

# WORLD TUNNEL CONGRESS 2016

*The underground infrastructure, a crucial tool  
to build resilient and attractive cities*

Highlights on its environmental and economic assets, technological innovations



**PRESS KIT**

*April 25<sup>th</sup>, 2016*

## INTERNATIONAL TUNNELLING AND UNDERGROUND SPACE ASSOCIATION: 73 MEMBER NATIONS, 20,000 EXPERTS AROUND THE WORLD

The International Tunnelling and Underground Space Association (ITA-AITES) is a non-profit non-governmental organization that promotes greater use of underground space as a key instrument in sustainable development. Established in 1974 and based in Lausanne, Switzerland, ITA-AITES is made up of a community of professionals who are actively involved in the tunnel and underground space industry: engineers, project owners, town planners, architects, industrial designers, companies specialized in public works and major structures, suppliers of construction site facilities and equipment, lawyers, politicians, researchers and academics, economists, financial experts and other stakeholders.

### A) THE PROFILE OF ITA-AITES

ITA-AITES currently brings together **73 member nations and 300 affiliated members, including 15 major sponsors and 60 donors**. The Association is run by an Executive Council made up of 15 members elected by the 73 member nations, each representing a different dimension of the tunnel community.

The President for the current 2013-2016 term is Mr. **Søren Degn ESKESEN**, from Denmark. He is assisted by four vice presidents: Mr. Rick P. Lovat (Canada), Mr. Tarcisio B. Celestino (Brazil), Mrs. Amanda Elioff (United States) and Mr. Daniele Peila (Italy).

One of the great strengths of ITA-AITES lies in the synergy created by its **20,000 international experts**. These experts from internationally renowned universities and the tunnel industry share their experience at conferences and meetings organised by ITA or its member nations. These discussions take place on a regular basis and have proven extremely fruitful: researchers share the latest scientific studies with the professionals in the industrial sector of tunnels and underground space. Conversely, industry players keep the researchers abreast of the new cutting-edge technologies in the sector and the fieldwork being carried out.

### B) AN INTERNATIONAL ORGANIZATION RECOGNIZED BY THE UNITED NATIONS

ITA is a technical-oriented international organization that has enjoyed Special Consultative Status with the United Nations since 1987. This status has enabled ITA-AITES to get involved with several international policy programmes:

- **Habitat II**, the Second United Nations Conference on Human Settlements, known as the City Summit,
- **Feasibility studies for linking Europe to Africa** through the construction of a tunnel across the Straits of Gibraltar,
- **Poverty Reduction**, integrated into the United Nations Development Programme.

On 14 December 2007 at the United Nations Headquarters in New York, ITA-AITES also jointly organized a conference on the theme: *“The use of underground space as an unexpected solution for promoting sustainable development.”*

As a special consultant to the UN, ITA-AITES has, moreover, participated in and contributed to:

- The **World Urban Campaign**, a platform dedicated to civil society as well as to public and private players eager to contribute to improving urban policies and share the tools and good practices launched for the sake of sustainable urbanization.
- The **“Making Cities Resilient” Programme, developed by the UN as part of the ISDR (International Strategy for Disaster Reduction)**. During the 4<sup>th</sup> session of the ISDR Global Platform for disaster risk reduction organized by the UN, ITA-AITES presented its vision of the City of the Future, in which tunnels could be used as an innovative solution to the challenges posed by urban growth.
- During the World Urban Forum in April 2014, ITA organized training sessions on the use of underground space.

### C) ITA-AITES’s PRINCIPAL MISSIONS: PROMOTING INDUSTRIAL INNOVATIONS IN TUNNELLING WORLD WIDE

ITA-AITES is the leading international organization promoting the use of underground space. It does this by systematically sharing knowledge and industrial applications related to the underground sector with all the stakeholders involved in major tunnel structures (companies, engineering firms, project owners, authorities, etc.). ITA-AITES’s role is twofold:

- Continue to exploit underground space insofar as it contributes in concrete terms to the sustainable development of cities.
- Encourage innovations in the planning, design, construction, maintenance and safety of tunnels and underground space.

To meet these goals, ITA-AITES has implemented several medium-term initiatives: creating synergies on an international scale, reinforcing the expertise of its technicians and engineers, and disseminating innovative sustainable applications that have been launched in the construction and operation of underground space.

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## BRING INTERNATIONAL EXPERTS TOGETHER TO SHARE THE LATEST INNOVATIONS IN THE SECTOR

ITA-AITES brings together engineers, entrepreneurs and other stakeholders involved in developing underground space, including architects, city planners, public authorities, lawyers, insurance companies, investors and politicians, with the aim of sharing the latest technological developments and feedback related to the construction of large underground structures.

The Association also undertakes to inform entrepreneurs about best practices in the field that can be available to them, in compliance with the regulations in force and safety rules. Moreover, thanks to its expertise, the Association devotes special attention to promoting the best methods of urbanization,

geological investigation, design, construction, operation, maintenance and safety of underground structures through the use of new development techniques and risk management principles.

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## ORGANIZE REGULAR TRAINING FOR EXPERTS AND ENGINEERS

The International Tunnelling and Underground Space Association has formed a Working Committee for initial and continuing training. Through workshops, international academic programmes and continuing vocational training sessions, it ensures that every technician, engineer and student has access to the highest level of expertise and technical innovations.

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## HIGHLIGHT DISRUPTIVE INDUSTRIAL TECHNIQUES AND APPLICATIONS

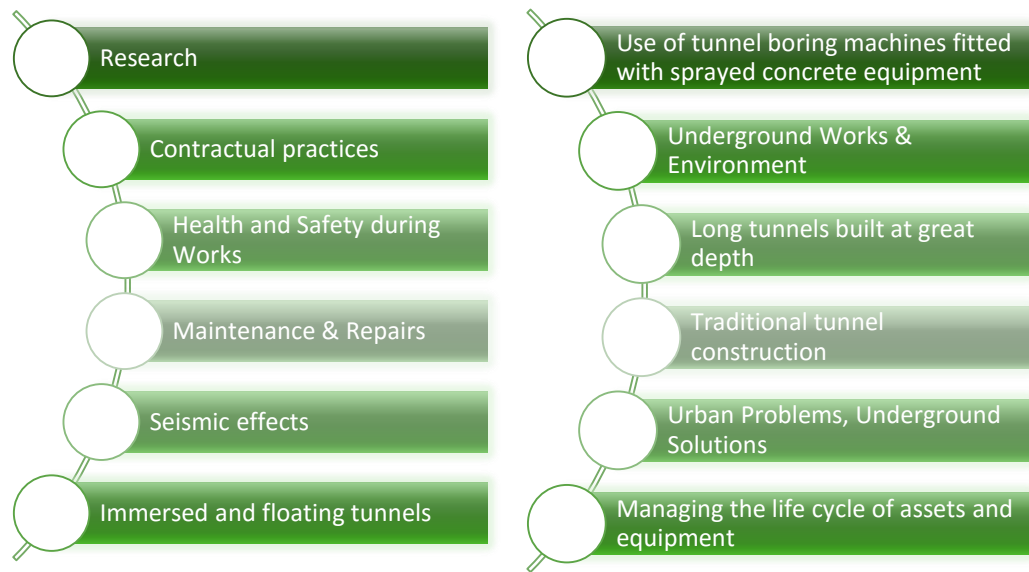
To meet the demographic and climate challenges of the 21<sup>st</sup> century, ITA-AITES constantly monitors new technologies and sustainable applications that take full advantage of the potential of underground space. Just how much innovation matters to ITA-AITES is reflected in the extensive support it gives to research studies devoted to the alternatives to surface constructions offered by underground space, in particular in terms of savings and indirect costs for the structures' life cycle as well as social and environmental advantages.

