Northern Exposure
An In-Depth Look at the Canadian Tunneling Market

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The Canadian tunneling market has come a long way in the last few years, most notably with endeavors such as the Seymour Capilano Project in Vancouver, British Columbia (pictured). (Photo provided by The Robbins Company.)

Northern Exposure — An In-Depth Look at the Canadian Tunneling Market

Tunneling is a vital part of Canada’s infrastructure and energy development. Often, it is the only feasible way to address the high demand for water supply and treatment, or the storage and treatment of sewerage in urban settings. Due to a variety of factors that continue to shape the Canadian market, tunneling is sure to remain active for several years to come.

By Garry Stevenson

Highlights of Hong Kong

With the ongoing recovery from the Asian economic crisis in 1997, the Hong Kong Special Administrative Region (HKSAR) continues to expand its infrastructure at an extraordinary rate.

By David Salisbury

Supplying Iceland’s New Hydropower Plant

The Kárahnjúkar Hydropower project is located amongst the mountains and fjords of remote northeastern Iceland. Impregilo S.p.A. recently completed the 8.7-mile long Jökulsá tunnel, which will carry water from the Ufsarlón reservoir to the plant’s main headrace tunnel.

By Joe Roby

Big Walnut Interceptor Back on Track

Despite a few setbacks early on, both parts of the extensive sanitary sewer upgrade program for the City of Columbus, Ohio, are expected to finish in time to satisfy the 2008 deadline.

By Glen Frank

ITA World Tunnel Congress Preview

The International Tunneling Association (ITA) will hold the 2006 World Tunnel Congress & 32nd ITA General Assembly in Seoul, Korea, April 22-27, promoting the theme, “Safety in the Underground Space.”

By Glen Frank
In developing the editorial plan for 2006, one area we felt that needed expanded coverage was the market outside North America. While our focus has always been — and will continue to be — the North American market, the tunneling community as a whole is intertwined and international in nature.

Therefore, in each issue in 2006 we will be presenting a “Global Feature.” In this issue, we kick things off with the Far East, particularly Hong Kong. Written by David Salisbury, an associate with Ove Arup & Partners Hong Kong Ltd., the article, beginning on page 18, details a recent surge of activity in this region.

In future issues, we will present: Germany, Austria and Switzerland (April); France, Italy, Portugal and Spain (June); Australasia (August); United Kingdom (October); and Hungary, the Balkans and Greece (December).

In these features we will address such questions as: What are market conditions now? What are the prospects for the future? What is driving the market? What are some of the major ongoing and planned projects? What challenges may be unique to this region? What innovative processes are being used in this region? What are the prospects for North American businesses in this region?

In this issue, we also present a focus on the Canadian tunneling market as the cover story. The article, which was prepared by Garry Stevenson, the current president of the Tunnelling Association of Canada, begins on page 14.

The Canadian tunneling market has been slow in comparison to the United States recently, but that is starting to change as activity is occurring all over the country. Vancouver, which is preparing the 2010 Winter Olympics, is building transit tunnels, as well as water and sewer tunnels, as it beefs up its infrastructure. One long-awaited project that is now back on the books is the Niagara diversion tunnel project for Ontario Power Generation. The 6.2-mile tunnel, awarded to Austria’s Strabag for $510 million USD, will be driven using a 41-ft Robbins TBM — the world’s largest hard-rock TBM.

Tunnel boring machine manufacturers commonly work across many borders, so felt that it was appropriate to highlight how one North American TBM builder — Solon, Ohio-based Robbins — completed a unique project in difficult conditions in Iceland. For more information, see Joe Roby’s article on page 22.

Changes Ahead

Be on the lookout for more changes to TBM in the next couple of months. In addition to new editorial focuses such as the Global Features, we are also working to improve the look of the publication from a graphic standpoint.

The design of the book has undergone incremental changes since the launch of the publication in January/February 1998, but has yet to be completely redesigned. While the old design has served us well, the time is right for an updated look. Stay tuned.

Regards,

James W. Rush
Editor
Parsons Brinckerhoff... contributing design and construction management services to tunnels that help our clients improve transportation, safeguard the environment and create a better future for people across the world.

1964: NORAD
(North American Air Defense Command Center)
Underground command center able to withstand nuclear attack.

1974: BART Trans-Bay Tube
Tunnel under San Francisco Bay safely withstood the 1989 earthquake.

1980: Fort McHenry Tunnel
Eight-mile tunnel, taking 1985 under Baltimore Harbor was completed on time and significantly under budget, earning the AGC's Grand Cuneploit Award.

1992: Glenwood Canyon
Environmentally sensitive design preserved existing beauty in Colorado.

2000: Boston Harbor Outfall
Nine-mile tunnel on fish-friendly habitat clean up Boston Harbor.

2000: Singapore Deep Tunnel Sewerage System
Tunnels and outfalls will provide a new sewerage system for Singapore.

2011: East Side CSO Tunnel
A tunnel along the east side of the Willamette River in Portland, Oregon will reduce CSO discharges by more than 90%.

2008: Sydney Rd Tunnel
The Sydney Rd Tunnel will be the first new addition to the heavy rail network in Sydney, Australia in more than 100 years.

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Reader Service Number 2
STV Announces Reorganization

STV has restructured and reorganized its organization as part of a continuing national mission to optimize performance, quality and client satisfaction. Operations have been reorganized into three principal divisions, each with a national mission: Building and Facilities; Transportation and Infrastructure; and Construction Management.

“This restructuring marks the next phase of growth for STV,” noted Dominick M. Servedio, P.E., chairman and CEO of STV. “We are focusing our efforts to make our organization even more responsive to our clients’ needs, to our employee-owners and to the ever-evolving industry trends.”

The three divisions report directly to Michael S. Della Rocca, P.E., president and COO of STV. “We plan to build on our solid reputation for performance by drawing upon talent from our network of national offices in each of our principal markets,” stated Della Rocca. He also noted that this structure provides opportunity for the continued geographic expansion of the firm.

The Buildings and Facilities Division is operating under the leadership of Maher Z. Labib, P.E., who has been promoted to executive vice president of the firm, and James Vilbert, P.E., who has been named a senior vice president. The Construction Management division is headed by Milo Riverso, Ph.D., P.E., who was promoted to executive vice president of STV.

William F. Mats, P.E., STV’s new executive vice president, is heading the Transportation and Infrastructure Division, assisted by John A. Agro Jr., who was named senior vice president. In his new position, Mats directs more than 500 STV employees engaged in all aspects of transportation and infrastructure planning, design and construction/program management services, including design-build projects. STV’s integrated transportation practice combines the firm’s rail, highway/bridge and aviation infrastructure capabilities.

With STV since 1978, Mats has more than 37 years of in-depth experience in increasingly responsible positions, including direction of major transportation projects for the nation’s largest cities. His expertise encompasses all transportation modes: rapid transit and bus systems, commuter rail, light rail and ferries, as well as rail and truck freight.

A registered professional engineer, Mats earned a bachelor of engineering degree in industrial engineering from Pratt Institute, a master of science in operations research from Columbia University, and a master of business administration degree in finance from New York University. He is a member of the Institute of Industrial Engineers and the Society of American Military Engineers.
CONTECH Construction Products Inc., a recognized industry leader in the design, manufacture and distribution of specialty construction products sold to the civil engineering infrastructure sector of the heavy construction industry, and funds advised by Apax Partners Worldwide, one of the world’s leading private equity investment groups, recently announced that Apax Partners Worldwide has completed its acquisition of a majority ownership interest in CONTECH. The transaction had a total enterprise valuation of more than $1 billion.

“This is a very exciting time for us. Apax Partners brings strong financial resources and a well-established international presence to CONTECH. We welcome their expertise as we identify value-creating, add-on acquisitions to grow our business and provide our customers with solutions that will meet their needs and add dollars to their bottom line,” said Patrick Harlow, chairman and CEO of CONTECH Construction Products Inc.

David Kim, partner of Apax Partners, commented, “Apax Partners is fortunate to have the opportunity to partner with CONTECH’s unusually talented management team. We look forward to working together as they continue to grow this outstanding company organically and through acquisitions.”

In addition, CONTECH has announced a market-focused realignment of its business. The new organization will consist of four operating divisions: Environmental Stormwater Solutions, Bridge Solutions, Earth Stabilization Solutions and Drainage Solutions as well as a new national sales organization — CONTECH Sales, which will be responsible for selling all of the company’s products. The organizational realignment will enable the company to better serve its customers and more effectively accommodate expected rapid future growth.

“The breadth of CONTECH’s product offering has grown significantly in the past five years,” according to Godfrey Little, COO of CONTECH. “That growth requires that we now realign our business to ensure we maintain the proper marketing and customer focus. It will enable our engineering and commercial resources to be experts in the areas most important to our customers. Whether it’s a CON/SPAN bridge, a Vortechs stormwater treatment unit or a Tensar geogrid, the realignment will provide our customers with a very clear, single-source contact and assure that our market-focused organization is providing the best in cutting-edge products, technology and cost-effective solutions.”

Correction
In the December 2005 issue of TBM: Tunnel Business Magazine, a caption on page 15 misstated the project name. The caption should have read Channel Tunnel Rail Link.
Atlanta Starts New Year with the Opening of Nancy Creek Tunnel

Engineers from Jordan, Jones & Goulding (JJG) recently celebrated with Atlanta Mayor Shirley Franklin, members of the Atlanta City Council, Department of Watershed Management officials and other invited guests to mark the completion of the Nancy Creek Tunnel.

JJG and the City of Atlanta had many reasons to celebrate the completion of the 8.3-mile long tunnel, including meeting the Consent Decree deadline and completing the project under budget. The Nancy Creek Tunnel was designed and constructed to store and transport wastewater to the R.M. Clayton Water Reclamation Center. As a result, most of the sanitary sewer overflows in the Nancy Creek basin will now be eliminated.

Echoing Franklin’s comments, Refik Elibay, JJG project manager, said “In order to have a great city, we must have great infrastructure.” Elibay added that personally he is “proud to be a part of the team and company that is helping to make Atlanta an even greater city to live in.”

Completing the project on time and under budget were important factors. However, other goals included minimizing environmental impacts during construction, minimizing disturbance of neighborhoods and not restricting property owners’ surface use of surface land. “I feel that we have accomplished these goals to the satisfaction of the community, which was equally as important as meeting the consent decree,” said Elibay. “For projects such as this one, it takes everyone working together — communities, government and businesses.”

Mike Robison, JJG resident construction manager, credits Ade Abon, the City’s assistant watershed construction manager, with helping to make the project a success. “Without his leadership skills, dedication and ability to work closely with both contractor and engineer, this project could not have been completed on time or under budget. Only when you have someone like Ade Abon can you expect such success on a project of this magnitude.” Abon reports to Marcia Hurd-Wade, the City’s construction management officer, Department of Watershed Management.

Construction of the Nancy Creek Tunnel began in July 2002. The project was completed with Franklin pushing a ceremonial “red button” to mark the tunnel’s official opening.

Parsons Brinckerhoff Awarded CALTRANS Consulting Contract

The California Department of Transportation (CALTRANS) has awarded a contract to Parsons Brinckerhoff for on-call professional and technical construction administration services to support the construction of a major new tunnel in San Mateo County.

The $230 million project calls for two approximately 4,000-ft long, 30-ft wide tunnel bores adjacent to the existing Highway 1 at Devil’s Slide near Pacifica. Each will support one lane of traffic with a standard 8-ft shoulder on the right, a 2-ft shoulder on the left and two 4-ft walkways. In addition, a 1,000-ft-long bridge will be built at the north portal of the tunnel over the California Red-Legged Frog habitat.

Upon completion of the tunnel, CALTRANS expects to deed the original section of Highway 1 to the County of San Mateo, which will preserve it for bicycles, hikers and other non-motorized traffic.

PB will provide a variety of support services to CALTRANS on an as-needed basis, including construction inspection, office engineering, industrial hygiene and other construction engineering services. Construction on the project was scheduled to start in the fall 2005, with completion slated for summer 2010.
Seattle Sound Transit Launches Beacon Hill TBM

Sen. Patty Murray recently joined Seattle’s Sound Transit in marking a major light rail construction milestone. A massive TBM is about to disappear into the side of Beacon Hill as it digs the first of two almost 1-mile long light rail tunnels.

“The tunnels we’re building will serve thousands of commuters every day traveling between downtown Seattle, the airport and the communities along the way,” said Murray. “Today is a big day in continuing to build the mass transit system that is connecting our region.”

The launch of the TBM represents the start of some of the most exciting and technical light rail construction work. The tunnels will tie in with the underground station that is under construction 160 ft below the surface of Beacon Hill. The work is being done by Obayashi Corp., Sound Transit’s experienced light rail contractor for the Beacon Hill segment. The machine is guided with a sophisticated tracking system that is accurate to within an inch.

“This machine means business,” said Sound Transit Board chair and Pierce County executive John Ladenburg. “It’s not often you meet a piece of equipment as long as a football field with an insatiable appetite for chewing up dirt and rocks and leaving behind a modern mass transit system.”

The TBM’s rotating head will cut through everything from sand to boulders, depositing excavated material on a conveyor system for removal. In its path, the machine will install precast concrete segments forming the lining of the tunnel.

