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TUNNELING & UNDERGROUND CONSTRUCTION
THE OFFICIAL PUBLICATION OF UCA OF SME WWW.TUCMAGAZINE.COM VOLUME 2 NO 1 MARCH 2008

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COVER STORY

CONTENTS — The 39-km (24-mile) East-Link project in Melbourne will include twin three-lane tunnels, designed to avoid building a motorway through an environmentally sensitive area. Project plans are discussed on page 28. The 2008 George A. Fox conference attracted a record crowd. There's a lot going on along the United States' Eastern Seaboard, page 38.

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FEATURE ARTICLES

DEPARTMENTS

CHAIRMAN'S COLUMN

Underground construction deserves recognition

Passing of Bob Pond leaves a void

The underground business is a good name for what we do so well — out of sight and out of most everyone's mind. Every day, day in and day out, we quietly put another completed $100 million underground project notch in our belts and turn the facility over to its owners to start operations.

On any given day, we can name tens of tunnel projects proceeding without unexpected problems, through some of the most difficult conditions we can find to build. No one stops to say, "Hey wait, what are they thinking? That's too hard. We're not going to bid it. We're not going to build it."

The jobs get bid, despite the conditions, and the projects get built.

Tunnels and the community responsible for building them need to be recognized. And not just for the successful completion of the tunnel or our next proposal qualifications.

We should brag about our larger contributions to improving the quality of life; whether it is a water tunnel that brings fresh water to new or existing homes or carries the waste water away for treatment before it goes into our rivers or coastlines; or a transit tunnel to send everyone home out of the weather and below the urban congestion; or a tunnel to carry cars more quickly, and out of sight, while keeping the ground surface available for more open space and sustainable development.

I was asked by *Engineering News Record* (*ENR*) whether the East Side Access Project in New York would serve as a model for future tunneling projects. But as I ran through the long list of projects nationwide that were contributing as much or more, I realized that we have grown to accept the extraordinary as mundane. We have come to take in stride the amazing feats of underground construction accomplished everyday.

ENR got it right in the recent editorial about the Central Artery Project. It is a legacy project built under challenging conditions in the soils and in the streets, one that will transform Boston by moving traffic through the city out of sight and opening the city to the waterfront with the creation of linear parks.

It does not take long for the feeling of awe to set in when running a mental calculation as I read through the array of tunneling magazines and find the number of active or pending tunneling projects totaling billions of dollars, in North America alone. The evidence is clear in the interest and record attendance at recent tunneling conferences, such as RETC 2007 in Toronto and the George A. Fox Conference in New York in January.

What is most interesting is the relatively small size of the tunneling community and the number of people responsible for the safe and successful planning, design and construction of so much infrastructure that, when completed, impacts the quality of life for millions of people. This is the story that can attract new and young people to the underground business. I sit in awe of what we do every day, so should you. I salute you.

Bob Pond's passing on Feb .18, 2008 has a created a large hole, one not to be filled in quite the same way (see story on page 9). The UCA community sends their sympathy and condolences to the Pond family.

Personally, I will miss him, his wit and good counsel.

Brenda Bohlke,
UCA of SME Chairman

Three of four TBM's at work on Brightwater project

Work on the massive Brightwater Treatment project in Kings County, WA is progressing well, with three of four tunnel boring machines (TBM) drilling on the 20-km (12.6-mile) conveyance tunnel system.

The third TBM, provided by Lovat and named Luminita, was launched from the North Creek Portal in late September.

Luminita will dig east to the Brightwater treatment plant site at the intersection of State Routes 9 and 522, where it is expected to be retrieved in November 2008. Joint venture Kenny/Shea/Traylor was awarded this part of the tunneling contract.

A TBM, named Helene, was launched from the North Kenmore Portal in mid-September and is tunneling east to the North Creek Portal, where it is expected to be retrieved in February 2009. A TBM, called Rainier, was delivered to, and assembled, at the North Kenmore Portal site in late 2007. Helene stopped production while Rainier was lowered and both machines were drilling in February 2008. Rainer will tunnel west toward the Ballinger Portal, where it is expected to be retrieved in November 2009. The joint venture of Vinci/Parsons/Frontier-Kemper is the contractor on this tunneling segment.

The fourth TBM, which has yet to be named, is expected to launch in April 2008 and dig east to the Ballinger Portal, where it is expected to be retrieved in December 2009. Jay Dee/Coluccio/Taisei has the contract to complete that portion of the tunneling.

The TBMs will dig a tunnel up to 4.8 m (16 ft) in diameter that runs from the Brightwater treatment plant's south Snohomish County location north of Woodinville to a deepwater outfall off Point Wells in Puget Sound. The tunnel, to be completed under four separate contracts. It is scheduled to be completed by fall 2010 at a construction cost of approximately $450 million.

The Brightwater system, most recently estimated to cost $1.7 billion, will treat wastewater from about 250,000 homes and businesses in north King and south Snohomish counties. Its conveyance tunnel will have the dual purpose of connecting existing sewage-collection pipes to the treatment plant and also conveying treated wastewater from the plant to the outfall in Puget Sound. ■

Federal Transit Authority to fund two rail projects

A light-rail extension project in Denver, CO is one of two new rail projects that will get major federal multi-year funding, Federal Transit Administration (FTA) officials said.

Seattle's $1.8 billion light-rail extension is the only other new transit project in the country in line for a full-funding grant.

The FTA said Denver's Regional Transportation District (RTD) will receive $60 million in federal money for the West Corridor project in the government's fiscal 2009 budget.

The total cost of the 19 km (12.1-mile) West Corridor line has climbed to $656.8 million, in part because of a rise in construction costs.

The federal funds are expected to cover about 44 percent of the West line's total price.

The 2009 grant is part of an anticipated total of $290.6 million in federal money that will come to the FasTracks project if FTA completes a Full Funding Grant Agreement with RTD later this year.

FTA Deputy Administrator Sherry Little said her agency is aware of "cost escalation" in the West Corridor light-rail budget.

The West Corridor is the first of six new rail lines that will be built as part of RTD's $6.1 billion FasTracks transit expansion.

FTA pledged $100 million to Seattle's light rail extension project this year.

Sound Transit broke ground on Link light rail in November 2003. When completed in 2009, Link will run from downtown Seattle to Sea-Tac Airport. By 2020, this line is expected to carry more than 45,000 riders each day.

Opening first, will be a 22.5-km (14-mile) segment from Westlake Station in the Downtown Seattle Transit Tunnel to the Tukwila/International Blvd. Station, next to SR 518 and just north of Sea-Tac Airport. This initial segment also serves Seattle's SODO industrial area, Beacon Hill and Rainier Valley. Sound Transit is working with the Port of Seattle on the 2.7-km (1.7-mile) extension from Tukwila to the Sea-Tac Airport, called Airport Link.

Little also announced funding for 16 smaller transit projects across the nation. ■

Bechtel and Parsons agree to Big Dig settlement

Bechtel Infrastructure Corp. and Parsons Brinckeroff, the two companies that formed a joint venture that managed the design and construction of the Big Dig project in Boston, MA, reached an agreement that settles claims by the Commonwealth of Massachusetts and the U.S. Attorney for the District of Massachusetts in regards to the work done on the 17-year, $15- billion project.

Together, the companies will pay $407 million for mistakes that included use of defective concrete, numerous leaks in tunnels and the collapse of a ceiling tile in a tunnel on I-90 that killed motorist Milena Del Valle. Bechtel will pay $352 million toward the settlement and Parsons Brinckeroff will pay $47,230,500. An additional $51 million in the settlement will be paid by section design consultants who allegedly made mistakes in drawing up construction plans for various parts of the project. Most of the settlement money will be held in an interest-bearing account to pay for future Big Dig maintenance. It will not be directly returned to taxpayers.

John MacDonald, chairman of the Bechtel/Parsons Brinckeroff joint venture issued a statement at read, "We have reached a full and final settlement of claims by the Commonwealth of Massachusetts and the U.S. Attorney for the District of Massachusetts. Protracted legal proceedings would have served no one well, and we believe that this resolution is in the interests of all concerned.

"We have always said that we take responsibility for our work. We understand and acknowledge with this resolution that our performance did not meet our commitment to the public or our own expectations. Above all, we deeply regret the tragic death of Milena Del Valle in the I-90 tunnel," McDonald said.

"Our companies have a long history of delivering safe, high-quality engineering and construction services. Our willingness to scrutinize our own performance and learn from experience has been a major factor in our success. Going forward, we will implement a number of specific measures to apply lessons learned to our future work, such as improving quality management systems, more extensive and mandatory training for field engineers, and additional standardized specifications for design and construction. The Boston Central Artery/Tunnel project remains one of this country's most remarkable infrastructure achievements. It will serve the people of Massachusetts well into the next century."

Massachusetts Attorney General Martha Coakley said, "This is the best possible resolution at this time. I don't say it is perfect, but it is the best resolution. Justice was done."

The agreement, signed by Coakley and U.S. Attorney Michael Sullivan, absolves Bechtel/Parsons Brinckerhoff of future liability for the project, barring a catastrophic event. The agreement states the company could be compelled to pay for any future incident that costs more than $50 million. The joint-venture's liability for such incidents would be capped at $100 million.

The Big Dig project is widely considered one of the country's most remarkable engineering feats. It replaced an elevated highway that ran through Boston with underground tunnels that have changed the Boston landscape and made tremendous traffic improvements. It connects the city's downtown area with the historic harbor and created a network of parks along the way. However, the project took 17 years to complete and the price tag ballooned from $2.6 billion to nearly $15 billion.

Under the agreement terms, Bechtel and Parsons Brinckerhoff can still be held liable for any catastrophic events that cause more than $50 million in damages during the next decade.

The companies must also conduct an investigation and tell the federal and state governments if it reveals any construction defects that could lead to something as serious as the 2006 collapse. ■

NAT 2008 heads to San Francisco

The biannual North American Tunneling (NAT) Conference is scheduled for June 7-11 at the Hyatt Regency in San Francisco, CA.

This UCA of SME Conference will feature a full agenda of professional programming as well as a robust exhibit floor with 60 exhibitors committed.

The UCA of SME presented the most recent NAT in Chicago in 2006.

More than 570 underground professionals attended the conference and 86 exhibitors were there.

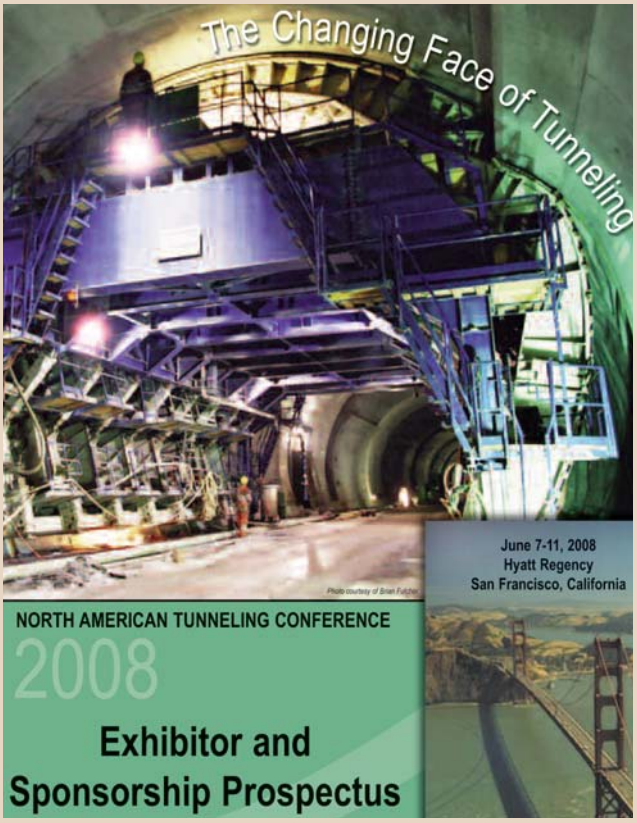
The theme of this years' conference is "The Changing Face of Tunneling."

The 2008 conference will feature four tracks covering technologies, design, project planning and implementation and case histories.

More than 50 topics will be discussed during three days of presentations, making it an important conference for any tunneling and underground construction professional.

In addition to the array of topic discussed, everything from air locks and bulk heads to winches will be on display of the exhibit floor during the three-day conference.

Registration for the conference is open and registration forms are available online at www.smenet.org, or by calling SME Meetings at 303-948-4234 or 800-763-3132. Check the SME Web site for conference updates. ■



Tunnel waterproofing and shotcrete symposium set for May

The UCA of SME, in conjunction with Sika Corp. and the International Tunnelling and Underground Space Association, will host a tunnel waterproofing and shotcrete symposium on May 5 at the Hilton Newark Penn Station Gateway Center/Raymond Blvd., in Newark NJ.

This symposium will feature an outstanding group of presenters. The goal of the symposium is to provide attendees lessons learned from recent projects.

Among the topics that are scheduled to be discussed will include the Trans Hudson Expressway (THE) Tunnel project and basics of shotcrete and a case study of shotcrete and waterproofing from the Beacon Hill project. On Feb. 6, a field trip will be offered.

Registration for the conference is open and registration forms are available online at www.smenet.org, or by calling SME Meetings at 303-948-4234 or 800-763-3132. Check the SME Web site for conference updates. ■

Bob Pond was an industry icon

The tunneling and underground construction industry lost an icon when Bob Pond, known to many as Sweet Old Bob, died as a result of cardiac failure.

Pond retired from Frontier-Kemper at the end of 2007. He had worked with that company for more than 37 years.

"Bob was known as a progressive thinker – someone that those with less experience would call upon for advice when faced with challenging projects or unique circumstances. Known equally well for his unique brand of humor and his quick wit, it is safe to say that we will miss the many laughs and insights that Bob bestowed upon us during his many years of service. Those of us that knew Bob will miss him dearly," said Frontier-Kemper.

Prior to joining Frontier-Kemper, Pond was a partner in Hardrock Contractors where he was a miner who progressed to foreman with Climax Molybdenum Company. He was also an engineer with Homestake Mining Company and a whipping boy for Bill Gianetto, the last of the old-time tunnel men. Pond also designed and sold rock drilling machinery for Denver Air Machinery.

In 1971, Pond joined Kemper Construction Company of Los Angeles as a tunnel superintendent and in 1972 become project manager on the Gathright Dam Cut-Off Wall project in Virginia for the joint venture of Kemper and Frontier. Subsequently, and with the formation of Frontier-Kemper, as eastern regional manager, Pond managed the construction of coal mine shafts and slopes in the Appalachian Region until he was promoted to headquarters as mining group general manager in 1978.

In 1989, Pond was promoted to vice president and in 1993 to executive vice president. He was elected as a director in 1994.

Pond was an officer of several related corporations. He was a 38-year member of SME and was a Mole and a Beaver.

Pond served for several years on the board of visitors for the Colorado School of Mines Mining Engineering Department. He served for 12 years as a director of the American Underground Construction Association, and was on the first board of its successor, the UCA of SME. He served a term as president of the American Society of Civil Engineers Construction Institute. He was chairman of the 1995 Rapid Excavation & Tunneling Conference (RETC). He was an experienced arbitrator and served on the Construction Industry Panel for the American Arbitration Association. He was a Life Member and

long time Advisory Council Member of the National Sporting Clays Association and a Life Member of the National Rifle Association.

Bob was married for 34 years to "The Prize in My Crackerjacks," Peggy. Their blended family of four girls and three boys produced 14 grandkids, two great-grandkids, a dog and two cats. ■

U.S. House passes national tunnel inspection program

U.S. House lawmakers approved a national highway tunnel inspection program aimed at preventing tragedies such as the Big Dig's fatal ceiling collapse in Boston, MA, (see story page 7), the *Associated Press* reported.