### *D) HOW IS ITA-AITES ORGANIZED?*

ITA-AITES members share their expertise by participating in:

- **4 Working Committees:** the Committee on Operational Safety of Underground Facilities (ITACOSUF), the Committee for Education and Training (ITACET), the Committee for Underground Space (ITACUS), and the Technology Committee

- and 13 active working groups, including:



The International Tunnelling and Underground Space Association shares its expertise by regularly publishing analyses, position papers and symposium reports, all of which are available on its corporate website.

## A NEW PERSPECTIVE ON TUNNELS AND UNDERGROUND SPACE: ECONOMIC AND ENVIRONMENTAL IMPACT IN THE US AND WORLDWIDE

**W**hat do water, electricity, buses, trains, or even humans have in common? They all need infrastructures to circulate at a large scale.

Whereas nature appears as a pioneer in terms of underground works, for years, mankind has privileged a two-dimensional view of the world, favoring traditional infrastructures built above ground.

Yet, with 7,416 billion people living around the globe and a demographic growth raising by 1.5 % per year, such infrastructures tend to reach their limits in certain areas. While urbanization grows at a fast pace, and cities expand widely, the space needed to improve mobility (subways, trains, freight, stations, etc.) and to provide basic needs to population (heating, water storage, sanitation, or conveyance, hydroelectricity stations, isolation) is also growing.

In this context, underground space can provide the settings of activities or infrastructures that are difficult, impossible, undesirable or less profitable to install above ground. It also permits to avoid the destruction of natural protected areas.

This is why states currently demonstrate strong needs in tunnels and underground spaces for public infrastructures. This is also why, beyond clichés that are hard to uproot, underground spaces appear as an interesting solution to contribute, at their own scale, to the building of resilient, sustainable and inclusive cities.

In this context, the tunneling industry, which is the part of the civil engineering industry building infrastructures as tunnels, cut-and-cover tunnels, and underground infrastructures for all types of use (transports of men and goods, parking, roads, subways, water and energy utilities, public buildings), takes a strategic part in the well-being and the competitiveness of countries.

*What if the world couldn't function without tunnels and underground spaces?  
What are they for and how useful are they?*

Beyond the clichés abounding about them, tunnels and underground spaces are of critical importance to develop collective transports and energy schemes, avoid water floods, or expand urban facilities, notably because of the rarefaction of space above ground due to a very dense urbanization. Every continent is concerned by these challenges, although the needs differ from a country to another, from a city to another, following the geographic context, the economic level, and demography.

**ARE TUNNELS AND UNDERGROUND SPACES REALLY CRUCIAL TO HUMAN ACTIVITIES?** Every day, people “make their living” out of underground infrastructures. If satellites nowadays allow people to benefit from

extraordinary services that have revolutionized their life, like the GPS, tunnels and underground spaces strongly improve our daily life too, with a level of technology that is often ignored.

In this way, underground infrastructures are strategic tools to accompany urban expansion. The OECD indicates that in 2015, 10 % of the global population lived in what one calls “mega-cities”, that are 26 of their kind around the world, among which 18 located in Asia. In such a context, ensuring the quality of life is more important than ever. It implies that cities, and more generally speaking public authorities, make sure that populations are well-provided with disposal facilities, storage of goods and energy, and transport amenities. Although most cities’ inhabitants are not very familiar with what is happening underground, the infrastructures deployed underneath their feet are multifarious, and directly concern them. If the ground was see-through, people would discover supply lines for gas, water, electricity, telecommunications and distance heating, constructed and settled by civil engineers all along their way for work, under their houses or their mall center.

Thinking underground implies to change one’s perspective of the world around. It offers a new dimension to imagine a different urban paradigm, which could consist in living in a four-dimension world, where tunnels and underground spaces could offer new opportunities for transport (New York Second Avenue Subway, Grand Paris Express), datacenters storage that could heat an entire city (Helsinki), or even research centers (think about the vast and totally innovative underground scientific city of Singapore). Interestingly, one should also add that installing infrastructures underground can permit to liberate space above the ground, in order to create more eco-friendly urban environments such as green areas, parks, and pedestrian roads...

**WHAT ARE THE MOST-PREFERRED UNDERGROUND INFRASTRUCTURES?** In 2014, rail tunnels and roads were definitely the most sought-after underground infrastructures worldwide, respectively representing a share of 33 and 34 % of the tunneling output. To date, rail tunnels form the longest networks of tunnels excavated in the world, ahead of underground roads (29 % of the total length of tunnels in the world). Though representing less than 9 % in kilometers regarding the total length of tunnels globally, subway tunnels are deemed strategic to states and cities, reaching a 17 % output within the tunneling industry.

#### WHERE ARE TUNNELS MOST NEEDED WORLDWIDE?

On its own, the booming Asia represent 68 % of the of the global tunnelling market (China representing 50 % of the global market on its own), taking top position from Europe (17 %) North America (3.5 %), and Latin America (3 %). Nevertheless, within the next decade, the Middle East and South America will experience the fastest growth in the tunneling sector. The African continent remains on the sidelines, but is expected to express a much stronger demand in the future decades, owing to the dynamism of some countries (Kenya, Ethiopia, Zambia, Nigeria, and South Africa, etc.).

#### The tunneling industry, a booming industrial sector worldwide:

Worldwide, the construction sector is providential to enhance economic development. As a strategic working sector, it represents 10 % of the world GDP (Gross Domestic Product), reaching up to 7.5 trillion dollars. Therefore, quite a dynamic branch, that notably includes the tunneling industry, which has been witnessing, for a few years now, an important growth of its turnover (+ 5 % per year). In 2014, the global tunneling market was estimated to 90 billion dollars (+ 7.5 % comparing to 2011).



**AND IN THE UNITED STATES?** In the United States, one of the main priorities has been given to the construction of transport infrastructures. Large-scale underground programs have been launched these last years, such as the Los Angeles Subway expansion, the New York Second Avenue Subway, or the Cleveland Combined Sewer Overflow Tunnel. In the American building sector, the underground transportation market segment has been rising by more than 60 % between 2000 and 2010, evolving from 20 billion to around 37.5 billion dollars in 10 years. The transportation and availability of clean water and the implementation of water storage facilities, are also at the center of the public focus, as the Lake Mead Project (Las Vegas) or the proposed Bay Delta project in California show.

The engineering of underground spaces and tunnels is also very precious for American states, for two reasons. On the one hand, the existing underground infrastructures in the US are aging. For instance, the sewers date back from a hundred years, and it is common to witness overflows going directly into rivers and lakes. On the other hand, faced with climate change pressures and following the prescription of the Environmental Protection Agency, public authorities in the country tend to pay a much greater attention to the cleansing and the sanitation of waterways and to underground protection against storm water overflows. In the context, tunnels operators are of major importance to inspect, maintain, repair and create underground networks.