“Project after project, we’re showing we’ve got the experience to build a mass transit system,” said Sound Transit board member and Seattle mayor Greg Nickels. “Central Link light rail will dramatically expand the regional system that is up and running today, connecting people from communities all around the region. The system benefits everyone and provides a foundation that can continue growing in the years ahead.”

Last year Sound Transit and Obayashi Corp. held a “Name the TBM” contest open to kids 12 and under who live in King, Pierce and Snohomish counties. Recently, Board members and Murray recognized 7-year-old Sean Davidson of Issaquah, who submitted the winning name: Emerald Mole.

Construction of the Central Link began in late 2003 and currently is now more than one-third complete. Overall, construction bids came in 6 percent below estimates and construction is currently about $200 million under budget. By 2020 the system is projected to carry more than 45,000 riders daily between downtown Seattle and the airport.
Baker, Cruz Win Moles Awards

The Moles’ Awards for Outstanding Achievement in Construction were presented Jan. 25 at the Moles’ annual Awards Dinner at the New York Hilton Hotel. Clyde N. Baker Jr., senior principal engineer with STS Consultants, was honored with the Non-Member Award and Edward Cruz, co-founder of E.E. Cruz & Co. of Holmdel, N.J., was the recipient of the Member Award.

James W. Owens, CEO of Caterpillar Inc., the world’s largest manufacturer of construction equipment, was the keynote speaker.

This year’s Non-Member award went to Clyde Baker Jr. Baker received a bachelor’s degree in physics at William and Mary College, then went on to earn both bachelor’s and master’s degrees in civil engineering at MIT. After graduating in 1954, he worked for STS Consultants in Chicago. Baker has served as geotechnical engineer on a major portion of Chicago’s high-rise construction, and has also served as geotechnical engineer or consultant on seven of the 16 tallest buildings in the world. In addition to this work, he has also developed a reputation for the design and construction of deep foundations and is a leader in using in-situ testing techniques correlated with past building performance to develop more efficient building designs.

Edward Cruz, the recipient of the Member Award, earned his bachelor’s degree in civil engineering from the New Jersey Institute of Technology in 1963. For several years, he worked for his family’s business, Cruz Construction Co. During this time, the company completed numerous projects under his leadership, including a large section of Boston’s Northeast Rail Corridor and the Round Valley, N.J. Water Pipeline. In 1984, Cruz founded E.E. Cruz & Co. with cousin Evaristo Cruz. The company is currently constructing a $250 million stormwater retention and treatment facility in Flushing Bay, N.Y.; the $135 million expansion to the Rahway Valley, N.J., treatment plant; and $75 million in improvements to New Jersey Transit’s Meadow Maintenance Facility in Kearny, N.J.

H.R. Gray Expands Workforce

H.R. Gray, a Columbus, Ohio-based construction management and consulting firm, recently hired Carl Geller as a construction inspector, Glen Frank, P.E., as a senior construction manager and Khalid Ladabi as a construction engineer.

Prior to joining H.R. Gray, Geller worked in the material testing and geotechnical consulting fields providing construction observation and material testing reports on new construction projects. In his new position, he will provide construction inspection services on tunnel, wastewater and sewer construction projects in Ohio.

Geller has a bachelor of science degree in civil engineering from the Technological Institute of the Philippines and an associate’s degree in civil engineering from Columbus State Community College.

Prior to joining H.R. Gray in December 2005, Frank worked for more than 11 years as a geotechnical engineer. He earned a bachelor’s degree in civil engineering and geotechnical engineering and a master’s degree in engineering systems from the Colorado School of Mines.

Frank will oversee construction of the Big Walnut Augmentation-Rickenbaker Interceptor (BWARI) sanitary sewer project. This $220 million project includes more than 34,000 ft of tunneling in mixed glacial soils. He will also be responsible for assisting in the marketing of H.R. Gray’s tunneling construction management practice.

Frank’s unique combination of experience as a designer, contractor and construction manager has earned him the highest respect in the tunneling community. He is a member of the American Underground-Construction Association, the North American Society for Trenchless Technology and the American Society of Civil Engineers.

In his new position, Labadi will provide construction management and engineering services on tunnel, wastewater and sewer construction projects in Ohio. Prior to joining H.R. Gray, Ladabi worked in the Middle East planning and supervising material testing for large construction projects and provided geotechnical engineering services for tunnel, dams and bridge projects.

Ladabi moved to the United States in 2000 and entered Ohio State University where he earned a bachelor of science degree in civil engineering and a master of science degree in construction engineering and management in 2005. Ladabi’s research paper, “Using Fuzzy Logic Model for Safety Assessment in Tunnel Grouting,” was presented at the 10th International Conference on civil structural and environmental computing in Rome, Italy, in September 2005 and will be published this year.
2006 Golden Beaver Awardees Selected

Patrick Kenny of Kenny Construction Co., 2005 President of the Beavers, awarded four individuals with the Golden Beaver awards at the 51st annual Awards Dinner, which was held Jan. 20, 2006, at the Hyatt Regency Century Plaza Hotel in Los Angeles. College basketball announcer Dick Vitale was the guest speaker.

Ronald W. McKenzie, chairman and CEO of TIC Holdings Inc., Steamboat Springs, Colo., received the Management Award. Starting in a Quonset hut in 1974, McKenzie has grown TIC into a major national contracting firm with $1.1 billion in revenue, ranked 32 on the most recent ENR 400 list. TIC’s major focus is on power plants, water/wastewater treatment plants, industrial process plants and petrochemical plants. TIC was one of the founding members of the National Center for Construction Education and Research and McKenzie will serve as its chairman in 2006.

Thomas E. Sherman, recently retired from General Construction, Poulisbo, Wash., received the Supervision Award. Starting as a tradesman, Sherman’s entire 40-year career was spent with General Construction, culminating as project manager and vice president of operations and facilities. His most recent post was as substructure project manager for the Tacoma Narrows Bridge project in Tacoma, Wash., where massive open dredge well caisson foundations were successfully installed despite treacherous currents and challenging high winds and tidal fluctuations.

Robert B. Bittner, President of Ben C. Gerwick Inc., San Francisco, received the Engineering Award. Bittner has spent 34 years in construction engineering and project management on major marine construction projects worldwide. Starting with Santa Fe/Pomeroy in 1969 as a project engineer on its Labarge subsurface oil production pipeline in Australia, Bittner held progressively larger posts with Riedel, Morrison Knudsen Corp. and the Oresund Tunnel Contractors joint venture in Denmark before joining Ben C. Gerwick Inc. in 1996.

Michael C. Peters, President and COO for Safeco Surety, Redmond, Wash., received the Service & Supply Award. Peters joined Safeco Insurance Co. in 1968 as a Surety Trainee after graduating from the University of Washington. Other than a brief period in Chicago, his career with Safeco has been in the Pacific Northwest, holding various positions of increasing responsibility. In 1992 he was named vice president and director of contract surety and in 2001 he was promoted to president.

Bids for Pittsburgh Light Rail Tunnel Still Too High to Proceed

For the second time in six months, bids for the first construction contract to extend light-rail to the North Shore in Pittsburgh came in significantly higher than anticipated. The apparent low bid of $156.5 million was $21.5 million higher than engineering estimates and 10 percent over budget. To continue, the authority will need to convince federal officials that it can cover the additional costs on its own.

The project includes boring twin tunnels under the Allegheny River and constructing 1,200 ft of cut-and-cover tunnel along the western side of PNC Park. Extending the light-rail system from downtown to the North Shore is considered a key to continuing development between PNC Park and Heinz Field. The contract also includes building about 300 ft of retaining walls and the concrete shell of the future PNC Park station.

After the bids received in September 2005 were rejected, authority officials deferred a proposed convention center spur and station in an effort to make the project affordable. The Port Authority has now put contingency funds in the $393 million project budget, which includes $314.5 million from the Federal Transit Administration. But it has to bid 13 additional, smaller contracts to build the 1.5-mile extension and three stations, including a new Gateway Center station, downtown.

The authority has 120 days to review and consider the low bid, which was submitted by North Shore Constructors, a consortium led by West Mifflin, Pa.-based Trumbull Corp. and Japan-based Obayashi Corp. Six companies and joint ventures submitted bids.

When bids for the tunnel-boring contract were opened in September 2005, the apparent low bid of $87 million (which was later disqualified) was said to be 25 percent higher than engineering estimates. The second-lowest bid of $112.9 million also was rejected. As it turned out, it was higher than any other bid submitted for the tunnel-only portion of the contract. The Port Authority repackaged the contract to give companies more options and include the cut-and-cover tunnel, as North Shore Constructors did, in hopes of lowering the price.
ASK DR. MOLE

How Straightforward is Value Engineering?

We have been discussing value engineering as applied to tunnel construction for several columns and Dr. Mole has received more comments about this topic than were received about all other topics combined since we started writing this column in April 2000. The entire thrust of these comments and discussions has been how can we increase the level of cooperation between the owner and the contractor, while at the same time controlling cost, minimizing risk and delivering a finished product to the owner that provides long-term value.

This objective sounds deceptively straightforward, but, as pointed out by Sweet Old Bob [Bob Pond, executive vice president and a director of Frontier-Kemper Constructors Inc.] in the December issue of TBM: Tunnel Business Magazine, the implementation strategy is anything but. As usual, Dr. Mole knows of no one in the tunneling industry who can “grumble about the vicissitudes of the tunnel construction business” better than Bob, based on his 40 years of experience and his ability to put his thoughts into writing. Distilling Bob’s column provides the following five bullet points:

1. Owners who understand, based on actual knowledge and experience, how difficult it is to implement a successful tunnel design. This is especially true with respect to the implementation of subsurface investigations. You can count on one hand how many times Dr. Mole has been asked by an owner, “Now are you sure you have enough test borings?” Cost cutting, for all aspects of design, is rampant and phenomenally counterproductive.

2. Designers who, also based on knowledge and experience, are capable of providing the contract documents for a fully acceptable finished facility and for a well-coordinated, well-conceived and well-documented approach to construction taking into account appropriate construction means and methods, appropriate temporary facilities and appropriate attention to detail with respect to third-party, community and environmental exposures.

3. An owner/designer team that truly understands the overwhelming and potentially “negative” impact that the differing site conditions clause can have on the outcome of a tunneling project. When this clause is used, the owner/designer is obligated to provide contract indications for subsurface conditions. If those indications are materially “different” from what is encountered during construction, then the cost and scheduling impacts of those differences become the responsibility of the owner. Most owners who are familiar with differing site conditions for above-ground structures, where the ground risk is limited, simply do not realize the huge negative impacts and associated ripple effects that can occur on a tunneling project.

Our approach to construction engineering has been to address this issue by combining the best aspects of design/bid/build and design/build procurement concepts; both approaches have advantages and disadvantages for tunneling. In general, our intention was to provide a well-designed finished facility accompanied by a flexible and cooperative approach to construction means and methods and temporary facilities. From the comments we received, I’m not sure that we made it, but I am still studying the results and will provide a final overview of this topic in my next column.

Gary Brierley is president of Brierley Associates, Denver.
Lovat Celebrates Automated Subway Opening in Turin, Italy

In advance of the Opening Ceremonies of the 2006 Olympic Winter Games, the City of Turin, Italy, celebrated the opening of its new automated subway system.

Participating in the public ceremony was Ing. Richard Lovat, Italian Minister of Transportation, and Ing. Piergiorgio Grasso, of Geodata/Systra. Participating in the public ceremony was Ing. Richard Lovat, Italian Minister of Transportation, and Ing. Piergiorgio Grasso, of Geodata/Systra.

Completion of the line was a “point of departure, not arrival,” for the City of Turin. The Metro uses Light Automatic Vehicles that are remotely controlled allowing for increased efficiency and safety of the Metro’s operation. This design has previously been used in Taipei and Chicago.

Approximately 6.2 km of the 9.6-km line was built by Lovat RME306SE earth pressure balance TBMs, which were first delivered in 2002. The contractors were GSG Tunneling S.r.l. (a joint venture of Grandi Lavori Fincost S.p.A., SELI S.p.A. and Impressa Grassetto S.p.A.) and TEC S.r.l. (a joint venture of SELI S.p.A. & Grandi LavoriFincostS.p.A.) which worked on behalf of the owner, SATTI S.p.A., now called Gruppo Torinese Transporti.

Arup to Survey Singapore Rail Extension

The Land Transport Authority (LTA) of Singapore has awarded an advanced consultancy contract to Arup for the new Downtown Extension (DTE) to the Circle Line, a $6.7 billion railway project currently under construction in downtown Singapore. Arup’s work will comprise a multi-disciplinary feasibility study, including the surveying of some 700 properties and the preparation of a geotechnical baseline report.

The downtown extension will consist of three new stations, plus an interchange at the existing Chinatown Station and another with the Circle Line Promenade Station and 3.4 km of new twin track tunnels. Construction is expected to start in mid-2007 and be completed by 2012 at an estimated cost of $1.4 billion.

“arup to survey north europe rail extension”

“This extension to Singapore’s Mass Rapid Transit system presents many technical and logistical challenges, and we have put together a strong team of local and international engineers and experts to meet this challenge for the Land Transport Authority,” said Bill Grose, global leader of Arup’s tunneling business.

