

Flexibility has been a Bechtel trait since Day One. But as the world changes, it comes in different forms.

Take working arrangements. That includes who's in charge. The Port Authority of New York and New Jersey needed a fully integrated team to withstand the demands of working on light-rail and other airport projects at JFK International and LaGuardia. **“Whoever can manage an assignment best gets to be the boss,”** says John Read, project manager. [\[GO THERE \]](#)

A Bechtel joint venture is in Kazakhstan revamping the Tengiz oil field's infrastructure. For many Kazakhs working on the project, the freedom that flexibility affords requires adjustment. **“They were used to being told what to do, and having someone else make the decisions,”** notes Program Manager Jack Sheehan. [\[GO THERE \]](#)

In Western Europe, Bechtel took on a fiber-optic buildout in a time frame that others thought impossible. Bechtel proved the skeptics wrong, **“brushing aside a series of setbacks and surprises with creative engineering, quick thinking, and plain old persistence,”** says George Baber, general manager of Bechtel's European telecommunications unit. [\[GO THERE \]](#)

Combining the right software with leading management practices at far-flung sites in Australia, Bechtel accelerated schedules and cut costs associated with Pasmenco's Century project, the world's largest zinc mining and concentrating operation. **“We reduced rework to a level never before seen for a mining and metals project,”** says Dave Copeland, project director. [\[GO THERE \]](#)

Features



ADAM LUBROTH/LIAISON INTERNATIONAL

Lessons learned at Tengiz extend well beyond the oil patch.

Bright Lights, Big City

A new light-rail transit system will ease the heavy burden often borne by travelers using New York City's JFK International.

Dreamtime Down Under

Bechtel sets new standards for productivity at the world's largest zinc and lead mining operation, in northwest Queensland.

Beacon on the Horizon

The revamp of Kazakhstan's vast Tengiz oil field is producing much more than hydrocarbons.

Whirlwind Tour

From Berlin to Biarritz, Bechtel is racing to complete a series of fiber-optic rings by year-end.



Talent and technology shorten schedules and close distances in the Australian outback.

DEPARTMENTS

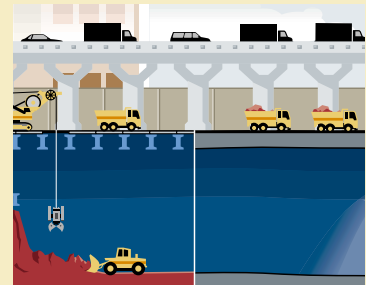
FRONT END

Hope for refugees, a U.S. football Hall of Famer, and solar-powered environmental cleanup.

MILESTONES

Keeping up with Bechtel projects and people on job sites and in offices worldwide.

DETAIL DESIGN



Tunneling in tight quarters Boston-style on the most complex U.S. highway project ever.

LIFE'S WORK

Jack Sheehan helped provide much-needed wintertime heat to a school in Kulsary, Kazakhstan.

©XPLANE

JOHN CRAWFORD/LIAISON INTERNATIONAL



HEIDI BRADNER/SABA

Building Hope, Helping Cope

Bechtel has helped out in the aftermath of two devastating events, the Kosovo crisis in the Balkans and the massive earthquake in northwest Turkey.

Refugees overwhelmed Albania and Macedonia during the Kosovo crisis. Some 860,000 fled the fighting, and relief agencies faced severe shortages. Bechtel was part of the international response to the emergency, helping build a sanctuary for displaced persons called Camp Hope near Fier, Albania.

The camps were constructed under the U.S. Air Force Contract Augmentation Program. One of seven subcontractors on the job, Bechtel served as the construction and procurement arm of the team.

Starting in May, construction crews worked 24 hours a day to finish Camp Hope by mid-June. It can accommodate 20,000 refugees.

Though the conflict ended June 9, many Kosovars have yet to return home. Relief agencies are responsible for the camp's operation and management, the medical care of the refugees, and other support services.

News of the August 17 earthquake in Turkey stunned the world. Available personnel and heavy equipment from Bechtel's joint-venture projects with Turkish construction contractor ENKA (see "Beacon on the Horizon") were immediately dispatched to help search for survivors. At press time, Bechtel-ENKA employees and equipment had played a role in a hundred survivor rescues.

