present Value (NPV)	£114 million	£52 million
Car Toll at 1999 prices (excl VAT)	£1.10 Base cost + high traffic £1.30 Base cost + medium traffic £1.55 Base cost + low traffic	£1.35 Base cost + high traffic £1.60 Base cost + medium traffic £2.00 Base cost + low traffic
PROGRAMME		
Procedural Risk	TWA Application imminent. Greater risk of objections.	Preconsultation required Private Bill Petition must be laid before parliament by 27 November 2002. Meeting this deadline will be difficult in which case 12-18 months delay.
Construction Period	36 months ± 3months Year of opening: early 2007	39 months ± 6 months Year of opening: 2007-2008
Construction Risk	Less risk to Programme and Cost.	Unknown ground for tunnelling. Delay risks, cost increase risk.
TRAFFIC		
Traffic indicator CRF Daily traffic (AADT)	80,000 vpd 52,000 vpd in 2031	80,000 vpd 50,000 vpd in 2031 (Suppressed by Toll)
PROPERTY		
Dwellings demolished Other Demolition	21 dwellings The "Gaslight" pub, St Peter's School, AMEC yard workshop buildings, Car Showrooms, The Grange Nursing Home, Newsagent, YMCA drop in centre	15 dwellings Newsagent, YMCA drop in centre
Other Impact	Part of AMEC yard and buildings taken for duration of contract Use of Howdon Basin limited by presence of the tunnel during construction No post construction impact	Ground settlement affecting up to 25 properties resulting in slight[1] or moderate damage (including Nursing Home) No post construction impact
ENVIRONMENT CONSTRUCTION		
Construction Noise	Greater impact in Jarrow	Greater impact in East Howdon and north of Howdon
Community Impact	Greater degree of temporary severance and temporary loss of Riverside Park.	Small degree of impact, mostly temporary
Spoil Disposal	Disposal to sea 65,000 m³*	Disposal to sea – None

[1] Slight is defined as needing 'minor redecoration'
Moderate is defined as 'minor structural repairs'

TABLE: 2.16: SUMMARY COMPARISON OF IMMERSED TUBE AND BORED TUNNEL		
ISSUE	**IMMERSED TUBE**	**BORED TUNNEL**
	Disposal to landfill 275,200 m^3 **	Disposal to Landfill – 185,000m^3
Marine Ecology	Area of river habitat temporarily disrupted	No impact
Fish & Fisheries	Tyne Fishery is of national importance for Salmon and Trout. Fisheries impact substantially mitigated by dredging controls and other monitoring mitigation measures. No post construction impact.	No impact, during construction or post construction
ENVIRONMENT OPERATION		
Landscape and Townscape	Large degree of impact, but this provides regeneration opportunities	Small degree of impact
Community Impact	Loss of Nursing Home, YMCA, newsagent, St Peter's School	Loss of YMCA, Newsagent
SAFETY		
Emergency escape	Provision in new tunnel via service cell. Existing tunnel improved by provision of two vertical escape shafts.	Provision of cross passages at 250m centres. Non-incident tunnel provides place of safety.
SOCIAL INCLUSION		
	Lower toll is more likely to assist in achieving objectives of social equity and distribution	Higher toll is less likely to assist in achieving objectives of social equity and distribution
ENGINEERING		
Length Maximum Gradient	1230m 6% (downhill) 5% (uphill)	1940m 5% (uphill and downhill)

* later amended to 140,000m3, ** later amended to 210,000m^3

2.17 The recommendation to the TWPTA stated; -

"*The capital cost penalty of the Bored tunnel is £24 million more, which translates into a requirement of a toll of about £0.30 more per car (bringing the toll to £1.60) to give a reasonable prospect that a tunnel concessionaire would find the project a sufficiently attractive investment.*

Whilst the Immersed Tube tunnel option represents a significant cost saving, each solution has a number of potential impacts namely:

- Application procedure;
- Property acquisition and demolition;
- Impact on the River Tyne;
- Impact on river environment (mainly fisheries);
- Impact on local residents.

These issues are of varying importance in terms of their effect upon feasibility, budget and programming. Many of the impacts are capable of mitigation either entirely or so as to minimise potential disruption or delay. In Arup's view, the issues do not in themselves preclude selection of either tunnel solution.

In light of the above, the decision issues in selecting either tunnelling solution relate to:-

- *Capital costs (and the resulting level of tolls);*
- *Construction timing and deliverability (and related impact on costs);*
- *Local sensitivities in relation to issues such as:-*
  - *disruption during construction and related noise and pollution;*
  - *permanent impairment to the local built environment and development potential; and*
  - *residual unmitigated environmental concerns.*

Matters of capital cost, construction timing and deliverability are readily susceptible to analysis. Local sensitivities, such as those indicated, involve considerations that the PTA, with its remit, is best placed to assess".

2.18 The TWPTA decided on the 31 May 2001 to continue to promote the immersed tube tunnel. They reconsidered the choice between two options at their meeting on 28 February 2002, and resolved pursuant to LGA 1972 to promote the immersed tube option to which this application refers.

Reference Design

2.19 Work has continued since that time on the preparation of a Preliminary Design (the Reference Design).

2.20 This Reference Design has to show sufficient detail to ensure that all engineering issues are capable of being resolved, that sufficient detail is available for all environmental implications to be assessed, that capital costs can be derived, that there is sufficient information for tenderers, and that sufficient detail exists to enable the TWA application to be made.

2.21 The Reference Design also has to be detailed enough for questions of land acquisition, and accommodation works to be resolved. Main engineering issues, apart from a more detailed design, that have been considered in sufficient detail for these to be achieved, are as follows: -

- **Disposal of spoil**

2.22 Considerable investigative work was undertaken in determining the most appropriate location for the storage and disposal of spoil excavated from within the River Tyne. In essence there are two main options, permanent disposal off-site, and temporary storage for re-use in filling the trench in the river.

Four options were assessed for temporary storage:

- Howdon Landfill west
- Mercantile Dock (RMC site)
- Whitehill Point
- In the River Tyne

2.23 A fifth option, that of sale of excavated materials and purchase of back fill, was also considered. The recommendation was that the use of the Mercantile Dock was the preferred option on engineering, environmental, and material handling factors. This is the location shown in the TWA application.

- **Tunnel Alignment North of River**

2.24 The proposed tunnel crosses over the existing tunnel in two locations. The vertical alignment is severely constrained because of

  - PoTA clearance requirements
  - Allowable vertical gradients
  - Clearance needed from top of existing tunnel to bottom of new tunnel

2.25 This early vertical alignment caused disturbance to AMEC and their tenants at Howdon yard. In October 2001, investigative work was undertaken to see if other options for the alignment were better. The only practicable options are:

  - Revise the vertical alignment
  - Revise the horizontal alignment to avoid the tunnels crossing
  - Continue with the existing alignment

2.26 These three options were assessed in engineering, environmental, safety (in construction) and capital cost terms. It was concluded that the original alignment should be confirmed on the basis of: -

  - Least disturbance to the residents of East Howdon
  - Least risk to the existing tunnel during construction
  - Least capital cost

- **Options for Northern Junction**

2.27 The existing road layout at the northern exit of the existing tunnel comprises of two closely spaced roundabouts linking the tunnel exit and entrance, the A19, the Howdon bypass and Tyne View Terrace.

2.28 It was proposed initially to continue this arrangement, but, in consultation with North Tyneside Metropolitan Borough Council, a simpler arrangement was designed. This omits the western of the two roundabouts, with no loss of flexibility in traffic destination for northbound traffic. Traffic exiting from the northbound tunnel splits; either going directly northwards along the A19, or eastwards directly into the eastern roundabout from where it can join the local highway system. All traffic entering the southbound tunnel must do so from either the A1058 "Coast Road" or the A193 junction immediately to the north of the proposed toll plaza.

- **Options for Southern Junctions**

2.29 The original tunnel design proposed the connection of the road through the tunnel to the local road network in South Tyneside at a point south of the Metro overbridge on the A19 ("the Simonside Junction"). The Unitary Development Plan incorporated this. As detailed design work progressed an alternative junction arrangement, which would have less extensive adverse environmental effect and lower construction costs, was identified ("the Jarrow Junction").

2.30 These alternative junctions were presented as part of the public consultation exercise in July and August 2001. The outcomes from the consultation were:

- The general public did not have a definitive preference for one option, but raised questions or matters to be considered, before a decision was to be made.
  The basis for deciding between the options should be environmental impact, effects on road users, effects on people, and cost.

