ENVIRONMENTAL AND SUSTAINABLE DEVELOPMENT REASONS FOR GOING UNDERGROUND

INTRODUCTION

The International Tunnelling Association (ITA) Working Group 15 – Underground Works and the Environment, was officially launched at the ITA Washington meeting in April 1996. The initial investigations of the Working Group was a review of the opportunities and constraints associated with the environment, which was backed up with an analysis of selected case studies that demonstrated the environmental benefits that can be derived from the construction of underground works. The summary report of this work was published in the ITA Newsletter Tribune in October 2002.

At the meeting in Durban in May 2000 the Working Group refocused its activities on the more practical aspects of underground works with the environment and sustainable development. The meeting prepared a questionnaire which was sent out to Member Nations to collect data on projects which have been placed underground for environmental and sustainable development reasons.

In 2002 the ITA published a booklet call 'Why go Underground'. The booklet illustrated the many reasons and features of the use of underground space. The main criteria for going underground were

- Land use and location reasons
- Isolation considerations
- Environmental preservation
- Topographical reasons
- Social benefits

In practice most projects can be placed under several of these heading. The environmental preservation reasons for going underground were given under two main headings:

- Aesthetics, less visual impact, and
- Ecology, to help preserve the natural vegetation, and less damage to the local and global ecological cycle.

Each Member Nation will have its own criteria for going underground for environmental or sustainable development reasons. In this context sustainable development has been defined as

" development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

This paper briefly discusses the data collected on projects which have been placed underground for environmental or sustainable development reasons. It highlights and discusses a number of the important projects.

COLLECTION OF DATA

A short questionnaire was prepared and sent to the 32 members on the Working Group, representing 21 of the Member Nations. Copies of the questionnaire were also sent to the other Member Nations not represented on the Working Group. The single page questionnaire asked for basic details of the project and for the environmental and sustainable development reasons for going underground.

Data have been received on about 100 project from 20 Member Nations, over five continents, and cover a broad spectrum of the Member Nations of the Association.

Highway Projects

The largest number of projects were in the Highway sector and from 16 countries around the world. Many of these projects were placed underground to reduce the impact of noise, pollution and congestion to improve the living conditions in cities and towns. Some were bypasses around towns or cities which removed traffic from the centres and allowed pedestrian areas to be developed. Others passed under botanical gardens or important parks. The projects were constructed in both bored tunnel and in cut and cover tunnels. The cut and cover tunnels removed traffic from the surface and were often designed to take five or six storey buildings above giving sustainable development. Others had recreational facilities or open areas above.

A number of projects passed under, or close, to archaeological or special sites of scientific interest, conservation areas, or historic cultural or old towns. Others were placed underground instead of deep and unsightly cuttings through mountain ranges or sensitive ecological areas.

Three highway projects are highlighted which were, or will be, placed underground for environmental or sustainable development reasons:

- El Azhar tunnel in Cairo, Egypt
- The Central Artery expressway in Boston, USA, and
- The Stonehenge Tunnel in UK

El Azhar Tunnel

The historic Fatimid area of Cairo, Egypt, which dates back to the 10th Century, has an elevated highway passing through it. As part of the preservation and development of the area it was decided to put the highway underground with the intention of removing the elevated highway and creating a free area for tourism and pedestrians in this Islamic Cultural centre of Cairo. The twin two lane tunnels, 2.7km long, have been constructed using one of the Tunnel Boring Machines used in the construction of the Cairo Metro Line 2. The 8.35m internal diameter of the tunnels has a restricted height of 4m and is designed to take private cars, taxis and buses.

Central Artery Boston

In Boston, USA, the Central Artery expressway was built between 1951 and 1959 to provide access to the downtown part of the City and major arterial roads. The alignment passed through depressed areas of the City to minimise the costs. A large part of the route was on elevated structures which in the late 1990s was in need of major renovation. As the City had expanded the corridor of land adjacent to the expressway became a depressed area compared to the rest of Boston.

The opportunity to place the expressway underground has not only improved the environment of this historic area of Boston but it will allow large areas of open space to be laid out for public use. In addition other large parcels of land will be available for commercial and housing development as the price of real estate increases. The tunnel has been designed for surcharge loading equivalent to six storey buildings where the alignment passes below the parcels of land earmarked for development, maintaining its aim of sustainable development.

Stonehenge

Stonehenge, UK, is a 4000 year old stone circle which is an UNESCO World Heritage Site of immense archaeological significance. The busy A303 trunk road from London to the west country passes south of the site and another major road passes to the north. The 50km of the A303 to the east of Stonehenge is a dual carriageway and to the west there are other short lengths of dual carriageway.

As part of the upgrading of the A303 the length south of Stonehenge will also become a dual carriageway. The original scheme to have an at grade dual carriageway was unacceptable to English Heritage, who run the Stonehenge site, and also to the National Trust, who own the surrounding land. After considerable studies and investigations the Government chose a preferred alignment with a 2km long cut and cover tunnel past Stonehenge to preserve the historic heritage site. Currently the project is out to Public Inquiry as a 2km long bored tunnel, but some parties are lobbying for a 4km long bored tunnel to further preserve the environment. Construction is planned to start in 2005.