Among Bechtel staff sent to help was a veteran of the Kuwait oil-fire effort. He joined other experts advising multinational fire-fighting teams as they controlled a burnout that lasted five days at the Yarimca oil refinery on the outskirts of Izmit.

In hard-hit Adapazari, Bechtel and ENKA are funding and building a school for 240 children, many of them orphaned by the quake.

Relief and rehabilitation assistance continue to be made available.

A Career Professional

There have been two constants in Tom Mack's career—Bechtel and professional football. The mechanical engineer is a 29-year Bechtel veteran who also played 13 seasons of U.S. football in the National Football League.

He's been a star in both arenas. In August, Mack was inducted into the NFL Hall of Fame, the highest honor accorded former professional football players in the United States.

Mack didn't miss a single game during his stint as a guard with the Los Angeles Rams, playing in 184 consecutive games between 1966 and 1978. Prior to turning professional, Mack was a standout tackle for the University of Michigan.

After graduation, Mack

accepted a position with Bechtel, working during the off-season. He continued full-time with Bechtel when he retired from football after the 1978 season.

Mack's Bechtel career has been just as distinguished. He has served as a marketing and business development manager, as an assistant project manager, and as manager of the company's Washington, D.C. office. Mack is presently deputy general manager at the Nevada Test Site, which Bechtel supervises for the U.S. Department of Energy.

Energy in Short Order

An aggressive schedule had a Bechtel team in Australia thinking on its feet—and looking for bargains.

BECHTEL BUZZ

“They could join forces with Madison Square Garden and Bechtel...to build and run state-of-the-art sports arenas abroad.”

—Unsolicited advice from *BusinessWeek* to the National Basketball Association on how to aggressively market its brand worldwide.

Bechtel recently completed for Western Underground Gas Storage a storage-and-treatment facility in Victoria that expanded Melbourne's energy supply. By allowing short-term storage of natural gas, the complex eases pressure on the existing gas grid. During low-demand seasons, gas will be injected into the underground facility from gas fields. During winter, gas can be withdrawn to meet demand.

Because the gas has a high CO₂ content, the state stipulated that the installation include an amine plant to reduce CO₂ to environmentally acceptable levels. But building a new amine plant would have taken 10 months, breaking the project's tight 6-month schedule.

The solution? Don't build an amine plant at all. Instead, the Bechtel team decided to buy an existing plant. Specialists located one in Oklahoma and quickly cut a deal. The facility was sourced, inspected, dismantled, and shipped in less than four weeks.

The “new” facility, near Port Campbell, Victoria, produced its first gas in June.

Low-Impact Soil Remediation

Removing soil contaminants can be dirty, expensive work. The two most popular methods, soil vapor extraction and bioventing, rely on blowers to create airflow that induces volatilization

or biodegradation of organic matter such as petroleum.

Typically, these blowers are loud, inefficient, and expensive to operate and maintain.

Lee Bzorgi has a better idea. The engineer at Bechtel's Oak Ridge, Tennessee, office has developed an award-winning remediation system that harnesses clean, inexpensive solar power to strip volatile organics from soil at a fraction of the cost of conventional techniques.

The Solar Remediation System (SRS) is powered by a photovoltaic cell that drives a high-efficiency blower for bioventing or vapor extraction. The SRS features just a single moving part—the blower's impeller.

By creating a vacuum, the SRS draws contaminated soil gases from an extraction well. Contaminants evaporate or are collected into a carbon canister. Flicking a switch reverses the airflow to introduce oxygen into the well to encourage contaminant biodegradation. A storage battery keeps the unit running around the clock.

SRS recently won a Tribute to Technology Award from the American Museum of Science and Energy.

GREEN EXPRESS

Railroads can use forests for more than cross ties. Early this year, crews started planting the first of 1.2 million trees as part of the Channel Tunnel Rail Link, the Bechtel-managed project that will establish high-speed rail service between London and the Channel Tunnel.