2.31 The advisors reviewed the merits of both options, taking into account environmental, cost and traffic implications, and the results of the public consultation. A summary of the environmental comparison between the two is as follows:

TABLE: 2.31	**Junction**	
	Simonside	Jarrow
Noise	Positive benefit in vicinity of Salcombe Avenue. Adverse, but not significant, impacts on Newlyn drive and Bilton Hill Road	Adverse, but not significant, effects at Epinay Walk
Air Quality	*Construction:* Dust impact at Salcombe Avenue *Operation:* Within Air Quality objectives. Pollutant concentrations slightly lower at the South Portal than Jarrow junction, but slightly higher in Simonside area	*Construction:* Dust impact at Epinay Walk, but less properties affected than on Salcombe Avenue. *Operation:* Within Air Quality objectives. Pollutant concentrations slightly higher at the South Portal than with the Simonside Junction, but slightly lower in Simonside area.
Greenhouse Gases	Higher levels than Jarrow Junction	Levels lower than Simonside Junction.
Landscape and Townscape	Embankment within 10m of nearest dwelling. Loss of substantial amount of woodland. Link road would alter the character of the River Don corridor. Adversely overlooks Cemetery.	Retaining wall 12m from nearest dwelling. Removal of existing woodland planting. River Don corridor not affected.
Biodiversity	New Link Road from A19 to A185 affects Straker Street Pond (potential SNCI). Water vole habitat at Straker St affected.	No designated sites affected. No ponds or water voles affected.
Severance	Loss of open space between A19 and Jarrow Cemetery. Footpaths severed during construction and operation	Footpaths in the area of the portal affected during construction. No footpaths severed during operation. Loss of open space in front of houses on

TABLE: 2.31	**Junction**	
	Simonside	Jarrow
		Epinay Walk
Heritage	No significant difference	No significant difference
Water Environment	No significant difference	No significant difference

2.32 Comparisons between the two options from a transport perspective, found that there would be a total vehicle kilometre savings of 7,015 vehicle kilometres per day in favour of the Jarrow junction. It was also noted that the effects of this vehicle kilometre saving would be reflected in a reduced number of accidents likely to occur on the local road network, so the Jarrow option would also result in less accidents, and also a reduction in exhaust emissions.

2.33 The capital cost difference between the two options was estimated to be about £4.5m in favour of the Jarrow junction.

2.34 South Tyneside Council and the Highways Agency were also consulted. South Tyneside Council resolved to accept the Jarrow option. The Highways Agency was consulted on the Jarrow alternative and requested operational details of the queuing at the junction, which was provided to their satisfaction.

2.35 As a result of this work the TWPTA agreed on the 17 October 2001 to proceed with the Jarrow option.

TWA Order

2.36 After completing these various studies and carrying out widespread consultations, a more detailed engineering layout was developed incorporating and dealing with the issues described above. This 'Reference Design', which is described fully in Section 3 was then used as the basis for the TWA Order and related Planning Direction. The Reference Design has been devised on the best engineering assumptions about how the scheme will be built, the probable construction methods, including how the various parts of the site will be used, and the duration of the construction work. An Environmental Impact Assessment was undertaken on the Reference Design, as reported in the New Tyne Crossing Environmental Statement, May 2002 (CD4).

The Concession

2.37 A Concessionaire will be selected by the TWPTA through a public tendering process, to design and construct the new tunnel and take over its operation and maintenance together with the operation and maintenance of the existing vehicular, pedestrian and cycle tunnels for a specified period. This period is yet to be determined but is likely to be about 30 years. The scheme will be financed by the Concessionaire who will raise money through loans which will be repaid to the lenders over the concession period, through the collection of tolls paid by the public to use the new and existing tunnels.

The programme for the procurement of the concession is attached at Appendix G.

2.38 The procedures are as follows:

- A Prior Information Notice (PIN) will be published in the Official Journal of the European Community (OJEC). This will request expressions of interest from interested Consortia. The call for Expressions of Interest will require prospective Concessionaires to demonstrate inter alia: -
  - The nature of their group and its constituent members
  - Their interest in the scheme

  The purpose of this notice is to advise interested firms that the bidding for the project has started.

- A Prequalification notice (PQ) will be published in the OJEC Journal. It is expected that this will be published in the summer of 2003. This notice will require prospective Concessionaires to:
  - Demonstrate the financial, technical and managerial performance and competence over a significant period of time for members of any consortium
  - Describe in general terms, the sources and types of their funding
  - Outline their past experience in Immersed Tube Tunnel construction and major civil engineering works
  - Give details of their Quality Assurance and Health and Safety procedures
  - Broadly describe their methodology for undertaking the works
  - Describe their policy for management and staffing of design, construction and operation

2.39 There will be a Bidders Open Day during the pre-qualification period of two months. The responses to the PQ will enable the Advisors to recommend a shortlist of three to four groups to undertake the full bidding exercise.

2.40 Following a positive decision by the Deputy Prime Minister, and approval of this and of the shortlist by the TWPTA, the short-listed bidders will be issued with the full set of Tender Documents. These will consist of sufficient information of a financial, technical and legal nature that will enable the Tenderers to bid for the design, construction, and operation of the tunnel for the specified concession period. The tender period is likely to be 5-6 months.

2.41 These offers will be evaluated, taking into account all the factors in the bids, of which, the intended tolls on opening will form a significant part. The overall construction period will also be important, as will their proposals for safety during construction and operation.

2.42 Following evaluation, the two best offers will be recommended to the TWPTA for carrying forward for final 'Best and Final Offers' (BAFO). These will be evaluated and the offer which provides best value will be recommended to the TWPTA as the selected Concessionaire

2.43 Contract negotiations will then take place with the recommended Tenderers, leading to the award of the Concession. This is likely to be at beginning of 2005, leading to opening of the new tunnel in late 2008/early 2009. The design and construction programme are discussed more fully in Section 8.

3. SCHEME LAYOUT AND DESIGN

Existing Conditions

3.1 The existing Tyne Tunnel organisation consists of a vehicular tunnel, a pedestrian and a cycle tunnel under the River Tyne between Jarrow and Howdon. These are shown on Figure 3.1 of the Environmental Statement (ES) (CD5), of which 3.1 is attached in Appendix H.

- **Vehicular Tunnel**

3.2 The vehicular tunnel, which links the A19 on the north and south sides of the river, is 1680m long with an internal diameter of 9.5m. It was opened in 1967. The crown of the tunnel is 17m below the river bed and 30m below high water level in the river. The carriageway is 7.3m wide overall, giving one lane 3.65m wide for traffic in each direction. The roadway is designed to carry vehicles weighing up to 180 tons. Ventilation Stations on the north and south sides of the river are equipped with fans to supply air to ventilate the tunnel. Air is also extracted from the tunnel and discharged at the same stations through 45m high chimneys.

3.3 The control and instrumentation systems for the vehicular tunnel monitor carbon monoxide, smoke density (visibility) and air flow, control the intensity of the lighting at the portals, and give warning of vehicles which exceed the permitted height. Closed circuit television scanning the whole of the tunnel, full radio control and emergency fire points are installed.

3.4 All vehicles using the tunnels pay tolls, which are collected at the north end where five toll booths are installed on both the entrance and the exit sides of the carriageway. The existing administration building and maintenance facilities are also located on the north side of the river, adjacent to the tolling facilities. A smaller maintenance building is also provided on the south bank, adjacent to the northbound vehicle inspection area.

3.5 In the north, the toll plaza joins a roundabout, which enables traffic to both enter and exit the toll plaza from the A19, and via a short eastward link to another roundabout at the end of the East Howdon bypass, the A187. This roundabout also joins Tyne View Terrace to the west, and local highways to East Howdon and the Sewage Treatment works. (Figure 3.2 of ES (CD5) attached in Appendix H).

3.6 In the south, a roundabout near the exit of the Tyne Tunnel, enables vehicular traffic to join the A19(T), the A185 and the local network in Jarrow. (Figure 3.3 of ES CD5 is found at Appendix H).

- **Pedestrian and Cycle Tunnels**

3.7 The pedestrian and cycle tunnels are each 274m long and respectively 3.2m and 3.65m in diameter. They were completed and opened on 24 July 1951. The tunnels are served at each end by lifts and by escalators. There is no charge for using the pedestrian or cycle tunnels. The tunnels and portal buildings are Grade II listed.