Grose noted that the DTE route passes through newly reclaimed land earmarked for Singapore’s Integrated Resort development and beneath the central conservation area of Chinatown, which showcases some of Singapore’s best preserved built heritage.
Tunneling in Canada has been given a boost in recent years from two distinctly different sources. Canada is rich in natural resources and rising prices for energy and minerals have led to tunneling activities in those fields. Social pressures have resulted in investments in transportation, water and wastewater infrastructure, with tunnels being the logical solution to avoid impacts to existing facilities in population centers. Increased tax revenue from the natural resources is, in part, paying for the urban infrastructure development.

In the June 2002 issue of *TBM: Tunnel Business Magazine*, Boro Lukajic, assessed the Canadian tunnelling market. What follows is a comprehensive update of that assessment, including several examples of the range of projects, both under way and in the planning stages across Canada. Lukajic noted in his overview that funding for public infrastructure at the time was lagging behind the demand for facilities, but this has changed dramatically in the last few years.

**Transportation**

Transportation tunnels have historically been largely limited to highway and train tunnels in mountainous areas and under streams, with three exceptions. The two major population centers of Montreal and Toronto adopted subway systems decades ago. The Montreal metro is currently being extended to the northern suburb of Laval, with an in-service date of 2007. Tunneling of the 3.2-mile line passing under the Rivière Des Prairies was completed in 2005. Construction of three deep stations is currently under way.

The last major expansion of Toronto’s system was the Sheppard line, completed in 2002. A second extension was designed at about the same time as the Sheppard line but was shelved.

The Gardiner Expressway in Toronto extends for several kilometers along the city’s waterfront. Recently, the city has considered reclaiming the attractive real estate by putting the expressway underground. The concept is similar in scope to Seattle’s plans to remove the Alaska Way viaduct along its waterfront.

Edmonton, a much smaller city in oil-rich Alberta, is the only other city with a significant (compared to the population) underground system. Approximately 40 percent of the light rail transit’s 7.4 miles is underground. The line was extended with a short tunnel rising to surface near the university in 2003, and it appears that future extensions away from the downtown core and the river valley will be on surface.

Vancouver has, to date, had little in the way of underground rapid transit. The “Skytrain” line, commissioned in 1979, has never extended into the city center where land values are high. The last major effort was a proposal to extend the network underground to a point in the suburbs. The city’s transit network, however, remains almost entirely above ground.
To facilitate advanced treatment of two of Greater Vancouver's water sources and interconnect the two distribution systems, 4.5 miles of twin, 12-ft diameter, hard-rock TBM tunnels will be driven beneath North Vancouver. A single water treatment plant is under construction at the Seymour valley. Untreated water from the Capilano reservoir will be delivered to the plant, and then returned after treatment for distribution. Shafts at each end are 594 and 891 ft deep, in order for the tunnels to pass beneath an infilled preglacial valley.

The head difference between the two sites offers opportunity for energy recovery. Bilfinger-Berger of Germany, in its first Canadian project, is constructing the tunnels and shafts. Currently, base excavation is under way in the launch shaft and the Robbins TBM is scheduled for start-up in June 2006.

At the third major water supply source to the east, Coquitlam Lake, a short design-build tunnel for the intake was recently constructed to allow reconstruction of the dam and conceptual plans for expansion of the supply include a short tunnel in the opposite abutment; this expansion is unlikely to take place for several years.

Edmonton is unique in Canada and perhaps North America. The city has had its own tunnel construction department for more than 50 years and owns several Lovat TBMs for use on water supply and sewage tunnels. In 2005, the 4,653-ft long, 9.5-ft diameter 23rd Avenue storage tunnel was completed. An additional 20 km of tunnels are in the planning stage.

Metropolitan Toronto's continued growth is putting increasing pressure on its infrastructure. In York Region, for example, the York Durham Sewage System has more than 12.4 miles of tunnels under construction or about to be awarded. The Southeast Collector Trunk Sewer, which will twin an existing 8.7-
Canada is richly endowed with fresh water, so hydroelectric power generation is one of its main energy sources. Construction is currently under way across the country to supply both domestic and U.S. consumers. A mile long system, is currently undergoing an environmental assessment. It is required to be in service by 2010.

Air conditioning in downtown Toronto is becoming increasingly environmentally friendly as Enwave Energy Corp. extends its heat exchange technology, using the the constant 4°C temperature of Lake Ontario, at a depth of 274 ft, as the heat sink. A TBM tunnel, completed in 2004, contains the heat exchange unit. The water then continues on to the city's potable water supply system.

Power Supplies

Canada is richly endowed with fresh water and hydroelectric power generation is one of the main energy sources. Construction is currently under way at several projects across the country for power to both domestic and U.S. consumers. In Quebec, the pace of development has slowed compared to the 1980s, when the James Bay mega project was at its peak, but development has never stopped.

The Toulnustouc project, commissioned in mid-2005, includes a 6.1-mile headrace channel, as well as a diversion tunnel around the dam site. Currently, the Eastmain 1 and the Péribonka plants are under construction, both featuring short (1,155- and 1,749-ft) diversion tunnels. The Péribonka powerhouse will be an underground powerhouse (site of the world’s second largest underground powerhouse) is under consideration. Three preferred proponents for the development were selected in mid-2005 and the next phase of feasibility review is under way. Two hydro developments, Gull Rapids and Muskrat Falls, will include significant diversion tunnels to facilitate dam construction.

Ontario Power Generation recently awarded the landmark Niagara Diversion Tunnel project to Austria’s Strabag — its first project in Canada. The approximately $510 million (U.S.) scheme will see construction of a 6.2-mile long, 41-ft ID tunnel in the swelling Queenston shale. The lining will be cast in place with a membrane backing to prevent fresh water from contacting the shale and initiating swelling. Robbins will provide the world’s largest hard rock TBM, with launch scheduled for fall 2006. Trail gear will be supplied by ROWA. The design-build project price is tied to actual flow capacity and schedule.

The Northwestern Territories are home to Canada’s first diamond mines, with two in production and a third recently receiving environmental approval. The Territories’ Power Corp. is examining the feasibility of power transmission to the mines from hydroelectric plants. Expansion of the Twin Gorges hydro plant is being considered, with one option including a short headrace tunnel. Currently, the remote mines use diesel power generation; the fuel is trucked in annually on winter roads and represents a substantial part of the operating costs. However, Twin Gorges is more than 290 miles south of the nearest mine; cost and security of energy transmission in the hostile arctic environment are significant issues to be addressed.

In British Columbia, several hydro plants are under construction. Close to the U.S. border on tributaries of the Columbia River, tunnelling was recently completed at the Brilliant Expansion Project. The Waneta expansion, less than a mile from the international border, is undergoing technical evaluation and environmental scrutiny; it will feature a short power tunnel. Both of these projects are owned by the Columbia Power Corp., a provincial government organization.

BC Hydro, the province’s main power supplier and the agency for international power sales, recently completed a comprehensive power development plan that is now under review by the province. The single big project under consideration is the Site C development on the Peace River. The scheme will require diversion tunnels in the order of 33-ft diameter, excavated in weak shale. This project has been on-again, off-again several times since the early 1970s.

Private development of hydro power in British Columbia has grown significantly in the past decade, as the provincial government has permitted...
smaller independent suppliers to provide energy. These tend to be run-of-river to minimize environmental impact and qualify as "green" power projects. Tunnel requirements include both diversion tunnels for construction and power tunnels. BC Hydro most recently called for tenders for independent power supply in December 2005. Under earlier calls, the Pingston Hydro plant, with 2.2 miles of tunnels and a 1,485-ft. shaft was completed. Among proposed plants, the Ashlu and Zeballos Lake projects, both in the southwest of the province, include power tunnels approximately 3.4 miles and 3,300 ft. long, respectively.

The storage of spent nuclear fuels remains a technically and socially challenging task. Canada has been in the forefront of research into underground storage for the past two decades. The Underground Research Laboratory constructed by Atomic Energy of Canada Ltd. is located in eastern Manitoba in granitic rock of the Canadian Shield. It has carried out research and development into characterization of the rock mass, instrumentation and controlled blasting techniques to minimize rock damage. Recent R&D has focused on techniques for sealing storage caverns. The facility is now in a safe decommissioning mode and the federal government is expected to make recommendations for the next step in long-term radioactive waste management. The Nuclear Waste Management Organization’s recommendations to the government include underground storage of waste, with the potential for waste retrieval until such time as society accepts a permanent means of disposal. It is possible that the next phase will include an underground facility in Ontario.

In Summary
Tunneling is a vital part of Canada’s infrastructure and energy development. Only tunnels are feasible to address increased demand for water supply and treatment and for storage and treatment of all sewage in many urban settings. Tunneling for these facilities is likely to increase in the future as populations continue to grow in the major cities and their suburbs. Most tunneling for water, sewer and transportation projects occurs in the larger population centers. However, nationwide demands for a safe water supply and adequate wastewater treatment, supported by legislated water quality criteria, will result in more work, including tunneling, in smaller population centers in the future. An incessant demand for energy, coupled with societal concerns over greenhouse gas generation and nuclear waste disposal, favor non-polluting, renewable hydroelectric generation where tunnels are an integral part of the developments. High prices for energy and minerals appear to be with us for some time and the spin-offs include tax dollars for continued infrastructure development. Tunneling will remain active in Canada for several years to come.

Garry Stevenson is president of the Tunnelling Association of Canada (TAC) and general manager of the geoenvironment group of Klohn Crippen Berger Ltd., Vancouver, Canada.

Acknowledgments
Thanks to fellow Tunnelling Association of Canada Members Dean Brox, Brian Garrod, Brendan Henry, Frank Huber, Greg Kuzik, Hani Mitri, Bill Steller and Derek Zoldy for contributions from their regions.
With the ongoing recovery from the Asian economic crisis in 1997, the Hong Kong Special Administrative Region (HKSAR) continues to expand its infrastructure at an extraordinary rate. The New Territories' urban developments, population growth and increasing trade with mainland China are the driving forces behind this expansion. The constraints of existing structures, natural terrain and environmental considerations are making the use of tunnels a key element of all the major projects under construction and planned for the near future.

There already exists more than 370 km of bored tunnels in the HKSAR – more than 65 percent of which are 7- to 13-ft diameter water transfer, sewerage and other utility tunnels, 22 percent are 16.5- to 26-ft diameter rail tunnels and 12 percent large span dual two- and three-lane road tunnels.

The tunneling industry in Hong Kong has had a history of feast and famine over the past quarter century that looks destined to continue over the next decade. It began with the construction of the mass transit railway (MTR) system in the 1980s, then a quiet period with a few utility and road tunnels. In the mid-1990s came two major projects that caused a boom in the local tunneling industry: the new airport project and the deep sewer drainage project.

Following on from these came the mass transit line extension into the Tseung Kwan O new town development and the Kowloon Canton Railway Corp. (KCRC) West Rail project. Since 2000, the tunneling workload had steadily decreased with many potential projects, like the proposed KCRC Sha Tin to Central link, a number of MTR extension projects and the second phase of the deep sewer scheme project either shelved or their implementation slowed down by red tape.

In early 2005, the future looked particularly bleak with many of the remaining tunneling professionals leaving Hong Kong, tempted by new projects worldwide. However, a surge in activity, at least for the design consultants, in the latter half of 2005 indicates that the pendulum is swinging once again back toward growth in the tunneling industry. This comes at the same time as what appears to be a general increase in major tunneling infrastructure projects worldwide.

By David Salisbury
KCRC recently awarded two contracts to complete the link between the West and East rail lines, a 2.2-mile project known as the Kowloon Southern Link (KSL). The northern section will be constructed as a cut-and-cover box along the mid-1990s West Kowloon reclamation with the 1.2-mile southern section, which includes West Kowloon station, being constructed using a 26.4-ft diameter slurry mixshield TBM along an extremely tight road corridor in very challenging mixed ground conditions. The stacked alignment then unwinds while negotiating a tight sub 825-ft radius curve and passes directly in front of the famous Peninsula Hotel with less than a diameter of cover to the road surface before crossing existing MTR lines and connecting to the East Rail extension at Tsim Sha Tsui.

In 2004, KCRC completed a scheme design study for a new Sha Tin to Central Line (SCL) that would provide it with the first connection from the mainland to Hong Kong Island.
The project was put on hold pending the merger negotiations with MTRC, as a combined network would affect the viability of the alignment and the layout of some of the stations. Until a final decision is made on the merger, this project is likely to remain stalled. If and when it does go ahead, the majority of the alignment is in tunnel with a potential for six mixed-face TBMs of 23- to 24 ¾-ft diameters, along with drill and blast, cut-and-cover and immersed tube to produce more than 11.2 miles of twin-tube tunnel.

KCRC has two other major projects that are at the feasibility stage, a third border cross into mainland China called the Northern Link and a regional express line from Guangzhou to Kowloon, both of which will require extensive tunneling work if they go ahead on the proposed alignments.

Highway Tunnels
The major ongoing highway project, known as “Route 8,” has three large tunnel projects, as well as large sections of viaduct and what will be the world’s largest cable stay when constructed, Stonecutters bridge. All three are hard rock drill and blast tunnels and are nearing completion. Several other highway projects involving tunnels are likely to move closer to reality in the next three to five years.