Native trees such as oak, ash, hornbeam, and hazel have been planted at five locations in Gravesham, Ashford, Tonbridge, and Malling. The horticulture compensates for woodland cleared along the railway route, and provides habitat for wildlife. Over the next seven years, the program will create or develop about 230 hectares of forest, hedgerow, grassland, wildflower grassland, reedbeds, alder carr, and wet grassland.

Environmental work is being undertaken in consultation with government agencies and advocacy organizations. Reforestation receives particular care. Ecologically valuable soils are moved to specially chosen sites, and native trees are planted in the relocated earth—the first time this technique has been used on such a large scale.

When complete in 2007, the Channel Tunnel Rail Link will halve travel time between London and the Channel Tunnel, reducing the duration of a trip to Paris to 2 hours and 20 minutes.

BRIGHT LIGHTS, BIG CITY

Improved airport access will take the frustration out of flying into New York.

FOR MANY, the hardest part of a flight to New York City starts after you've landed. Travelers arriving at John F. Kennedy International Airport (JFK) have two options for reaching Manhattan: bus or taxicab. Even in perfect weather and light traffic, either form of transportation may significantly increase travel time. Factor in a snowstorm or a backup in the Midtown Tunnel, and things can really get complicated.

Poor airport access has plagued New York for more than 30 years. It's more than an inconvenience. The issue is frequently cited when business firms relocate to other urban areas, eroding the city's competitiveness.

Another transportation option is on the horizon, due for completion by 2003. Its name is AirTrain—a

13.4-kilometer-long, automated light-rail system that will connect JFK, New York's busiest airport, to the city's vast network of subways, buses, and commuter rail systems. And the name of the company overseeing AirTrain's construction is Bechtel.

The Port Authority of New York and New Jersey selected Bechtel in

August 1998 to provide construction management oversight for the \$1.5 billion AirTrain contract as part of a \$4 billion improvement program that covers construction and renovation at JFK and LaGuardia airports.

Bechtel and the Port Authority go back a long way. Bechtel has had an ongoing relationship with The Authority since 1985, when the company completed planning studies for JFK. In 1987, Bechtel landed a construction management contract for the JFK2000 program, and has maintained a presence on several smaller projects at JFK ever since. Apart from the long-term relationship between the two organizations, one of the primary reasons Bechtel was selected for its current assignment was its willingness to develop a fully integrated management team of both Authority and Bechtel staff.

"In some cases, Bechtel people report directly to The Authority, and in other cases the reverse is true," says Bechtel Project Manager John Read. "Whoever can manage an assignment best gets to be the boss.

BY ROBERT H. KANTOR

PHOTOGRAPHS BY MICHAEL DENORA/LIAISON INTERNATIONAL

PROJECT PROFILE



LOCATION

New York City

CUSTOMER

The Port Authority of New York and New Jersey

PARTICIPANTS

Bechtel Infrastructure Corporation

DESCRIPTION

13.4-kilometer-long light-rail project linking JFK International Airport to New York subway and commuter rail systems, and renovation of tenant facilities at JFK and LaGuardia airports

SCOPE OF WORK

Construction management and oversight

VALUE

\$4 billion

SCHEDULE

Completion by 2003

There's no room for ego or one-upmanship on this project."

"We strive to form a team at every level, including the field," says Ray Finnegan, The Authority's manager of construction. "We implement the best practices from Bechtel personnel or from seasoned Authority construction personnel, and over the years, both entities have gained from this open working relationship."

The team's goal is to deliver the highest quality construction oversight and management services to all projects at JFK and LaGuardia, including tenant work carried out by the airlines and vendors in the terminals, airport facilities work such as a new tunnel, and of course the new AirTrain system. Teamwork is crucial, because Bechtel and The Authority must manage and coordinate several difficult efforts.

AirTrain consists of three segments:

- A 3.2-kilometer elevated train loop linking all nine passenger terminals. The loop will also connect to the rental car areas and long-term and employee parking lots.
- A 4.9-kilometer elevated railroad runs to Jamaica Station in Queens. The viaduct will extend along the median of the Van Wyck

Expressway, at some points as high as 20 meters above street level.

- A 5.3-kilometer extension from JFK to the Howard Beach subway station.