Proposed Scheme Layout

3.8 The proposal involves the retention and continued use of the existing tunnels and the provision of the New Tyne (vehicular) Tunnel on the east side (downstream) of the existing vehicular tunnel. (Fig 3.1 of ES attached in Appendix H). Under normal operating conditions

both vehicular tunnels will carry traffic in one direction only, with the northbound traffic remaining in the existing tunnel and southbound traffic being routed via the new tunnel. These changes to traffic flow require the junctions at either end of the tunnels to be reconfigured, in order to maintain the connections to the local highway network and the A19. Both tunnels will be wide enough to carry two lanes of traffic and will be designed to be capable of carrying traffic either as a two way flow or reverse direction flows in the event of planned maintenance or emergencies. From a north to south direction, the main tunnel and highway works are as follows:

- The scheme commences on the north side of the Tyne, just north of the junction with the A193.
- The existing A19 highway will become part of the tunnels road.
- The southbound carriageway will be realigned from a point just south of the existing Metro Overbridge, through the new southbound vehicle toll plaza to the start of the **130m long retained cutting** which will extend to the tunnel portal.
- The retained cutting will enter a **cut and cover tunnel section**, extending to the edge of the Tyne, at Howdon Basin.
- At the river's edge the cut and cover tunnel will join to the **immersed tube tunnel** in the river bed.
- The immersed tube tunnel will extend approximately 360m to the south bank of the Tyne.
- The immersed tube tunnel will join the **cut and cover** and **open cut sections** of the tunnel for 840m to the tunnel portal.
- From the southern portal the scheme will extend approximately 500m south, incorporating the **Jarrow Junction**.

3.9 These works are illustrated by Figures 3.1, 3.2 and 3.3 of CD5 and Drawing Ph-SL-700 which I provide at Appendix H.

Toll Plaza and Related Areas

3.10 Both toll plazas will be located north of the river, with no proposed tolling facilities on the south side. Both toll plazas will have facilities to charge tolls for traffic using each tunnel in either direction, e.g. due to planned maintenance or emergencies.

3.11 In the northern cutting a new toll plaza will be constructed to accommodate southbound traffic, as provided by Work No. 1 and 1B of the TWA Order, and shown on Fig 3.1 of the ES attached in Appendix H. The plaza will include toll booths, a vehicle inspection area and car parking facilities for tunnel staff. Any vehicle prevented from entering tunnel will be directed to the Howdon Bypass via a new road. This road will also be available for use by public transport to access the southbound tunnel direct from Howdon Bypass, bypassing the Toll booths.

3.12 Traffic wishing to travel south through the tunnel (other than public transport) will need to have joined the A19 at the A1058 Silverlink roundabout or the A193 junction.

3.13 The existing toll plaza at the northern end of the existing tunnel will be reconfigured for the northbound traffic, which will then exit and rejoin either the local highway network or the A19 North. (Fig 3.1 of ES attached in Appendix H). The works at this plaza will mean the removal of existing tollbooths and replacement with new ones, and a means of allowing public transport to exit without toll.

New Administrative Building

3.14 A new administration building and car parking area has been allowed for in the open cut area adjacent to the new toll plaza, as provided for by Work No. 1E of the TWA Order. It will be for the Concessionaire to decide whether to construct a new building or to make use of the existing Tyne Tunnel facilities.

Ventilation Building

3.15 The New Tyne Tunnel will be ventilated to control vehicle emissions and the discharge from the tunnel in a way which causes least environmental impact and to provide fire control. Emissions from this tunnel will be at the south end to match the direction of traffic flow. A new ventilation building and stack will be provided in order to minimise the impact on air quality.

3.16 These works will be constructed on the south side of the new Howard Street Bridge, adjacent to the southern portal and within the Jarrow Junction road network. (Figure 3.1 of the ES attached in Appendix H). The ventilation building will be 20m x 25m in area and the ventilation stack will be 15m high on a 7m high building. This is provided for by Work No. 6G of the TWA Order. Several different locations were examined for the site of the ventilation building. The choice of the preferred site was largely dependent upon environmental considerations, in terms of air quality noise and visual impact, plus length of the tunnel and position of portal.

Howdon Yard and Basin

3.17 There are numerous impacts on Howdon Yard and Basin, arising both from its assumed use by the Concessionaire during the construction period (to construct the immersed tube sections) and by constraints placed upon the future operation of the yard due to its proximity to the new tunnel. This results in a need to reconfigure the layout of the basin, and to extend the existing quay wall further to the east to permit berthing clear of the new tunnel.

3.18 The combined effect of these changes results in the following permanent works at Howdon Yard (as shown on Fig 3.2 of the ES attached in Appendix H):

- Provision of a new substation and undertaking services diversions prior to tunnel construction commencing.
- Demolition and reconstruction of office buildings.
- Construction of new quays in Howdon Basin and extension of the basin to the west to offset encroachment caused by extending the piled platform.
- Howdon Quay will be extended eastwards (downstream) by approximately 45m to enable vessels to continue to berth at Howdon Quay.

3.19 These measures will enable AMEC, the tenants, to operate in an identical manner to that currently, after construction and during construction, although suffering some inconvenience, to operate with minimal interference.

New Vehicular Tunnel

Design and Approvals

3.20 Design of the tunnel will based on BD 78/99, the Highway Agency's design manual specifically for road tunnels. As mandated by BD 78/99, a Tunnel Design Safety Consultation Group (TDSCG), which comprises representatives from the TWPTA, the current tunnel operator, the police, the emergency services plus emergency planning unit and the designers, has met several times to consider the overall safety of the tunnel, and the safety in operation of both the new and existing tunnels. The TDSCG is satisfied that at this Reference Design phase, the proposed design parameters will enable the tunnels to operate safely. After appointment, the Concessionaire will become responsible for completing the detail design. As required by BD 78/99 the TDSCG will continue to examine design features and identify any safety implications.

3.21 The TWPTA has asked the Highways Agency to be the technical approval authority for the tunnel and North and South Tyneside Metropolitan Borough Councils and Newcastle City Council (NCC) to be the Technical Approval Authorities for the road structures.

Layout

3.22 As summarised in paragraph 3.8 above the overall tunnel structure will comprise sections of retained cut, cut and cover and immersed tube construction. On the north side of the Tyne it commences with an open cut approach to the tunnel, which is then changed to cut and cover form of construction where the tunnel alignment goes deeper into the ground. An example of cut and cover construction is shown on Fig 3.4 of the ES attached in Appendix H). On the south side of the Tyne in the vicinity of Howard Street the existing ground levels result in a fairly abrupt change (lowering) of ground level such that a retained cut is not required beyond the south portal (Fig 3.3 Appendix H).

3.23 The length of immersed tube is dictated by the width of the river at its crossing point, commencing at the edge of Howdon Basin on the north bank and extending to the south bank of the Tyne (Figs 3.2 and 3.3 in Appendix H). More details on this form of construction are given in Section 4. In brief the immersed tube form of construction enables the tunnel sections to be constructed remote from the site, then towed into place and sunk into a trench dredged beneath the river bed which is then backfilled. Compared with other forms of construction e.g. a bored tunnel, this results in a shorter length of tunnel, because the tunnel is shallower.

3.24 The design involves various elements which are provided for in the TWA Order as Work No. 4A, 4B, 4C, 4D and 5 (CD1).

3.25 The tunnel cross section will provide space for a 7.3m wide two-lane carriageway with 1.0m wide shoulders on each side of the carriageway The sides of the tunnel will be protected from vehicle impact by barriers.(See Drawing Ph-SL-701 in Appendix H). A separate 'cell' adjacent to the main vehicular cell is shown on these cross sections; this will be used as an escape passage and for routing utilities. This will also provide emergency access from the shoulder at the side of the inside lane. The escape/services passage will have three zones to accommodate pipes for, water supply and drainage, a 2.5m high walkway escape passage, and a cable passage for power and communication cables. Access from the traffic cell to the escape passage will be via emergency doors. The escape cell is not required in the retained cut

sections, as the section is no longer enclosed (i.e., it is open to the atmosphere) and a means of egress to the portal is more easily achieved.

3.26 A maintained headroom of 5.1m will be provided above the carriageway. Additional space above the maintained headroom will be provided in the cut and cover section to accommodate permanent fixtures such as ventilation fans, lighting fixtures and signs, plus a tolerance to provide clearance to these permanent fixtures and to allow for flapping tarpaulins.