In its report last year on the 2006 Big Dig ceiling collapse, the National Transportation Safety Board called for a mandatory federal tunnel inspection program similar to the one already used for the nation's bridges.

There are no national standards for tunnel inspections.

Massachusetts Congressman Michael Capuano, a member of the House Transportation and Infrastructure Committee, led the effort on Capitol Hill for the measure.

"Clearly, this level of scrutiny was not enough in Massachusetts and more must be done to ensure the safety of the traveling public. There is no question that national standards should exist for the inspection of all highway tunnels," said Capuano in a statement on his Web site. ■

CALL FOR PAPERS

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INTRODUCTION

RETC is the premier international forum for the exchange and dissemination of developments and advances in underground construction. RETC provides innovative solutions to the unique challenges associated with the tunneling industry.

Since the first conference in 1972, RETC has been recognized as the premier international tunneling conference for contractors and engineers. Conference attendance exceeds 1,000 professionals from more than 30 countries. Industry sectors include: construction, mining, geotechnical engineering, exploration, environmental, economics, manufacturing, government, land, water/wastewater, and transportation.

CALL FOR PAPERS

The 2009 RETC Organizing Committee has issued a Call for Papers. Prospective authors should submit the following by June 15, 2008:

- Abstract of 100 words.
- Contact author, address, phone, fax, and email
- Please indicate project name.

The ideal paper presents an interesting or unique challenge and the solution or outcome of that challenge.

TOPICS

- Contracting Practices
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- Ground Support and Tunnel Linings
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- NATM Tunnels
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- TBM Case Histories
- Water and Gas Control

Additional topics of interest will be considered.

FORWARD TO:

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Authors will be notified of acceptance by September, 2008. Final manuscripts from accepted authors are due January 15, 2009. Manuscripts are mandatory for inclusion in the program and will be included in the proceedings volume distributed on-site to all full registrants.

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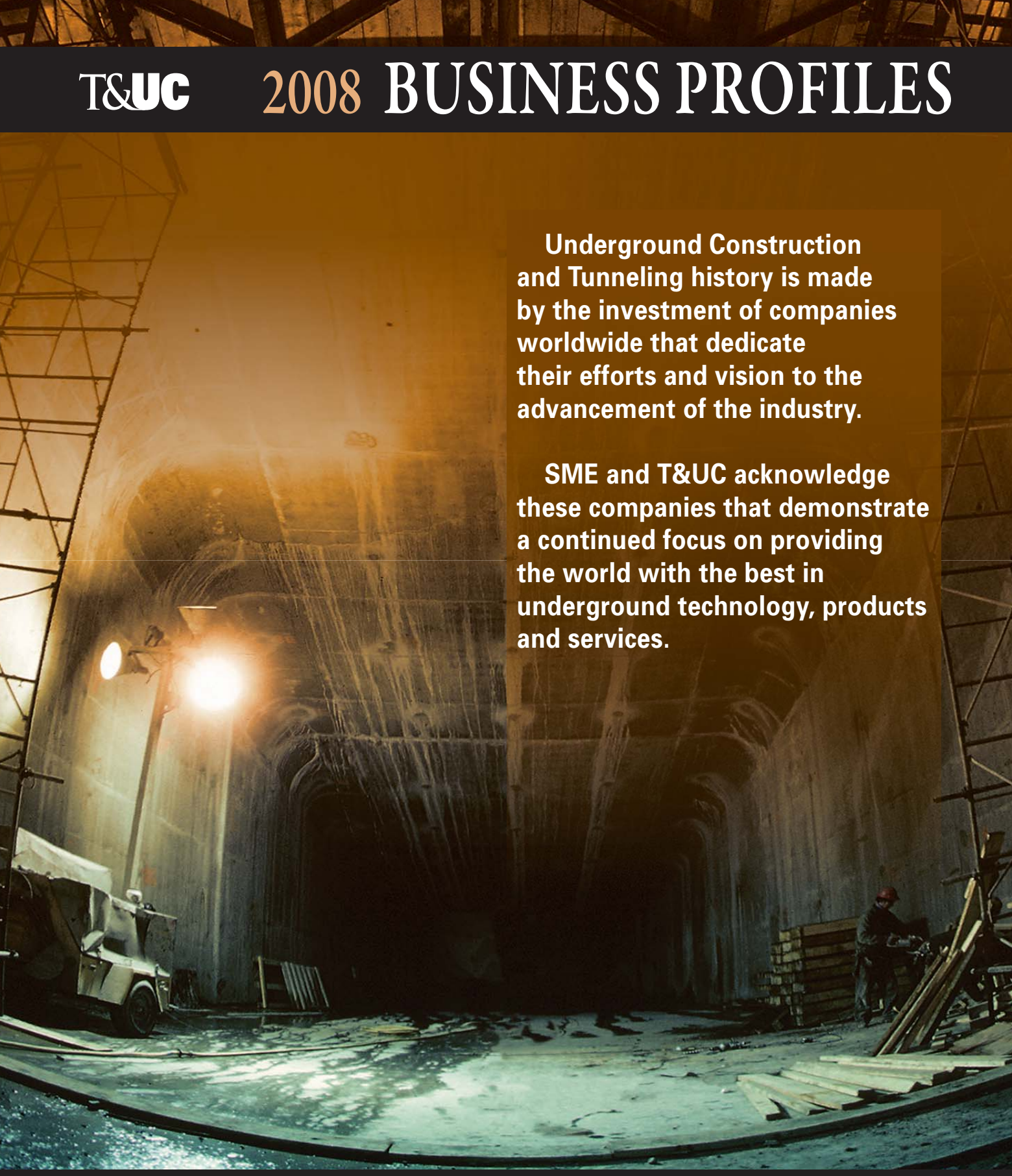

Underground Construction and Tunneling history is made by the investment of companies worldwide that dedicate their efforts and vision to the advancement of the industry.

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Hayward Baker has worked on hundreds of tunneling projects and has the right tools and experience for yours.

Seattle, WA
Brightwater Conveyance System (right)

Construction of the Brightwater Conveyance System required surgical jet grouting to facilitate tunneling operations. Utilizing their proprietary jet grouting equipment, Hayward Baker created soilcrete blocks outside of four deep vertical shafts to assist with both TBM and handmined tunneling operations. The ground improvements allowed TBMs to be launched or received into and out of the shafts without the risk of water and ground run-in. Overlapping columns to depths up to 94-feet compose the soilcrete blocks.

Los Angeles, CA
Lower North Outfall Sewer Rehabilitation Project (far right)

Rehabilitation of the 82-year-old Lower North Outfall Sewer included grouting around the outside of the tunnel to densify and strengthen the soil above the tunnel in order to protect the overlying structures from settlement. Hayward Baker performed permeation and fracture grouting through over 3,500 holes from within the tunnel, stabilizing the overlying structures. State-of-the-art survey technology and proprietary grouting instrumentation allowed Hayward Baker to first probe the soil to determine existing conditions, and then observe the soil response during grouting while monitoring the ground surface in real time.

Los Angeles, CA
East Central (ECIS) & North East (NEIS) Interceptor Sewer Tunneling Projects

Extensive tunneling operations for ECIS and NEIS required numerous ground modifications. Hayward Baker provided chemical grouting and microfine cement

Brightwater Conveyance System

grouting for four shaft break-ins, five major freeway over-crossings, 27 manhole connections, and six major or sensitive utility crossings as well as for a major siphon structure and hand-mined access shaft, founded in silty soils containing less than 35% fines.

Other ground modification included locating and filling an abandoned water tunnel, and compaction grouting.

Los Angeles, CA
Metro Gold Line C800 (below)

Construction of twin subway tunnels for the LA Metro's Gold Line would cause ground loss, endangering overlying structures unless the soils surrounding the tunneling zone were treated prior to excavation. Using conventional horizontal drilling to install steel and PVC sleeve port grout pipes, Hayward Baker performed chemical grouting to stabilize soils and soilfrac compensation grouting to protect overlying structures. Heave and settlements were monitored by exterior remote robotic total stations and interior wireless tiltmeters.


Metro Gold Line

St. Louis, MO
Baumgartner Tunnel Alignment

Water-bearing rock formations in the path of the Baumgartner Tunnel Alignment needed to be sealed. Unsafe levels of hydrogen sulfide forced the grouting to be performed from the surface in advance of the tunneling operation. Hayward Baker drilled and grouted the water-bearing rock formations along a 1,200-ft long segment of the proposed 20,000-ft long, 12-ft diameter combined sewer tunnel. A total of 40,000-feet of grout holes were drilled to complete the project. Depths of the drill holes were approximately 170-ft from ground surface.


Lower North Outfall Sewer

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Since 1920 American Commercial Inc. has been known for its Rib Steel, Liner Plates and Lattice Girders as they apply to shafts and tunnels. We have worked or are currently working in most U.S. states and have supplied our products to other countries on six continents.

In 1998 the owners of ACI at the time had a vision to form an equipment division, which now brings to the table several different products from various alliance partners from around the world. We also formed relationships with several different Alliance partners to market and distribute their products in North America, still with our focus on tunnels and shafts.

Today, however, we are highlighting Wirth and their shaft sinking equipment. We have represented Wirth for 9 years now, and have been very successful with their series of Pile Top Drilling Rigs for use on shore and off shore. To date there have been more than 15 rigs placed in North America and more than 25 projects completed using the Wirth RCD (Reverse Circulation Drilling) method for drilling holes in hard rock.

Wirth GMBH is located in Erkelenz Germany and is a 110-year-old company that is known around the World for their Shaft Sinking Equipment. They produce equipment for drilling on shore and off shore, with small diameters (4 to 6 inches) for core drilling or exploration drilling, to large diameter drilling (up to 23 feet off shore and up to 31 feet on shore).

During the summer of 2007, Wirth, ACI and Frontier Kemper entered into a joint venture agreement to build a Blind Shaft Boring machine for FK, for use in mechanically sinking large, deep shafts, for use in the Coal Mines as well as other applications. This machine will incorporate the RCD technique, which allows for a relatively small amount of air to bring all of the rock cuttings to the surface very easily, quickly, and economically.

Frontier Kemper has done some smaller diameter Blind Boring in the past, but most of their shafts have been constructed using the Raise Bore method, or conventional drill and blast methods.

Wirth is providing assistance and equipment to update and modify existing FK equipment that will allow drilling diameters of 8' to depths of roughly 1,000', plus assisting with a design and the fabrication of a new rig that will allow for drilling diameters up to 16' to depths of roughly 1,300' in hard rock. Equipment from Wirth is in various stages of manufacture; some has already been delivered and FK is expecting for the first of many shafts to be drilled late in the first quarter of 2008.

Wirth and FK are also in the planning stages to build another rig together. This one will be capable of drilling into the 26' diameter range x 1,000' deep, or smaller diameters like 21' into the 1500' depth range. Cutters, multi-diameter staged cutting heads, spares, and technical assistance will all be supplied by Wirth and ACI, over and above the orders in motion, to support the cooperative agreement entered into by this team.

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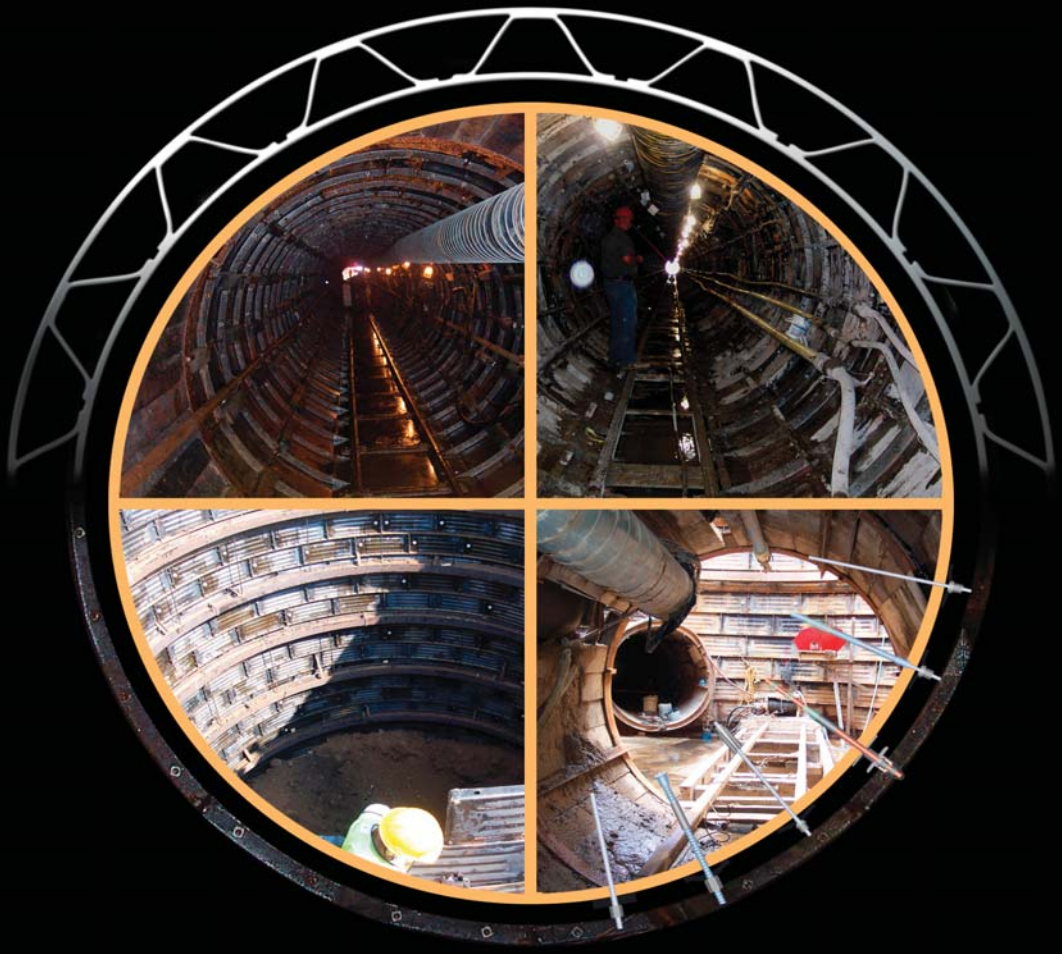

American Commercial offers a complete selection of ground control solutions. Beginning with steel liner plates installed in the Gratiot Avenue sewer system in Detroit, Michigan in 1920, we are today the leading designers and manufacturers of underground steel supports in North America. The first solid, square-cornered tunnel liner plates were designed and patented by American Commercial in 1926 for use in the pioneer bore of the Moffat Tunnel in Colorado. Our experience in the art of tunneling spans over seventy-five years and thousands of projects, great and small, on six continents.

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Wholesale Mine Supply Playing Role in Landmark Pittsburgh Tunneling Project

City's "T" train line extension would travel beneath Allegheny River to connect Downtown to PNC Park and Heinz Field

Leading industrial communications provider Wholesale Mine Supply and its division, HC Global, are working on a joint venture with Gomez Tunneling and world tunneling expert Rick Gomez to provide two-way radio communications to the tunneling project that will extend Pittsburgh's "T" rail line under the Allegheny River and connect the city's downtown region with Heinz Field and PNC Park.

WMS President Bill Hensler said he saw an opportunity in the tunneling environment that was similar to what it was already doing with much success for the underground mining market.

"We are the world leader in underground mining communications, with 85 systems in mines across the United States," said Hensler. "We have system in tunneling jobs across the USA in sites in Seattle, at the Hoover Dam, and in Cleveland, Pittsburgh and Nashville, just to name a few."