#### *Currently, what are the major underground infrastructures projects in the US?*

In the United States, there are currently a few mega-projects under construction. Among them, the New York Second Avenue Subway Project aims at reducing overcrowding and delays on the Lexington Avenue Line, and at providing better access to mass transit for residents in the East Side of Manhattan.

On the other sides, local authorities also have environmental challenges that incite them to settle underground solutions. It is notably the case in Las Vegas. Sheltering almost 2 million inhabitants and welcoming around 40 million tourists every year, the city needs to be provided with water. The Lake Mead is located approximately 30 miles away. It normally supplies 90 % of the Las Vegas Valley, but during the last decade, it witnessed one of the worst drought ever recorded in the Colorado basin; the level of waters decreased significantly, dropping by almost a 100 feet. While two intake pipes had already been built to keep providing Las Vegas with water, they both face a high risk of being lost if the water level keeps dropping. To protect the existing water system capacity, the Southern Nevada Water Authority decided to launch the construction of a third intake program, that would reach 300 feet deeper into the lake and keep water flowing for as long as there is water to pump. An objective that could not exist without boring tunnels and imagining a new underground pumping system. The challenge was serious and required the high-level expertise of civil engineers. Highlights on a few underground projects launched in the United States on the following pages.

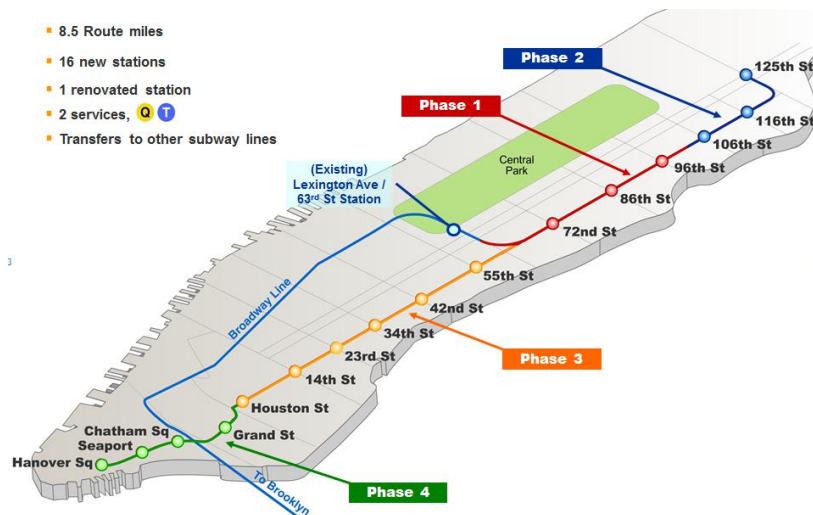


## The New York Second Avenue Subway Project:



**Main objective:** Providing a dedicated line for the East side of Manhattan, with a link to the existing subway network, for the lines 4, 5 and 6 are currently the only ones serving the Upper East Side. The proposed alignment runs from Harlem in the North to the financial district in the South, with possible extension to Brooklyn. The first phase of the project (4.5 km) will be finalized by the end of 2016. On its own, it is expected to welcome over 200,000 weekday riders.

**Main features:** The New York Second Avenue Subway Project is one of the major capital expansion of the New City Subway network to date and the largest US transit project so far. The whole project is approximately 14 km long, including 16 stations. 10 stations will be cut-and-cover and six mined caverns, which will be constructed through vertical shafts within the right-of-way Second Avenue.



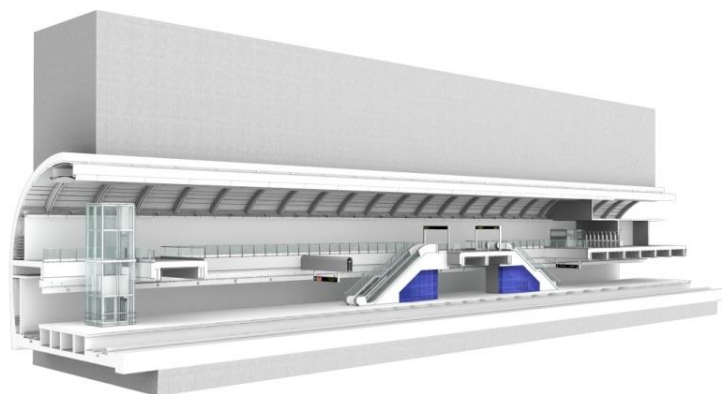
Noticeable innovations/technologies launched through this project: Owing to its dense urban environment (one of the highest concentration of utilities, skyscrapers, and traffic in the world) and the challenging underground conditions, the project is deemed a reference in North America, notably for its innovative engineering solutions. Indeed, several challenges in the construction structure were addressed thanks to unprecedented innovations. Large and shallow station caverns including optimized excavation sequencing and support system, drilling and blasting in close proximity to multiple tall building foundations, vibration and dust control approaches, underpinning an occupied 30-storey luxury high-rise building, or building two highly sophisticated muck houses for each station's excavation to minimize environmental impacts. A unique example of inter-disciplinary coordination (tunnelling and underground experts, architects, electricians, mechanical engineers...), the project recently received the Green Building Design Award from the US Environmental Protection Agency.

Amount of investment: 17 billion dollars (4.5 billion dollars for the 1<sup>st</sup> phase).

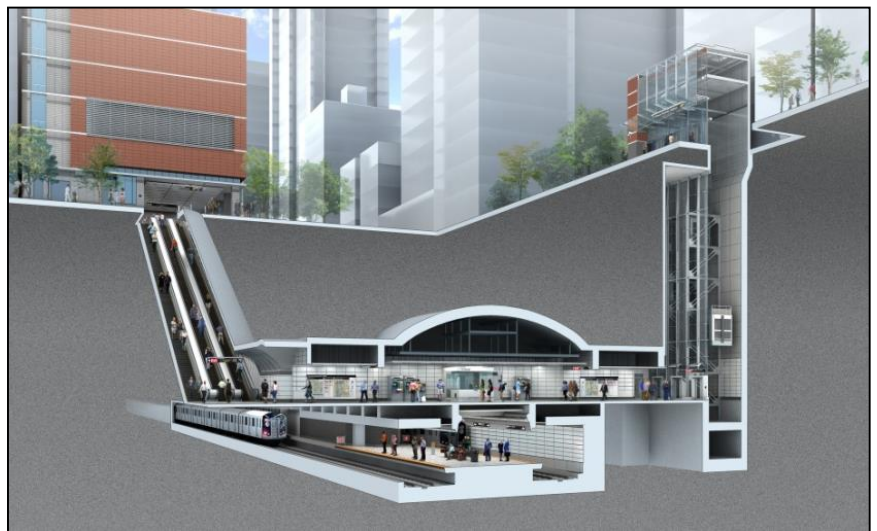
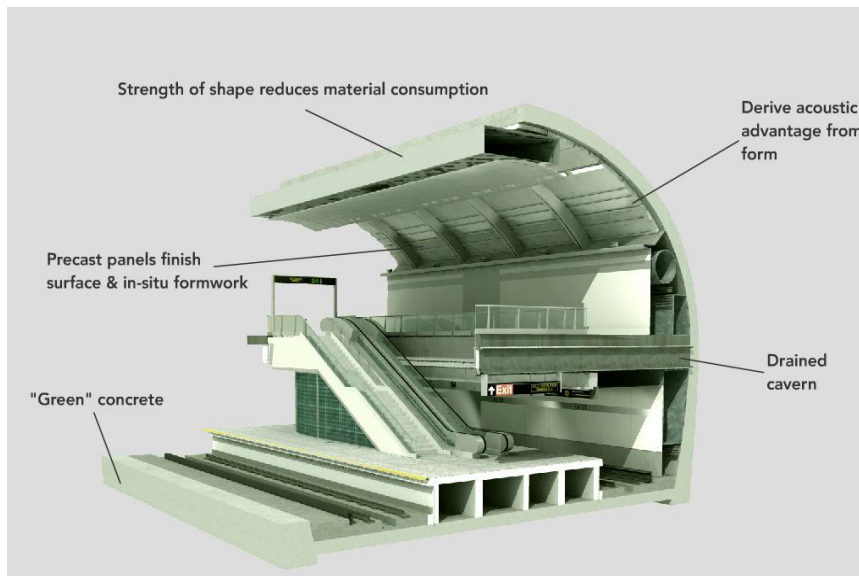
Construction deadlines: 8 years