3.27 The vertical alignment of the tunnel has been designed to meet the constraints imposed by the navigation and dredging requirements in the river, the need to cross over the existing tunnel on the north side, and the existing A19 highway alignments on the north and south of the river. (Details of the tunnel's vertical alignment under the river are shown on Drawing Number PH-SL-702 in Appendix H; this indicates the allowance for future dredging of the navigational channel by the PoTA down to a level of –11.6m Chart Datum).

3.28 In addition, there is a need for the new tunnel to cross over the existing tunnel in two locations north of the river where it is climbing, and curving to ground level. In order to achieve this safely, sufficient clearance must be allowed between the top of the existing tunnel and the bottom of the new tunnel. This places a constraint on the vertical alignment of the new tunnel. As a result, the road gradient on the north side of the river will be 6% (downhill for normal uni-directional traffic flow). The road gradient on the south side of the river will not exceed 5% (uphill for normal uni-directional traffic flow). See Drawing Numbers PH-SL-700, 712 and 713, included in Appendix H).

Existing Tunnels

Vehicular tunnel

3.29 The existing tunnel will be operated on a one way basis after the opening of the new tunnel, and certain improvements and modifications are consequent on this.

3.30 Ventilation will be modified to reflect the new traffic arrangement, and the lighting, signing and communication systems will be improved. In addition, two vertical escape shafts will be constructed from the existing tunnel to ground level adjacent to each river bank, to provide better access in the event of emergencies. The toll collection system will be changed to take account of the new traffic arrangements.

Pedestrian and Cycle tunnels

3.31 These tunnels, (Grade II listed buildings) will remain unchanged, except that their southern access will be improved. These works will both ensure that the public will have continued access during the construction period and are intended to provide better access and visibility after construction, to encourage increased use of these facilities.

New Highway Approaches

General

3.32 The existing Tyne Tunnel is linked to the highway network via the A19 dual carriageway and by local connections at roundabouts either side of the tunnel. A fuller description of the works

either side of the river is given in the following sections. This is supported by a description and reason for the highway at Appendix C. Key layout drawings are provided as Figures 3.2 and 3.3 of the ES and are attached in Appendix H.

3.33 The Reference Design is based on the standards set down in the Department of Transport Design Manual for Roads and Bridges (DMRB) and other Department documents. Typically these standards include the following:

- TD 9/93 - Highway Link Design.
- TD 22/92 - Layout of Grade Separated Junctions
- TD 16/93 - Geometric Design of Roundabouts.

3.34 A design speed of 40mph was used throughout for the new tunnel alignment and the associated approach roads.

North Tyneside

3.35 At present two roundabouts (north of Tyne View Terrace) connect the toll plaza at the north end of the existing tunnel to the A19 Trunk Road and local highway network. Following the introduction of the new Tyne Tunnel (which provides new arrangements for southbound traffic) one of the two roundabouts (the western one) will be removed whilst the junction still retains all the traffic movements achieved by the existing layout (see Figure 3.2 attached in Appendix H).

3.36 The new junction will allow for traffic exiting northwards from the existing tunnel to connect either directly to the A19 or to the local highway network via the retained eastern roundabout, where traffic can disperse to Howdon Bypass or westwards to Tyne View Terrace.

3.37 All traffic wishing to enter the southbound tunnel will have to do so from the A19, as it will not be possible to join from the existing junction at the south end of the East Howdon Bypass.

3.38 Southbound traffic unless it wishes to go through the tunnel, leaves the A19 at the A193 interchange, onto the local highway network. Tunnel traffic, after passing under the Metro Bridge, will stop at the tollbooths. There will be a facility for those vehicles that have not exited in error at the previous interchange, to avoid the Tunnel and go directly to the Howdon Bypass. There will also be a facility for public service vehicles to bypass the tollbooths free of charge.

3.39 The full extent of permanent alterations to the highway, cycle and pedestrian network as covered by the TWA Order are summarised as follows:

- Widening of the present A19 trunk road southbound lane commencing below the Metro bridge over the A19 trunk road and terminating south of the bridge. (Work No.1A)
- A road for public transport access commencing on East Howdon bypass/ Howdon Road roundabout and terminating northwest of East Howdon bypass. (Work No. 1C)
- A road for rejected vehicles and staff access, commencing east of the A19 trunk road southbound carriageway and terminating on the East Howdon bypass north of Mitford Street. (Work No. 1D)
- An emergency crossover, commencing south of Metro bridge over A19 trunk road. (Work No. 1F)

- Widening and realignment of existing A19 trunk road north bound lane commencing south of the Metro bridge and terminating north west of the existing tunnel administration building. (Work No. 2A)
- A crossover on the A19 trunk road commencing south of the Metro bridge and terminating south of the bridge. (Work No. 2B)
- A reconfiguration of existing A19, A19 roundabout (part of) and entrance to existing toll plaza for an alternative route during 2-way working of existing tunnel. (Work No. 2D)
- A realignment of existing A19 roundabout commencing at the termination of Work No. 2A and terminating west of the existing tunnel administration building. (Work No. 2E)
- A tunnel and road commencing south of the Metro bridge over the A19 and terminating south of the Tyne View Terrace. (Work No. 3A)

South Tyneside

3.40 South of the tunnel portals at Howard Street there will be a new junction which will provide for all movements between the A19, the tunnels and the local highway network. This arrangement is shown as the Jarrow Junction on the Figure 3.3 of Appendix H.

3.41 Northbound traffic on the A19 vehicles can either proceed through the existing tunnel or divert to the local highway network, turning left off the A19 then progressing via the new spiral to the enlarged Howard Street roundabout. From here traffic can either disperse into Jarrow via Priory Road or Howard Street or towards South Shields via the A185.

3.42 Similarly south-bound traffic using the new tunnel will be able to continue either directly southbound along the A19 (via a new section of dual carriageway which will pass below the existing Mineral Railway and Metro Bridges to tie into the existing A19 just south of the Metro Bridge-Work 7K) or exit the A19 via the south-bound slip road and link to the local highway network at the new A185 roundabout.

3.43 Provision will also be included in the junction for an inspection area for Heavy Goods Vehicles travelling northward prior to passage through the tunnel. Any rejected vehicles will be able to leave the A19 and rejoin the local highway network.

3.44 The new junction will consist of a falling curved access road between the Howard Street roundabout and the A19. It will occupy some of the ground below Epinay Walk, and its outer edge will be formed by a retaining wall, as provided for by Work No. 7N and 7P of the TWA Order. The top of the retaining wall, including a safety barrier, will be at approximately the same level as the ground. This retaining wall will be extended higher, to mitigate noise effects, prevent accidental access to the road, and enhance screening of the road from Epinay Walk. It will be planted to provide a further screen from Epinay Walk. Mr Colin Jubb's evidence contains further details of this facility.

3.45 For details of the junction and the reasons for its selection, see section 2.29.

3.46 Following completion of the development, there will be a number of permanent changes to the road, footpath and cycle networks. These include the revised access arrangements, to the southern end of the existing pedestrian and cyclist tunnels (plus access to premises of Rohm and Haas) off Chaytor Street, and the proposed foot and cycleway routes shown on Figure 11.3 of the ES attached in Appendix H.

Bridges

3.47 A summary of the type and location of all new and existing bridges is given in Appendix F.

Existing Structures North of the River Tyne

3.48 Two existing bridges across the A19, one carrying the Metro and one carrying part of the national cycle network are unaffected by the works except that collision protection will be provided to the central columns which will be in a narrowed central reserve.

Existing Structures South of the River Tyne

3.49 Howard Street Bridge across the tunnel exit road will be demolished and replaced by a new bridge immediately to the north. The mineral line bridge carrying the Jarrow Branch line over the approach roundabout, and the River Don viaduct carrying the A185 will be unaffected by the works, except that the wingwalls may be modified and collision protection added if required.

3.50 The Metro bridge across the A19 will be unaffected by the works except that collision protection will be provided for the central columns in a narrowed central reserve, and the wingwalls may be modified.

3.51 The structures supporting the existing approach and roundabout will be modified or removed to suit the revised alignment.

New Bridges

3.52 Howard Street bridge will be replaced by a two span structure, one span forming the portal to the new tunnel and the other crossing the existing tunnel approach.

3.53 A new multispan bridge will be built as part of the Jarrow junction. The form of these bridges will be determined by the Concessionaire in consultation with STMBC or NCC.

3.54 All new bridges and structures will be subject to the Technical Approval of North and South Tyneside MBC's and NCC respectively. The detailed design will be produced by the Concessionaire and will be to DMRB standards. The Concessionaire will also be responsible for arranging design checks and securing final technical approvals, and any other consents needed for construction.