The VARIS leaky feeder network system planned for the project will be the first in the world to communicate to a tunnel boring machine located under ground and provide both leaky feeder communications and Ethernet capabilities over the same cable. The system will also provide two-way radio communications to both the underground and surface areas of the job site.

"Using our VARIS leaky feeder network with Ethernet, we are able to communicate from Pittsburgh to Germany so the engineers in Germany can see the machines operating Navigation System and control the machine," said Hensler.

Hensler said that WMS and HC Global, who seek to be a complete turnkey communications provider to the international tunneling industry – much like the industry-leading position it currently holds in mining – will provide their own brand of American Radio Communications (ARC) that have been modified specifically for the project to be both waterproof and provide the utmost in effectiveness within extreme conditions.

"Alan Quinn was our system designer on this site and did a great job of working with the TBM provider and onsite personnel to link everybody together," Hensler said of the project, which is set for completion in 2010.

WMS's VARIS/Becker systems have several safety-and production-enhancing benefits, including the use of a single cable to distribute wired or wireless voice, video, and data signals to an underground work force and equipment, miner tracking using RFID tags and interrogators, and easy maintenance and expansion.

Wholesale Mine Supply, based in North Huntingon, Pennsylvania, is a leading communications provider for the tunneling and underground mining industries and the largest supplier of two-way underground communications. It has more than 85 systems in American mines alone and 25 years of experience in the servicing of mining and tunneling.

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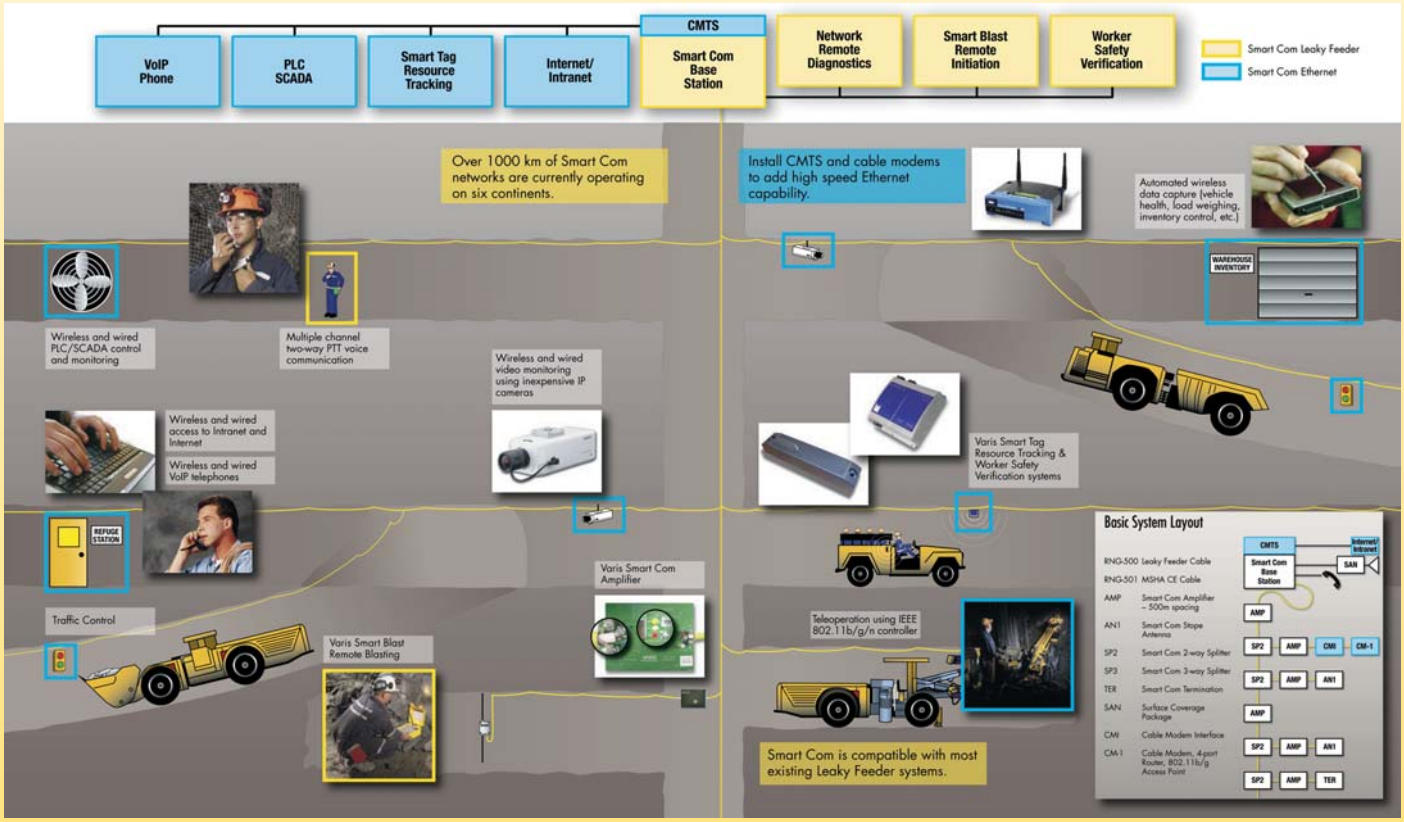

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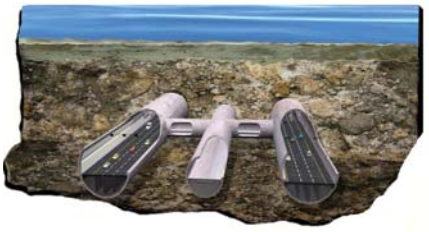
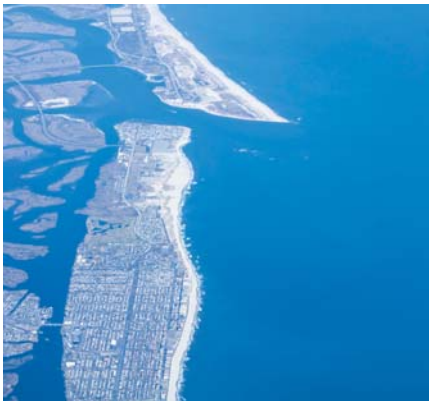
Hatch Mott MacDonald's Tunneling Expertise Drives Plans for the World's Longest Highway Tunnel

Hatch Mott MacDonald is the design engineer for a private consortium led by Polimeni International, NY, which proposes to plan, design, build, operate, and maintain the Cross Sound Link Tunnel© in New York. Extending from Syosset, Nassau County to Rye, Westchester County beneath Long Island Sound, the tunnel would provide a direct route between Westchester and Long Island that would ease the congested circuitous routes used today. The privately financed tunnel would be approximately 18 miles in length, making it the world's longest highway tunnel.



The tunnel configuration would consist of two outer unidirectional bores each conveying three lanes of traffic, and a central maintenance bore that would provide emergency ventilation and egress. The New York tunnel is forecast to carry between 59,000 and 79,000 vehicles per day when completed in 2025. By reducing travel distances and times, the tunnel is estimated to save more than 24 million gallons of gasoline per year, thereby significantly reducing CO_2 emissions.



The Cross Sound Link Tunnel would draw from Hatch Mott MacDonald's worldwide experience with large diameter transportation and subaqueous tunnels, including the Channel Tunnel, St. Clair River Tunnel, Storebaelt Tunnels, and the recent Stormwater Management and Road Tunnel (SMART). "HMM prides itself on progress and innovation," says Randy Essex, Hatch Mott MacDonald's Director of Tunneling, "We firmly believe the Cross Sound Link Tunnel will provide a long-term, sustainable and positive benefit to the region's traffic congestion, while enhancing the region's air quality."

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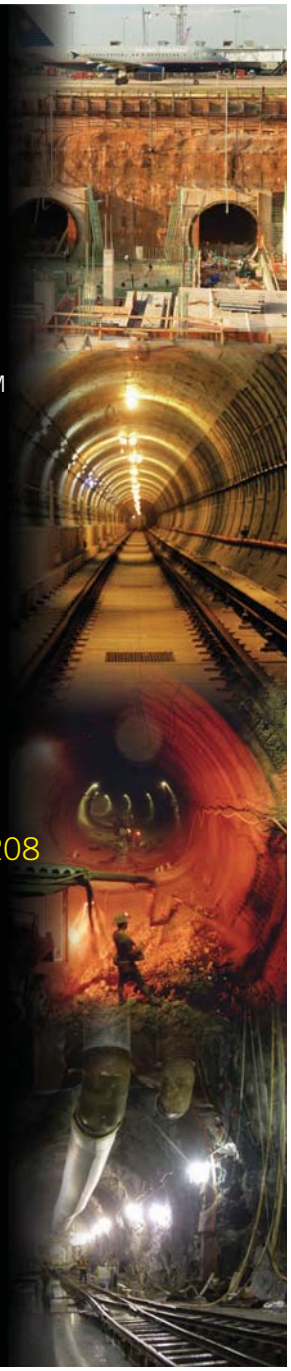

New Geofoam SP – Pervious Cellular Concrete

Use of cellular lightweight concrete continues to increase worldwide. New products from the Innovations Lab of Cellular Concrete LLC are helping to drive this powerful trend, including the introduction of Geofoam SP, a synthetic foaming agent for producing pervious cellular lightweight concrete, which helps developers, specifiers, and project owners to economically meet the goals and demands of sustainable, effective land use.

Geofoam SP produces an engineered, permeable, open-cell lightweight concrete, able to stabilize soil without disturbing or redirecting natural water flow. Geofoam SP pervious cellular lightweight concrete provides proven geotechnical solutions for fields and golf courses, parking lots, roads and runways, pipe and conduit bedding, and retaining wall backfill applications requiring drainage capacities exceeding those obtainable from compacted soil or controlled low strength material (CLSM).

Environmental Performance Advantages

Geofoam SP pervious cellular lightweight concrete is environmentally safe, has no flash point, and support sustainable development.

Testing by Middle Tennessee State University documents the ability of Geofoam SP pervious cellular lightweight concrete to enhance the environment by filtering contaminants that can adversely affect soil and water. Various chemicals and solids were placed on Geofoam SP pervious cellular lightweight concrete and then rinsed with increasing amounts of water (0.5 inches to 30.0 inches) over a given surface area. Test results showed Geofoam SP pervious cellular lightweight concrete filtered 78% of the hydrocarbons and heavy metals. When the Geofoam SP pervious cellular lightweight concrete was tested for oil retention, 97% of the oil remained on the pervious cellular lightweight concrete test specimen.

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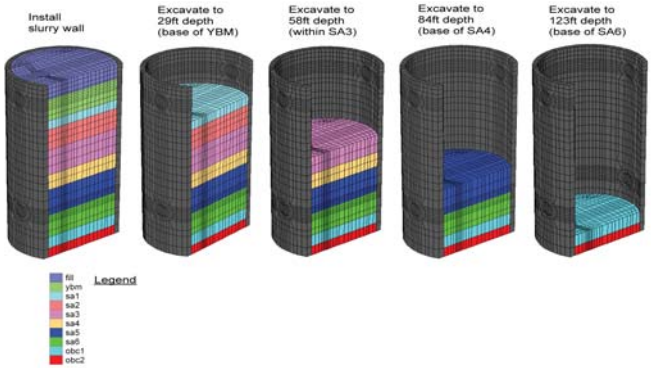

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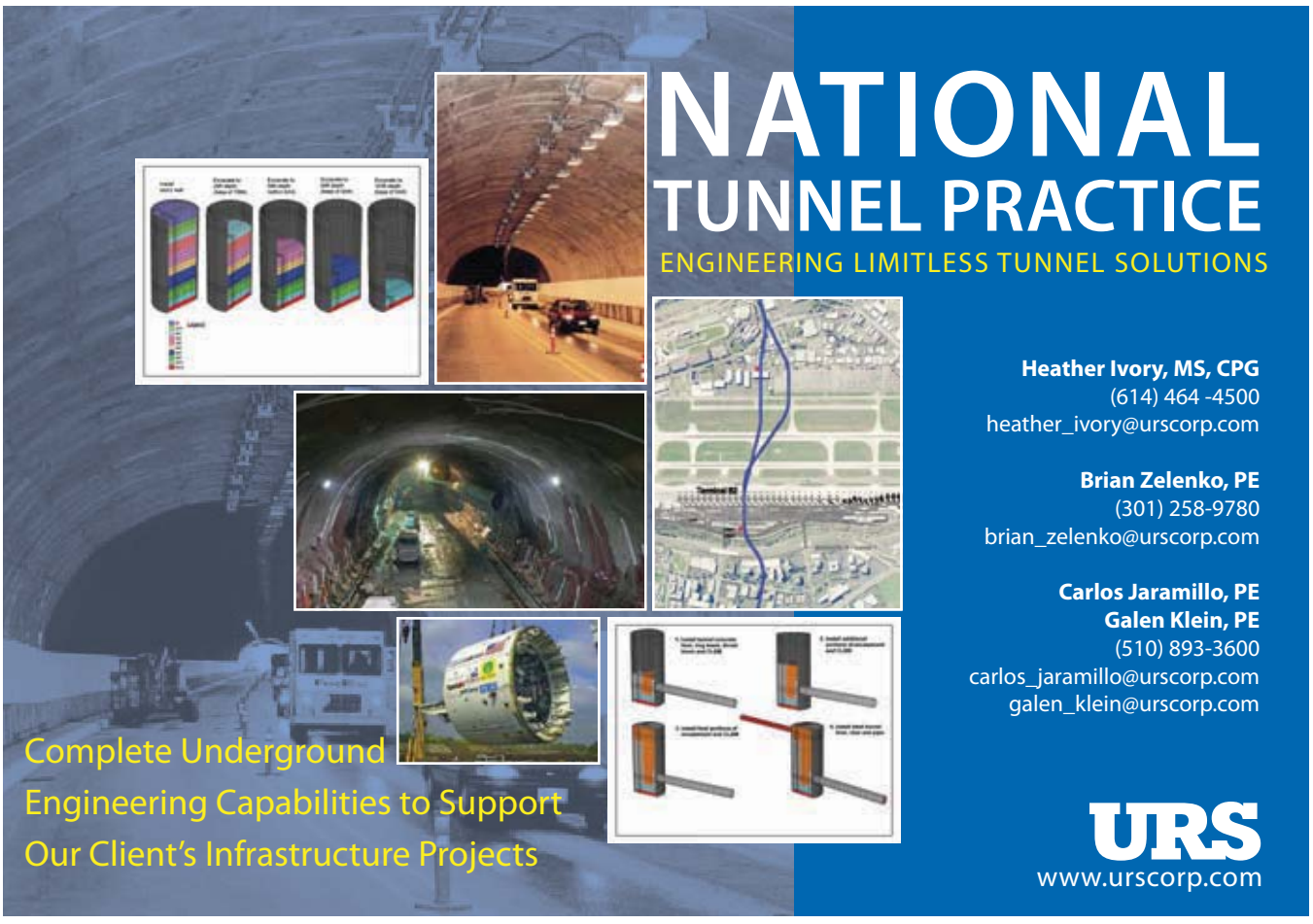

Jennmar Corporation Announcement of Major Expansions

Frank Calandra Jr.
President

Major expansion plans of Jennmar Corporation were completed August 30, 2007, which included a new subsidiary, Jennmar Corporation of West Kentucky Inc. and Metal Corrugated Products, a division of Jennmar Corporation of Virginia.

The manufacturing plant, Jennmar of West Kentucky, is located in Earlington, Hopkins County, KY. The plant, approximately 60,000 sq. ft., will manufacture a complete product line used in ground support for the coal industry, which will compliment the growing sales territory of the mid-western coal fields.