Bid sponsor: New York City Metropolitan Transportation Authority.

Contractors: They are several: SKANSKA, SHEA, KIEWIT, SCHIAVONE, and TRAYLOR. Two engineering firms have been hired for the project: AECOM for 67 % of the project, and ARUP for 33 % of it.



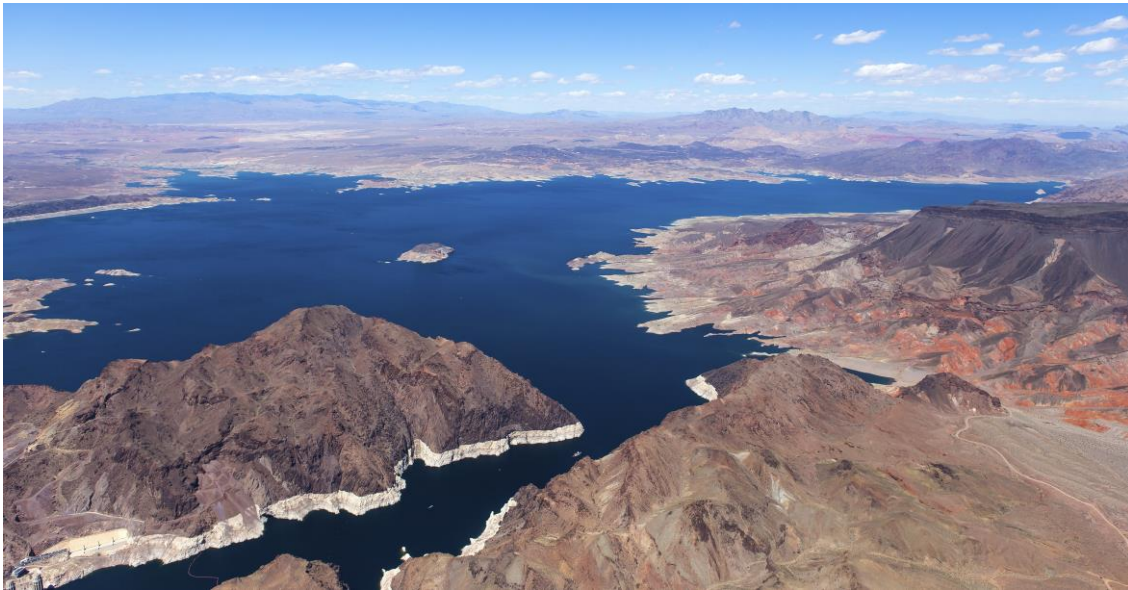






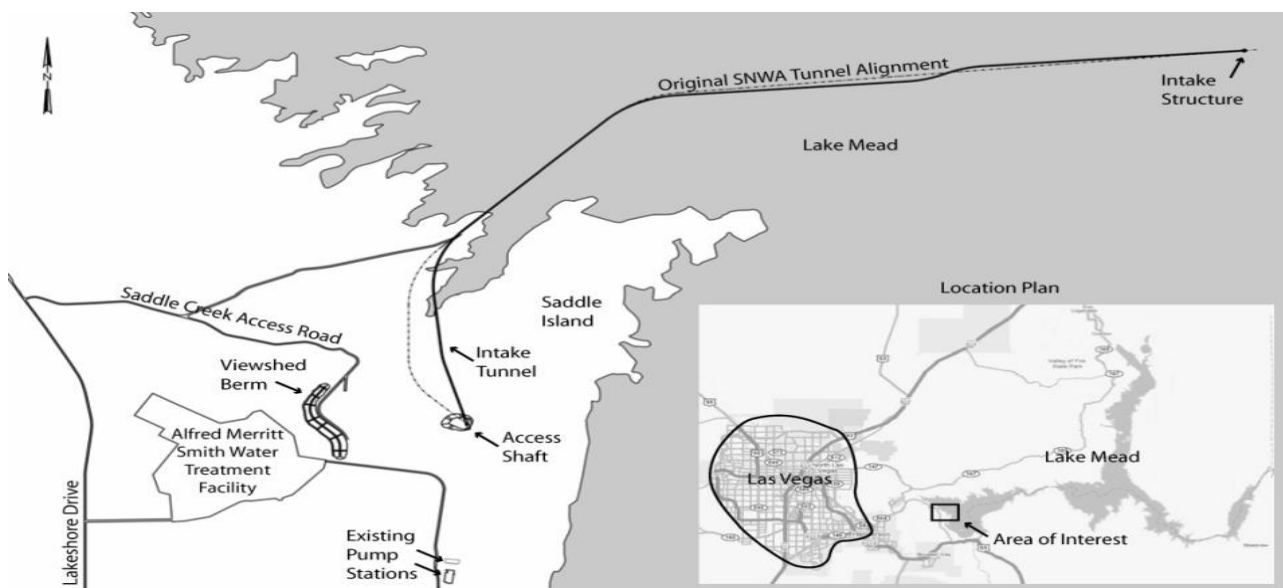


## *The Lake Mead Third Intake Project:*



Main objectives: Maintain access to Southern Nevada's primary water supply in Lake Mead as drought conditions reduce lake levels and threaten to drop below the community's two existing water intakes. Allow Southern Nevada to draw better quality water from the deeper elevation in the lake.

Main features: A 4.5 km concrete-lined tunnel constructed deep under the water (- 300 feet) that appears as the deepest sub-aqueous tunnel in the world to date.



Noticeable innovations/technologies launched through this project: The project required equipment that could resist a maximum pressure of 17 bars, and actually encountered 15 bar during excavation, which set a world record. Achieving a subaqueous excavation at the bottom of Lake Mead, required the use of highly-advanced technologies: shaped charges blasting methods, removal of the material by air-lift, clam shell utilizing Remote Operated Vehicles without divers. A 1,200 ton intake structure was built on a barge, equipped with a strand-jack hoisting system that had a lifting capacity of 2,000 tons. For the excavation of the tunnel, a prototype hybrid Tunnel Boring Machine was designed to operate at pressures which had never been done before, and in particularly difficult geological conditions.