Land and Public Open Space

Land

3.55 In order to construct the New Tyne Crossing, land will need to be acquired. Land acquisition has been shown in the "Plans" volume of the ES. It falls into two categories:

- Limit of Deviation (LoD) land that will be required for the works and acquired permanently.
- Limits of Land to be Acquired or Used (LLAU). This is land that is required temporarily or for survey purposes.

3.56 The purpose for acquiring land includes construction of works, working areas, storage areas housing / property surveys, and access. Appendix B lists each piece of land in both North and South Tyneside and the reasons for acquiring the land. Land to be acquired is shown on drawings 57621/OA-CSK-086 and 087.

Public Open Space

3.57 There will be a loss of open space to the east of the A19 in North Tyneside, some of which will be re-instated on completion of the tunnel. The loss of space on completion will be 2.77 hectares. In South Tyneside 0.86 hectares of open space will be lost, but will be replaced with 2.67 hectares of new open space.

Listed Buildings

General

3.58 Three Grade II listed buildings / structures will be affected by the development: the Gaslight Public House; the curtilage of the Tyne Pedestrian and Cycle Tunnel; and the statue of Sir Charles Palmer situated in the existing Riverside Park. The impact of the proposal on these buildings/structures was assessed and applications for listed building consent were made in July 2002.

3.59 This matter is addressed in full in the Planning Proof of Evidence of Mr Harvey Emms. However, I set out below the engineering issues in each case.

The Gaslight Public House on Commercial Road

3.60 The building is within the LoD and lies on the land needed to construct and access the works. The cost of moving the building elsewhere would be in the region of £150,000-£300,000. Beamish museum have said that they would not be interested in acquiring the building for relocation elsewhere, but would be interested in acquiring some of the constituent parts for reuse elsewhere.

The Tyne Pedestrian and Cycle Tunnel access complex on Tyne Street

3.61 The proposed works do not affect the structure of the rotunda and lift shafts themselves, but affect the landscape boundary wall surrounding the tunnel entrance building in order to accommodate a bus turning circle. The purpose of the works is, in part, to improve public access to these tunnels.

The Statue of Sir Charles Palmer on Tyne Street

3.62 The statue would be affected by tunnel construction works and needs to be relocated. In doing so it would also be renovated.

Utility Diversions

3.63 A number of service diversions will be necessary and will require careful planning and management. The services that will be affected are listed in Appendix D

3.64 Records of the existing utilities have been gathered and preliminary discussions have been held with the Utility Companies to identify key issues and provide estimates. Most of the detailed design for the utility diversions will be the responsibility of the Concessionaire. However, the present discussions seek to identify where any advance works or additional studies are required in order to enable the Concessionaire to make a prompt start to diverting and protecting services

- **Northumbrian Water Ltd**

3.65 The works will affect existing Northumbrian Water Ltd (NWL) sewers and water supply mains. NWL have indicated in meetings that they have no objection to the scheme in principle, but have concerns about a number of issues they are seeking to be resolved. NWL have also raised concerns about access to their site from the highway and the river.

3.66 In the majority of cases the effect of the tunnel construction works on existing NWL sewer and water supply infrastructure will only be temporary. The Concessionaire will be required to liaise with NWL and to ensure continuity of service by supporting the existing service across the excavation or providing an approved temporary (or possibly permanent) diversion to the service. Once appointed, the Concessionaire will have to have discussions with NWL in order to agree the proposed programme for the works and to plan any diversions.

3.67 In a limited number of cases, a permanent diversion will be required, e.g. the tunnel itself will intersect with the existing service or for some other reason. The Advisors have reviewed these locations and consider it will be possible to re-route the affected service in order to provide a satisfactory solution. NWL have indicated in meetings that these diversions will require study over a wider area to ensure that there are no problems created elsewhere in their network. The TWPTA and the Advisors are in discussion with NWL as the appropriate timing for any necessary advance studies of NWL's infrastructure in order that there is no delay to the Concessionaire once appointed.

3.68 NWL have raised concerns about their tunnel beneath the River Tyne carrying sewer pipes ("The Siphon") from Jarrow to their treatment plant at Howdon. This tunnel lies beneath the eastern part of the LLAU within the river and south bank of the river. Assurances have been given that works will not be carried out over their tunnel unless the Concessionaire first submits a proposal for the works including sufficient information to enable NWL to be assured that the works will not affect their tunnel.

3.69 NWL have been assured that access will be available at all times (unless otherwise agreed with them) to their treatment plants at East Howdon and Jarrow and to their quay for the movement of sludge vessels.

- **Telewest**

3.70 Telewest own and operate a significant fibre optic network in the area of the works, having a cable routed through the Pedestrian and Cycle Tunnels, and a "hub" immediately adjacent to the southern entrance of these tunnels. The proposed works will affect some of these cables, but not the "hub" itself.

3.71 Meetings have been held with Telewest and discussions held concerning protection of their facilities. The Concessionaire will need to agree a programme of temporary and permanent diversions to the Telewest network in order to enable the construction of the works. The Concessionaire will need to protect the Telewest infrastructure from damage.

- **Consignia**

3.72 Consignia have been provided with assurances that they will be able to continue to deliver mail to all locations adjoining the works area.

Environmental Effects

General

3.73 As previously described a full assessment of these effects has been made in the ES , which accompanied the TWA application. These are additionally described in the Environmental Proof of Mr Paul Johnson.

3.74 The Concessionaire will bid to construct the tunnel based on the parameters set down in the Instructions to Tenderers, (and any later modifications agreed during negotiations), the Reference Design, the Code of Construction Practice (CoCP) and the Environmental Statement and any agreements reached with any parties for the protection of their property or interests. The Concession Agreement will require the Concessionaire to comply with these documents. Method Statements indicating how the Concessionaire will carry out the development and use various parts of the site will be required.

3.75 **Mitigation through design**

3.76 The choice in design of a development or parts of a development can significantly reduce the impact that it will have on the environment. The Environmental Impact Assessment (EIA):

- Identified the environmental baseline;
- Evaluated the environmental impacts of the scheme; and
- Explored the potential for mitigation.

Mitigation through management and control of working practices

3.77 The construction process also creates effects which can be mitigated. The management of the construction process is set out in the Code of Construction Practice (CoCP), and is discussed at Section 4 and Section 5.21.

4. CONSTRUCTION

Introduction

4.1 Having described the permanent works in Section 3, I will now examine how these works might be constructed. The assessment included in the Environmental Statement was based on the assumed method of construction. It should be noted that the final choice on construction techniques rests with the Concessionaire, subject to compliance with the Environmental Statements as previously explained in section 3.73 and technical standards such as the DMRB.

Tunnel Construction

4.2 As summarised in section 3.22 of my evidence, the development will consist of several distinct sections, which will be constructed by different techniques. The sections are:

- the immersed tube tunnel within the Tyne;
- the cut and cover tunnel on both sides of the Tyne; and
- retained cuts and open cuts at each end (north and south)

4.3 The possible means of Immersed Tube construction, and cut and cover construction are illustrated in Appendix H (ES Figs 3.4 and 3.7), where cross sections of section are shown.

Immersed Tube

4.4 The construction of the immersed tube section consists of a number of phases as described below. The Reference Design has assumed certain construction methods and phases, as shown on Figures 3.4 and 3.7 of the ES and included as Appendix H.

- **Casting of tunnel elements**

4.5 The Reference Design shows four reinforced concrete tunnel elements, each of which will be constructed within a building dock. A building dock, will be constructed in Howdon Basin. The building dock will have a second purpose of protecting the quay walls around Howdon Basin.

4.6 The tunnel elements will be sealed at each end with water-tight bulkheads. Pre-stressing cables will make the structure act monolithically during immersion. Internal water ballast tanks will be used to control the buoyancy of the elements.

- **Storage of tunnel units in the Tyne**

4.7 It is intended that the four tunnel units will be installed consecutively after dredging of the immersion trench. As a result, the first two tunnel units to be cast will need to be stored until the remainder are cast, and while the trench is dredged. A berthing pocket in the Tyne will be dredged for the temporary storage of tunnel elements 3 and 4. The proposed location is to the south of the south side of the navigation channel, west of the pedestrian tunnel. Tunnel elements 1 and 2 will be stored in the building dock.