Also, included in the 30 acre tract another state of the art resin capsule manufacturing plant has been started, approximately 55,000 sq. ft, and will be completed by March 2008. Salary personnel and hourly labor are being initiated in all of the completed projects, and J-Lok Corp. will be the name of the company in West Kentucky.

In Pounding Mill, VA, a 60,000 sq. ft. plant was completed August 30, 2007 to accommodate corrugated galvanized steel pipe, fabricated arches and other steel beam products.

Overseas, Jennmar Australia has moved to larger facilities both at the Queensland and Sydney locations. Jennmar Jining, also announced additional investment concerning added equipment and plant expansion, which was completed October 2007.

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Underground Inelligence with Brierley Associates

Brierley Associates was formed in March, 1999 when Gary Brierley founded the company with Gregg Sherry. In 2001, Alan Howard and Jim Smith joined the firm as partners. "When we formed the company we adopted the business philosophy that to create space underground you had to be innovative," says Sherry, a professional engineer and an MBA. "What sets us apart is our experience" says Smith. "The experience gained by working on all aspects of tunnel design and construction management allows us to better assist our clients," says Howard, the engineering geologist. "The key to success in tunneling is to understand ground behavior," says Brierley. "If you know how the ground will behave and how it will interact with construction methods, then you've accomplished 90 percent of a successful project."

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Jacobs Associates and the History of Bay Area Rapid Transit (BART)

If you plan on attending NAT 2008, the San Francisco Bay Area's diverse neighborhoods may tempt you to venture onto BART. This renowned mass transit system links downtown San Francisco to the East Bay, SFO Airport, and many places in between.

Engineering and construction of BART (from 1963 to 1972) forms a significant part of the history of Jacobs Associates. This engineering consulting firm, incorporated in 1956, still maintains its headquarters in San Francisco. During the planning of BART, Jacobs Associates performed several estimating and feasibility studies for designers. Later, contractors retained Jacobs Associates for support-of-excavation design on many underground stations. In fact, during BART's construction, Jacobs Associates developed several cut-and-cover techniques still used today. Learn more at www.bart.gov.

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Image Courtesy of Thiess John Holland

The Australasian Tunnelling Society presents the

13th Australian Tunnelling Conference 2008

4 – 7 May 2008, Melbourne, Australia

Dear Colleagues

On behalf of the Australasian Tunnelling Society, I invite you to attend the 13th Australian Tunnelling Conference, a triennial event to be held in Melbourne in May 2008.

The present conditions in both civil infrastructure and the mining sectors are very buoyant, and are expected to remain so for some time. 2008 will be an opportune time to take stock of the underground industries in Australia, and to discuss and promote your own work and products or learn from others.

The theme of the Conference is "Engineering in a changing environment". In all underground work, we are working within environmental, technical, social and legal frameworks. All these are developing and evolving to meet the challenges and expectations of the community and our society today.

We have a wide range of topics which will stimulate thought and even create some debate in todays changing and challenging environment.

I am delighted to announce that Ken Mathers CEO of South Eastern Integrated Transport Authority (SEITA) will open the conference and provide insight into the establishment and development of major infratstructure projects. Other quest speakers include Dr Martin Herrenknecht who will discuss some of the challenges projects are presenting equipment manufacturers, and Mr John Gardiner, CEO of ConnectEast on the EastLink project.

I highly recommend this conference to all involved in tunnelling or underground construction as a must event to attend in 2008.

Melbourne and the state of Victoria, have many additional attractions (www.visitvictoria.com), providing the setting to make this conference enjoyable as well as worthwhile.

I hope to see you there.

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Email: dedwards@ausimm.com.au

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
ESA GCT Caverns Project	NYCTA (MTA)	New York	NY	Station	5,000	Various	2007	Awarded D/J JV
County Grounds Tunnel	Milwaukee MSD	Milwaukee	WI	Flood Management	2,700	17	2007	Being negotiated
Lake Mead Tunnel #3	SNWA	Las Vegas	NV	Water	15,500	20	2007	Impreg./ Healey JV low bid
Bi-County Water Tunnel	Washington Suburban Sanitary Commission	Laurel	MD	Water	28,000	10-12	2008	Prequal
Lake Mead IPS 2 Connection	Southern Nevada Water Authority	Las Vegas	NV	Water	Tunnel 600 Shaft 380	Tunnel 14, Shaft 28	2008	Final design
River Mountain Tunnel #3	Clean Water Coalition	Las Vegas	NV	Wastewater	44,000	15	2008	Design
CWC Reach 3	Clean Water Coalition	Las Vegas	NV	Wastewater	7,500	15	2008	Design
DRO-2	Detroit Water and Sewer Department	Detroit	MI	Wastewater	6,400	21	2008	Prequal
Mission Trails #1 Tunnel #2 Tunnel	SDCWA	San Diego	CA	Water	 2,000 2.,875	 11 11	 2008 2008	Advertising
New Crystal Springs Bypass Tunnel	S.F. Public Utility Commission	San Francisco	CA	Water	4,200	13	2008	Advertising June 2008
Bay Division Reliability Upgrade	S.F. Public Utility Commission	San Francisco	CA	Water	25,000	9	2008	Advertising August 2008
New Irvington	S.F. Public Utility Commission	San Francisco	CA	Water	18,200	12-13	2008	Advertising June 2008
Harbor Siphons Tunnel	NYC-DEP	New York	NY	Water	10,000	10	2008	Advertising late 2008
Port of Miami Tunnel	Florida DOT	Miami	FL	Highway	4,000	36	2008	Awarded, in negotiation
SVRT BART	Santa Clara Valley Trans. Authority	San Jose	CA	Subway	22,700 twin	20	2009	Under design
Upper Rouge River CSO North Segment South Segment	Detroit Water and Sanitation Authority	Detroit	MI	CSO sewer	 18,500 21,200	 20 32	 2009 2008	 Under design Under design
Univ. Link Light Rail Extension	Sound Transit	Seattle	WA	Rail	16,700 +		2008	Under design
Sewer replacement	Miami Dade	Miami	FL	Sewer		5	2008	Under design
Market St, Drainage Improvements	City of Charleston	Charleston	SC	Sewer	3,000	10	2008	Under design

There is an extensive list of upcoming projects in the New York City area available on the Internet at www.mta.info under the Capital Construction, Procurement link. These are projects for the NYCT, MNR, LIRR, MTACC and B&T.
For more information see http://www.mta.info/mta/capital/eotf-allagency.htm.

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
Hudson River Crossing	NJ Transit Board	New York	NY	Rail	21,600 +		2009	Under design
W. Corridor Light Rail Tunnel	Transit Authority	Denver	CO	LRT	280 x 2	18	2009	Under design
Drumanard Tunnel	Kentucky DOT	Louisville	KY	Highway	2,220 x 2	35	2010	Under design
Drumanard Tunnel - Pilot Tunnel	Kentucky DOT	Lousiville	KY	Highway	2,200	12 x 12	2008	Bid 2007 - bids rejected
New Irvington Tunnel	S.F. Public Utility Commission	San Francisco	CA	Water	18,200	10	2009	Under design
Bay Tunnel	S.F. Public Utility Commission	San Francisco	CA	Water	26,200	9	2009	Under design
Caldecott 4th Bore	CALTRANS	San Francisco	CA	Highway	5,000	50	2009	Under design
Near Surface Interceptors	Narragansett Bay Commission	Providence	RI	Sewer	19,500 11,000	3-6 3-6	2010	Preliminary design
Alum Creek Relief Sewer (1st of 3 phases)	City of Columbus	Columbus	OH	Sewer	26,000	10	2010	Under design
Water Tunnel # 3 KCT Tunnel	NYC Dept. of Envr. Protection	New York	NY	Fresh Water	24,000	20	2010	Under design
ESA Queens Tunnel	NYCTA-MTA	New York	NY	Subway	10,500	20	2008	Advertise late 2008
Corvalis to Fox Mill Water Main	Fairfax County Water Authority	Fairfax	VA	Water	8,600	8	2008	Advertise mid 2008
Lockbourne Interceptor System Tunnel	City of Columbus	Columbus	OH	Sewer	10,000	12	2009	Under design
LBJ Highway Tunnel	Texas Dept. of Transportation	Dallas	TX	Highway	5,300 x 2	60 x 35	2010	Under design
Kicking Horse Canyon Tunnel	BC Dept. of Transportation	Golden	BC	Highway	4,800 x 2	45 x 32	2010	Under design
Belmont-Southport Plant Connection	City of Indianapolis DPW	Indianapolis	IN	Sewer	29,000	12	2009	Under design
Palisaides Tunnel	NJ Transit THE Program	Newark	NJ	Subway	5,400 x 2	20	2009	Under design
Hudson River Crossing Tunnel	NJ Transit THE Program	Newark	NJ	Subway	8,000 x 2	20	2009	Under design
New York City Tunnel	NJ Transit THE Program	New York	NY	Subway	6,000 x 2	20	2010	Under design
THE 34th St. Cavern & Station	NJ Transit THE Program	New York	Ny	Subway	2,200	60 x 60	2010	Under design
Western Reg. Conveyance Tunnel	Northern KY Sanitation District # 1	Covington	KY	Sewer	36,000	13	2008-12	Under final design

The editor's of Tunneling & Underground Construction encourage UCA of SME members to submit projects to the online Tunnel Demand Forecast at www.smenet.org, log in as a member. The items will be posted on the online TDF once they are verified.

FEATURE ARTICLE

Tunneling for the EastLink project, Melbourne, Australia

Harry R. Asche, Edmund G. Taylor, P. Scott Smith, Peter Campi and Ian P. Callow

Harry R. Asche, is principal, Connell Wagner Pty. Ltd., asche@conwag.com; **Edmund G. Taylor,** is engineering manager, Thiess John Holland JV, etaylor@tjh.com.au; **P. Scott Smith,** is associate, Connell Wagner Pty. Ltd., smiths@conwag.com; **Peter Campi,** is senior geotechnical engineer, Connell Wagner Pty. Ltd., campip@conwag.com; **Ian P. Callow,** is principal hydrogeologist, Australasian Groundwater and Environmental Consultants Pty. Ltd.

The US$1.85-billion EastLink project is a 39-km (24-mile) tollway being constructed in Melbourne, Victoria, Australia. The tollway links the Eastern Freeway in the northeast of Melbourne to the Frankston Freeway in the southeast. Along the alignment, the tollway includes tunnels, 88 separate bridges, 17 major interchanges and a dedicated Shared Use Path for pedestrians and cyclists. Figure 1 shows the overall EastLink project in relation to Melbourne.

The state government of Victoria, through the agency of the Southern and Eastern Integrated Transport Authority (SEITA), has set up the project as a build, own, operate and transfer (BOOT) scheme. The successful proponent, ConnectEast is arranging financing, design and construction of the facility, maintenance and tolling.

ConnectEast has let a design and construct contract (known in the U.S. as a design-build contract) to the Thiess John Holland joint venture (TJH) as the principal contractor for the project. CW-DC Pty. Ltd., a wholly owned subsidiary of Connell Wagner, has been engaged by TJH to provide the detailed design documentation for the civil works of the northern 6 km (3.7 miles) of the project, including the twin tunnels.

The driven tunnels

The project includes twin three-lane, 1.5-km- (1-mile-) long, undrained driven tunnels built to avoid passing the motorway through the Mullum Mullum Creek Valley, to help preserve the unique flora and fauna in the area. Figure 2 shows the tunnels in plan.

The 15.8-m- (52-ft-) wide by 11.9-m- (39-ft-) high driven tunnels are excavated through ground conditions with varying strengths from 3.5 MPa to 200 MPa, through the cross bedded bands of siltstone and sandstone. The concrete secondary lining for the tunnels has been designed to carry the full hydrostatic pressure and the long term ground loads. The temporary support for the tunnel is provided by five support types of increasing stiffness, including rockbolts, shotcrete and steel sets.

FIG. 1

EastLink project in relation to the city of Melbourne.

The majority of the main heading drive for the tunnels has been excavated using roadheaders with drill-and-blast techniques used through the areas of harder rock. Excavation of the bench and invert sections used roadheaders, rock hammers and drill-and-blast techniques.

The tunnel includes several key fire life and safety aspects, including:

- A 1,200-mm (47-in.) walkway at roadway level located in front of the road side barriers.
- Egress cross passages at minimum 120 m (394 ft) centers.
- A deluge system throughout the tunnel.
- Monofilament polypropylene fibers within the concrete lining.

Excavation and temporary support procedures

Legal framework. There have been two major incidents within Australian hard-rock tunneling in recent years. The first resulted in a tragic loss of life due to a rockfall. The second involved a major collapse to the surface that severely damaged an apartment block. These incidents have highlighted the complexities of design and construct contracts with respect to safety. At the same time, Victoria's Occupational Health and Safety legislation has been recently strengthened (as has similar legislation in the other Australian states,) adding new responsibilities for designers and contractors.

In all tunnel contracts, there is a tension between the designer and the contractor with respect to safety and support. The designer must attempt to foresee the ground conditions and provide sufficient support elements for the proper support of pervasive and individual ground conditions. The contractor must implement these support systems but wishes to do so on his terms, to maximize the benefits of his own equipment and knowledge.

In a traditional contract (where the designer is employed by the principal), the designer must provide direction in situations:

- where the contractor is unsure of how to proceed safely, or
- where the designer observes that the ground response is not as expected.

Under these circumstances, the responsibility for safety and support is with the designer to provide the correct direction, and with the contractor to follow that direction.

In a design and construct contract, the designer is employed by the contractor. The designer cannot contractually direct, he may only advise. On the contractor's side, to the same extent that the contractor follows advice from the designer, the responsibility remains with the designer. However, these lines of responsibility can quickly become obscure.

In the EastLink project, the contractor (TJH) and the designer (CW-DC) have carefully set out to make the responsibility for safety and support clear between the parties. This has been achieved in the specifications and work method statements, and then in procedures. In addition to clarifying responsibility, the procedures have been designed to improve communication between all people in the tunnel with benefits for safety and progress.

The procedures included the following:

- Daily support reviews.
- Daily tunnel inspection checklists.
- Ground awareness inductions and daily tunnel face photos.
- Weekly monitoring reviews.

FIG. 2

EastLink Tunnels — plan.

Daily support reviews

Every day, or more often if required, a meeting between the designer and the contractor was held to review the support at every face and to adjust the support being installed where necessary. The fundamental principle agreed to by the parties was that an increase in support was encouraged as a unilateral decision by the face crew, but that a reduction in support required agreement from all parties at the daily support meeting.

The process was embodied in a form that acted as the agenda and record of the review meetings. At the same time, it was important that the form was easy to use and provided information clearly to all using the system, especially the construction crews at the face.