Amount of investment: 500 million dollars

Construction dates: 7 years (2008 – 2015)

Bid sponsor: The Southern Nevada Water Authority (SNWA)

Contractor: Vegas Tunnel Constructors (VTC)



The tunnel boring machine used for the Lake Mead Third Intake Project : a hybrid rock/slurry machine, with an Open/Closed mode operation, designed for a 17 bar pressure



## The Los Angeles Metro Transit System:



**Main objectives:** The Los Angeles County Metropolitan Transportation Agency's (Metro) Regional Connector Transit Corridor project is a design/build, light rail underground project that will extend the Metro Gold Line from the Little Tokyo/Arts District Station to the 7th/Metro Center Station in downtown Los Angeles, allowing passengers to transfer to Blue, Expo, Red and Purple Lines, bypassing Union Station.

**Main features:** The 3.1-km (1.9 miles) alignment will include construction within the Little Tokyo and Bunker Hill neighborhoods, and the Financial District in the heart of downtown Los Angeles. The project includes the construction of three underground stations with depths ranging from 12 to 34 meters (40 to 112 feet), approximately 1.5 km (0.9 miles) of twin tube tunnel mined with earth pressure balance (EPB) tunnel boring machines (TBM), approximately 1.6 km (1.0 mile) of cut and cover tunnel including station excavations, and system wide elements including track, traction power, train control, and communications.

**Main benefits of the project:** The Regional Connector is a critically important rail connection project overwhelmingly approved in 2008 by voters of the Measure R sales tax ordinance for Los Angeles County transportation improvements. It improves mobility through downtown Los Angeles, but its benefits also bring significant mobility improvements for transit commuters throughout Los Angeles County. The project will provide a one-seat, one-fare ride for commuters from Azusa to Long Beach and from East Los Angeles to Santa Monica without the need to transfer between rail lines for major east/west and north/south trips. The Regional Connector will form the link to create these north/south and east/west lines that will operate on the new trunk section in tunnel. Once built, the Regional Connector Project will attract **17,000 new daily riders** and **provide access to more than 90,000 passengers saving commuters up to 20 minutes off their daily commutes**.



Main innovations of the project: The Los Angeles Metro Transit System Construction had mitigated impact to Little Tokyo Community. The tunnelling works for construction of the metro line was aligned to pass under buildings in Little Tokyo to achieve optimal rail alignment and avoids impacts of construction in the street. The Tunnel Boring Machines are being set up across the street from the center of Little Tokyo instead of at end of station excavation. The innovative dimension of this project also rests upon the installation of high-speed elevators instead of long escalators for the deep Second & Hope Station (40m 112 feet deep). A large cavern (88m long [290 ft], 17m wide [57 ft]), a first for Los Angeles, for a rail crossover adjacent to one of the stations will be constructed in weak rock by conventional tunneling (a technic named “sequential excavation method” [SEM]). Constructing by mining, rather than cut and cover, avoids major community disruption including impacts to adjacent important and historic structures.

Amount of investment: 1.5 \$ billion

Deadline of the project: 2014-2021

Bid sponsor (roles on project team)

Metro’s Project Manager for the Regional Connector Transit Corridor Project is Girish Roy. Preliminary Engineering was by The Connector Partnership JV (CPJV), a joint venture of AECOM and Parsons Brinckerhoff. The design-build contractor is Regional Connector Constructors (RCC), a joint venture of Skanska USA Civil and Traylor Bros. Hatch Mott-MacDonald is RCC’s engineer for Final Design

Owner: Los Angeles County Metropolitan Transportation Authority (LACMTA)

## HIGHLIGHTS ON OTHER UNDERGROUND PROJECTS OUTSIDE THE UNITED STATE: THE EXAMPLE OF THE GRAND PARIS EXPRESS



## Map of the Grand Paris Express Project

Main objective: Better connecting the city of Paris to its outlying areas by means of a green public transport that runs underground. The Parisian context support this objective : there are currently 15.5 million car journeys made daily in the Île-de-France region, with an average of 7 out of 10 households owning an automobile, a figure that seriously affects the quality of the air. According to a study conducted by the organization Airparif (May 2015), *“the concentrations of atmospheric pollutants remain well over the thresholds set by regulations – up to double the set limits along certain arteries.”* At the same time, 8.5 million passengers use public transportation every day. The Île-de-France region alone, for example, accounts for 10 % of the country’s railroad lines and 40 % of domestic traffic. This density of traffic (which has risen by 21 % in 10 years) calls for significant development of public transportation infrastructure, especially given that until now the underground metropolitan network was confined exclusively to the heart of Paris (2 million inhabitants, compared to 20 million in the Île-de-France region). Besides, the current subway network is designed in the shape of a star. This configuration requires users to go through the center of Paris in order

to get from south-western to north-eastern Paris. This kind of geographic arrangement of the subway lines means that passengers must change frequently from subway to buses to RERs (urban trains), causing time-consuming transfers. This is evidenced by the fact that Île-de-France residents' commute times has been getting steadily longer, increasing from about 10 minutes in the 1960s to nearly half an hour today.

Main features: The Grand Paris Express is constituted of a 208 km network of 5 new subway lines (line 14, 15, 16, 17 and 18), among which 90 % will be constructed in underground space. 68 multimodal stations will be spaced along the lines. From the viewpoint of tunnel expertise, the completely unprecedented character of the Grand Paris Express lies in the fact that the environmental issues of regional development, the design of the lines and the use of underground space were taken into consideration right from the design stage of the project. In this regard, the 68 stations spaced out along the lines illustrate this preoccupation. Far from being confined to being just subway stations or multimodal hubs, these platforms are destined to become centers of cultural activities, trade and services. Their design will permit them to be compatible with new surrounding real-estate constructions.

Noticeable innovation of the project: The Grand Paris Express underground network is a colossal construction work. The current network had not been renewed since the construction of the Parisian subway at the beginning of the 20<sup>th</sup> century. At that time, the underground construction technics were different and tunnel boring machines had not been invented yet. The large avenues were torn up by open trenches. In the same way, it was very difficult to define a track alignment beyond the biggest road arteries, and to go under buildings. The boring in great depth was also deemed almost impossible. The arrival of Tunnel Boring Machines has favored the acceleration and has improved the safety of underground works. It notably permits to maintain a high pressure on soils in order to ensure their stability while boring. This technic also reduces the need for space above ground, which considerably reduces the discomfort for the residents around. The Tunnel Boring Machines will evolve in great depth (from 15 to 55 meters underneath) with a progression of 10 to 12 meters daily (the equivalent of 3km per year). These drilling engines, whose total length can reach 100 meters, do have several functions: boring, material excavation, retaining structure, definitive lining of the tunnel, etc.

Amount of investment: 22.6 billion euros

Construction deadlines: 2015 - 2030. The **Line 15 South** between Pont de Sevres and Noisy-Champs will be the first line of the Grand Paris Express to be inaugurated, by the end of 2022.

Bid sponsors: the French State and the Ile de France Region.

Owner: Société du Grand Paris



Underground section of the future Saint Denis train station, integrated into the Grand Paris Express (image from the presentation video on the Grand Paris Expression, <http://urlz.fr/2Dxj>).