The proposed Hong Kong-Zhuhai-Macau bridge, which would link the three economic centers, looks likely to go ahead in 2006 or 2007. While the majority of the road will be a bridge viaduct across the Pearl Delta, which separates the three areas, at the Hong Kong landfall on Lantau Island adjacent to Chek Lap Kok airport, there are proposals for either drill-and-blast or very large diameter bored tunnels to carry the dual triple lane highway. If the link goes ahead it will have consequences for a proposed link across to Tuen Mun from Lantau Island and the Eastern and Western Tuen Mun bypass projects, all three of which are at the feasibility study stage and will involve extensive tunneling if they go ahead.

The Highways Department is also believed to be studying the possibility of a second tunnel — from east Kowloon to the new development of Tseun Kwan O — to relieve the existing tunnel, which is expected to reach designed capacity before 2010.

Drainage Tunnels
The Drainage Services Department (DSD) has recently invited investigation, scheme design and construction supervision bids for four major tunnel schemes. All bids were submitted by Jan. 6, 2006, and award of design assignments are pending. Of the four projects, the largest is 14.3 miles of 4- to 11.5-ft diameter tunnels forming the Harbor Area Treatment Scheme (HATS) Stage 2. This is the next phase of the scheme previously known as the strategic sewage disposal scheme (SSDS), which suffered major delays and cost overruns during the first phase works excavating deep sub-sea hard rock tunnels, where excessive faulting and water ingress was experienced. HATS Stage 2 is likely to consist of four or more design and construct tunnel contracts and will commence prequalification in early 2008.

The other three tunnel projects are stormwater drainage schemes that continue the major upgrade of the existing urban drainage system, which, due to continuing development and reclamation, is prone to cause flooding during heavy rainstorms. Of these three, the West Hong Kong Stormwater project is the largest, consisting of more than 6.2 miles of 22- and 25.5-ft diameter tunnels with more than 30 intake shafts and a large outfall structure. This, along with the other two similar smaller projects in Tsuen Wan and Lai Chi Kok, are likely to start prequalification for design and construct contracts in mid-2006 with construction commencing in 2007 and extending over the following five years. It is expected that these will continue the success of the recently completed Kai Tak Stormwater Transfer Tunnels.

The Civil Engineering Development Department has a small, but interesting, project on Hong Kong Island about to begin prequalification, which is designed to drawdown the groundwater table beneath and behind an existing slope that has a history of landslides. The current raking drain system requires continuous maintenance and is in need of replacement. The proposal is to drive two gallery tunnels behind the slope in the
underlying granite bedrock and drill arrays of drain holes out of the tunnel up to the rockhead, the aim being to create as much water seepage as possible. The scheme design is ongoing and prequalification documents are due to be issued in early 2006.

**Utilities**

One of the two local power companies, China Light and Power (CLP), has recently awarded its fifth cable tunnel project for a 2.8-mile, 15-ft diameter hard-rock TBM drive from its remote Castle Peak power station down to the urban network as part of the ongoing upgrade of the main electricity grid.

This follows the successful completion of four other cable tunnels in 2005. The other utility companies also have some minor tunnel projects ongoing and proposed for the future, which keep several local medium-sized contractors relatively busy.

**Pedestrian Subways**

The value of real estate on Hong Kong Island is such that developers are willing to invest large sums in infrastructure to connect their buildings to the mass transit network. The Swire Properties/MTR 990-ft long Queensway Subway, currently under construction, is one such project that will connect Swire’s new office development to its existing retail and office development and the local MTR station pedestrian subway. This is one of several similar projects ongoing with a number of others in various stages of development.

**Ocean Park Funicular**

Following the opening of the Hong Kong Disneyland, the local theme park Ocean Park has decided it will undertake a $500 million redevelopment and expansion program — a key feature will be a funicular railway, the majority of which will be tunneled to transport park visitors through the hillside from the lowland entrance to the headland attractions.

The 0.8-mile long railway will be one of the first items of infrastructure to be constructed and a design-and-construct tender is likely to be issued for a two-year construction period in mid-2006.

**Elsewhere in East Asia**

The government of Thailand appears to be pushing ahead with the next phase of the Bangkok MRT. Several new lines are undergoing scheme design with the promise of tenders being issued in 2006.

Singapore continues its steady development of mass transit infrastructure with the ongoing central line extension and the future downtown line extension to service the future “Integrated Resort” development (they try not to call them Casinos in Singapore).

Before we get too excited about the future and start booking one-way flights to Southeast Asia, it should be noted that not all the projects outlined above have received the funding necessary to move into the construction phase. Some are already under construction, while others haven’t made it past the feasibility study stage. The majority, however, are real projects, which are in various stages of their design development. There are also a number of other potential major and minor projects not mentioned here that could further boost the region’s tunneling industry.

David Salisbury is an associate with Ove Arup & Partners Hong Kong Ltd. and leads Arup’s East Asia tunnel design team.
The Kárahnjúkar Hydropower project is located amongst the mountains and fjords of remote northeastern Iceland. When completed, the 690-MW plant will provide 4,600 GWh per year of power to Alcoa’s Fjarðaál (aluminum of the fjords) plant, which is now being constructed at the port of Reyðarfjörður. The first new primary aluminum facility Alcoa has constructed in 20 years, the new smelter will have a capacity of 350,000 tons per year.

While the project has been discussed for nearly 50 years, it only became a reality in the last five. In 2001, a thorough environment impact assessment (EIA) on the project was completed. The Iceland Ministry for the Environment gave a final positive ruling and in 2002, followed by approval from a sizable majority of the Althing, Iceland’s parliament.

Later that year, the Ministry for Industry issued all of the necessary permits for the project and preparatory work was able to begin, including road construction. Local municipalities issued the necessary construction permits in February 2003 and in March 2004, a 40-year contract to provide power for the new aluminum smelter was concluded with Alcoa.

The Kárahnjúkar Hydropower project will harness the power of the Jökulsá í Fljótsdal and the Jökulsá á Dal glacial rivers, which flow from the northeast area of the 3,100-sq mile Vatnajökull ice cap, the largest glacier in Europe. Water from the Jökulsá á Dal River will be collected behind three dams, the largest of which, Kárahnjúkastífla, is located at the southern (upper) end of the Hafrahvammar canyon and is approximately 2,400 ft long and 633 ft high.

This concrete-faced, rock fill dam will be the highest of its type in Europe. Thus is formed the Hálslon Reservoir — 2,050 ft above sea level. From the Hálslon Reservoir, the water will flow 24 miles through the headrace tunnel. Midway along the headrace tunnel, the diameter will increase from 23 to 25 ft and additional water will be introduced from the Ufsarlón Reservoir. The Ufsarlón Reservoir will be formed by damming the Jökulsá í Fjótsdal River. Three other smaller rivers will also be diverted into this reservoir. The 8.7-mile long Jökulsá tunnel will carry the water from the Ufsarlón reservoir to the main headrace tunnel.

At the end of the long headrace tunnel, the water will drop 1,375 ft down two 11-ft diameter, vertical shafts to the powerhouse. After passing through the six 115-MW Francis turbines the water will flow through a long tailrace tunnel and then an open channel, from which it is returned to a river. Total head of the project is 1,965 ft and the maximum flow rate is 2.3 million gal per hour. Electricity will begin to flow in April 2007 and the project is scheduled for total completion in 2009.

In early 2003, Impregilo S.p.A., of Milan, Italy, was awarded the construction contract for $341 million — approximately 94 percent of the cost estimated by the owner’s engineers. To complete the project, Impregilo is employing three TBMs manufactured by The Robbins Company, Solon, Ohio, for the majority of the adit and headrace tunnel excavation. The excavated rock is transported on conveyor belts to disposal areas near each adit. A total of 43 miles of tunnels are being
excavated on the project by TBM and drill-and-blast methods.

Geology

The bedrock in the project area was formed over the past 6.5 million years, now consisting of an approximately 8,910-ft thick sequence of basalt flows with intercalated sediments and moberg formation of various kinds. The basalt is classified into the following three petrographic types, including holeiite basalt, Olivine basalt and Porphyritic basalt.

The power plant will harness the power of two of glacial rivers that flow from the 3,100-sq mile Vatnajökull ice cap.

The accumulation rate of lava and the average period between eruptions in the Fljótsdalur-Jökuldalur area have been determined to be about 1,600 ft per million years and 20,000 to 30,000 years, respectively. Sediments in the area occur as intercalations between lava flows, as well as thick accumulations filling depressions and old valleys. Moberg formations occur in the upstream part of the project as buried bodies of pillow lava, pillow breccia, tuff-breccia and tuffs.

The nature of the sediments varies with their location within the lava-pile. In the lowest part of the pile, most sediments are fine grained and tuffaceous. In the upper part of the pile, the sediment intercalations indicate cold climate with deposition of glacial conglomerates and tills. The thick sediments are of fluvo-glacial origin, mainly consisting of conglomerates and sandstones. Heavy underground water inflows were expected during the tunnel excavation phase with peaks up to 143 gal per second.

TBM Specifications

<table>
<thead>
<tr>
<th>TBM Specifications</th>
<th>TBM No. 1</th>
<th>TBM No. 2 &amp; 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBM Diameter [m]</td>
<td>7.63</td>
<td>7.23</td>
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<td>Cutter size [in]</td>
<td>19</td>
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<td>Cutter load capacity [kN]</td>
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<tr>
<td>Number of cutters</td>
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<tr>
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</tr>
<tr>
<td>Cutterhead power [kW]</td>
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<tr>
<td>Cutterhead torque [kNm]</td>
<td>6,275 at 4.62 rpm</td>
<td>6,275 at 4.62 rpm</td>
</tr>
<tr>
<td>Cutterhead speed [rpm]</td>
<td>3,490 at 8.3 rpm</td>
<td>3,490 at 8.3 rpm</td>
</tr>
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<td></td>
<td>0-8.3</td>
<td>0-8.3</td>
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</tbody>
</table>
provide the optimum cutter spacing for the particular geology. The cutterhead support assembly also includes the front, side, and roof supports. These supports firmly stabilize the cutterhead during boring and ensure precise cutter tracking.

The main bearing is a three-element roller bearing. This is similar in design to the bearings used on all Robbins HP TBMs. The bearing is capable of sustaining the high thrust loads realized under HP operation. The three-element bearing has large rollers and the bearing diameter is large compared to the tunnel diameter. The bearing is designed specifically for Robbins HP TBMs for sustaining the eccentric loads that can occur during steering of the HP TBM or in blocky or “mixed face” conditions.

The gripper system anchors the thrust reaction gripper shoes to the tunnel wall. The gripper system consists of a large bore, double rod gripper cylinder and two gripper shoe assemblies. The gripper cylinder is capable of providing a gripping force that is many times greater than the thrust force of the machine. This ensures a rigid anchoring system during forward propulsion of the TBM with virtually no slippage of the gripper shoes on the tunnel wall. The contact area of gripper shoes is large enough to maintain low ground pressure in the weaker rock formations. The gripper shoes are slotted to accommodate ring beam installation immediately behind the cutterhead support. The thrust system consists of four propel cylinders that provide the required cutterhead thrust.

The TBMs are equipped with roof/probe drilling systems, ring beam erectors, mesh handling cranes and shotcrete robots to install ground support as required. The roof and probe drilling system consists of two Tamrock HL560 super rock drills mounted to the TBM in such a way that rock bolts can be installed in the upper half of the tunnel cross section as the TBM moves forward. When probe drilling is required, a hydraulic actuator rotates the rock drills into the correct position for probing ahead of the machine.

The shotcrete robot system and an invert-cleaning muck bucket are installed on the bridge structure. These systems can travel along the axis of tunnel while the TBM is boring. An Aliva spraying arm type AL-302 was installed to handle the large amounts of shotcrete required during excavation.

Also included in the TBMs are core drills, cutter handling systems and service beam/hoists for material handling work. Behind the TBM is the 325 ft long back-up system. This system is continuously towed by the TBM. It consists of a bridge between the rear section of the TBM and the first rolling deck, a transfer conveyor, nine rolling decks with upper and lower platforms, as well as one ramp section. A single-track rail, with 36-in. gauge, is installed at the center of lower platform of all decks. Supplies such as rails, continuous conveyor components, fan lines, etc., are brought forward with a supply train and stored in designated areas along the backup.

Status of Tunnel Excavation
Throughout the design and manufacturing of the three TBMs, several meetings were held between The Robbins Company, Impregilo S.p.A., the client and outside consultants to review the progress of the TBM design and manufacture in order to produce the best possible product. TBM No. 3 was shipped to Iceland by mid-October 2003. TBMs No. 2 and No. 1 were shipped to Iceland in mid-January and mid-February of 2004, respectively.

TBM No. 3 components arrived at the jobsite in early January 2004. Prior to the TBM assembly, an assembly shed with a gantry crane was erected to protect the workers and equipment from the harsh winter conditions in Iceland.

The TBM cutterhead was manufactured in nine pieces that were welded together at the jobsite. An international welding company was contracted to perform the welding, which required nearly a full month. A detailed
assembly sequence for all of the major TBM components was developed prior to arrival at the site.

The main skeleton of the TBM was set on top of transportation dollies. Backup decks and the bridge were assembled and connected to the TBM. The entire tunnel boring system was then brought into the tunnel-starting chamber. After completion of wiring and plumbing, the TBM was fully tested and commissioned on April 24, 2004, when the boring operation started.