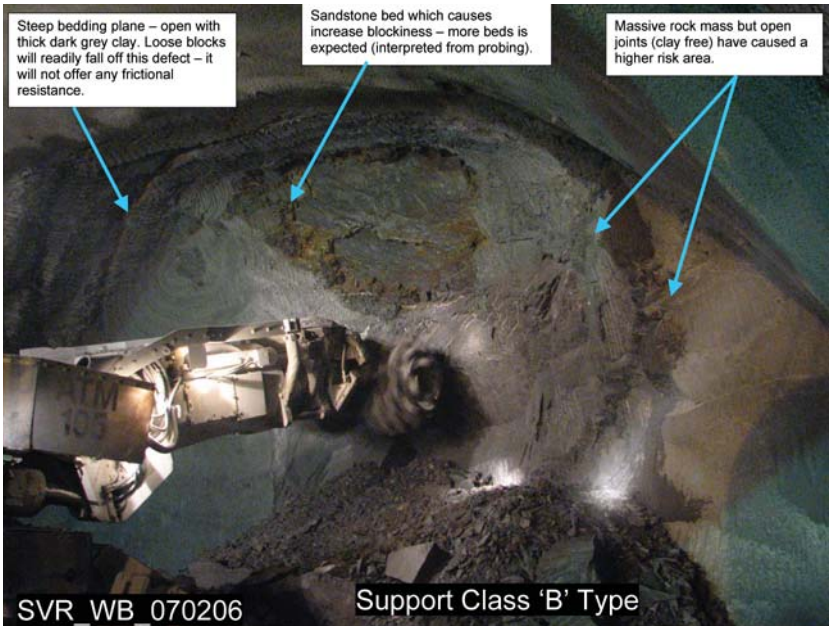
The content of the form was refined through a series of reviews between CW-DC and TJH to ensure that the form was accepted and owned by all parties. It was recognized that the form was a look ahead rather than a question and answer document recording the installed support. However, the review process included a prompt to consider the installed support in the light of the ground conditions exposed in the recent advances, as these might provide additional information on features not exposed earlier.

The form was designed to:

- Be limited to a single page.
- Record the review items listed in the project specification, reflecting the design requirements.
- Record the agreed support type as one of a standard set, with provision for noting additional requirements if needed.
- Comprise checklists that allowed for easy recording of the reviewed items by circling responses.
- Retain the flexibility to allow its use for support determination in heading, cross passage or bench.

FIG. 3

Example of annotated face photographs.



- Record the reviewers and their responsibilities in the process.

Daily tunnel inspection checklists

To assist in the implementation of the support review process and to avoid complacency during site inspections, CW-DC developed two daily checklists — the Tunnel Site Visit Checklist and the Daily Tunnel Support Review form. These checklists were a designer initiative. They formed the key designer inputs into the daily support review process, including:

- A review of the geological model.
- A review of the design documentation, showing support restrictions, monitoring requirements and information on anticipated conditions.
- A review of the lead heading support and conditions when considering the trailing heading.
- A visit to the tunnel for observation of the ground conditions and support behavior.
- A review of the monitoring data.

The checklist included a record of the pre-visit risk assessment. This comprised a review of the tunneling records or contact with senior staff of the contractor. It alerted CW-DC staff entering the tunnel to any potentially hazardous conditions or new activities in the tunnel. It also served as a briefing on the current activities and any incidents or exposed conditions since the previous visit.

The body of the form provided prompts for observing the rock conditions and support in the tunnel during the visit. These observations were recorded in a manner that matched the inputs to the daily support review. An area for sketches allowed for recording the layout of features in the face and the backs, a clearer record than a description in words.

Ground awareness induction and daily tunnel face photos

The conditions at the EastLink tunnel were different to other tunnels in Australia, and particularly different from conditions in Sydney where many of the tunnelers had recently worked. TJH requested CW-DC to provide training that dealt with the geological issues specific to these tunnels. In addition, CW-DC and TJH geologists provided daily reminders of the issues for the benefit of the workforce.

- A ground awareness induction was set up to educate the tunnel workforce. The induction session involved a video followed by a PowerPoint presentation. These sessions were aimed at inexperienced underground workers or experienced workers who had not worked in this type of ground before. Updates of these sessions were undertaken throughout the year.
- On a daily basis, annotated digital photographs were presented to the tunnelers at their toolbox meetings. The photos provided geotechnical information in areas of potential concern and an overall general description of the tunnel faces. On occasions, photographs were combined with some basic analytical information regarding potentially poor ground or likely rock wedges (Fig. 3).

Weekly monitoring reviews

Each week, all of the monitoring results were presented and discussed by the parties.

The monitoring included:

- Extensometer readings.
- Settlement arrays.
- Convergence arrays.
- Ground water monitoring bores.
- Flow measurements in Mullum Mullum Creek.

This meeting was usually attended by the external review parties representing the interests of ConnectEast and SEITA. The monitoring results confirmed the visual inspections made of the tunnels by the parties and confirmed that the construction was meeting the design expectations.

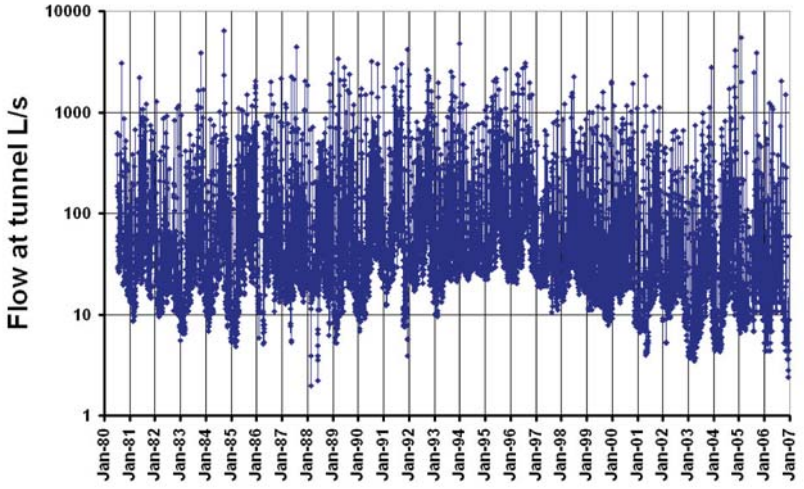
The process described above has been a success, and both tunnel headings broke through in late 2006.

Hydrogeology

The section of the project that is now constructed

FIG. 4

Mullum Mullum Creek flows.



in tunnel was the subject of an environmental impact study (EIS) in 1978, and approval was granted to build a freeway on the surface. However, in the years after the EIS was approved, public interest in maintaining the native bushland along Mullum Mullum Creek led to the construction of the road tunnels. The tunnels are, therefore, intimately linked to Mullum Mullum Creek. A key issue in the design and construction of the tunnels has been the understanding and modeling of the hydrogeology, as well as the design and implementation of the waterproofing and the secondary lining.

The tunnel alignment chosen involves a downgrade to reach acceptable cover at the creek crossing, followed by an upgrade to return to the surface. At either side of the creek crossing, the tunnel passes beneath hillsides.

At concept design stage, some issues relating to hydrogeology were not well known. Issues that have emerged and that are now better understood include:

- The hydrology and hydrogeology of Mullum Mullum Creek and how this relates to the environment.
- The ground water chemistry.
- The hydrogeological modeling of a tanked tunnel.
- Waterproofing and structural design of the secondary lining.

Hydrology and hydrogeology of Mullum Mullum Creek

Mullum Mullum Creek is a tributary of the Yarra River. Set in the slightly more hilly terrain east of Melbourne city, the creek catchment experiences an average rainfall of about 860 mm/a (34 in./year). The rainfall, like that in Australia generally, is not constant, but varies significantly each year. In addition, the temperature and the consequent evaporation characteristic varies significantly seasonally, as well as yearly.

A gauging station measuring the daily flow in Mullum Mullum Creek is located downstream of the tunnel crossing and has operated since 1980. The measurements (adjusted to account for the upstream location of the tunnel) are shown in Fig. 4, with a log scale for flows to denote the occurrence of low flows.

During December to March (summer), the rainfall is more frequently a heavy storm downpour (with higher than usual runoff) and there is an increase in evapotranspiration due to higher temperatures. As a consequence, the low flows reduce. The records show significant variation over two-and-a-half decades. The years from 1993 to 1999 were exceptionally wet, with flow never falling below 10 L/sec (2.6 gal/second), while the years from 2001 to present have been exceptionally dry, with flows falling below 5 L/sec (1.3 gal/second) in most years.

From a hydrogeological perspective, the issue is that water that may flow into the tunnel is water derived directly from the creek, or is water that may have entered the creek but which has been intercepted by the tunnel.

Mullum Mullum Creek runs through a landscape composed of Silurian rocks of the Anderson Creek Formation. This formation of interbedded mudstones and sandstones is gently folded and sheared in places. Some dykes and sills of basaltic material have been injected

FIG. 5

Hydrogeological conceptual model.

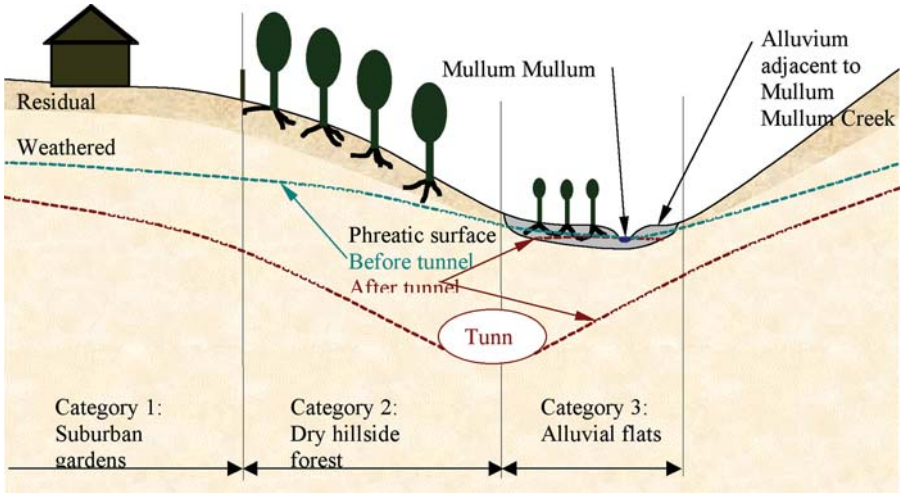
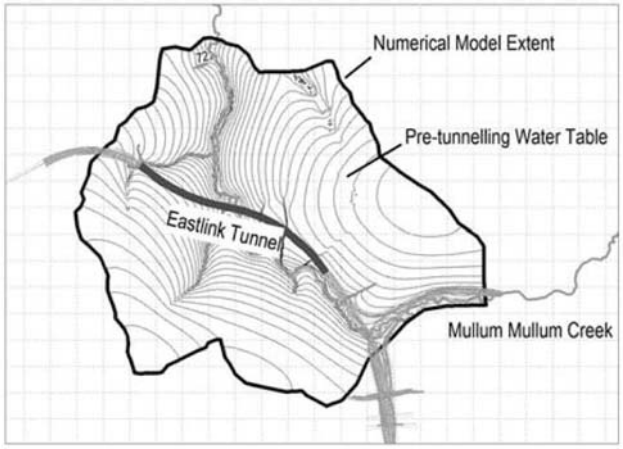


FIG. 6

Hydrogeological model — plan.



into the formation, usually at pre-existing weak zones. The rock is weathered towards the surface. At the surface, the material may have weathered to a residual soil, with some fill or colluvium also present. In the valley of Mullum Mullum Creek, there is a small pocket of alluvium up to 4 m (13 ft) deep, several meters wide. In the slopes on either side of the creek, there is a native forest, and higher up the slopes, houses sit in lots of relatively large size with gardens around each house.

Figure 5 shows a conceptual model of the hydrogeology before and during tunneling construction. Three ecosystems are identified:

- **Suburban gardens that sit high on the hillside.** The plants are fed by rain and by irrigation systems. The roots of the plants sit in the unsaturated zone, above the water table. During tunnel construction, it is expected that the water table will be pulled down to the tunnel level, but this is not expected to affect these gardens.
- **Hillside forest.** The plants are native trees that sit above the water table and derive water from the unsaturated zone. Again, it is not expected that these trees will be affected during construction. However, this ecosystem is monitored by the contractor (to date, no impact due to tunneling has been observed).
- **Alluvium at Mullum Mullum Creek.** The plants are native plants and shrubs that sit in the water table. During construction, a double phreatic surface has developed, with the alluvium recharged from the creek water. These plants are being monitored and currently show no impact due to tunneling.

Ground water chemistry

The ground water chemistry was an important driver for the project — it was a key factor in the decision to construct a fully tanked tunnel. CW-DC engaged an expert, professor Brain Cherry of Monash University, in the field of ground water attack on concrete structures. Cherry's work is discussed is summarized here. Two main points are important for tunnels in ground water.

First, to understand the ground water chemistry, it is important to sample properly. Unless special care is taken, the samples are an uncontrolled mixture of ground water from all levels of the borehole, as well as drill and flush water in the borehole. With such a sample, useful chemical analysis is impossible. Cherry (1993) describes the necessary procedures for taking a useful sample.

Second, among many components of the ground water, the effect of dissolved CO_2 can be critical for a tunnel in contact with the ground water. Two situations can be distinguished.

1. Under certain circumstances, the CO_2 can attack the concrete itself: $CaCO_3 + H_2CO_3 \rightarrow Ca(HCO_3)_2$ In addition, under the same circumstances, similar reactions will occur that can be deleterious to reinforcement.

2. In the reverse situation, the CO_2 will combine with calcium or magnesium salts to form an insoluble precipitate:

$$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2\ CaCO_3$$
$$Mg(HCO_3)_2 + Ca(OH)_2 \rightarrow CaCO_3 + MgCO_3$$

The propensity for these reactions to occur are increased with a reduction of CO_2 partial pressure as the ground water is released from pressure, and also with an increase in pH due to contact with nonhydrated cement, such as in no-fines concrete.

Distinguishing between the potential to attack the concrete or to clog drainage systems is made using the Langelier Saturation Index (LSI), which is based on the pH of the ground water compared with the pH of saturated calcium ions.

On the EastLink project, the potential to clog was found to exist in most of the boreholes. A practical demonstration of the effect was made by passing ground water sampled from one of the boreholes through a small sample of no-fines concrete. The flow completely blocked up within a few days by the deposition of insoluble precipitate of calcium and magnesium carbonate. In practical terms, this meant that a drained tunnel with a flat invert would require significant maintenance to avoid clogging of the drainage systems and that the invert would be potentially subject to uplift forces.

Hydrogeological modeling

The modeling methodology used was typical for tunnel projects:

- Choose the model boundaries and input the topography (Figs. 6 and 7) — note that the model covers an area of approximately 5.6 km^2 (2.1 sq miles).
- Extrapolate the known head data to provide

initial conditions for the model.
- Adopt a (continuous and uniform) recharge rate.
- Calibrate the model for hydraulic conductivity at steady-state against the known ground water heads (Fig. 8).
- Model the tunnel to produce predictions of impact on ground water.

During the design of the secondary lining, the modeling assumptions were subjected to some scrutiny, given that the output of the modeling included predictions of hydrostatic head on the structure. It is noted that the adopted unfactored design head onto the tunnel was below the ground surface.

Particular issues that were identified included:

- **Choosing the appropriate initial conditions for the model.** In the EastLink project, most of the head data was collected during dry years. Therefore, a correction was made for the initial conditions based on a two-dimensional transient model using all rainfall data from 1930 onwards.
- **Choosing the appropriate recharge rate.** This rate is a simplification of a complex process. Therefore, three recharge values were chosen (dry, wet and, after discussion, exceptionally wet). The values adopted are given in Table 1.
- **Choosing the appropriate storativity value for the model.** This parameter does not affect the initial steady-state calibration. Instead, it is a key parameter for assessing transient effects and had to be calibrated following excavation of the tunnel and measurement of ground water drawdown compared with time and assessment of the measured inflows into the tunnel. The value finally adopted was 0.025 percent, which is a number that is relatively low but compatible with the fracture spacing and packer test results. A typical transient model result is shown in Fig. 9, compared with measured values.
- **Modeling longitudinal flow along the tunnel.** This issue turned out to have the greatest impact on the final ground water table. Initial modeling adopted the simplistic view that the completed secondary lining could be represented as an impermeable block of rock. However, the structural analyses of the secondary lining showed that invert deflections create a significant gap, along which water will travel. This effect was analyzed in the model by the incorporation of a two-dimensional planar element that was positioned at the tunnel invert. To mitigate the longitudinal flow and also allow improved recovery of the ground water table, external compartments were positioned at three discrete locations along the alignment. At the locations of these external compartments, the planar element was interrupted. Figure 10 shows the expected steady state ground water table along the tunnel. Note how the longitudinal flow affects the ground water table.