View of intermediary levels of the Arcueil Cachan Station, at the Theme stop

**INTERVIEW WITH... SØREN DEGN ESKESEN**  
**FORMER PRESIDENT OF ITA-AITES (2013-2016):**  
**“UNDERGROUND SPACE CAN CONTRIBUTE TO**  
**REDUCING THE CARBON FOOTPRINT AND**  
**PROTECT CITIES FROM FLOODS.”**



*The effects of climate change can be felt throughout the world, with repeated, increasingly frequent river floods and marine submersions. In the face of these phenomena, which endanger both populations and structures, what solutions can underground infrastructures provide?*

**Søren Degn ESKESEN:** Cities around the world must deal with the **challenge of rapid urbanization and climate change**. At ITA we are convinced that underground space in urban areas can be used for meeting the many challenges cities face today. If done at an early stage and in an organized manner, the development of underground space can contribute to the sustainable development of urban areas, including to help them adapt to the effects of climate change. The solutions fall into two categories.

First of all, exploiting underground spaces can contribute to the **reduction of the carbon footprint** generated by big cities. Several options are open in this framework. The first consists in **developing an underground transport system that uses renewable energy**, like the subway that runs on non-carbon energy. Another possibility could be to **produce energy based on green resources such as water**. Indeed, when it comes to **hydroelectricity**, it is essential to make use of underground spaces by building tunnels for water conveyance and underground storage spaces for electric power stations.

The occupation of underground space could also offer the possibility of protecting cities from floods by **bringing flood control tunnels into service to regulate flows**. The principle consists in **diverting water through these tunnels to prevent potential overflow on the surface**, or creating underground infrastructures to **retain water in periods of flooding**. Such solutions have been used in several cities such as Buenos Aires in Argentina



*Are governments becoming aware of the potential of underground infrastructures to protect populations and buildings? Is there a new awareness on the part of the international community about the subject?*

**Søren Degn ESKESEN:** ITA has been reaching out to decision makers and urban planners for several years to convince them of the relevance of exploiting underground spaces. During our annual tunnel conferences held over the period 2011 to 2013 in Helsinki, Bangkok and Geneva, we organized open sessions where the subject was the use of underground space in a changing world. Cities everywhere are under pressure to deal with population growth and meet their future energy and transportation needs, using far more sustainable methods in order to reduce their carbon footprint and mitigate the effect of climate change. Decision makers and organizations are now talking about underground space and considering how to include the underground when building cities to make them more resilient. **The ITA community supports them in their approach.** The association has **established its reputation and is invited to participate in working groups registered in the United Nations agenda.** ITA was **named as one of the partners in the Expert Group on urban drainage set up by UN Habitat.** An excellent example of this is the **SMART project in Kuala Lumpur.**

UN Habitat recently identified 5 basic principles concerning urban drainage. One of them stipulates that **"effective use of tunnels and underground spaces is appropriate when conditions so require."** **Tunnelling and underground space are now becoming an integral part of UN policy.** So yes, the international community is aware of this issue. This is only a first stage, but it is a step forward which shows that ITA's efforts are bearing fruit.

*Did the New York Climate Summit in September 2014 enable ITA, which took part in it, to raise government representatives' awareness of the solutions put forward for limiting the effects of weather disturbances?*

**Søren Degn ESKESEN:** ITA was represented by the Chair of our Committee on Underground Space Han Admiraal and myself at the UN Climate Summit in New York in September 2014. At this historic meeting many governments and organizations pledged their alliance in combatting climate change.

From that moment on, it became clear that investors were increasingly backing green projects geared towards reducing carbon emissions. This is caused by three reasons outlined by the speakers.

Firstly there is no longer any doubt as to the fact that **climate change is wreaking havoc with the environment and that it is caused by human activity.** Moreover, **the cost of not doing anything about climate change now outweighs the cost of taking steps to curb it.** Lastly, governments alone cannot change anything; the **involvement of the private sector is vital.**

This commitment must be the collective action of businesses that want to act together on the basis of common interests rather than the fruit of an individual initiative. Companies should be driven by a simple credo: **if we don't act now, there will soon be no planet left.**

In the closing session UN Secretary General Ban Ki-Moon announced the introduction of a **Global Geothermal Alliance** in the field of Energy, which clearly shows that ITA's efforts in planned development of underground space must continue. Other important fields that ITA must remain focused on are the **transportation sector and urbanization**. These two sectors will play a vital role in implementing a low-carbon economy. The participants in the UN conference on the climate agreed that underground space is a relevant response to numerous urban challenges, thereby **acknowledging ITA's expertise as a global leader in the field of tunnelling and underground space.**

*How and with what kind of scientific and technical arguments can your industry encourage States to invest in underground infrastructures to limit the devastating effects of flooding and submergence which we know will get more frequent and more severe in the coming decades?*

**Søren Degn ESKESEN:** Our industry has solutions for controlling floods by diverting water into tunnels to prevent water from rising to the surface. By launching a certain number of projects, we have proven that solutions already exist. The message that must be conveyed is that it is cheaper, safer and more efficient to propose solutions at an early stage to prevent disasters from occurring. We need to convince states and government to invest in order to avert catastrophes.

**The capital is better spent on investment for disaster risk reduction than on rebuilding cities after a disaster such as a flood.**

Cities everywhere are under pressure to deal with population growth and meet their future energy and transportation needs. There are methods that are far more sustainable for reducing the carbon footprint and mitigating the effect of climate change.

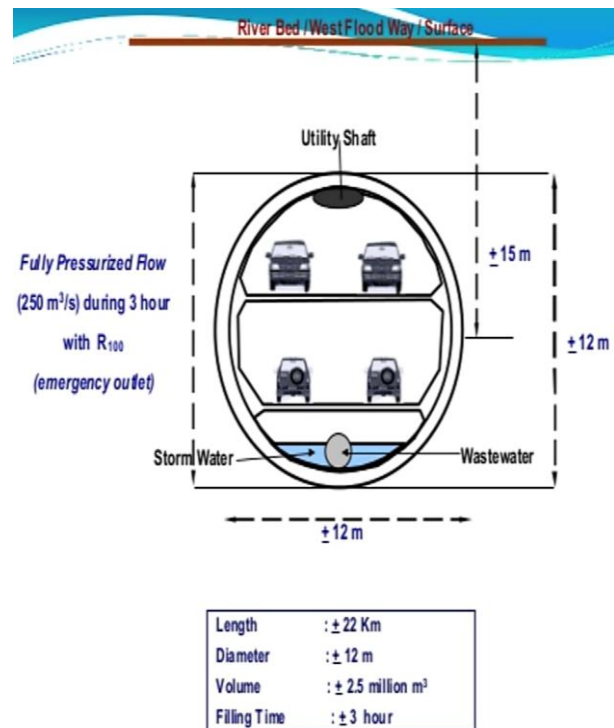
Ensuring that populations can move around efficiently is critical to the quality of life and economic success of cities. Success depends on how cities utilize their underground, because what happens below the ground strongly influences what it is possible to achieve above ground. **By investing in the underground you create room at the surface to develop the city into an economic powerhouse.**



Currently, are there any significant ongoing construction sites in the world aiming at reinforcing the safety of populations and property located in flood-prone areas? If so, what are they?