- **Dredging of tunnel trench**

4.8 A trench will be dredged across the river. The trench will consist of three sections: a section within the building dock, a section across the river from the building dock to the training walls extending from the southern bank, and a section within the training walls extending from the southern bank. The Concessionaire will select the type of dredging plant that will suit their assessment of dredging operations and to meet the CoCP and environmental criteria.

- **Disposal and storage of material**

4.9 The methods of excavation are summarised in the ES together with an assessment of the environmental consequences. The Concessionaire will determine the disposal route, or combination of disposal routes for arisings and be responsible for making applications for the relevant licences. For materials which are to be re-used in the river trench or elsewhere, the site of the former Mercantile Dock Yard is identified in the Reference Design as the proposed location for storage. Mr Ian Lofthouse's Proof deals with the storage and disposal issues.

- **Assembly of tunnel units in the trench.**

4.10 The first two tunnel units to be laid will form the southern half of the immersed tube. The remaining two tunnel units will form the northern half of the immersed tube tunnel, including the area within the building dock extending from Howdon Basin. This is shown in Figure 3.7 of the ES, attached in Appendix H.

4.11 The assumed construction phasing is as follows: Tunnel units 1 and 2 will be pulled out of the building dock by tug boats, and tunnel units 3 and 4 will be moved by opening the berthing pocket and floating them into place. The assembly will begin with tunnel element 1 and continue with the remaining units. The process will be as follows:

- Each unit will be manoeuvred above the immersion trench and lowered with the aid of sinking catamaran barges and towers (the Tyne will be closed to navigation for one day for each element during this process).
- Each unit will be sealed in place using hydrostatic pressure created by pumping water from the cavity between the bulkheads
- Another permanent seal will be installed on the inside of the joint.
- The bulkhead in the tunnel element will be removed
- The next unit will be installed against the previous element

- **Backfill and protection of the tunnel**

4.12 Once the tunnel units are installed in the trench, the open trench areas either side of the tunnel will be filled with material previously dredged from the trench and stored or suitable marine dredged material sourced elsewhere. Backfilling will be carried out using a fall pipe to maximise accurate control during placement of fill material. A rock armour protection layer will be placed above the tunnel by grabs. The protection layer will be thickened where it approaches Howdon Yard to provide additional protection from ship impact.

4.13 Arup have met the Environment Agency to discuss their concerns that the immersed tube tunnel and other works might affect the risk of flooding on the Rivers Tyne and Don. The Environment Agency's representative has verbally confirmed that the information supplied

satisfies their concerns at this stage of the design development. The Environment Agency will require formal submissions from the Concessionaire for approval in due course.

- **Cut and Cover**

4.14 The cut and cover construction will comprise a deep cutting along the route of the tunnel to allow the construction of the tunnel box section, which will later be buried. The depth of the excavation will vary, up to 20 m below ground level on the north side and 12 – 30 m below ground level on the south side of the Tyne where the deepest sections will be closest to the river.

4.15 The stages involved in this process are as follows:

- Diaphragm walls are built into the ground to invert level of the box section.
- The ground will be excavated between the diaphragm walls.
- Excavated material will be loaded directly into lorries. Surplus will be removed for disposal to landfill or for re-use elsewhere.
- Excavation will take place in sections, with the ends of sections supported by cross walls and ground water pumped out.
- Water quality testing of groundwater will be conducted to assess the impact of discharging the groundwater into the Tyne, and treatment undertaken if necessary, to allow this to take place.
- Once excavation between the diaphragm walls reaches the level of the base of the tunnel box, the base slab will be constructed. The walls and roof slab will then be cast.
- Backfill over the concrete box will be compacted.
- When backfilling is complete the top of the diaphragm walls will be cut off and ground surface reinstated.
- When the tunnel structure is complete it will be fitted out using access from the portals.

- **North Tyneside Cut and Cover Construction**

4.16 The North Tyneside Cut and Cover section extends from the north edge of Howdon Basin to north of the southern crossover of the existing bored tunnel. This cut and cover is provided for by Work No. 1G, and 3A of the TWA Order.

4.17 In order to allow the present occupants of Howdon Yard to continue their operations throughout the construction works, the Concessionaire's site is likely to be located at the Howdon Landfill East site with access to Howdon Bypass.

4.18 The diaphragm walls described above will be extended northwards over the existing tunnel. At the crossover location the toe level of the walls will be raised 2m above the top of the existing tunnel, and special measures taken to protect the existing tunnel.

4.19 The stockpile of excavated material for backfill of the trench between the diaphragm walls will be located within the contractor's compound on the East Howdon Landfill site.

- **South Tyneside Cut and Cover Construction**

4.20 The south side cut and cover tunnel will extend from the south bank of the river to a position adjacent to the existing tunnel south portal. A haul road will be required on the east side of the tunnel route, and this will join the road system at Chaytor Street, which leads onto the

southbound A19. Temporary crossings over the cut and cover excavations will be provided to maintain pedestrian and vehicular accesses. The chemical storage area of Rohm & Haas is proposed as the location of the temporary stockpile of excavated material to be re-used for backfill. (See Figure 3.6 of the ES attached in Appendix H).

Retained Cut

4.21 As the depth of the tunnel relative to ground level reduces the tunnel construction will change from cut and cover to retained cut. The method of construction (except for the backfilling over the box) and cross section are similar to the cut and cover section. The props installed during the construction phase may be retained if there is sufficient headroom in the permanent case.

- **South Tyneside Open Cut and lower Tunnel Section**

4.22 The tunnel section between the existing portal and Howard Street Bridge will be open cut and then covered over. The ground behind the existing east side retaining wall will be excavated and battered towards Stothard Street. It may be necessary to excavate behind the west side retaining wall to balance loads on the existing structure. A 130m long reinforced concrete box section will then be constructed in the open behind the existing retaining wall.

5. COMMUNITY SEVERANCE

Introduction

5.1 This section deals with the likely impacts of the construction of the new crossing on community severance. This is an issue that was considered as part of wider social and community issues in the Environmental Statement. The assessment of severance is based on guidance from the Design Manual for Roads and Bridges (Volume 11, Section 3, Part 8).

5.2 Construction of the tunnel will require significant excavations, particularly where the cut and cover and retained cut sections are to be built. This will have the inevitable effect of temporarily interrupting the local network of highways, public Rights of Way, footways and cycleways especially where these existing routes cut directly across the new tunnel.

5.3 After completion of the tunnel, many of these routes will be reinstated along (or close to) their existing line, although future constraints result in some routes being substituted by other suitable crossing points. Full details of the effects on these local routes are given in Appendix H. This explains which routes are affected, whether there is a permanent reinstatement (or diversionary route) after construction of the tunnel and what arrangements are being made during the construction phase.

Significance Criteria

5.4 Significance criteria were developed to reflect a range of issues affecting community and recreational facilities. In relation to community severance, the following apply:

- Severe adverse – severance that irreversibly and adversely changes the functioning and structure of the local community
- Major adverse – Severance that seriously compromises the functioning and structure of the community in the short term (construction phase) but is reversible through mitigation or reinstatement prior to the operation phase.
- Minor adverse – Temporary or reversible severance of local community resources and public open space. May infrequently give rise to permanent effects but suitable mitigation options are available.
- Not significant – No measurable or discernible effect.
- Beneficial – Enhancement of existing or provision of new community assets.

Baseline Conditions

5.5 A review of community facilities, rights of way, footpaths and cycle routes was carried out and a survey of usage carried out in February 2001. The results are provided in Appendix 11.1 to the Environmental Statement. The frequency of pedestrians and other users using affected links on the north side of the river was considered low. On the south side of the river, the frequency of pedestrians and cyclists using the affected links was higher as the route of the proposed scheme lies between Jarrow Town Centre and residential areas.

Construction Impacts and Mitigation

5.6 There are five severed routes north of the river and fourteen on the south side. These are described in more detail in Appendix 11.2 of the Environmental Statement (CD5), and Figure 11.4 of that appendix which is attached in Appendix H.

5.7 North of the river, effects are considered minor adverse due to the need for realignments, slightly increased journey length and low usage of paths.

5.8 South of the river, the effects are again considered to be largely minor adverse or not significant. This is because alternative accesses will be provided during construction. During operation full access will be returned or alternatives provided. However, two moderate adverse effects are noted. The loss and severance of Riverside Park during construction (although reinstatement would be a beneficial impact), and the demolition of St. Peters School in Jarrow which although not a severance matter, would cause disruption and possibly involve children walking greater distances to the Jarrow Ellison School.