FIG. 7

Hydrogeological model — oblique.

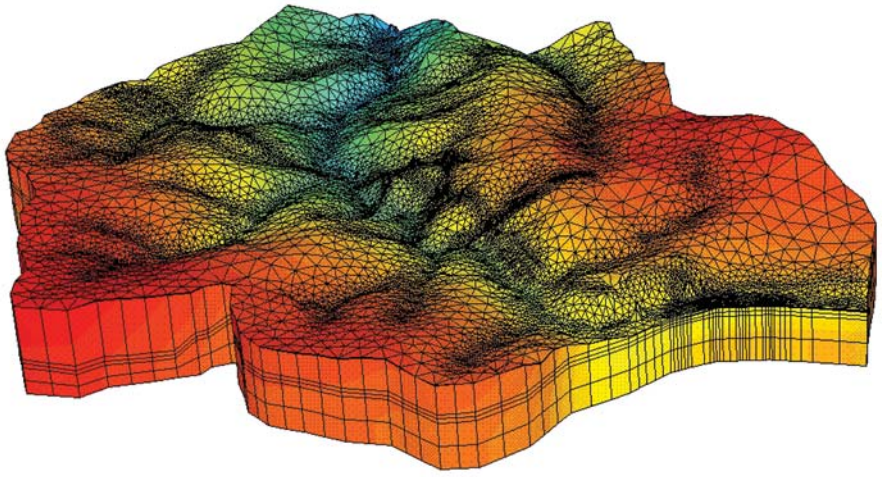


FIG. 8

Model calibration at monitoring bores.

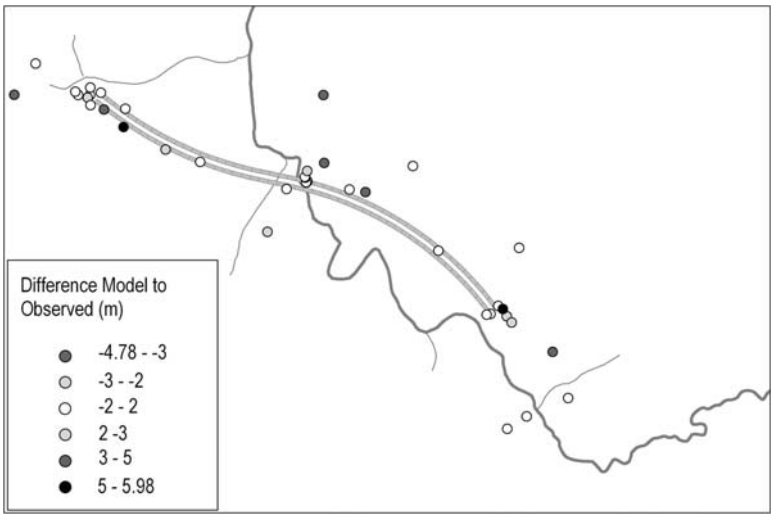
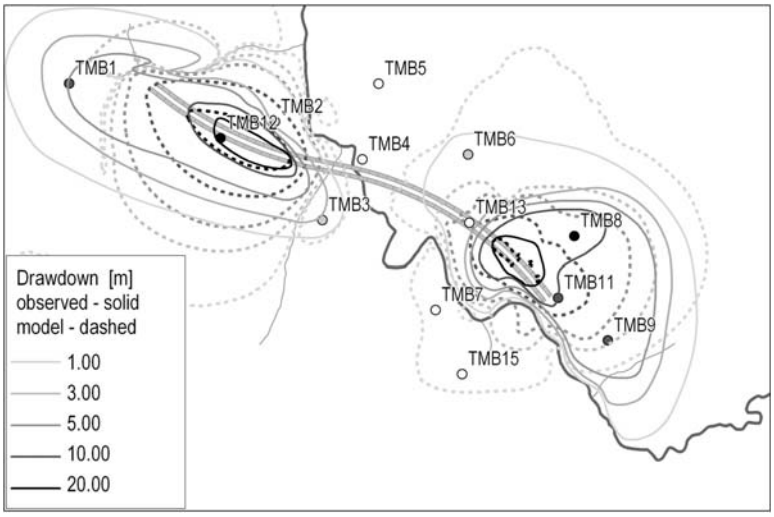


FIG. 9

Transient model drawdown versus measured values.



Waterproofing approach

The project requirements for waterproofing were specific and required an undrained tunnel fully tanked using a membrane system. There was also an upper limit of 1 L/sec (0.26 gal/second) placed on ground water inflow into the total tunnel system.

It is within this context that the waterproofing details of the tunnel are based.

Construction risk assessment

As a part of the constructability input into the design, a detailed construction risk assessment was undertaken by the contractor to highlight the potential areas of risk in achieving these stringent project requirements. The resulting design was then developed with the following philosophy.

With the design specifying a continuous, fully circumferential and impermeable membrane as the primary waterproofing medium, there was a strong focus on ensuring membrane integrity at all times.

Surface preparation of the shotcrete placed as a part of the primary support was the initial focus. With the tunnel action under full hydrostatic head, there are large forces exerted from the lining to the rock in the haunch and crown areas, consequently sandwiching the membrane. Therefore, the shotcrete finish and profile, as well as the geotextile protection layer, were given a high priority.

Tunnel membrane installation and welding techniques are well established so the design and construction focus was on quality control, the use of experienced labor and the use of project specific installation gantries.

Following membrane installation, the design and construction methods were developed to ensure minimal opportunity for damage to the membrane. The tunnel structure required reinforcement to the invert and lower haunches. Two key initiatives were developed to minimize potential damage to the membrane from construction traffic in the invert and from the placement of reinforcement to the invert and haunches.

Precast tunnel segments were designed for placement in the invert. This greatly reduced the need to traffic over the membrane as well as eliminating the placement of reinforcement in this zone. The segments were trafficable once they were fully grouted in place.

With the invert segments in place, haunch reinforcement could be positioned from the starter bars extending from the segments. A specially designed and manufactured reinforcing mesh was developed to meet the structural requirements. The mesh was rolled to suit the tunnel curvature that, in conjunction with the mesh concept, simplified the installation and so minimized the potential damage to the membrane.

The final aspect to the construction risk assessment was recognition of the importance of the hydrogeological regime. Observations of ground water inflow into the tunnels during the excavation phase, combined with an understanding of the impact on groundwater levels, enabled sections of the tunnel to be defined as "wet." Such wet areas were then considered to be higher risk zones for potential tunnel leakage and so a suite of contingency (or supplementary) waterproofing details were prepared for use as determined by the contractor in these areas.

Ground water recovery and operational impacts

Following completion of the tunnel lining, the ground water will recover from the drawdown state that existed during construction. The tunnel structure becomes fully loaded hydrostatically, and as a result, will deflect. It is anticipated that the invert may deflect up to 15 mm (0.6 in.) in the long term.

To limit the longitudinal flow, external compartments, or flow barriers, were designed to seal this flow gap around the tunnel. The compartments comprised rear guard water barriers cast into the rock with a membrane flap welded between them and the tunnel membrane. The flap is designed to accommodate movements from the tunnel lining

Table 1

Recharge rates for EastLink modeling.

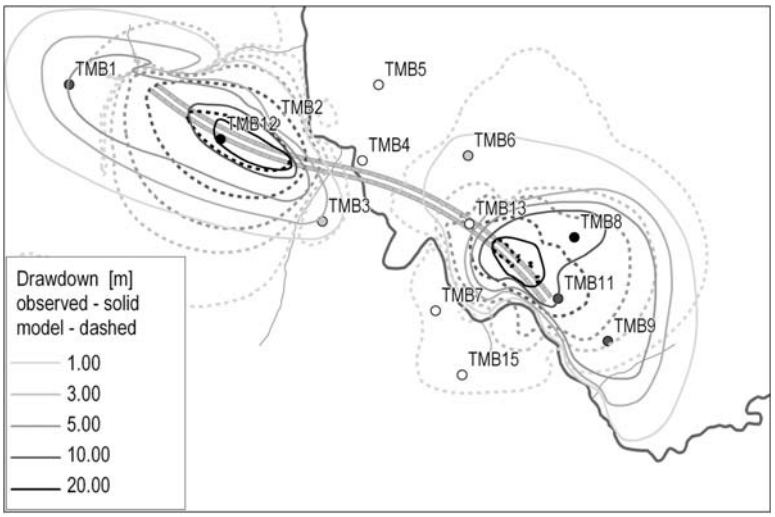
Scenario	Recharge as % annual rainfall (860 mm/a)	Recharge to catchment (5.6 km²)
High recharge	5.7	8.7 L/s
Low recharge	2.3	3.5 L/s
Very high recharge	5.7% of 1,300 mm/a	13.1 L/s

deflecting under load and from long term creep. To ensure the water path is not short circuited through the rock, pressure testing was carried out in the vicinity of these external barriers. And, where the ground was found not to be tight, grouting was carried out.

Despite design and construction best efforts, there is the potential for ground water to penetrate the membrane and leak into the tunnel. To isolate potential leaks and to protect the tunnel lining, various additional measures are incorporated into the design. Internal compartments are created at the membrane-to-concrete interface by use of fully circumferential and longitudinal rear guard waterstops welded to the tunnel membrane. The joints between precast invert segments and between segments and the cast-in-situ arch are sealed by use of hydrophilic waterstops and low-shrink grout. The internal compartmentalization, therefore, allows any operational rectification of leaks to be targeted to a specific segment of the tunnel.

FIG. 9

Transient model drawdown versus measured values.



Waterproofing details

A tool box of waterproofing design details were developed that comprised the "standard waterproofing solution" to meet the project specifications and operational requirements as well as "supplementary waterproofing solutions" for use by the contractor as dictated by the construction risk assessment (as discussed earlier).

The standard solution comprised:

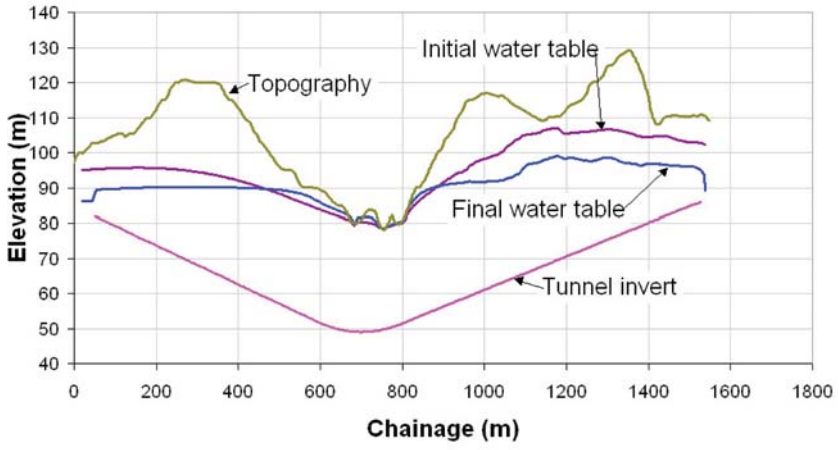
- Geotextile fleece, 500 g/m^2 to the full tunnel perimeter.
- 2-mm (0.08-in.) thick PE membrane to the tunnel arch.
- 3-mm (0.12-in.)thick PE membrane to the invert.
- Continuous longitudinal rearguard water stop above the invert/arch construction joint.
- Radial rearguard waterstops at 40 m (131 ft) maximum centres.
- Hydrophilic waterstops to joints between invert segments and between invert segments and the arch.
- A minimum number of external compartments that enable reasonable recovery of the groundwater regime.

The supplementary details, provided for use by the contractor to supplement the standard details, as a line of defense to minimize risk in areas of potential high inflow (or wet zones) are:

- Additional external compartments to isolate wet from dry sections of the tunnel.
- Reduced spacing of internal compart ment rearguard waterstops.
- Inclusion of regroutable tubes at com partment waterstops.
- The provision of a double membrane sandwich with groutable systems to the invert.

FIG. 10

Predicted ground water head along tunnel alignment.

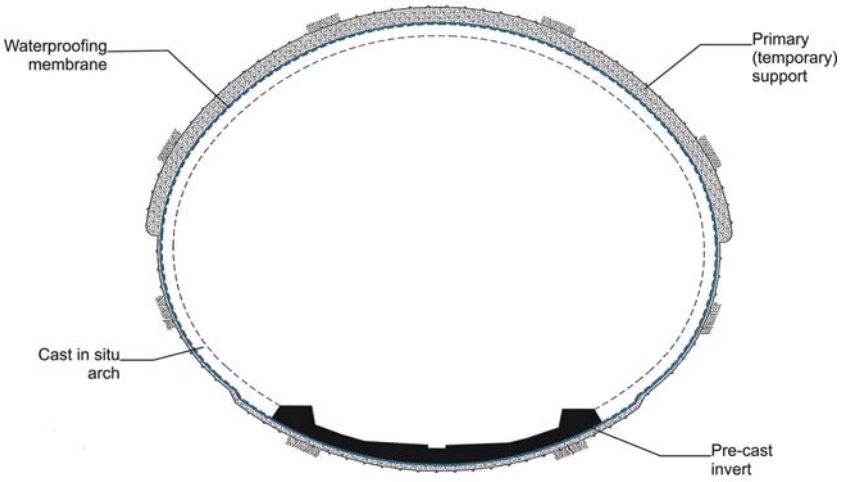


Construction phase assessments

The hydrogeological assessment (as discussed in the earlier section on hydrogeology) was based on a model calibrated against observed geology, ground water movements and inflow into the tunnel during the excavation phase. Ongoing ground water monitoring enabled the best possible understanding of the ground water regime. This knowledge was used to determine the

FIG. 11

Precast invert and secondary lining.



best possible location for external compartments and also to clearly define the wet areas of the tunnel.

The process to establish the minimum number and location of external compartments was to run the hydrogeological model under transient conditions and compare the projected ground water recovery to the pre-existing conditions. The location of the compartments was fine tuned by a review of the mapped geological conditions in the tunnel, focusing on areas of tight rock (minimal jointing and absence of potential interconnection features).

During and following excavation, the tunnel was mapped and monitored for ground water inflow. These observations enabled the tunnel to be divided into wet and dry areas.

Precast invert

The drivers — program, leak prevention. The EastLink tunnel is being delivered by a BOOT scheme in which the private sector provides financing to build the project in return for toll revenue. This delivery method emphasizes speed of construction. The financial outcome is better if the toll revenue arrives earlier.

During early studies, the time taken to construct the invert arch was identified as a critical aspect for the tunnel program. So it was decided to use a precast invert section in the secondary lining. This decision has brought with it one major benefit, as well as some significant challenges.

Initial thinking involved a precast invert with gasketed seals, similar to a bolted segmental lining. However, it proved impossible to design a connection between the segmental invert and the waterproof membrane in the crown. The decision was then made to proceed with a full circle of membrane and to place the precast invert inside the membrane. Figure 11 shows the precast invert.

Schockemohle and Heimbecher (1999) reviewed the success of membrane waterproofing tunnels with invert arches. The German experience is that most membrane damage occurs when invert reinforcing steel comes accidentally in contact with the membrane; the risk being greatest at the bottom of the tunnel. This damage is usually extensive and that without considerable repairs, the waterproofing will not work. (The second most common cause of membrane damage is due to voids at the crown of the tunnel.) The major benefit of using a precast invert segment is that the segment protects the area of greatest risk.