TBM Nos. 1 and 2 were assembled in the same fashion as TBM No. 3, and started boring on July 26, 2004, and Sept. 21, 2004, respectively. TBM No. 1 was spectacularly moved along an adit with downward slope of up to 5 percent. As of the end of December 2005, the three TBMs have bored a total of 61,238 ft, or 47 percent of the total TBM bored tunnel.

TBM No. 3, the first to arrive at the project, started boring from Adit No. 3 toward the Hálslón Reservoir. The machine bored 3,039 ft in its first full month of operation, and 3,396 ft in only its third full month of production. This was an extraordinary start and the machine continued very well, averaging 1,973 ft per month over its first year of production through a wide range of geology, until it encountered extremely high water inflow and the ground became more fractured.

Crews have experienced extremely inhospitable environmental conditions on the Kárahnjúkar Headrace Tunnel, including temperatures of -13 F and wind speeds up to 105 miles per hour.

TBM No. 3 was stopped in July 2005, brought back to Adit No. 3 and turned 180 degrees to begin boring toward Adit No. 2. The decision to withdraw the TBM from the Hálslón heading was taken a bit ahead of the original plan after encountering tunnel water exceeding 260 gal per second.

Original expectations were that flows would not to exceed 143 gal per second, and at times more than 52 gal per second was issuing directly from the tunnel face. Since the tunnel could be more aggressively pre-grouted by full-face drilling and the final 3,630 ft could be finished well within schedule by drill-and-blast methods, the decision was taken to turn the machine ahead of schedule. TBM No. 3 started boring toward Adit No. 2 at the end of December 2005.

TBM No. 2 is boring from Adit No. 2, and now directly toward the oncoming TBM No. 3. This machine also had a stellar start, boring almost 2,900 ft in its first full month of operation. Through widely ranging geological conditions, the machine averaged 1,838 ft per month over its first nine months of operation, before encountering multiple faults in May 2005.

The fault zone was not predicted in the original geological studies. Core drilling revealed a zone more than 115.5 ft immediately ahead of the machine with cohesion-less material up to 26 ft thick. In addition, water inflows to 39 gal per second were encountered. Impregilo made plans for a significant ground improvement program requiring the machine be stopped for several months. The plan called for the machine to start boring again in November 2005, which it did, achieving 1,188 ft that month. The rock continues to be difficult, however, more than 660 ft was completed in December. Fortunately, the early turnaround of TBM No. 3 will help to alleviate any potential delays as the machines now bore toward each other.

TBM No. 1 is boring from Adit No. 1 toward Adit No. 2, and has been performing extremely well, averaging 2,076 ft per month for the 15 full months it has been in operation. It has bored 31,749 ft, or 72 percent of its total tunnel, since starting in late September of 2004. Boring utilization has generally exceeded 40 percent.

Project Summary

The Kárahnjúkar Headrace Tunnel, KAR-14 is a large and challenging project in extremely inhospitable environmental conditions. Temperatures of -13 F and wind speeds of up to 105 miles per hour have been experienced at the site. In addition, the very hard and abrasive rock in combination with extreme fractured zones and high water inflows create some difficult geological conditions for tunneling. The extreme weather and geological conditions, of course, have the potential to negatively impact the tunneling performance on the project.

Recognizing the adverse conditions, engineers and technicians from Impregilo S.p.A. and The Robbins Company have worked closely together to design, manufacture and employ three high-power TBMs in the construction of the headrace tunnels. The cooperative approach has had a very positive result. Impregilo S.p.A.’s experience in TBM tunneling, combined with Robbins expertise in TBM design and manufacture, has resulted in one of the best performance records in the tunneling industry. A project that frightened many international contractors is being completed on schedule, despite the severity of conditions. The record speaks for itself.

Joe Roby is vice president of The Robbins Company, based in Solon, Ohio.
For over a quarter of a century, Linabond’s award winning composite liners have been considered by many design engineers worldwide to be the most efficient and durable technology for corrosion protection, infiltration/Inflow prevention, containment and structural reinforcement of municipal infrastructure. Thorough evaluation, including testing to pressures of up to a half-mile of water head, by the design team for the Columbus, Ohio, BWARI Tunnel led to the selection of Linabond’s Composite Structural Polymer System as the liner of choice. Linabond leads the field in long-term performance, cost effectiveness, and fast installation. 818-362-7373 www.linabond.com

Reader Service Number II
The Big Walnut Augmentation/Rickenbacker Interceptor (BWARI) project is part of an overall program for the City of Columbus, Ohio, intended to significantly increase the capacity of its sanitary sewer system by midyear 2008. The program includes sewerage plant and conveyance improvements totaling $300 million that are currently in construction under the supervision of H.R. Gray, which is serving as construction manager for all of the projects in the program. The BWARI tunnel project includes approximately 36,800 ft of pressure balance tunneling and is made up of two parts, both of which are currently under construction.

Part One of the BWARI project was awarded in September, 2003, to the Jay Dee/Michels/Traylor Brothers (JDMT) joint venture for the bid price of $91 million. Part Two was awarded to the McNally/Kiewit Construction (M/K) joint venture in October 2004 for the bid price of $79 million. The lowest bids for both contracts are well below the engineer’s estimates of $116 million for Part One and $89 million for Part Two. Estimates for the two design-bid-build contracts were prepared by H.R. Gray during the design process, which was led by URS Corp., and based on geotechnical investigations, tunnel design and geotechnical baseline reports prepared by Lachel Felice & Associates.

Additional requirements for the main conveyance tunnels included a one-pass bolted and gasketed precast concrete segmental lining, which is protected on the inside with a 320-degree corrosion-proof lining across the crown. Depth to the top of the tunnel ranges from 28 to 68 ft deep on both tunnels, with one stream crossing with only 10 ft of cover on Part One and a water table well above the crown on both projects. Working pressure for the closed-face pressurized TBM’s will be in the order of 18 to 30 psi.

Both tunnel contracts and the associated Southerly Waste Water Treatment Plant upgrades are scheduled to finish together, with the BWARI sewer tunnels and new treatment plant headworks expected to accept flow in July 2008. These improvements, comprising a $300 million investment by the City of Columbus, are designed to relieve the area’s existing 108-in. Big Walnut outfall sewer main, provide sewerage service to

By Glen Frank
new developments around the Rickenbacker Airport (former Air Force base and current air cargo facility) near Lockbourne and accommodate approximately 37 million gal of storage, which will greatly reduce the frequency of sewage overflows. In addition, the improvements will provide the required downstream capacity for the City’s long-term wet weather management plan.

Part One of the BWARI project consists of approximately 21,400 lf of 168-in.-diameter concrete sewer, of which approximately 470 lf is open-cut construction and approximately 20,930 lf is tunnel construction. Two small-diameter road-crossing connections to shallow sewers will be constructed by trenchless methods. Production of pre-cast concrete segments began in August 2004 and is now complete. The joint venture of CSI Tunnel Systems and Hanson Concrete will continue to supply the segments to the main shaft from Hanson Concrete’s local facility.

Also known as the Big Walnut Outfall Augmentation Sewer (BWOAS), Part Two of the Big Walnut Interceptor project consists of approximately 15,850 lf of 144-in. diameter concrete sewer tunnel, plus approximately 5,393 lf of 42 in. diameter sewer. Of the total length, approximately 4,523 lf will be open-cut construction and approximately 877 lf will be tunnel construction. In addition to 12 ft and 42-in. conveyances, a large gate/drop structure, where the flow from the existing 108-in. sewer can be bypassed and regulated once all of the ongoing work is complete, will be constructed under the Part Two contract.

**BWARI Reaches Halfway Point**

The new 16-ft diameter Lovat TBM for Part One was delivered to the site in September of 2004 and the first ring was installed in November 2004. After overcoming early delays due to flooding of the area surrounding the main shaft, JDMT has installed over half of the more than 4,000 5-ft rings and mining is on schedule for completion in November 2006.

Ground conditions encountered have included hard clay and soft silt, but the majority of the tunnelling thus far has been in well-graded sands and gravel. Boulders were a significant concern during the design and contingency plans have been developed for accessing the cutterhead chamber under compressed air. While boulders have doubtlessly been encountered, they have not had a significant impact on the mining, and JDMT has been successful thus far in maintaining the cutterhead under atmospheric conditions.

“We are just over half way complete with the tunnel and are beginning what we think is the most challenging ground on the project,” said Mike DiPonio of JDMT. “We are very pleased with the capabilities of the machine, especially where boulders are concerned. There is significant evidence that boulders have been encountered, and the machine appears to be breaking them up with the cutterhead.”

The Part One contract also includes seven access shafts, six of which have service connection drops, and several hundred feet of a 14-ft square box section that connects the tunnel to the new headworks of the Southerly Wastewater Treatment Plant. All of the initial shaft excavation is complete on the Part One tunnel, and the initial connections between the shafts and tunnel has been made at Shafts 2, 3 and 4. The large box structure was constructed at the beginning of the project in an open-cut excavation, backfilled and used as a tail tunnel for the launch of the TBM.
While continuing the mining operation, JDMT is planning the future work required in the Part One contract including the installation of two small-diameter road crossings and the placement of the Linabond corrosion protection liner. Preliminary work is now being carried out in developing and proving the installation method for the liner, as well as the most efficient means for cleaning and prepping the inside of the finished one-pass concrete sewer. Crews will be mobilized in the near future for a hand-mined installation of 450 ft of 30-in. sewer pipe, as well as another 250 ft, 18-in. crossing that will possibly utilize pilot tube microtunneling.

### BWOAS Under Way

The initial work on the Part Two (BWOAS) project included the construction of the launch shaft, drilling of the four intermediate shafts and setup of the main shaft site. Constructed using slurry wall panels, the main shaft is 38 ft in diameter. The ground outside the shaft in the zone of the incoming and outgoing sewers was stabilized using jet grouting. The intermediate shafts were constructed by large diameter drilling and also included the stabilization of the adjacent soils with jet grouting. The main site was prepared for the arrival of the TBM by late summer 2005.

An innovative segment design was proposed by McNally/Kiewit (M/K) and is being incorporated in the work on Part Two. The BWOAS segments are a “hybrid” design and utilizing both steel fibers and standard steel reinforcement in combination to provide the strength required for the tunnel structure. These segments are being manufactured by the North American Segment Company utilizing a static mould system in a leased facility in Mt. Vernon, Ohio. The segment casting began in May 2005 and is approximately 70 percent complete.

The new 13.8-ft diameter Lovat TBM for Part Two was delivered to the site in August 2005 and the first ring was installed in September 2005. M/K has had to overcome significant challenges in the launching of the TBM including mechanical difficulties, as well as the complexity inherent to the shaft launch of an EPB TBM without the benefit of a tail tunnel. As of the end of January 2006, the entire TBM has been assembled in the tunnel and 340 lf of BWOAS tunnel has been completed.

“We have the machine completely buried and are confident that we should be in full production mode mining in the next couple of weeks [mid-February],” said Steve Skelhorn of M/K. “Right now the main constraint is the cycle time on emptying the muck boxes which will be cumbersome until we can get enough tunnel built to install our switch.”

In addition to the TBM launch, work has been progressing on the installation of the 42-in. Hobas pipe, which was required to decommission a pump station that serves the airport and the surrounding area. The pipe is approximately 25 ft deep, but the lack of groundwater in the mostly clay soils has been conducive to good production. With the exception of concerns associated with unknown utilities on the old Air Force base, the open-cut work has been going quite well with more than 1,000 ft of pipe installed.

The mass excavation required for the gate/drop structure is expected to commence in mid-February 2006. The dewatering system was installed during the summer 2005, but work at the location was on hold in order to focus attention to the critical TBM launch.

### Making Up Lost Time

All four of the contracts associated with this sewage plant and conveyance upgrade have faced challenges since going to construction. A major flood of the Scioto River in early 2005 caused problems for JDMT on the Part One tunnel project and delayed the associated headworks construction at the treatment plant. The delay of the headworks construction resulted in challenges for the second major construction contract at the treatment plant since the design assumed that much of the work on the first project would be complete prior to the start of the second contract.

Despite the setbacks, all of the work in the program currently under construction is expected to finish in time to satisfy the 2008 deadline agreed to by the city, according to George Daily, COO of H.R. Gray.

“Professional construction managers are trained to react to the uncertainties of a project. Before the floodwaters began to subside, we were working with the contractors on a recovery schedule. Proper construction management tools are in place to see that the project can make up the lost time and be completed within the project’s original timeframe.”

Glen Frank is senior construction manager for H.R. Gray
He’ll probably be working for us in about 15 years.

He might engineer a new subway line that improves the commute for thousands of city workers, or design a light rail system to shuttle passengers from a suburban airport to a nearby city.

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The ITA-AITES World Tunnel Congress & 32nd ITA General Assembly will be held in Seoul, Korea, April 22-27, 2006. The Korean Tunneling Association and the Organizing Committee of ITA WTC 2006 have prepared various programs under the theme of “Safety in the Underground Space,” where four internationally known speakers will deliver keynote lectures.

Seoul's long history made it a perfect fit for the 2006 Congress, chosen to be Korea's capital city since the Chosun dynasty completed construction on March 30, 1392. The Korean Society of Civil Engineers has since designated March 30 as “Civil Engineers' Day.” Organizers are sure that all participants will enjoy experiencing the mixture of modern and traditional flavors of Seoul, where diverse traditional cultures and heritages remain well preserved.