5.9 As required in the CoCP the Concessionaire will prepare a Traffic Management Plan, which will take account of advice from the Highway Authorities and Police. The objective is that as far as reasonably practicable, existing public access routes and rights of way will be maintained during construction. Where this cannot be achieved, suitable alternative routeing will be provided where practical and will be sign-posted. The Traffic Management Plan will include details on the temporary control measures, temporary road layouts, and routes to be used by construction traffic. The public will be issued information of dates and durations of any closure and alteration, and there will be opportunities to discuss these with affected parties before they are implemented.

5.10 A summary of the assumed temporary and permanent effects of the tunnel construction is given below for the respective Borough areas.

North Tyneside

Highways

5.11 All existing highways generally retained with the exception of the existing roundabout at the south end of the A19, which is not required to operate in its current mode in the future due to arrangements for accessing the new southbound tunnel.

5.12 During construction the major crossing points (over the tunnel) that will be affected are Tyne View Terrace and the link between the two roundabouts immediately to the north. (See Figure 3.1 attached in Appendix H).

5.13 The Concessionaire will be required to ensure access along Tyne View Terrace to the roundabout at the end of the East Howdon Bypass for traffic and pedestrians during the works. (See Figure 3.5 Appendix H).

5.14 The Concessionaire will not be required to maintain access for traffic between the roundabout at the south end of the East Howdon Bypass/Tyne View Terrace and the South End of the A19/Tunnel Entrance during construction as alternative access to and from the A19 is available via the East Howdon Bypass and A193 junction to the north. For traffic southbound

on theA19 wanting to exit to East Howdon or Tyne View Terrace and traffic from East Howdon and Tyne View Terrace wanting to access the A19 northbound this will be the same as the completed scheme. The temporary closure of this link will only be a temporary disruption for northbound traffic exiting from the tunnel which will, in the completed scheme, be able to exit the tunnel and connect to the East Howdon Bypass/Tyne View Terrace roundabout directly. (See Fig 3.2 Appendix H).

5.15 The Concessionaire may require temporarily to close the northbound carriageway of the East Howdon Bypass during construction of the cut and cover tunnel and open cut immediately to the west. In this case he will need to maintain two way traffic flow by using contra-flow working on the southbound carriageway of the bypass.

Public Rights of Way, Footways and Cycleways

5.16 Figures 11.3 and 11.4 of the ES (attached in Appendix H) indicate the existing routes and the arrangements to be implemented during construction. Both of the two main crossing points along (Tyne View Terrace and across the former railway bridge to the south of the Metro bridge) will be kept open during construction, but the link on the east side of the existing A19 will be diverted for safety reasons, as this area will form part of the Concessionaire's working site. This diversion has been agreed with the local Council. Public access to the Pedestrian and Cycle Tunnels will be maintained at all times.

South Tyneside

Highways

5.17 Between the south bank of the river and Howard Street numerous existing highways traverse the route of the new tunnel. It is not intended to replace all the highways. Some minor rationalisation of road network will be undertaken. Affected highways will be Commercial Road, Ormonde Street, Stanley Street and part of Tyne Street. The removal of these roads from the highway network is not expected to result in any significant level of permanent severance as the routes are currently lightly used and have alternatives nearby.

5.18 During construction, provision will be made to keep Chaytor Street and High Street open to vehicular traffic. These routes have been chosen largely on the basis of their importance to the local community and businesses and the volume of traffic they carry, and therefore maintaining the cohesiveness of the local highway network (See Figure 3.6 of ES attached in Appendix H).

Public Rights of Way, Footways and Cycleways

5.19 Figures 11.3 and 11.4 of the ES attached in Appendix H indicate the current layouts, future provision for these routes and the arrangements during the construction period. During construction four separate crossing points will be retained between Chaytor Street and Howard Street to serve the residential areas located in this area. Public Access to the Pedestrian and Cycle Tunnels will be maintained at all times.

5.20 In the permanent situation new foot and cycleway routes are proposed as shown on Figure 11.3 of the ES (attached in Appendix H).

Mitigation of Effects

5.21 Construction effects can be mitigated through management and control of working practices.

5.22 Given the length of construction time (approximately 3 years) and the scale of the development in relation to the relatively small urban area, the potential impacts on the environment and amenity of the surrounding area from the construction of the crossing are potentially substantial. In order to mitigate environmental impacts from the construction process, the construction works will be closely co-ordinated, monitored and controlled by all parties involved in the construction.

Howdon Yard

5.23 In addition to the permanent alterations at Howdon Yard and Basin the construction phase of work will also introduce impacts on the owners of the Yard (Amec) and their tenants. The main issues here are the accommodation works to be provided and the phasing of the work to permit the continuation of operation in the yard.

5.24 A series of measures have been drawn up which include the temporary relocation of offices, temporary access arrangements, utility diversions and arrangements for Contractor's site compound. Following successful implementation of these measures, other phases of work will include completion and handover of eastern end of the Howdon Quay, reorganisation and finally reinstatement of the affected areas.

6. COSTS

Capital Cost Estimate

Summary of capital costs

6.1 The following table summarises the main elements of the construction cost, at Quarter 2, 2000 prices together with project on-costs such as compensation, land purchase and professional fees.

	Summary of key work elements	Amount £ million
A	**General**	
1	Acquisition of land and rights over land	7.2
2	Earthworks (including land reclamation and landscaping)	8.5
3	Fees of professional and other advisors	10.4
B	**Tunnel Works, etc**	
1	Tunnels and bridges	58.3
2	Highway works and other works to roads	23.6
3	Workshops, depots and other buildings	5.3
4	Electrical plant and equipment	9.2
5	Alterations, modification and removal of existing works	0.9
C	**Works which interfere with rights of navigation**	
1	Immersed tube	14.8
	Plant equipment and ancillary works required in connection with constructing the immersed tube	0.6
	TOTAL	**138.9**

Risk allowance

6.2 Rather than applying a single percentage addition for contingencies a project specific risk allowance has been assessed for addition to the base estimate. This risk allowance has been derived from the output of a project risk workshop, together with subsequent reviews and input from other specialists provided by the Advisors.

6.3 Potential risks considered include resources, land, design, construction, maintenance, operation, environment, public inquiry, utilities, finance, procurement and programme time constraints.

6.4 The overall risk contingency was derived from the product of probability (% likelihood) and impact (cost increase) for individual identified hazards, using an established risk analysis technique to derive a range of possible project costs. This process takes account of not all risks identified on the risk register occurring or to the full extent envisaged (in worst case scenario) and generates a range of costs based on probable outcomes.

6.5 The complete range of likely capital costs extends from below £120 million to more than £150 million. Having established this range of cost distribution it is then necessary to report which percentile figure shall be used in estimates and financial forecasts. The 80^{th} percentile value (£139 million) has been used in the financial model; this means that there is 80% confidence level that the reported figure will not be exceeded.

Basis of Estimate

6.6 Where possible, principal quantities have been derived from the outline design information, which have then been priced using unit rates.

6.7 The majority of items were measured manually, with the exception of the earthworks volumes in the highway works, which have been calculated by computer on the basis of the highway alignment information and existing topography data.

6.8 Budget quotations have been obtained for most statutory utility diversions

Unit rates were derived from a number of sources, including similar major civil engineering projects, nationally published price data and professional opinion.

Some aspects of the project have been priced on the basis of percentage additions to the construction cost. These are:

Tunnel mechanical & electrical services	15% on tunnel civils costs
Site preliminaries/ overheads (land)	16% on land infrastructure costs
Site preliminaries/ overheads (tunnel)	25% on tunnel costs
Profit	7.5% on construction costs
Insurances	3.3% on construction costs
Detail design	4% on construction costs

Operational Costs (Opex)

6.9 Operating costs are basically the cost of operating the existing and new tunnels from the start of the concession period. It is assumed that once the concession is signed, the concession company will take over the existing operation. When the new tunnel is opened, higher operating costs will arise.

6.10 Operating costs are mainly staff costs, but also include cost for the buildings (heat, light etc) transport (operating and maintaining vehicles) and general supplies and services (e.g. cleaning, canteen etc). These values would include some minor maintenance and cleaning of tunnels, but not major capital works (e.g. road resurfacing, replacement of lining panels, ventilation etc.).

6.11 Staff make up around 70-75% of the existing opex costs.

Capital Maintenance Costs

6.12 Capital maintenance covers the larger maintenance issues associated with tunnels.

6.13 Capital maintenance items on the existing tunnels (Road and two pedestrian tunnels) are included. These were developed using past maintenance records and future expected life of assets as a guide to cost and timing of replacement.