Søren Degn ESKESEN: **South East Asia** is probably the area of the world with the greatest risk of flooding. In the Indonesian capital of Jakarta, flooding occurs too often. Several projects have been launched to cope with immediate remediation **such as the tunnel that will connect the Ciliwung River in Bidaracina with the East Flood Canal in Eastern Jakarta**. But the most important long-term project is the multi-purpose tunnel in Jakarta, based on the example of the Kuala Lumpur SMART tunnel.

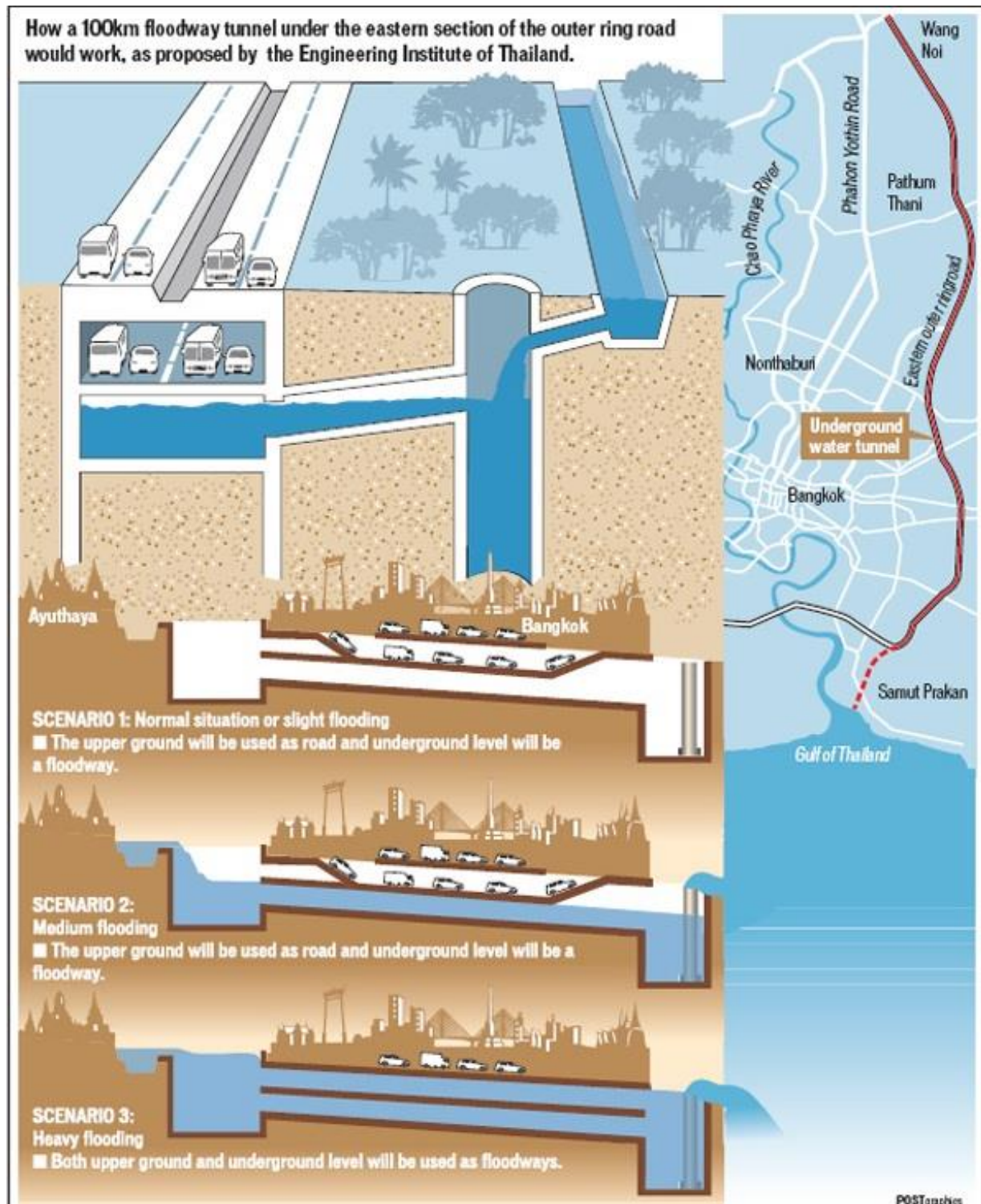
After the huge flood that occurred in Bangkok during autumn 2011, the Bangkok Metropolitan Administration (BMA) as well as the ITA members in Thailand (TUTG) came up with various solutions including tunnels to prevent such flooding. TUTG suggested **constructing a long multi-purpose tunnel running from north of the capital city to the sea, and BMA is reinforcing its network of drainage tunnels**. The construction of the tunnel began a few months ago. The tunnel will measure **6.4 km in length and 5 m in diameter**.



Example of a multi-purpose tunnel

Other projects exist in various countries and parts of the world. Even in my hometown Copenhagen, the capital of Denmark, we are considering building a tunnel that will serve as both a drainage tunnel and a six-lane road. At the moment there is a heavily congested road on the surface that follows the alignment of a river, which now flows in the drainage pipes. By making the road an underground artery and combining it with the function of a drainage tunnel that will serve to channel large amounts of falling water, we will free up surface space and put the river back in its original bed. We will create a recreational area nearby for the city's inhabitants to enjoy.

**Bangkok:**  
**How a 100 km long floodway beneath the eastern part of the city would work**



*Beyond large-scale structures built underground, in particular for transport, installations on a more modest scale may be set up in cities. Which of them is the most likely to be rolled out in European cities?*

**Søren Degn Eskesen:** In addition to underground facilities related to the supply, storage and conveyance of water, those most commonly used in our cities, we are observing a new trend these days: urban construction of underground infrastructures dedicated to the **control and drainage of the volume of water**. We have already noted that a certain number of projects related to these facilities have been launched and initiated by many cities, including Copenhagen. There, more than 100 projects are about to be put in place for the purpose of coping with torrential rains and floods. This modest example can be applied to many cities in the world. That is why we urgently need to act now and think about how underground space can be one of the solutions that should be envisaged, if we want to protect our urban heritage from the impacts generated by climate disruption.

*A few months ago, Paris hosted the COP21, the World Climate Change Conference. During this event, climate disruption was once again at the heart of the debates. What were the key messages ITA-AITES conveyed at the summit?*

**Søren Degn Eskesen:** In our work with UN Habitat we have emphasized the role underground space can play in urban drainage and disaster risk reduction. We are now part of a process that consists in **bringing cities and private partners closer together to launch projects** that will achieve these goals.

The idea is **to give up concepts and theories** and concentrate on concrete action, especially in those fast-growing cities that need such infrastructures but have never even considered the issue. We are challenged to come up with solutions to solve the problems these cities face, especially problems of drainage and channeling flows.

The advantages gained from the decisions about human management that we take today will be evaluated fairly by future generations the same way we measure the benefits of investments that our grandparents began. Such as the construction of the subway, or underground, in cities like Paris, London and New York.

**Today's city dwellers are still benefitting in their daily life from the investments made more than 100 years ago.** ITA has never been so close to its goal: to attract the world's attention and make sure tunnels and underground space are considered vital solutions to the greatest challenges our planet has ever faced. We are deeply committed to this goal and ITA will continue to proactively propose and implement solutions to these challenges.