When the system is complete, travel from JFK to Jamaica Station will be cut from 30 minutes to 8 minutes. Travel time to Manhattan will drop from 1 to 2 hours to 45 minutes, regardless of time of day, weather, or traffic. A complete loop around JFK's terminals will take about 8 minutes, eliminating the 45-minute delays sometimes experienced. Perhaps most important of all, the ride will be comfortable and hassle-free. AirTrain's cars will be electric-powered and computer-controlled, with wide doors and cushioned seating. The 10 stations along the route will be fully enclosed, heated, and air-conditioned.

AirTrain will be a revelation for airport commuters, but several obstacles remain before passengers can start celebrating. One is the construction of the viaduct to Jamaica Station—not an easy proposition given the heavy congestion on the Van Wyck, a major Interstate Highway known as I-278. Another daunting prospect is

Bechtel in the Big Apple

The New York metropolitan area is the sixth-largest economy in the world, and Bechtel has been performing work there since the 1940s. Bechtel has had a presence in the city since 1985, and opened a permanent midtown office in Manhattan in 1987.

In 1985, Bechtel conducted planning studies for the Port Authority and the Long Island Rail Road electrification of the Ronkonkoma-to-Hicksville line. Later, the firm performed construction management for the LIRR Penn Station Concourse and the New Jersey Transit Kearny Connection, and both design and design management services for Route 9A. These and other early successes, along with Bechtel's determination to be a major player in New York, led to current contracts at JFK and LaGuardia airports, the Park Avenue Viaduct, the Gowanus Expressway, the University of Connecticut, the Southern New Jersey Light Rail project, and the East Side Access project, which at \$4.3 billion is the largest commuter rail project since the New York City transit system was built.

Park Avenue Style

Bechtel is providing overall construction management for upgrading both the 100-year-old, 3.2-kilometer Park Avenue Viaduct and the historic 125th Street Station. The project team is nearing completion of a six-year schedule.

The customer is Metro-North Railroad, the second-largest commuter railroad in the United States. In the course of the project, numerous issues regarding logistics, safety, the environment, and minimization of disruption arose and were satisfactorily resolved.

Says Walter Sewell, Metro-North project director, “The very nature of rebuilding a 100-year-old structure is a seemingly endless stream of nasty surprises. . . . It is gratifying to Metro-North that . . . this team has approached each difficulty with a cooperative spirit. . . . Bechtel’s approach . . . as construction manager has been significant in fostering the spirit of partnering which has been crucial in making the project an effort that Metro-North is justly proud of.”

construction of the six stations within JFK’s central terminal area, which must take place in the midst of major terminal expansion and renovation, without disrupting passenger and ground vehicle movement. A third challenge is construction of a cut-and-cover tunnel beneath two aircraft taxiway overpasses to allow the AirTrain tracks to transition from the Van Wyck to the central terminal loop.

Perhaps the most demanding task is the construction of a new transfer facility and airport-type terminal station at the historical rail terminal in Jamaica. Owing to restricted access and the need to maintain the current traffic level of 100,000 passenger movements per day, the effort promises to be complicated. At present, Bechtel is providing preconstruction services, including constructibility input to the design, staging, and scheduling. In addition, Bechtel has drawn up a comprehensive construction plan to address site access and passenger movement questions, and has developed an early action plan that

addresses modifications to the Long Island Rail Road electrical and mechanical infrastructure.

Bechtel and the Port Authority will oversee the highly visible renovation of JFK. The renovation will involve coordinating \$9.3 billion of tenant and public investment. The International Arrivals Terminal and the American, Delta, and British Airways passenger terminals are being rebuilt or expanded, and other