In 2005, the program for the ITA Congress in Istanbul gathered more than 80 participants, who listened to lectures from 15 experts from all over the world. For the 2006 Congress, several technical sessions and five open session lectures are planned, arranged to thoroughly discuss topics related to “Managing Risks in Tunneling.”

“All technologies related to safety in underground space — during construction and operation — continue to progress and to be implemented in all tunnels worldwide,” noted Claude Berenguier, ITA secretary general. “Among them are technologies protecting infrastructures from fire and those related to automatic incident detection. There are also studies being completed on automatic fire extinguishing systems and communications means to be used in tunnels during normal operation, as well as during accidents.”

At present, ITA 2006 will feature 13 working groups, including Research; Contractual Practices in Underground Construction; Health and Safety in Works; Maintenance and Repair of Underground Structure; Immersed and Floating Tunnels; Shotcrete Use; Mechanization of Excavation; Underground and Environment; Quality; Long Tunnels at Great Depth; Training; Conventional Tunneling; and Urban Problems: Underground Solutions.

In addition to the activities already addressed by the working groups, ITA has added several new issues of importance to the agenda, including the creation of the ITA Committee on Operational Safety of Underground Facilities (COSUF). The production of the soon-to-be-published WG12 report will be addressed, in addition to the creation of a University Network, the seminar on waterproofing in Sao Paulo (which took place in November 2005) and the creation of the Master Course on mechanized tunneling by the University of Torino, with ITA sponsorship.

“The Congress and the General Assembly is the converging point of the whole tunneling community worldwide,” added Berenguier. “People are generally coming from more than 40 different countries. In this sense, the types of exchanges within the tunneling community are larger and deeper than in many other congresses. Moreover, during the meetings of the working groups and task forces, everybody is invited to participate, bringing his own experience and exchanging with others.”

In addition, four post-Congress technical site visits will be offered to visitors, including two subways, a rail construction and the site of the Seoul Ringway. Diverse technical exhibitions and social programs are scheduled during the congress, in addition to an open forum for exchanging new information and ideas related to the tunneling industry. A variety of programs planned in this Congress will deepen the friendship amongst participants, and various explorations with many cultural attractions will leave unforgettable memories for all participants.

For more information on the World Tunnel Congress and ITA General Assembly, visit www.ita2006.com.
North American Tunnel Project Update

CALIFORNIA

Bakersfield
Kern River Powerhouse Rehab
Merco Western Inc.

Tunnel rehabilitation work is continuing on Phase I of the Kern River Powerhouse 1 tunnel rehab project. Forebay reconstruction has started, along with the tunnel liner replacement and repairs. Valves and steel frameworks are to be delivered in March 2006. The tunnel lining is ongoing, as well as the new invert at the Forebay portal, scheduled for completion by April 28, 2006.

MercoWestern – Clyde Joseph: project director; Lock Spenser: project superintendent; Bogdan Velcu: project engineer; Jerry Stark: tunnel superintendent; Renn Joseph: forebay superintendent. S.C. Edison – project manager: Terry Falleson; construction inspectors: David Oehley, Hank Chavez, John Feeney.

Los Angeles

Eastside Light Rail Transit Project
Traylor/Frontier-Kemper JV

Two Herrenknecht EPBMs were delivered to the site in October 2005. The shields and backup are assembled in the Boyle Station and will be ready for excavation by Feb. 1. Crews completed shoring and excavating Boyle Station Shaft in November for turnover to Traylor-Frontier. Tunnel excavation is scheduled to start in early-February and finish within 12 months. Hayward Baker has grouted the break-in and breakout location for Boyle and Soto Stations. It has also grouted critical structure areas along the alignment. It is currently grouting cross passages and drilling compensation grout holes.

San Bernardino

Arrowhead East and West
Shea/Kenny JV

East - Strawberry Portal

The Strawberry tunnel has advanced more than 10,000-ft as of early December 2005 — approximately 45 percent of the total drive. Grouting continuously primarily from the cutter head support. West - Waterman Canyon Portal: The Waterman portal has advanced to 4,000-ft, with approximately 22 percent of excavation to completion. Grouting and probing has been continuous, with pre-excavation grouting being conducted to alleviate the water inflow.

To help the situation in the unstable ground, TBMs machines in both headings have been modified with new gearboxes, with slurry removal and reclamation systems installed. The ground has so many fines that they overload the conveyor from the screw and deposit the fines in a bathtub built below the conveyor. A muck removal slurry pump is used to transfer the fines and water from the TBM to thereclamation area at the portal where the fines are removed with a cyclone separator and the clean water returned to the TBM.

Ed Marcus, project manager; Bob Gordon, assistant project manager; Mike Belcher, PA; Stuart Lipofsky, project engineer; Renald McInnes, equipment superintendent; Ron Walton, superintendent east. Walkers East: Bob Leslie and Danny Sayre; Don Fulmer and Eddie Meeghan, superintendent west. Walkers West: Kenny Frego, Jeff Bright, Daniel Spenser. Office East: Joe Nagy; West: Dana Downs. MWD program manager: Dan Tempelis; resident engineer: John Townsend. Information: (909) 883-3399.

Sacramento

Lower Northwest Interceptor
Affholder Inc.

The TBM holed through into the receiving shaft on Aug. 23, 2005 and was disassembled and transported to the North Shaft and reassembled for the final drive under the Sacramento River. The entire Hanson 72-in. CRP pipe has been installed and Pacific International Grouting was scheduled to complete the final 2,000 ft placing the cellular concrete grout by the end of December 2005.

Area Manager: Dan Martz, Project manager: John Forero, General Superintendent: Perry Dreckshage, Project Engineer: Tolga Tolgan, Safety: Mike Mickelsceely. Resident Engineer URS: Tom Martin. Information: Dan Martz (708) 201-7666, or John Forero (916) 302-7258.

San Diego

San Vicente Pipeline
Traylor/Shea JV

Fabrication and refurbishment of the TBMs has begun. Two new open-face digger shields are being built by Construction Tunneling Services (CTS) in Washington. Crews are proceeding according to schedule and are expected to be ready for testing by the end of March 2006, with delivery of the first to follow immediately to the central shaft, where it will mine Reaches 4, 3, and 2. The second shield will be stored until delivery to the Slaughterhouse Shaft, after completion of Reaches 5 and 6. It will be set down that shaft and head west to excavate Reach 4E.

The rock TBM is a used machine being refurbished by Robbins in Solon, Ohio. It was previously used on a project in South America, and has been delivered from Bolivia. The machine will mine Reach 6 first and then be removed to the West shaft to mine Reach 1.
Lake Hodges Tunnel Project
Kiewit Pacific Co.

The design-build Lake Hodges to Olivenhain Pipeline Tunnel, Shaft & Site Development project consists of a 5,848-ft long, 12-ft, horseshoe-shaped tunnel constructed for the San Diego Water Authority. Excavation of the tunnel will be completed by Drill and Shoot methods. Additional project scope consists of 195-VF raise bore shaft, installation of 10-ft diameter steel liner and placement of cellular grout.

The tunnel, shaft and portal design aspects were completed to 100 percent in July 2005. All operations relating to the site development and portal excavation and support have been completed. The tunnel excavation started in September 2005. The tunnel excavation operations are currently working three shifts and have completed 1,750 lf of the 5,848 lf to-date.

Personnel (Kiewit): Ray Backen, area manager; Sean Menge, project manager; Jarrett Carlson, project engineer; Mike Shough, tunnel superintendent; Curt Millsaps, tunnel superintendent; Larry Andersen, equipment superintendent; Lee Friedman, electrical superintendent. Personnel (Parsons): Jon Kaneshiro, project manager; Luis Piek, design engineer.

Information: (760) 466-1080.

San Diego

Lake Hodges Tunnel Project
TBM: Tunnel Business Magazine FEBRUARY 2006

The West shaft, the western terminus of the tunnel, and starting point for Reach 1 excavation, has been until recently put on the back burner. Critical path mining occurs at other locations and an adjacent Contractor has been periodically occupying the site. In early December 2005, mobilization to site occurred, and was immediately followed by the excavation of surface material, thereby lowering the site to required grade. Several thousand yards of material have been removed so far. Shaft excavation will commence in early January, with excavation of 300-ft starter tunnel to follow.

Mobilization to Central Shaft Site has been completed. Erosion control measures, fencing, utilities, offices, etc. have been installed. Numerous pieces of equipment and materials have been delivered here, and some have been subsequently disbursed to the other sites. Shaft excavation has been completed to depth, 75 ft. The shaft is a 62 ft by 30 ft ellipse, supported by 10-in. steel ribs and shotcrete. Excavated material has been stockpiled onsite, according to agreements made by the owner and surrounding property owners/developers.

The Slaughterhouse Shaft Site and the Reach 5 excavation from it, are the project’s critical path activities. The site has been cleared, graded and setup for construction. The 75-ft shaft excavation reached bottom, installation of the tunnel eyes have been completed, and excavation of the tunnels has commenced. The shaft is 36 ft in diameter and is supported in the conglomerate with 6-in. ribs and shotcrete. The rock is supported by rock bolts. The tunnels so far have been in granite and have been supported by rock bolts, or ribs in highly weathered zones. Specialized Reach 5 excavation equipment has arrived on site, but most of this will be used in the conglomerate sections of tunnel, and would be needed until late January.

The San Vicente Portal Site has been cleared and graded, shop installed, erosion control measures placed, site access road installed and main office trailers installed. The grading work resulted in the removal of approximately 50 percent of the portal material, without requiring the use of blasting. The remainder was removed using surface blasting, and Taylor-Shea is currently removing the muck and installing rock support. Upcoming work will include preparation for the rock TBM delivery.

Project manager: Mike Jatzak. Information: (619) 631-0777, mobile: (858) 248-9042.

Atlanta

Nancy Creek Tunnel
Nancy Creek Constructors

Substantial completion of the project was achieved on Dec. 31, 2005 when sewer flow was diverted from the eight intake structures to the tunnel.


Information: (404) 352-0701.

Atlanta

West Area CSO Storage Tunnel and Pumping Station
Atlanta CSO Constructors

As of Jan. 3, the Clear Creek Tunnel TBM had excavated 1,000 lf and the North Avenue Tunnel TBM has excavated 1,300 lf. The Clear Creek shaft excavation is complete and the Deaeration chamber is being excavated. The North Avenue Shaft excavation is underway. Work on the Pump Station is being performed by W.L. Hailey as a sub-contractor to ACC. The connecting tunnel excavation is complete and the overflow tunnel has been excavated 550 lf. Surface work is ongoing for the diversion structures at Clear Creek, North Avenue and Tanyard.

Construction Manager-City of Atlanta: Ken Johnston; Atlanta CSO Constructors: Project Manager: Taro Nonaka; Assistant Project Manager: Darrell Liebno; Project Engineer: Ray Hutton; Office Engineer: Tj Kobayashi; Tunnel Engineer: Adam Stremcha; Project Superintendent: Jeff Early. JDI Joint Venture: Resident Construction Manager: Mike Robison; Resident Engineer: Don Einarson; Project Engineer: Randy Divitto. Information: (404) 352-0701.

Atlanta

Greensferry Sewer Separation Project
W.L.Hailey & Co. Inc.

The Greensferry Project being construct- ed for the City of Atlanta is under way. W.L.Hailey will install 1,200 lf of 72-in. diameter hand-mined tunnel and relocate 300 lf of 120-in. diameter reinforced concrete pipe as a sub-contractor to Metals and Materials Engineers (MME) The project is located in historic Washington Park.

Civil operations manager: Randy Wieck, project manager: Bill Hawthor, superintendent: Mike Rast, tunnel superintendents: Sid Haney and David Chambers, project engineer: Ashley Quinn, foremen: Larry Todd and Duwayne Corey, MME project engineer: Dunstan Campbell. Information: Donald Ackerman (615) 255-3161.

Atlanta

Indian Creek Sewer Project
Bradshaw Construction Corp.

Bradshaw has been awarded the remedial work to re-mine and correct grade problems with the sewer pipeline installed by Modern Continental on the Indian Creek Sewer Project. Portions of the pipe “floated” while backfilling the tunnel. Mobilization started in January 2006. Project Manager: David Wanhatalo, Superintendent: Frank Jones.

ILLINOIS

Chicago

TARP-Calumet Tunnel System, Little Calumet Leg
Affholder/Jay Dee

Through the end of September 2005, Affholder had completed all TBM excavation and concrete lining of the tunnels, concrete lining of the construction shaft and the vent shaft, 2,030 lf of the drill-and-shoot tunnel with concrete lining in place and concreting of the lower air separation chamber. Jay Dee has completed 29,197 lf of RCP sewers, all 10 of the drop shafts including the boots, exit conduits and tunnel connections are excavated and concreted to the surface, all of the soft ground shafts
are excavated and all but five have been completed and the structures backfilled.

Work continues on the microtunnel EPB excavation for a 42-in. RCP sewer, the clean up and restoration of the surface sites and the connection to the Existing Indiana Tunnel. The final connection to the Indiana Tunnel was to be completed by December 2005, so flows from the existing sewers could begin being diverted into the new system. Contract completion is for spring 2006.