## IMAGINE THE SUSTAINABLE CITY OF THE FUTURE:

### ITA-AITES'S 7-POINT COMMITMENT

The use of underground space in an urban environment takes on a strategic character nowadays. Planned for the long term, in the urban planning phase, it is a response to environmental, social and energy issues that put today's cities in difficulty (urban density, congested traffic, severe flooding, and problems of where to put certain basic infrastructures such as urban heating, water storage and data centres). The International Tunnelling and Underground Space Association intends to play a major role in devising sustainable solutions for urban authorities. To do so, it has set itself 7 key commitments for the coming years.

#### 1. *ITA-AITES, heightened commitment to the UN missions for the climate.*

ITA-AITES has been involved in the United Nations since 1987, and has a consultative status on the Economic and Social Council. As the chairman of ITACUS (ITA-AITES Committee on Underground Spaces) and the new ITA-AITES representative to the United Nations International Strategy for Disaster Reduction (UNISDR), Han Admiraal will bring Margareta Wahlström, the Special Representative of the UN Secretary-General, finely honed expertise in the concrete role that underground space can play in preventing climate disaster risks.

#### 2. *A commitment that militates for a holistic, multi-disciplinary approach to the sustainable city.*

The role of underground space in urban areas meets many needs: public transport, new roads to relieve traffic congestion, drainage, water diversion and storage, accommodation of data centres generating electricity and thermal power for the city, and so on. ITACUS is militating for a comprehensive multi-disciplinary approach to sustainable cities. For this reason, ITACUS has entered into close collaboration with the International Society of City and Regional Planners (ISOCARP) to encourage the dissemination of good underground urban planning practices. ITACUS and ISOCARP have in fact just published a book entitled: « Penser en profondeur : de la planification urbaine et de l'exploitation de l'espace souterrain en ville » ("Think Deep: Planning, development and use of underground space in cities"). It features five cities that have opted for underground urban development<sup>1</sup>.

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<sup>1</sup> Link to the pdf document: <http://isocarp.org/our-partners/memoranda-of-understanding/13393-2/>

### ***3. Raise big cities' awareness about the many uses of underground space in urban areas.***

ITACUS has recently been organizing Conversations about the Underground Space of the Future at the local authorities level. To date, 4 cities have shown interest in the concept and have welcomed ITACUS: Gothenburg and Stockholm in Sweden, Wroclaw in Poland, and London. In London the meeting between politicians and underground space experts was very successful, underlining how important underground space has become in the city's overall policies. The meeting led to the establishment of a Multidisciplinary Activity Group for Use of Underground Space in the UK. The group includes architects, urban planners, engineers and geologists.

### ***4. Raise awareness amongst the new generations of urban planners about the opportunities tunnels and underground space offer in the city.***

In its international strategy, ITA-AITES gives priority to raising awareness amongst young people. In May 2015 the International Tunnelling and Underground Space Association formed a new committee, ITA Young Members. The committee's job is to gather engineers under 35 from all over the world who would like to benefit from the sharing of good practices and feedback, or wish to keep abreast of the latest innovations in the sector. In 2016, ITA-AITES wants to strengthen its approach: during the annual tunnel and underground space congress to be held in San Francisco from 22 to 28 April 2016, the ITA Young Members Committee will jointly organize an event dedicated to underground space in cities together with the International Society of City and Regional Planners (ISOCARP). For the first time, young city planners and young engineers will work together on a real urban challenge and propose a disruptive underground solution.

### ***5. Create an international center for applied research on the use of underground space.***

At a time when ITA-AITES notes growing interest amongst project owners in exploiting underground space, a host of questions arise about the methods for designing these spaces. For this reason the Committee for Underground Space (ITACUS) has just created ICARUS: the **International Centre for Applied Research on Underground Space**. It is intended to become a global laboratory that will devise and test innovations created by engineers, city planners and the tunnelling and underground space industry as a whole. One of the main fields of research will concern the study of human needs in an underground environment (luminosity, ventilation, orientation and signage). This international research center will be set up in the underground test gallery in Hagerbach, Switzerland, in an underground space beneath the Swiss Alps that will provide researchers with a perfect study environment. In France, AFTES, the French Tunnelling and Underground Space Association, recently launched a similar initiative: "Ville10D", a national R&D project focused on underground development of the sustainable city, supported by the Ministry of Ecology, Sustainable Development and Energy (<http://www.ville10d.fr>).



## **6. *Begin in-depth examination of the development of multimodal underground freight to reduce traffic density in the city.***

Demographic growth is causing a considerable increase in needs for supplies of goods and property -- a trend that international organizations involved in the climate agenda are well aware of. In the framework of their road map for COP21, several UN branches are studying means of helping cities adjust to climate disruptions and evolve towards a more sustainable way of functioning. The Global Green Freight Action Plan, launched by the Climate and Clean Air Coalition and supported by the UN Environment Programme, aims to reduce carbon emissions produced by freight. It is a subject familiar to ITA-AITES and its committee ITACUS, which is working intensely to raise European Parliament members' awareness of the underground multimodal freight system with the aim of reducing the density of freight traffic in urban zones. Recently, European deputy Wim Van der Camp stated that he is in favour of this initiative. He is currently preparing a parliamentary motion that will call on the Member States of the European Union to examine these solutions. **One of the solutions the ITACUS committee will launch in 2016 is the CargoCheck project, which will enable cities and port authorities to find out about the opportunities underground multimodal freight offers.**

## **7. *Join 100 Resilient Cities, an initiative pioneered by the Rockefeller Foundation, to raise public authorities' awareness of the risk of floods and earthquakes.***

Urban resilience, one of the major challenges faced by cities today, is one of the main issues ITA-AITES works on. The International Tunnelling and Underground Space Association is a partner in the 100 Resilient Cities initiative supported by the Rockefeller Foundation. A commitment that will involve forming a mixed working group made up of tunnel engineers and public authorities in 2016. The ITA Committee for Underground Space is currently engaged in discussions with Rotterdam to begin the process with the city's authorities. The working group will focus on studying the possibilities of deploying urban water drainage networks and underground space beneath cities in the wake of earthquakes.

# APPENDIX:

## LIST OF ITA-AITES MEMBER NATIONS IN 2015

Algeria	France	Poland
Argentina	Germany	Portugal
Australia	Greece	Qatar
Austria	Guatemala	Romania
Azerbaijan	Hungary	Russia
Belarus	Iceland	Saudi Arabia
Belgium	India	Serbia
Boutan	Indonesia	Singapore
Bolivia	Iran	Slovakia
Bosnia and Herzegovina	Israel	Slovenia
Brazil	Italy	South Africa
Bulgaria	Japan	Spain
Cambodia	Kazakhstan	Sweden
Canada	Korea	Switzerland
Chile	Laos	Thailand
China	Lesotho	Netherlands
Colombia	Macedonia	Turkey
Costa-Rica	Malaysia	Ukraine
Croatia	Mexico	United Arab Emirates
Czech Republic	Montenegro	United Kingdom
Denmark	Morocco	United States of America
Ecuador	Myanmar	Venezuela
Egypt	Nepal	Vietnam
Finland	Norway	
	Panama	
	Peru	



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