The challenges that are being overcome in the EastLink tunnel include.

- Placing the precast units onto membrane in such a way that the membrane is not damaged.
- Managing the joint between the precast units and the cast-in-situ lining.
- Providing internal and external compartmentalization of the membrane with a precast unit.

Design issues

The principal load on the lining is the hydrostatic load caused by the recovery of the ground water following

FIG. 12

Blinding beneath precast invert.

completion of the waterproofed secondary lining. Figure 10 shows that the hydrogeological model, even when calibrated to a preconstruction steady state, can include uncertainty. Consideration of other effects, such as the variation between wet and dry years, has highlighted the probabilistic nature of the ground water loading. These effects have been taken account of in choosing an appropriate load factor in the structural analyses.

Other loads that have been taken account of in the design include:

- The transient loading as the water table rises.
- The effect of a possible leak around the perimeter to create asymmetric loading.
- The effect of construction loading including trucks, concrete formwork and fill placing.
- The invert fill and roadway pavement.
- The gap between the secondary lining and the rock, filled with the compressible geotextile fleece and membrane.
- The effect of different concrete moduli depending on the load and time.

For the precast invert — casting and handling loads. Following assessment of each of the design load cases and several iterations regarding the shape of the tunnel invert, the final design solution adopted included:

- Reinforced 50 MPa concrete invert segment complete with concrete corbel as a base for the arch formwork and starter bars into the arch pour.
- Lightly reinforced 40 MPa concrete lower haunch areas with the reinforcement extending from the precast invert segments to approximately roadway level.
- Unreinforced 40 MPa concrete tunnel arch.

A particular issue for reinforcement design was the difference in shrinkage between the precast invert modules and the cast-in-situ lining. This differential shrinkage occurs between each arch pour and was controlled with additional longitudinal reinforcement near the invert segment to arch construction joint.

Construction details

The main issue for construction is the placement of the precast invert such that the membrane is not damaged while maintaining the tight placement tolerances set by the designer. Two issues must be considered, damage to the membrane when placing the unit, and avoiding air voids in the grout under the units so that the membrane has no place to expand and tear due to the decreased section thickness.

The process adopted starts with the production of concrete invert blinding to within 10 mm (0.4 in.) of the theoretical position. This is achieved by using curved steel screed formers, placed by survey, in a hit and miss sequence (Fig. 12).

FIG. 13

Precast invert units located in tunnel.

The precast invert is then placed on groutable pads on either side of the units. These pads are made from polythene and are a flat rectangular profile normally used in strip drains, with a water path in all directions. This detail allows the free flow of grout to allow the complete filling of the underside of the profile.

A low shrink grout is then pumped into the void beneath the segments through pre-formed grouting holes. Due to the curved profile of the segments and the longitudinal grade of the tunnel, the grouting process can only be undertaken up to four segments at a time if grouted in a single stage (Fig. 13).

Due to the complex nature of this construction, detailed full-scale trials were undertaken in a purpose-made structure outside of the tunnel portals. The structure was built to replicate the tunnel invert profile and grade and allowed repetitive trials for the placement and grouting of the precast segments. This enabled the optimization of the contractor's work methods and a training ground for the tunnel workers. Only on successful completion of each of the aspects of the placement and grouting process did production within the tunnel commence.

Joints between the precast units have a shear key profile to lock the units together. The bottom of the shear key joint included a seat for locating a triangular section of hydrophilic material. The rest of the joint is grouted up with low shrink grout. ■

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FEATURE ARTICLE

Record attendance turns out for 2008 Fox Conference

The state of the tunneling and underground construction industry and the advancements of the industry's biggest machines were the main topics at the 2008 edition of the UCA of SME's annual George A. Fox Conference.

This year SME hosted more than 250 tunneling and underground construction professionals at the Graduate Center, City University of New York.

During the morning session of the long-running one-day conference, attendees heard a state of the industry through the annual Hometown Update where it was evident that the industry is doing well.

Michael McHugh of Moretrench cruised through the many projects that are under way along the Eastern seaboard of the United States and said he could have gone longer if time allowed.

An example of how well things are going for the industry is a look at New York, where the industry is flourishing.

The New York City Water Tunnel # 3 project is a $668 million project that was awarded to Schiavone/Shea/Frontier Kemper joint venture in 2004. McHugh said that mining on the project was completed in August 2006 and that all contract work is expected to be completed by August 2009.

The Second Ave. Subway is a $337-million twin tunnel project that will connect upper Manhattan with the financial district. This is a four-phase project. McHugh said the Metropolitan Transit Authority obtained full funding in 2007 and construction awards will be awarded during the next two years.

The No. 7 Line Flushing extension, a five-year, $1.15-billion project that will redevelop the Hudson Yards area of Midtown West and the New York City Water Tunnel No. 3 project is the largest capital construction project in New York City's history. McHugh said the project was given notice to proceed on Dec. 13, 2007.

The project includes three large shafts, two parallel 6.7 m (22 ft) tunnels at 2,000 liner m (6,500 liner ft), one large cross adit, one large underground rock cavern station with two interlocks and eight penetrations.

These were just a few of projects mentioned in the Hometown Projects update.

A record crowd of more than 250 professionals were on hand for the one-day George A. Fox Conference in New York City in January.

Trans-Hudson Expressway

Arthur D. Silber spoke about the proposed, 13-km (8-mile) rail project that will expand transit capacity to meet current and future demand for mass transit between midtown Manhattan and points in New Jersey and New York. The rail expansion will pick up passengers in New Jersey and deliver them to the heart of Manhattan with a stop at Penn Station. The project, owned by the New Jersey Transit and the Port Authority of New York and New Jersey, is so large, ($7.58 billion with an eight-year construction plan) that local media has dubbed it the THE Tunnel project.

The project is nearing its preliminary design completion phase. It is a five-segment project that is expected to be completed by 2016. Silber said one contract is expected to be worth more than $500 million, while a number of others will be valued at less than $499 million and as many as eight will come in at less than $50 million.

The preliminary engineering work is expected to cost $90 million and take 18 months to finish. It will include finalizing track alignment, determining how best to build the tunnel and coordinating efforts with Amtrak and the Metropolitan Transportation Authority to minimize passenger disruptions during construction. Another

William M. Gleason,
Associate Editor

key component of the overall project is creation of a new rail terminal for New Jersey Transit passengers.

On Dec. 13, 2006, New Jersey Transit picked a construction management firm for the Trans-Hudson Express tunnel. The CM Consortium is a joint venture between Tishman Corp., Parsons Corp. and ARUP. It will perform the construction management services for the project.

East Side Access

Donald Hickey, project manager of the Dragados UCA/Judlau Joint Venture, spoke about the East Side Access Project. It will expand the Long Island Commuter Rail Road that currently serves more than 260,000 people a day. The four tunnel project will link connect the Long Island Rail Road's (LIRR) Main and Port Washington lines in Queens to a new LIRR terminal beneath Grand Central Terminal in Manhattan. The new connection will increase the LIRR's capacity into Manhattan, shortening travel time for Long Island and eastern Queens commuters traveling to the east side of Manhattan and provide a new commuter rail station in Sunnyside Queens.

UCA of SME chairperson Brenda Bohlke welcomed the large crowd to the 2008 George A. Fox Conference in New York City.

Hickley spoke to the record crowd about the project, the challenges that were encountered and the project's tunnel excavation contract.

A Seli tunnel boring machine (TBM) that was built on site had progressed about 460 m (1,500 ft). And a second TBM, a Robbins, a refurbished machine that was used on the Epping-Chatswood rail tunnel project in Australia, was launched in October.

Hickley said the joint venture has hit some difficult conditions and received permission for limited drill-and-blast, usually a five-minute window.

The East Side Access is a $6.3-billion project that will provide access to Grand Central Terminal for Long Island Rail Road commuters. When complete in 2013, East Side Access will serve approximately 160,000 customers a day.

The bi-level 63rd Street tunnel was constructed starting in 1969. It designed to carry both subway and commuter rail trains. Due to budget shortfalls, the tunnel remained unused until 1989, when F train service was routed through the tunnel's upper level to 63rd Street and Lexington Avenue. Until now, the lower level has terminated at 63rd Street and 2nd Avenue, where the TBM began boring toward Grand Central. Connecting tunnels will be completed in Queens to link the tunnel to the LIRR's Main Line and Port Washington branch tracks.

North Shore Connector

On Jan. 20, drilling began on the North Shore Connector project in Pittsburgh, PA. This $435 million project will extend Port Authority's Light Rail Transit system, the T, 1.9 km (1.2 miles) from the Gateway subway station underneath Stanwix Street and the Allegheny River. It will be twin-bored tunnels below the river to the North Shore.

Remaining underground along the North Shore, the alignment would travel adjacent to Bill Mazeroski Way accessing a station near PNC Park. Continuing below grade adjacent to Reedsdale Street, the alignment will transition to an elevated alignment near Art Rooney Avenue to a station along Allegheny Avenue near Heinz Field before terminating near the West End Bridge.

The North Shore Connector is a significant regional investment that will support the revitalized downtown Pittsburgh and North Shore's residential areas, business districts, educational institutions, entertainment developments and cultural venues in addition to enhancing development opportunities. The North Shore Connector will also enable the Authority to construct future extensions of the T to other destinations within Allegheny County.

New developments in mechanical excavation methods.

In the ever-changing world of tunneling and underground construction, the makers of the tunnel boring machines are always finding ways to tunnel deeper and faster. At this years' Fox Conference, representatives from the major players in the field, Lovat, Robbins, Herrenknecht and Wirth were on hand to discuss the most recent advancements and the keynote presentation from Edward J. Cording was also about this topic.

Cording is professor emeritus, University of Illinois at Urbana Champaign.

In his keynote address, he spoke of the critical issue of ground control in shield tunneling.

He covered everything from the history of tunnel-

The New York City Water Tunnel #3 project was one of the many tunneling and underground construction projects that was discussed at the 2008 George A. Fox Conference.

ing with TBM's to the current challenges faced in the industry.

Not so long ago, TBMs were built to the conditions that they would be encountering. However, conditions can, and often do change. At times, the TBM runs into ground that i is not prepared or made for. When this happened in the past, it would cause major delays and expense to change the face, the cutters and other parts of the machine.

Unexpected ground conditions can also lead to ground control loss because the TBM face pressure or contitioner is not adjusted fast enough, said Cording.

The introduction of earth pressure balance (EPB) machines has helped in this issue, said Cording.

Herrenknecht. Jack Brockway, senior vice president of Herrenknecht Tunnelling Systems USA, expanded on the importance of ground control that was discussed in the morning session by Cording. He spoke of some of the projects that Herrenknecht has tackled using mixed-shield and multi-use TBMs.

In 1990, a Herrenknecht mix-shield TBM tunneled through a mix of molasses, sihl ballast and rubble in the 2,354-m (40,551-ft) Zürich-Thalwil Zimmerberg Basistunnel tunnel in Switzerland. More recently, Brokway said Herrenknecht has meet unique challenges at the Arrowhead project in California with a pair of single-shield TBM's and is engaged in tunneling through a mix of clay and silt, silty sand and sand with a S-379 and S-380 machine at the Brightwater Conveyance Project in King's County, WA. (See page 5)

Lovat. Craig Bournes, product manager for Lovat discussed the Metro Seville Line 1, in Seville, Spain. Not only was this project in a confined area, under historically significant buildings, but the geology of this 3.6-km (2.2-miles) twin tunnel project included numerous soil types and three preconstructed stations.

Lovat launched a RME238SE, mixed-face, earth-pressure balanced-machine for the job.

From the start of the project, it was a challenge as the TBM was assembled in a tight urban environment. Once it began tunneling, after a delay of more than two months, the machine hit challenges of ground conditions and the challenge of breaking through the submerged station walls. These conditions, said Bournes, caused extreme wear on the cutting tool. To address these problems, Lovat came up with a new, more aggressive cutterhead with more rippers and new tools to continue on with the job.

Robbins. Michael Kolenich of Robbins spoke at length of the future for tunneling and TBMs, a future that he said will include the use of advanced communications and remote monitoring and sensors.

The benefits of these advances would includes less downtime for inspections, which, in turn, would lead to reduced maintenance and costs to fix repairs when needed.

Wirth. Willi Schmitz, general sales manager, foundation and mining, Wirth-American Commercial Inc., spoke of reverse-circulation drilling and the use of a tunnel reaming machine. In 2006, at the Uetliberg Tunnel near the Swiss capital Zurich, Wirth was responsible for a tunneling milestone. This was the first-ever use of undercutting technology, a pioneering effort successfully carried out and resulting in the largest final tunnel diameter ever opened by a hard-rock tunnel reaming machine at 14.4 m (47 ft) in width. Wirth was awarded the Innovation Prize 2006 for the development of this cutting-edge technology.

Drill-and-blast. While the use of TBM's is the preferred method of tunneling, the use of explosives cannot be discounted. At times, the only way to advance through a tough spot is to blow it up. At the Fox Conference, Vic Sterner, blast consultant with Austin Power Co., addressed the crowd on the art of drill-and-blast methods.

Another technique for tunneling, the use of a road header, was discussed by Uwe Restner, head of geotechni-

cal consulting and engineering, Sandvik Mining and Construction.

Alternative dispute resolution

The price tag on tunneling projects routinely climbs to hundreds of millions of dollars. The price tag on some projects even gets into the billions of dollars. With that kind of money in play, it is not uncommon for owners and contractors to have their differences about how things are progressing. However, at the Fox Conference, one thing these two sides could not dispute is that the best way to settle such disputes is through the practice of alternative dispute resolutions (ADR).

David Caiden, principal with Arup New York, introduced the section of ADR. It is a fairly young practice in which both sides find a common ground without the aide, or expense, of an attorney or judge.

Caiden pointed out that many deals are headed for disputes from the very start because the way contracts are won and awarded creates adversity from the start and often do not get any better.

Representing the contractors on this issue was Buck Atherton, executive vice president, J.F. Shea Construction Inc. Speaking up for the owners in the issue was James Haggins. He is the former assistant general manager for the Washington Metro Area Transit Authority.

While their careers often pit them on opposite sides of the fence, they both said that ADR's have benefited all sides with disputes being settled quickly and fairly; resolution to problems coming at the lowest possible levels and not always at the most executive levels. They can improve the owners image by showing that they are willing to work problems out. Because of ADR, Haggins said both sides can concentrate on the tasks at hand and, therefore, some bids are lower in the future. "It is a win-win situation," he said.

Of the burdens, he said that owners must have a willingness to work things out and accept the outcome. There must be a mutual respect. And those who are selected for the mediation process should be picked for their experience and knowledge and not because there is a bias. Confidentiality and documentation must be kept.

Carnegie Hall and South Ferry alternative excavation methods

Anthony DelVescovo and Michael Ryan, of New Jersey-based Schiavone Construction, wrapped the conference up with a discussion of challenges their company faced at the South Ferry Terminal Subway Station and under the famed Carnegie Hall in New York City.

Part of the George A. Fox Conference was dedicated to discussions about the advancements being made to tunnel boring machines, like the one used on the North Dorchester Bay CSO Storage Tunnel in South Boston, MA.

At the South Ferry Station, ground conditions near Battery Park work plans were changed when the project met solid rock rather than the usual shysts found in Manhattan. Construction includes a station platform and mezzanine levels, was well as the approach tunnel and tie-in to the existing tunnel, totaling 488 liner m (1,600 linear ft) of supported excavation with temporary decking during construction.

Under Carnegie Hall, tight working conditions under the historical theater limited the amount of equipment that could be used. This forced Schiavone to explore alternative methods of excavation, such as chemical expansive mortar splitting.