Greg Hauser: project manager for the joint venture and Jay Dee; Jim Foley: project engineer; Brian Christ: senior safety superintendent for the JV and Jay Dee; Renee Halley: office manager for the JV and Jay Dee; Louie Shapiro: soft ground superintendent; Tom McMahan: rock superintendent; Jack Kruzewski and Greg Slusher: field engineers. For Affholder, James Byrd is area manager; Len Postregna is project manager; Ben Gask is project engineer; Terry Beesley is project superintendent; Milan Jovanovich is tunnel superintendent; Harry Gajan is concrete superintendent; Lisa Setser is office manager; Jim Eichberger is purchasing agent; field engineer is Narcizo Garcia; Darrell Grimes is safety superintendent. Information: (708) 201 7166.

Calumet Tunnel System
TARP Pump Station, Valves Isolation Chamber
Kenny Construction Co.

The 320-VF valve access shaft has advanced to grade and drilling and shooting of the first phase of the chamber has been completed. The overburden and drill shoot excavation of the West Pump Room Access Shaft and access-way has been completed. The lining of the access-way and the shaft will start after the completion of the Valve Access shaft concrete.

The overburden of the access shaft to the existing TARP tunnel is scheduled to start in late January 2006. This will be followed by the lining of the shaft and diversion of the existing TARP flow to one side of the bifurcation so the new valves and flumes can be installed in the vacated side and encased. Concurrent with this operation will be the required demolition of the inactive pump room followed by the installation of the new TARP pumps. Crews will also be working in the existing wet well in preparation for its division.

Ted Budd: tunnel division manager; Mike Surman: project manager; Christian Heinz, project engineer; Jess Rhynes, superintendent; Ken Dumas, safety manager; and Luminita Calin; cost and schedule manager. Information: (847) 541-8200.

Hodgkins
C.U.P. McCook Reservoir
Kenny Construction

The $60 Million C.U.P. project being built by Kenny Construction for the Corps of Engineers is in the final stages of completion. All of the below ground concrete work has been completed. The below ground mechanical and electrical work is going through final testing and punch list items. The shaft piping is complete and the control building at the surface is under construction with an early summer completion anticipated.

Ted Budd: tunnel division manager; Bob Rautenberg: project manager; Paul Lauricella: safety manager; Jack Finn: superintendent; Doug Heinz: project sponsor. Information: (847) 541-8200.

Hodgkins
MWRD McCook Haul Tunnels
Kenny Construction Company

Crews completed the drill and shoot haul tunnels in early December 2005. The paving of the 2,100 lf long tunnels was completed the second week of January. Crews are demolishing from the haul tunnels and moving to a follow-up project for Vulcan Materials that includes and access decline to the newly completed tunnel and development of a starter pit for future quarry development.

Doug Heinz, Kenny Construction Co. project sponsor. Ted Budd, tunnel division manager; Bob Rautenberg, Project Manager; Paul Lauricella, safety manager; Jack Finn, superintendent. Information: (847) 541-8200.

INDIANA
Griffith
Cady Marsh Drainage Ditch Tunnel
Jay Dee /Kenny Construction JV

The Lovat soft ground TBM has advanced to the retrieval shaft and crews are cutting the lining for entry and removal of the machine. Setting up concrete lining operations for the reinforced concrete lining and dewatering the last section. Anticipate concrete operations completion by April 2006 and structure work and outlet conduit wrap up in June 2006.

Project manager: David Stacey, Project Engineer: Jason Cade, General Superintendent: Jerry Pardon, Quality Control Manager: Steve Jensen. Information: (708) 473-5473.

MICHIGAN
Grand Rapids
Christman Co. Tunnel
Kiewit Construction Co.

This project for the Christman Co. consists of 100 lf of 19 ft by 18 ft NATM tunnel excavated in clean sands under Michigan Street in Grand Rapids, Mich. Drilling for chemical grouting program is underway; this work is being performed by subcontractor Nicholson Construction, Pittsburgh, Pa.


MISSOURI
St. Louis
Baumgartner Tunnel
Frontier-Kemper/Gunther Nash JV

The TBM “daylighted” Dec. 15, 2005, and was dismantled and removed from the receiving shaft — along with the support equipment — in late December. Tunnel cleanup was completed in late January and installation of the reinforced carrier pipe started in February 2006. Cast-in-place concrete work at the Deaeration chambers is being completed and surface work will continue to the end of the project with scheduled completion May.

Project manager: Jim Nickerson. Information: (314) 293-0058 or (314) 261-2611.

NEW JERSEY
Weehawken
Weehawken Tunnel/ Bergenline Ave. Station
Frontier-Kemper/Shea/BUM JV

Weehawken Tunnel is approaching completion. Almost all electrical and mechanical systems have been tested. The SCADA system is approaching completion. SCADA will be the brains of the light rail station. This system will control many of the fire life safety items, and communicate with the overall Hudson-Bergen Light Rail system. SCADA which controls system-wide train operations, signals and communication. The three elevators have been installed and are in the final test phase.

Training sessions are being conducted on the various systems, equipment and components. The elevators will bring the commuters down to the station platform where they can board the Hudson Bergen Light Rail Trains. Granite flooring has been installed on the platform and the platform finish work is nearing completion. One of the last items at the platform level to complete is the installation of the ceiling panels. The race is on above ground at the plaza to complete the surface work. Concrete base slabs and architectural finishes are almost complete. Site work is moving along as fast as possible. The winter weather has not helped progress. Granite paving installation at the plaza level will start as soon as the concrete slabs are finished. Trains will be running through the station by Jan. 27 for integrated system operational testing, and revenue service is scheduled to start by February pending completion of all fire and life safety items.

Project director: Vinny Sambrato, project manager: Leon Jacobs, general

NEW YORK

Long Island City

**Amtrak Ventilation Shaft Reconstruction.**

Granite Construction Northeast

Shaft demolition is nearly complete. Construction of the new ventilation facility has already begun with project completion scheduled for 2007.

Project manager: Steve Price has been moved back to the regional office as the chief engineer for Granite Northeast. Kerem Acar is project manager: Jason Stevens project engineer, Brian Reilly, general superintendent, Tony Marshall, business manager.

**New York**

**Water Tunnel #3 Stage 2**

Schiavone/Frontier-Kemper/Shea JV

North Tunnel excavation was completed in September 2005 and the TBM backed out and assembled in the east starter tunnel to complete the remaining 13,035 ft of the east tunnel drive. South tunnel excavation was completed under a previous contract. Mining commenced Jan. 3.

As part of the $658 million joint venture project, J.F. Shea Co. is excavating and concrete lining nine shafts, 550 VF each. Site preparation and mobilization has been completed at seven locations. Four shafts on the Southern portion have been raised bored 430 VF each. The overburden has been frozen under a sub-contract by Moretrench America for ground support to rock which ranges from 60 to 110 ft. Shafts 27B and 31B have been excavated through the frozen ground and slashing and the blasting operations by drilling and blasting method is ongoing to oversize the upper shaft from 12 ft, 6 in. diameter to 34 ft-diameter. Concreting started in January 2006 for the largest diameter of 26 ft in these two shafts. The next diameter (22 ft FD) will be slashed out and lining poured, followed by the 14-ft and 11-ft, 6-in. diameter finished lining. Raise bores have been completed in Shafts 30B and 28B and the overburden excavation of shafts 30B and 28B has just begun. The bottom parts of the shafts will be lined to a finish diameter of 10 ft.

Drilling and blasting of the adit at Shaft 25B is complete and currently setting up for raise bore operation, starting drill blast operations at Shaft 24B. Currently mucking out in the south tunnel all the rock from the raise bores and the slashing of the shafts. A total of eight shafts sites have been set up.

The distribution chamber excavation (70 ft by 70 ft by 30 VF) for shaft 25B was completed by drilling and blasting and prepared for the raise bore. The support of excavation for Shafts 24B and 32B is ongoing, which will be followed by conventional drill and blast excavation of the distribution chambers.

Schiavone vice president: Tom King, project manager: Anthony Del Vescovo; project engineer: Florentino Sison; general superintendent: Dale Estus, shaft construction manager: Jeff Salai, shaft superintendent: Mike Jennings. DMJM + H Harris subcontractor to Jenny Engineering/URS for construction management. Information: (212) 564-8552.

**Ticonderoga & Willsboro**

**CPR Tunnel Clearance Project**

This project involved the enlargement of two existing railroad tunnels for Canadian Pacific Railway (591 and 433 ft), rock reinforcement and improvement of the existing drainage system. Drill and shoot excavation was used to heighten the existing tunnels from 1 to 3 ft. Drilling, blasting, scaling mucking had to be performed during a five-hour track window with limited access.

The project was started on June 28, 2005 and completed Nov. 18, 2005.


NORTH CAROLINA

Charlotte

**Irwin Creek Relief Sewers Contract II**

Bradshaw Construction Corp.

Bradshaw Construction Corp. is currently constructing multiple shafts and tunnels associated with the sewer improvement program commissioned by the Charlotte-Mecklenburg Utilities Department (Irwin Creek Relief Sewers-Contract II) The general contractor is Rockdale Pipeline Inc. and the project was designed by CDM. Shaft and tunnel excavations have encountered rock which has slowed progress. The contractor, engineer and owner are currently working their way through these problems in a professional manner.

Rockdale project manager: Ken Richardson; Rockdale Superintendent: Jerry Morrow.

High Point

**Deep River Outfall Project, Segment 2**

Bradshaw Construction Corp.

Bradshaw Construction Corp is finishing construction on the last tunnel for a sewer project in High Point, N.C. The project is being financed by the City of High Point. The engineer is DMP. The general contractor is Thalle Construction.

The last tunnel crosses under Business I-85 and US-29. The 280-ft of tunnel was started using an 83-in. Jarma rock TBM. After tunneling 23 ft from the end of the starter tunnel, completely decomposed rock was encountered in the roof of the tunnel. The TBM was removed and hand-mining techniques using 96-in. steel ribs and wood lagging were used to advance the tunnel through the mixed face conditions requiring blasting the bottom while supporting the roof. Multiple shafts and tunnels were constructed for the BCC for the 60- and 66-in. Hobas pipelines through rock and mixed geology. BCC successfully installed and backfilled the pipelines.

Thalle project manager: Chris Haverstraw, Thalle superintendent: Eric Khuenel; Bradshaw project manager: Eric Eisold, Bradshaw superintendent: Franks Jones. Information: (401) 461-4466.
Ohio
Cleveland
Mill Creek Contract 3
KM&M&K JV
Mining of the main tunnel continues. Approximately 13,000 ft of the tunnel has been mined and with 2,000 ft remaining. Shaft 9A construction is complete. Shaft 12A construction is nearing completion and Shaft 12 construction is to start soon.
Project manager: Robert J. Kassouf; project superintendent: Ralph Doderro. Information: (216) 651-3333.

Columbus
BWOAS
McNally/Kiewit JV
With completion of the shaft the Lovat TBM was assembled in the shaft area, with no tail tunnel to work with all the components had to be assembled in sections on the surface and some suspended in the shaft while room was made for their assembly to the TBM as they turned under with the cutterhead, and initial mining and shakedown of the machine started.
As of mid-December a total of 20 rings have been installed. Modifications to the Lovat TBM have been completed and mining operations are ready to commence to allow for completion of assembly of the trailing gear and start of full mining operations. The open-cut work is proceeding as planned.
Project sponsor: Larry Lenahan; project manager: Steve Skelhorn; project operations manager: Tom Szaraz; project engineer: Gary Bulla; project superintendent: Richard Bouteille. Information: (614) 491-2800.

Oregon
Portland
West Side CSO Tunnel, Shafts, Pump Station & Pipelines
Impregilo/S.A. Healy JV
All tunneling and microtunneling is complete, while shaft build-out, drop structures and tunnel tie-ins at the various shafts are underway. The Clay Street shaft is essentially complete and Upshur Shaft build-out is progressing. Work on the Ankeny Shaft build-out and the Ankeny Diversion Structure is underway, as is the Nicolai Shaft and Diversion Structure.
The final ground level deck in the pump station has been placed and surface access rooms are under construction. Mechanical and electrical work is in progress. The operations and maintenance building adjacent to the pump station is structurally complete. Construction of a 115-KV substation has begun.
Project director: Giuseppe Quarta; manager: Jim McDonald; construction manager: Renzo Ceccato; deputy construction manager: Brad Bush; chief engineer: Jim Kabat; tunnel superintendents: Mickey Alfiff, Valerio Violo; microtunnel superintendent: Blancchet; shaft superintendents: Bill Kiehl and Gary Sivacorvich; safety manager: Boodie Hurd; City of Portland program manager: Paul Gribbon; Jacobs Associates construction managers: Greg Colzani and Craig Kolell. Information: (503) 595-4400.
North tunnel was expected in late January 2006 and completion of the excavation of the dead-end South tunnels is expected at the same time.

The cut-and-cover excavation next to the Main Terminal also continues, with bottoming out expected in late January. This progress means the concrete operation shifts into gear in February, typically a month for difficult weather.