6.14 These assets include secondary lining panels, road surfacing, ceiling tiles, concrete repairs, and some primary lining repairs (associated with new tunnel construction, and possible settlement/re-caulking of joints etc.).

6.15 On Mechanical and Electrical assets (existing tunnels), assets include ventilation buildings (north and south), and main tunnel systems such as lighting, ventilation, fire protection etc.

6.16 Estimates for the new tunnel have been divided into Civils and Mechanical and Electrical assets. In the former category inclusions are road surfacing, lighting replacement and "other repairs and maintenance" (£100K pa). Most of the existing M&E assets will be replaced during the 30 year concession (between 10.8 million and 14.0 million of cost). The uncertainty here is when this work is carried out.

7. SAFETY

General

7.1 Safety has been considered from four perspectives: safety on-site during construction; public safety during construction (off-site safety); safety during the operation, and marine safety. Each is discussed in turn.

Safety on-site during construction

7.2 On-site safety is regulated by the Health and Safety at Work Act 1974 and will be undertaken to the satisfaction of the local Health and Safety officers. The Health and Safety at Work Act 1974 places a number of general and specific duties on employers, employees and the self-employed. Section 2 of the Act places a duty on every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all employees. Employers are also under a duty (s.3) to ensure, so far as is reasonably practicable, that persons not in their employment, are not exposed to risks to their health and safety. Section 7 of the Act places a duty on every employee while at work to take reasonable care of the health and safety of themselves and other people, and to cooperate with their employer or any other person with regard to any duty or other statutory requirement. In this project the employer will be the Concessionaire.

Safety off-site during construction

7.3 Public safety during the construction phase will be addressed through the CoCP, which inter alia requires the TWPTA and Concessionaire:

- to ensure that all reasonable endeavours are made to provide for the protection of the general public;
- to prepare and distribute emergency procedures and emergency plans for each construction site in agreement with all emergency services;
- to prepare and distribute a workers' safety information Sheet at sites which may have contaminated material;
- to limit the placement of cranes so that they will not overhang into public space without the prior agreement of the relevant authorities;
- to agree on access (including location of access points, timing of movements and parking) to and from the site with the relevant councils and police; and
- to manage the behaviour of personnel on each site.

Safety during operation of the development

7.4 The design of the tunnel will comply with BD 78/99. This design manual, incorporates a great deal of recent tunnel safety best practice. A TDSCG has met several times to review the preliminary design, as this affects operational safety. The Concessionaire will be required to progress the design through the TDSCG to ensure that it complies not only with international safety standards, where appropriate, but also national standards and local practice. Table 1 in Appendix E shows a comparison of European Road tunnel safety standards, which demonstrate the comprehensive nature of the UK standard, and that they are amongst the best in Europe.

7.5 Recent fires in Alpine road tunnels have caused great public concern. Where road tunnels allow free flow of commercial traffic and have bi-directional flow, there is the possibility of head-on collisions and escalating incidents with traffic stopped in both directions. In these circumstances, initiation of emergency procedures and control of evacuation and emergency operations can be extremely difficult.

7.6 Uni-directional traffic flow results in a reduction in traffic accidents and the removal of head on collision risk. In the event of a major accident, traffic ahead of an incident can proceed out of the tunnel whilst ventilation can be used to protect those persons stopped in vehicles upstream of the accident.

7.7 The principal safety enhancement of the proposed scheme over the present Tyne Crossing is that the traffic in both tunnels will be unidirectional in normal operation; the new tunnel will also be provided with a safety cell.

7.8 The proposed new Tyne crossing configuration, therefore, provides very significant safety advantages over bi directional road tunnels as the risk of head on accidents is virtually eliminated. There are numerous other design aspects which produce high levels of safety and these are briefly discussed below:-

- **Geometric Design**: The design speed of 40mph restricts the vehicle energies and reduces the accident severities compared to dual carriageways. The road curvatures, gradients, super elevations etc all conform to modern practice. The choice of a submerged tube also provides the shortest tunnel route possible, which reduces the risk of tunnel related accidents.
- **Ventilation**: As well as the beneficial piston effect (caused by vehicles pushing air through the tunnel), present in unidirectional tunnels, longitudinal mechanical ventilation will be provided in both tunnels to remove fumes and to extract smoke in the case of a fire. The fans will be designed to ensure good visibility and supply of fresh air even in heavily congested conditions and to help ensure safe evacuation routes.
- **Tunnel Lighting**: Lighting will be provided in accordance with British Standards for lighting in the tunnels. It will be suitable for each tunnel to be operated in the normal unidirectional mode but also in an occasional bi-directional mode (for instance if maintenance is necessary).
- **Drainage**: Road drainage will be provided to cope with the normal runoff from wet vehicles and from other surface water. Special measures will be taken to contain any spilt hazardous substances.
- **Fire**: The tunnels will be designed to withstand a design fire selected in accordance with the anticipated usage and the ventilation system will be sized accordingly. Emergency points, fire extinguishers, hose reels, fire mains, hydrants, telephones etc will be provided in accordance with BD 78/99.
- The immersed tube will be provided with a continuous protected escape route accessed by regular escape doors. The existing bored tunnel will be provided with new escape and intervention shafts at the south and north banks of the Tyne. The tunnel structure, linings and critical safety equipment will be provided with enhanced fire resistance.

7.9 **Traffic Control and Communications and Information Systems:** The traffic control and communication systems to be provided include:

- Monitoring of conditions: including CCTV, CO monitoring, fire detection
- Traffic control: including traffic lights, variable message boards, movable and temporary barriers
- Audible communications: PA, radio channels (and possibly use of mobile phone channels in the future)
- Special communication devices for emergency operations

Marine Hazards

7.10 As described in Section 4, the new tunnel will be sunk in a trench in the river bed, the tunnel will be covered by a metre thickness or rock, and the trench backfilled. The rock armouring will be below the existing riverbed level. The immersed tube tunnel has been investigated for the risks arising from Marine Hazards. These are the risks to tunnel users arising from vessels colliding with, or anchors falling on the tunnel. The likelihood of this happening is very small. A risk assessment arising from Marine Hazards, has been carried out which shows that the level of risk to users of the tunnel will be acceptable to the PoTA.

8. PROGRAMME FOR DESIGN AND CONSTRUCTION

8.1 An indicative programme for the remainder of the TWA application process and Award of Contract is as shown in the Appendix G, Figure A. This is approximately two years.

8.2 An indicative programme for design and construction is shown in Appendix G, Figure B. The programme extends over approximately 3 years. A more detailed programme will be prepared by the successful Concessionaire with the aim of introducing more certainty and reducing risk elements.

At the present time key items include the diversion and protection of existing services (to permit the construction of the cut and cover sections and open cut sections of the tunnel), the modifications to Howdon Yard and Basin (to allow commencement of these works at an early stage), and the dredging of the trench in the Tyne to receive the immersed tube elements (which is constrained to specific time periods November to March) as required by the Environment Agency.

9. CONCLUSION

9.1 My evidence has described the various engineering investigations, and decisions that have lead to the selection of the current preliminary design, "the Reference Design", for the Transport and Works Act application.

9.2 The engineering and other features of both a bored tunnel and an immersed tunnel have been re-examined in detail and presented to the TWPTA. They concluded that there was nothing that altered their conclusion that an Immersed tunnel should be the preferred means of crossing the river.

9.3 I have described the engineering design parameters and the constraints and solutions which have lead to the Reference Design, and the features which result from this design.

9.4 I have described a possible method of construction, upon which the Environmental Assessment has been undertaken. I have also indicated how public transport access will be structured to enable it to use the tunnel easily.

9.5 In particular I have described the reasons for the selection of the Jarrow Junction instead of the earlier choice, the "Simonside Junction", which are, reduced cost and lower overall adverse environmental effects.

9.6 The effects on community severance during construction have been outlined; all highways, footpaths and bridleways that are/or will be affected during this period will be diverted, safely and maintained to a good standard. The effects will be minor. On completion the majority will be restored to their original location; the remainder will be relocated with minimum interruption.

9.7 The capital costs of the immersed tube tunnel is £138.9m (2000 prices). I describe how this was calculated. I also describe the derivation of the operating costs and major maintenance costs.

9.8 The programmes for procurement of Concessionaire and for construction are also outlined. These are my best estimate at the current time.

9.9 I have addressed those issues which were specifically raised by the Secretary of State in the the body of my Proof of Evidence.