Railway Projects

Data on railway projects were received from nine countries. These included the extension of existing railways through mountainous areas to reduce congestion, noise and pollution on the existing roads; new railways in urban areas to minimise environmental effects in sensitive areas; and placing sections of new high speed railways underground. On one high speed railway project cut and cover tunnels were used to lessen the impact of the railway on a village, and to join together two halves of another village which had been separated for over 100 years by the existing railway. In the latter case the ground was reinstated as a meadow to give a safer environment for the nearby local school.

Boortunnel Groene Hart

The new high speed line from Amsterdam to the Belgium border will dramatically reduce the travelling times between Amsterdam and the rest of Europe. The times between Amsterdam and Brussels, London and Barcelona will be halved. The route between Amsterdam and Rotterdam passes through some of the most densely populated areas of the Netherlands. In the north there is Amsterdam and Schipol Airport, further south Leiden, Den Haag and Rotterdam.

To the east of Leiden is one of the remaining rural landscapes in this area of the Netherlands. The "Groene Hart" is a traditional farm landscape and a decision was taken that the alignment should have the minimum environmental impact on the Groene Hart to preserve the rural atmosphere. The Groene Hart grasslands have been well documented in the paintings of the Dutch Masters.

Underground Storage, Emplacement and Disposal

Data were received from five countries on underground storage, emplacement and disposal. A variety of substances and materials are being stored underground including wine, paper, LPG, gas, oil, petroleum, chemicals, low, medium and high level nuclear waste. The emplacement project was for high level nuclear waste and the disposal projects for industrial waste from the production of zinc and nickel, and for general waste.

In this sector the environmental reasons for going underground were very different to those for highway and railway projects. Safety and avoidance of pollution were high on the agenda. The storage of inflammable liquids or gases below ground reduces the incidents of fire. The safe and controlled storage, emplacement or disposal of industrial or nuclear waste is very important to avoid pollution of aquifers, fjords or the coastal areas.

Storage of Wine

An unusual and different form of storage is that of wine in caverns in California, Washington, Oregon and North Carolina, USA. To date over 120 caverns have been constructed from plan areas of 15m2 to 5,000m2, but typically 50m2. The caverns have been constructed in various impermeable strata. Underground storage reduces evaporation of the wine and there are substantial benefits with the underground storage. Although the capital costs are high the running costs and are dramatically reduced. The facilities are intrusive and the reception areas are often used for visitors, receptions and other events.

Nuclear Waste

In Norway The Himdalen repository for low and medium active nuclear waste has been planned for an operational period to 2030. The repository is based upon the safe and reliable storage of the waste in four caverns for 1000 years. Each cavern is 12m wide by 12.5m high and 54.5m long. The waste in drums is placed and cast into concrete chambers protected from water seepage by an impervious cover and sealing. The caverns are drained and the concept is based upon inward gradient to prevent contamination of the ground water.

Sewage Treatment and Water Projects

Six countries provided data on underground sewage treatment and water projects. For sewage treatment plants near fjords, coastal areas or the sea the avoidance or minimising of pollution is very important. In rural areas, particularly in areas of outstanding beauty, surface treatment works may not be acceptable. Placing the treatment works underground in caverns or tunnels, or completely below ground level in cut and cover have been very successful in minimising environmental impacts.

Sewage systems often also take surface water which may overflow during, or after, heavy rainfall, causing major environmental problems. The provision of underground stormwater caverns, tunnels or cut and cover structures, where the surplus water can be stored temporarily, are now quite common. After the rainfall the water is allowed to flow, or is pumped, into the treatment works for treatment in the normal way.

Sydney Northside Storage Tunnel

The Northside Storage Tunnel in Sydney, Australia, was constructed to provide storage facilities for waste water to clean up the Sydney Harbour during heavy rain. The storage tunnel consists of 22km of bored tunnel between 3.8m and 6.6m in diameter, together with access drifts, ventilation shafts and underground caverns.

Other Projects

Details of a number of metro or subway projects were provided were sections had been placed underground for environmental or sustainable development reasons. The reasons given varied from the reduction of vibration and noise, and improving the landscape, to a large area with 6,000 trees in the centre of a city where only the cut and cover station were allowed to break the surface. Any trees removed for the station constructions had to be replanted.

The remaining projects were service tunnels and mining projects. The service tunnels were tunnels carrying high voltage cables under cities to reduce the environmental impacts, for security reasons and

to reduce the effect of the magnetic field for health reasons. The one mining project was a tunnel to remove polluted water from a copper mine to avoid the pollution of the local river.

Mission Valley East Extension, San Diego

At San Diego, USA, the Mission Valley Subway scheme passes under the College University with a station at the Students Union with access to an adjacent redevelopment site. The alternative was an elevated route along the State highway. The longterm benefits of access to the University and the development site and the sustainable development benefits were paramount and the project was placed underground.

Conclusions

The Working Group's draft report on Environmental and Sustained Development considerations for going Underground will be discussed at the Working Group meeting in Singapore and will be published later in the year. This paper has highlighted a few of the projects and some of the reasons that projects have been placed underground for environmental and sustainable developments considerations.

Noise, pollution and reducing congestion were the main factors for the highway and railway projects and there were a number of projects close to or under historical, cultural, archaeological or other areas to be conserved. Cut and cover tunnels allow the surface areas to be used giving sustainable development. For the other types of underground projects safety, the avoidance of pollution, safe and controlled facilities, and sustainable development were the main reasons for designing projects underground.