This year's George A. Fox Conference was being sponsored by Allentown Shotcrete Technology Inc.; American Commercial Inc.; Arup; Basf Construction Chemicals; Black and Veatch Corporation; Bradshaw Construction; Cellular Concrete Inc.; DMJM Harris; Donovan Hatem LLP; Frontier-Kemper Constructors Inc.; GZA GeoEnvironmental; Halcrow; Hatch Mott McDonald; Herrenknecht Tunneling Systems USA; Jacobs Associates; Kiewit Construction Company; LiRo Group; Lovat Inc.; Moretrench; Mueser Rutledge Consulting Engineers; PB; Sandvik Mining and Construction; Schiavone Construction Co.; Sika Corp.; Skanska USA Civil Northeast Inc.; David R. Klug & Associates Inc.; Gall Zeidler Consultants and ILF Consulting Engineers. ■

Countdown to ConExpo-Con/Agg 2008 has begun

It only comes along once every three years and this is one of those years. From March 11-15, the Las Vegas Convention Center with play host to the 2008 ConExpo-Con/Agg and International Power Transmission Exposition (IFPE) shows where the latest equipment, products and technologies for the construction industry will be on display.

In 2005, the last time the show was held, more than 125,000 industry professionals gathered amid the sea of equipment that made the parking outside of the Convention Center in Las Vegas, NV, look like the world's largest construction project.

ConExpo-Con/Agg 2008 exhibits now cover more than 212,024 m^2 (2.28 million net sq ft), taken by nearly 2,000 exhibitors, while IFPE exhibits cover nearly 12,000 m^2 (127,000 net sq. ft) taken by 400 exhibitors.

In addition to the impressive show of equipment, this year there will be an expanded focus on the education program of both shows. Sessions will emphasize industry issues and trends, management and applied technology.

ConExpo-Con/Agg 2008, as in past shows, will have exhibitors grouped into product-concentration areas to help attendees find the products and companies they're most interested in. These product groupings are: aggregates, asphalt and compaction, concrete, earthmoving machinery and attachments, engines and components, information technology, trucks, utilities, lifting (aerial and cranes), associations/industry events, drilling, safety and traffic and trenching and shoring.

The show has signed on 10 international exhibit pavilions, from Brazil, Canada, China, Finland, Germany, Italy, Korea, Spain, Turkey and the United Kingdom.

ConExpo-Con/Agg 2008 will also feature displays of historical equipment throughout the show, illustrating the industry's rich heritage and the show's history from 1909 to the present.

New show floor additions

New show floor additions to ConExpo-Con/Agg 2008 will focus on industry safety training and the need for a qualified industry workforce.

More than 125,000 industry professionals attended the 2005 ConExpo-Con/Agg show in Las Vegas.

A special Safety Zone exhibit area will feature live demonstrations and information resources focused on jobsite safety, from groups including the U.S. Mine Safety and Health Administration (MSHA), U.S. National Institute for Occupational Safety and Health (NIOSH) and the International Powered Access Federation (IPAF).

Show sponsor National Ready Mixed Concrete Association (NRMCA) will hold its first ever Mixer Driver World Cup competition at ConExpo-Con/Agg 2008. It is designed to recognize the exceptional talent and skills of ready mixed concrete mixer drivers from around the world.

Show sponsor Association of Equipment Manufacturers (AEM) will hold the finals of its first ever teen-oriented Construction Challenge at the show. The goal is to of spur interest in construction industry careers and spotlight industry contributions to quality of life such as good roads and clean water.

Education Highlights

There will be more than 120 educational sessions delivered by industry experts with a focus on industry trends, case studies and "how to" application techniques and strategies. The sessions are divided into 10 program tracks to help attendees locate topics of most interest to them: aggregates, asphalt, concrete, construction project management, earthmoving, environmental/recycling, equipment management, management, personal development and safety.

New for 2008 is a special free program on best practices for small fleet management. It will be held the last day of the show. The program will provide practical solutions for the specific fleet management needs of small business owners specializing in commercial, industrial and public construction. Also new in 2008 will be additional seminar delivery methods that are planned using electronic technologies, such as podcasts, to extend the show's educational value to attendees.

Selected ConExpo-Con/Agg 2008 education modules will be conducted with simultaneous interpretation in Portuguese, Spanish and Russian. Industry organizations will also offer certification and examination programs. ■

Tunneling's role in sustainable development discussed at United Nations

The Earth's population is approaching 6.6 billion people. More than half live in urban areas. And, as those figures continue to grow, the need to make wise use of the world's natural resources as well as its living space will also grow.

Thus, the concept of sustainable development — meeting the needs of the current generation while preserving resources for future generations. The use of underground space is only one part of the sustainable development concept. But it is an important one.

Tunnels and underground space are environmentally friendly and contribute significantly to sustainable development. But it takes years to plan and build tunnels and other underground infrastructure. And the demand for infrastructure in the world's mega cities has grown significantly.

In December, about 100 people representing several developed and developing nations spent a day at the United Nations (UN) in New York City discussing the future of underground space development throughout the world. The meeting was put on by the UN's Department of Economic and Social Affairs and the International Tunnelling and Underground Space Association (ITA).

The conference was titled "The Use of Underground Space as an Unexpected Solution for Promoting Sustainable Development." Its aim was to promote practical solutions to the use of underground space and tunnels as feasible alternatives to promote sustainable development throughout the world.

A panel of speakers from government, academia, the UN and the ITA stressed that development is not sustainable without infrastructure. And, as the world's population grows, there is now an urgent requirement to efficiently plan for the use of underground space to preserve it for the future benefit of mankind. The benefits of the use of underground space are many, they said. Among them:

- Tunnels channel clean water in and waste water out. This promotes health and sustainability worldwide, particularly in developing countries.
- The use of tunnels and underground space helps conserve energy and increases its efficient use — the use of tunnels cuts commuting time and so saves energy.
- Tunnels, microtunnels and other underground structures promote the more efficient use of space in large cities — the bulk storage of water, fuel and other goods.
- Underground structures are subject to less stress than surface structures, making them safe havens for natural and man-made hazards, including earthquakes. And, because underground structures are more durable, lifecycle costs are less than surface structures.
- Underground structures promote the multiple use of available land. Land ownership at several layers increases land use and provides more usable space.

Steve Kral,
Editor

Han Admiraal is director of the Center for Underground Construction in the Netherlands. He said that urban planners need a new vision concerning the use of underground space. Going underground protects historical and archaeological surface facilities, he said. Underground space use can also protect populations located in adverse climates. And sensitive environmental areas on the surface can also be protected from development.

In addition to the transportation of people, freight and water, underground development can also store water, as well as provide storage for waste, hazardous materials, carbon dioxide and geothermal energy.

The upshot of this new awareness and vision for underground space is that its use should be considered before surface development, Admiraal said. And planners and developers are placing more emphasis on underground space development as part of their overall development plans for urban areas. That was not always the case, he said. In the past, underground space was not considered until after the surface space had run out, he said.

Urbanization in China

Perhaps the best example of the need for more efficient underground space planning is China. During the past 20 years, China has been the fastest growing country in terms of urbanization, said Shi Xiaodong, senior planner of Beijing's Urban and Plan Design Institute.

There are more than 10 million births in China each year, he said, and up to 18 million rural people migrate to urban areas annually. And another 21 million migrant workers move from one place to another each year. All of that places an enormous amount of pressure on existing infrastructure in China's major cities, Xiaodong said.

A 2003 study regarding sustainable development in China pointed out five "balances" the country must attain, Xiaodong said. They are:

- The balance of urban and rural development.
- The balance of development between regions.
- The balance of economic growth and social development.
- The balance of humans and nature.
- The balance of domestic development and the country's open-door policy.

All of that means that China will rely more and more on underground space development, Xiaodong said. One result will be the creation of closed-loop cities, where underground structures will hold electricity distribution facilities, sewage and waste disposal facilities, and water collection and storage facilities.

The country's overall scale and area of underground space development will rank first in the world. By 2020, constructed underground space in Beijing is expected to amount to 90 Mm^2 (9.6 billion sq ft). And China's other major cities will experience similar growth in underground development, he said. ■

Thompson high-pressure jet pump

Thompson's JSC Series Solids Handling Enviroprime pump leads the pump industry in bypass applications. With its heavy-duty cast-iron construction and ability to dry-prime and re-prime automatically, this model is ideal for general construction dewatering and sewage bypass applications. The 152 mm (6-in.) pump is designed for flows to 9,400 L/min (2,500 gal/minute), maximum heads to 60 m (195 ft), and can handle solids up to 76 mm (3 in.).

This pump also features the Enviroprime compressor-assisted dry priming system that prevents blow-by, such as sewage and waste, from discharging onto the ground, making it environmentally safe. The sturdy, weather resistant, sound attenuated Silent Knight canopy is also available on Thompson's JSC series and allows the pumps to operate at 67dBa. The features of Thompson's 152 mm (6-in.) solids handling Enviroprime pump provide the high performance needed to get the job done quickly.

Thompson Pump is an industry leader in the development of high quality engine-powered portable pumps, ranging in size from 50 to 457 mm (2 to 18 in.), for use in varied applications in the areas of public works, municipalities, construction, agriculture, dewatering, mining, sewer/lift stations and water/waste water. The company sells and rents their entire line of dewatering pumps including wet and dry prime trash pumps, sound attenuated models, diaphragm pumps, hydraulic submersible pumps, high pressure pumps and wellpoint pumps as well as bypass systems, wellpoint systems and a complete line of pumping accessories.

Thompson Enviroprime pump.

www.thompsonpump.com

Hitachi introduces two new machine monitoring systems

Hitachi now offers two ZXLink Machine Monitoring Systems to control fleet operations.

The two new option levels, advanced and ultimate, add more sophisticated capabilities to the popular ZXLink Machine Monitoring system. They are available for field or factory installation on any Zaxis Dash-3 excavator.

The original ZXLink Standard level automatically collects, transmits and manages machine data. The data can be viewed at a single secure Web site. Customers can then use the data to check machine operation times, track machine locations and set restrictions on when machines are allowed to run. ZXLink integrates into

The new ZXLink Advanced provides all the standard level features plus a percentage breakdown of machine-idling hours versus working hours. To immediately inform maintenance managers of impending machine problems, ZXLink Advanced also provides dashboard alerts such as low fuel level warnings via Internet, cell phone or pager.

With ZXLink Ultimate, a maintenance manager can receive the kind of detailed information needed to extend the economic life of equipment, as well as improve productivity. Machine pressures, temperatures and speeds are captured and displayed in an understandable format that can be downloaded onto a spreadsheet for further analysis.

ZXLink Standard is an all-makes-and-models solution and can be used to cover a contractor's entire fleet. The advanced and ultimate levels can be used on all Zaxis Dash-3 excavators, models ZX160LC-3 and higher. ZXLink Ultimate systems come standard on the Zaxis 450, 650, and 850 Dash-3 models, with three years of service included in the price of the machine.

Customers determine who sees the data collected by their ZXLink system. ■

www.hitachiconstruction.com

April 2008

• **10-12, The Sixth International Symposium Geotechnical Aspects of Underground Construction in Soft Ground,** Tongji University, Shanghai, China. Contact: Xiongyao Xie, Tongji University 1239 Siping Rd., Shanghai 200092, China, phone 0086-21-65982986, fax 0086-21-65982986, e-mail secretary@tc28-shanghai.org, Web site www.tc28-shanghai.org.

• **29-May 2, 2008 No-Dig Show,** Gaylord Texan Resort and Convention Center, Dallas, TX. Contact: Michelle Magyar, Benjamin Media, Inc., 1770 Main Street. P.O. Box 190 Peninsula, OH 44264, phone 330-467-7588, fax 330-468-2289, e-mail mmagyar@benjaminmedia.com, Web site www.nodigshow.com.

• **22-24, Fifth International Symposium on Sprayed Concrete,** Lillehammer, Norway. Contact: Siri Engen, The Norwefian Society of Chartered Technical and Scientific Professionals, P.O. Box 2313, Solli N-0201 Oslo, Norway, fax 47-22-94-75-01, e-mail info@sprayedconcrete.no, Web site www.sprayedconcrete.no.

May 2008

• **4-7, 13th Australian Tunneling Conference,** Grand Hyatt, Melbourne, Australia. Contact: The AusIM, P.O. Box 660 Carlton South Vic 3053, phone 03-9662-3166, fax 03-9662-3662, e-mail dedwards@ausimm.com.au, Web site www.atstunnellingconference2008.com.

More meetings information can be accessed at the SME Web site — http://www.smenet.org.

June 2008

• **23-25, Second Brazilian Congress on Tunnelling and Underground Structures,** Sao Paulo, Brazil. Contact Acqua Consultoria, Rua Dr. Candido Espinheira, 560-cj.32 05004-000, Sao Paulo-SO, phone 55-11-3871-3626, e-mail 2cbt@acquacon.com.br, Web site www.acquacon.com.br/2cbt.

September 2008
June 2008

• **17-18, IUT Fifth Annual International Underground and Tunnel Fair,** VersuchsStollen Hagerbach Polistrabe 1, 8893 Flums-Hochwiese, Switzerland. Contact GmbH Stormarnstrabe 47, 22844 Norderstedt, Germany, phone 49-0-040-35-72-32-0, fax 49-0-40-35-72-32-90, e-mail info@deltacom-hamburg.de, Web site www.deltacom-hamburg.de.

• **22-27, ITA-AITES World Tunnel Congress 2008,** Agra, India. Contact: G.N. Mathur, phone 91-11-2611-5984, fax 91-11-2611-6347, e-mail sunil@cbip.org, Web site www/cbip.org.

• **23-25, InnoTrans 2008,** Berlin, Germany. Contact Mary Jo Balve or Franz Balve, 33 Prince Place, Little Silver, NJ 07739, NJ, phone 732-933-1118, fax 732-741-6437, e-mail mjbalve@globaltradeshow.com, Web site www.innotrans.de. ■

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TUNNEL WATERPROOFING AND SHOTCRETE SYMPOSIUM

PRELIMINARY PROGRAM

Hilton Newark Penn Station
Gateway Center/Raymond Blvd.
Newark, NJ 07102

8:40am – 9:20am	**THE Tunnel Project** *Overview and Snapshot of THE Tunnel Project*	Arthur Silber, *NJT*
9:20am – 9:50am	**Basics of Shotcrete** *Materials, application and advantages*	Patrick Bridger, *Putzmeister/Allentown*
9:50am – 10:30am	**Beacon Hill** *Example of modern shotcrete and waterproofing techniques/soft ground*	Steve Redmond *Obayashi Corp.*
11:00am – 11:40am	**Weehawken** *Example of modern shotcrete and waterproofing techniques/hard ground*	Leon Jacobs, *Frontier-Kemper*
11:40am – 12:20pm	**Waterproofing System Components** *Key considerations, types of systems and components*	Peter D'Antonio, *Sika-Sarnafil*
2:00pm – 2:40pm	**Waterproofing from an Applicators Perspective**	Peter Strasser, *Wisko America, Inc*
2:40pm – 3:30pm	**Engineering Design Considerations**	Robert Goodfellow *Black & Veatch Corp*
3:30pm – 4:10pm	**Owners Considerations**	*tbd*

HOTEL ACCOMODATIONS

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$269
Reservations must be made by April 11, 2008 to receive this rate and are based on availability.

To reserve, call: 973-622-5000
(Ask for the SME special rate)

FIELD TRIP – MAY 6, 2008

A field trip of special interest will be offered in conjunction with this symposium on Tuesday, May 6, 2008 from 9:00am – 1:00pm. Specific details will be available shortly. The field trip will include lunch.

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