Chantilly

**Dulles East APM**

Atkinson-Clark-Shea JV

The $230 million East Tunnel project for the automated people mover was awarded to the joint venture and mobilization is under way. The project will consist of twin NATM tunnels 427 ft long, 4,500 ft of TBM bored tunnel with segment support and the segments will be cast locally by the joint venture of Taylor/Sea/Ghazi, Palmdale, Calif. Included is 7,000 lf of APM cut-and-cover box structures, and construction of two 400 lf underground stations, including architectural and mechanical fit out.

The East APM project continues to excavate the cut-and-cover trench for the APM boxes along the 8,500 lf of airport property. Sub grade has been reached in three work zones, allowing structural concrete operations to staff up.

The Tier 3 East Station concrete operation is pouring track slabs, getting up out of the wet silstone just in time for winter. The Tier 1 East Station excavation has reached sub grade in several areas. Preparation of the mud slab work is under way; the crews are racing to have the TBM drag-thru slab poured before the TBM holes thru into the Station, anticipated to be in late January. Both TBM are on site, one mining the other was to have been erected in December 2005.

Passengers using the A and B Concourse at Dulles get the opportunity to observe the work when standing on the bridge that spans the Tier 1 Station. These observers add a new meaning to the label of sidewalk superintendents.


Project manager: Mark Rybak; general superintendent: Larry Rigsby; equipment superintendent: Kelvin Sampson; electrical superintendent: Don Magyar; Walker: John Hammer; chief field engineer: Rob White, office manager: Bertha Sampson. Information: (202) 345-1087.

Chantilly

**Dulles West Utility Tunnel**

Kiewit Construction Co.

Finalizing structural concrete and mechanical/electrical in the vent structure. Expected project completion in early spring 2006.


**WASHINGTON**

Seattle

**Beacon Hill Tunnel**

Obayashi Corp.

As of Dec. 31, 2005, the main shaft/headhouse excavation with tiebacks is down 180 ft; top four drifts of the Concourse Cross Adits are complete and excavation of the lower four side drifts has begun. Jet grouting over the platform tunnels is complete. Excavation of the ancillary shaft/headhouse will begin by mid-January. East Portal development work is nearing completion. The 6.5-m Mitsubishi EPB-TBM was scheduled to start mining mid January. Pre-cast segment production is 7 percent complete. Work on the aerial section began Sept. 1, 2005. The drilled piers are complete and work has started on the concrete track way sections.

Sound Transit jobsite personnel: John Critchfield, resident engineer; Zeph Varley, station project engineer; Clement Wiggins, tunnel project engineer; Rick Capka, office engineer; and Roger Smith, construction engineer. Obayashi Job Site Personnel: Masaki Omote, project manager; Steve Redmond, tunnel manager; Rohit Shetty, SEM manager; Nick Garavelli, TBM project engineer; Gregg Olsen, project engineer; Billy Hahn, safety manager; Jon Kirk, business manager; Jim Hyatt, shaft superintendent; Rob Stark, equipment manager; Duke Wilhite, surface superintendent; Satoshi Akai, SEM engineer; Yoshi Sawamoto, equipment manager; Tomo Kudo, EPB tunnel engineer; Bob Clucas, structural manager; Darrel Dobson, structural superintendent, Russell Nash. Information: (206) 262-0665.

Bothell

**Brightwater Conveyance System - East Contract**

Kenny/F. Shea/Traylor JV

King County awarded the Brightwater Project to the joint venture of Kenny Construction (Sponsor)/F. Shea Co. and Traylor, on Dec. 29, 2005, after a lengthy protest by the second bidder, Jay-Dee/Coluccio, J.V. The $130.9 million project will get underway in February, after the Jan. 30 Notice to Proceed. The scheduled completion date is Aug. 28, 2009. The project located in Bothell, Wash., is in both King and Snohomish counties.

It is the first of the major projects scheduled by King County to complete the Brightwater System. The East Contract consists of the following major elements: 14,050 ft of 18 ft, 10 in. EPB TBM mined tunnel using 16 ft, 8 in. ID bolted, gasketed precast concrete segments for a primary liner; installing and grouting 14,200 ft each of 48-, 66-, 27- and 84-in. diameter pipes inside the tunnel, along with three runs of fiber optic cable; 2,430 ft of 72-in. diameter microtunnel including three shafts including structures; one intercepting structure to mine from that is 74 ft deep and 80 ft in diameter with 130 ft deep slurry diaphragm walls, tremie slab and final concrete wall lining; one influent pump station shell 83 ft deep, twin 84 ft inside diameter cells, with 160 ft deep slurry diaphragm walls, tremie slab and final lining; two short 12 ft in diameter connector tunnels; one extraction shaft 40 ft deep x 40 ft wide and 140 ft long for connection to new treatment plant piping.

Until a site office is set up in Bothell, inquiries can be directed to Ted Budd at Kenny Construction Co., 250 Northgate Parkway, Wheeling, IL 60090. Information: (847) 541-8838, E-mail: ted-budd@kennyconstruction.com, aconey@kennyconstruction.com, jmkennedy@kennyconstruction.com.

**WISCONSIN**

Milwaukee

**Elm Road Generating Plant – Cooling Water Intake System**

Kenny Construction Co.

Marine crews completed the 2005 season work on the first two of the four drilled intake shafts. The 2006 season will include the completion of the first two followed by the completion of the remaining two. The overburden excavation using a 32-ft ID caisson method to the rock for the first of three land based shafts is under way with a late January completion of the 80-ft of overburden. This will be followed by the drill-and-shoot excavation to complete the 200-ft deep shaft where the erection chamber will be excavated for the 27-ft, 4-in. TBM. The machine is currently being rebuilt by the joint venture forces in Milwaukee.

The first season dredging operation in the Intake Channel has been completed. This will be followed by the dock wall steel
sheeting cofferdam placement followed by the second deep land based shaft.

Ted Budd: tunnel division manager; Paul McDermott: project manager; Jon Isaacs: project engineer; Austin Cooney: home office sponsor. Information: (847) 541-8200.

Milwaukee
Northwest Side Relief Sewer
Shea/Kenny JV

The project is being demobilized with final punch list work being completed. Anticipate closing the project late February 2006. Project manager: Marten (Dutch) Vliegenthart, Project Engineer: Carl Christianson, Master Mechanic: Keith Walters, Office manager: Bonnie Senkowski. Information: 414-258-2510

Rosemont
Empire III

Ames Construction, Jay-Dee Sub

Jay Dee has subcontracted the pipe jacking of 3,400 lf of 78-in. ID Hanson heavy wall reinforced concrete pipe. Currently setting up on the site and mobilizing equipment. Empire II has been bid and Ames is low bidder with Jay-Dee to do the jacking of 4-5,000 lf of 66-in. Hanson heavy wall RCP in three runs: one 3,400 lf two runs of 600 lf each. Information: Glen Rorison (734) 591-3400.

CANADA
BREITISH COLUMBIA
North Vancouver
Seymour-Capilano Filtration Project
Bilfinger Berger (Canada) Inc.

The (SCFP) comprising the construction of water filtration, transmission and pumping facilities in North Vancouver is well under way. The Seymour-Capilano Twin Tunnels portion of the work commenced in the fall 2004, with the contractor mobilizing equipment and personnel.

The Seymour Shaft collar was excavated and poured in December 2004 and the shaft sinking in dense glacial deposits commenced in January 2005 from an elevation of 179.8 m asi. A sloping bedrock contact was encountered (as expected) at 27m depth from the surface. Drill-and-blast excavation continued in meta-volcanics and grano-diorites for a further 142 m. The bottom of the 11-m ID shotcrete and rockbolt supported shaft, at elevation 0m asi, was reached on Nov. 11, 2005 without a serious accident.

Drill-and-blast operations to excavate the shaft bottom chambers required to install and launch the two Robbins TBM’s commenced on Nov. 14, 2005, and are expected to continue through February 2006. The two new 3.88-m diameter Robbins machines will sport 19-in. cutters. Mucking will be by locomotive and high capacity shaft buckets, utilizing an integrated Bilfinger Berger system design.

The TBM drives will be approximately 7,130 m long and down drive to elevation -150 asi to Capilano, adjacent to the Cleveland Dam and underneath the newly constructed pump station. Two 4-m raise-bore holes will connect the Capilano shaft bottom chamber to the surface and 3-m ID steel pipe liner will be installed in selected areas of the excavations.

Greater Vancouver Regional District (GVRD) provides supervising engineers. Project manager is Pacific Liaicon & Associates Inc., a subsidiary of SNC Lavalin, design and construction manage ment engineer is Hatch Mott MacDonald and the tunnel contractor is Bilfinger Berger (Canada) Inc. (BBC)

GVRD-Tom Morrison, senior project engineer tunnels; Doug Neden, manager Water Treatment Engineering, Goran Oljaca- Senior Engineer. PLA - Andy Saltis- Area manager Tunnels, Jeff Spruston- PM for SCFP, Brian Gardner - Project Director & VP Project Services. HMM Dean Brox- RE, Joe Rotzien-ARE (geology-Golder as sub to HMM-Grant Bonin). BBC- Christian Genschel-PM, Joseph Messner-CM. Information: Andy Saltis (604) 982-3197.

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e-mail: tlynn@berkeleyengineering.com
Atlas Copco PB 420 Hydraulic Breaker

At 795 lbs, Atlas Copco’s PB 420 Penta Series hydraulic breaker is designed for use with skid steers, backhoes and mini-excavators. Featuring a high power-to-weight ratio and quiet operation, the PB 420 is ideal for road construction, landscaping, light demolition and trenching applications.

The tool is able to fit a broad range of small carriers and offer the hitting force of larger models, delivering an impact rate of 1,050 blows per minute (with a maximum hydraulic flow of 23.8 gpm at 2,175 psi).

The PB 420 also features the VibroSilenced damping system, which uses elastic elements between the percussion mechanism and box enclosure to provide full acoustic insulation, reducing noise by up to 18-dB(A). A long-stroke piston design further reduces noise and minimizes recoil back to the carrier, which lessens the strain on the operator and machine.

The unit’s streamlined design also reduces maintenance and eliminates the need for a high-pressure accumulator and tension rods. A one-piece, field replaceable slip-fit bushing is pinned in place by the working steel, allowing the operator to replace both the steel and bushing by removing the pin, as opposed to dismantling the entire hammer.  

Multiquip’s C-30HDN

Mayco’s C-30HDN from Multiquip is a high-performance pump ideal for a variety of shotcrete and grout applications. It is available with a 46-hp, 4-cylinder liquid-cooled Nissan gas engine or 39-hp Deutz diesel engine and offers a number of performance improvements compared to its predecessor, the C-30 HD.

The pump features a new frame-integrated 18-gal fuel tank for improved safety. The C-30HDN also features a direct-flow hopper design. This efficient and economical design offers the advantage of locating the hopper directly above the primary pumping cylinder. Gravity draws the material directly from the hopper into the pumping cylinder. It is then quickly and efficiently pumped out of the discharge end of the pump. Larger, oversized inlet valving allows pumping up to ½-in. aggregate and stiff, low slump shotcrete (wet-gunning) material mixes.

The C-30HDN weighs 2,831 lbs and comes with a standard 2-in. ball hitch. A 2 5/16-in. ball hitch and a 3-in. pintle hitch are also optional. The unit is 150 in. long, 38 in. wide and 62½ in. high. It has a maximum rated volume output of 25 cu yds per hour.
Tiles are for bathrooms, not for tunnels. If any hydrostatic pressure builds up behind them, they pop off the wall. It might take a little help from a tough tunnel cleaning machine, but sooner or later (usually sooner) they will start to come off.

The worst thing for my blood pressure is to get caught driving back from New York City to New Jersey through the Holland Tunnel just around midnight on a Saturday. If you don’t make it in before the lane closure (for maintenance, mostly tile replacement) you can end up not moving for an hour, just hoping to start that miserable stop/start crawl to the portal.

And once I am in the tunnel, cruising at a magnificent speed of about 2 mph in the single working lane and I see those tile replacements in progress, I really start to lose it. My unfortunate passengers will get my lecture on how tiles are the worst possible finish anyone can select for a highway tunnel. And then the veins start to bulge in my forehead.

There are basically only two good ways to do a highway tunnel finish (or three if you count “no finish” as an option). The best and first is to use a good quality vitreous enamel (VE) panel with a corrosion-proof fixing on rails. The second method is to use a good quality, built-up sprayed paint.

Granted, this will need repainting after 10 years, but the economics can often stack up. There are various subsets of the first method, which involve the use of alternative types of cheaper panels and fixings ranging down to regular steel rails and nuts and bolts. Even the worst of these is far superior to tiles. For ceramic tiles are the most horrible option possible and this point really is a no-brainer.

The arguments for VE panels apply much the same to subway and metro stations as they do to road tunnels. Some stunning effects can be created by imaginative architects, some of whom have turned VE panel graphics into an art form. And even ugly things like cable ducts can be made to look beautiful.

One particular panel manufacturer uses a good slogan in its brochure: “Quality remains long after price has been forgotten.” I think about that every time I am standing on the subway platform staring at dingy cracked tiles. And of course the irony is that the true life-cycle cost of putting in the quality product in the first place is actually less than tiles plus periodic tile replacements.

People get obsessed with the initial capital cost of everything instead of thinking about performance and maintenance; not to mention beauty. My plea is that designers and architects give this some thought and do all they can to help my hypertension.

David Caiden is a principal for Arup.
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