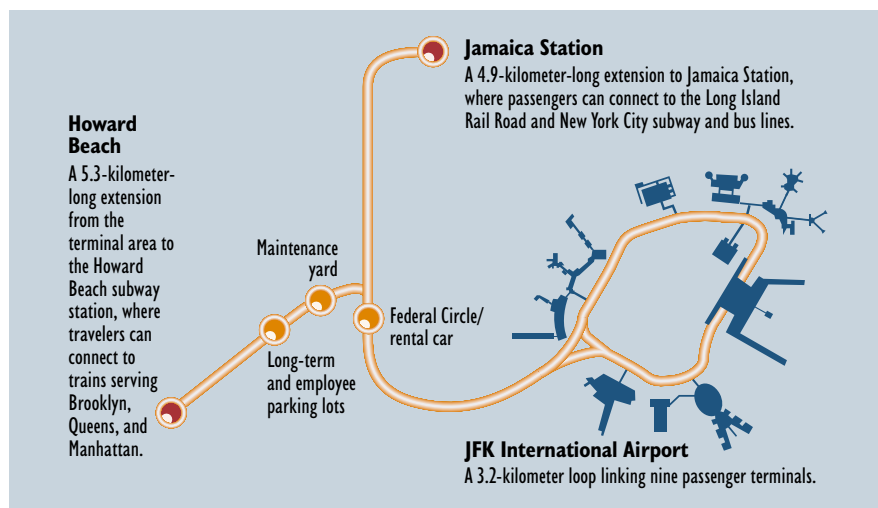
airlines are building cargo facilities. There is also an almost continuous stream of new building by concessionaires, rental car companies, and other enterprises.

At both JFK and LaGuardia, the project team will perform construction management for improvements such as roadway upgrades and taxiway and runway repairs. Some of the ongoing projects at LaGuardia include taxiway and runway enhancements, a \$6 million lighting and painting upgrade to the central terminal building garage, a major rehabilitation of the airport’s roadways, and \$60 million in tenant alterations.

Work is just beginning, but Port Authority Chairman Lewis M. Eisenberg is very excited. “The Port Authority is building a marvel of convenience, speed, and dependability. . . . New York City will be a winner. So will more than 54 million passengers who choose the extraordinary variety of destinations offered by New York’s busiest airports.”

Read can hardly wait: “As a longtime resident of Long Island, I am excited to see this program move ahead. For me, AirTrain will be an ideal way to travel to JFK and keep me off congested expressways and parkways.

“I wish I could ride it to work now.” 🚇



Beacon on the Horizon

Kazakhs are building confidence at the Tengiz oil field.

BY LAUREL ENGLISH PHOTOGRAPHS BY ADAM LUBROTH/ LIAISON INTERNATIONALE



YOU CAN see Tengiz long before you reach it. The processing facilities dominate this broad, featureless plain in the Caspian Basin. They are a beacon.

Two decades ago, the Soviet Union pinned its hopes for domestic oil production on Tengiz, which occupies the remote northeastern coast of the Caspian Sea. Those plans sputtered with the breakup of the Soviet bloc. Now, the installation's infrastructure is being revamped and a new oil and gas processing plant, Train 5, is being added. The independent Republic of Kazakhstan is counting on Tengiz hydrocarbons to help drive the nation's developing economy.

Experts say the region surrounding the Caspian Sea possesses reserves that equal those of the North Sea and rival those of the Middle East. Chevron and the Kazakh government formed Tengizchevroil in 1993 to tap that potential. From that time on, Bechtel people have been providing engineering, procurement, and construction services to help enhance the oil field operation at Tengiz—and to effect a large-scale transfer of skills. Since 1994, Bechtel has worked at Tengiz as part of a joint venture with the Turkish construction company ENKA.

Engineering takes place in London and Istanbul. Equipment and materials are procured globally. Detailed logistical planning is essential; there is no direct coastal access to Tengiz, and the nearest seaport capable of offloading

major pieces of equipment is 700 kilometers south and inaccessible from November through May, when rivers and canals feeding the Caspian freeze over. Just as vital to the project as developing a logistical plan is developing the on-site workforce.

Each night in the Bechtel-ENKA canteen, thousands of voices converse in Russian, Hungarian, Turkish, English—and Kazakh. Most of those belong to native Kazakhs. This is the first work most of them have ever done outside the old communist system. For some, it's the only job they've been able to find in several years. Much of what is being restored and expanded at Tengiz is confidence.

Although two-thirds of the project's construction personnel have Soviet experience, the work at Tengiz is being done to higher standards, which require a new set of techniques and skills.

"The Soviets put in the Russian education system, which is excellent. The area has 98 percent literacy," says Jack Sheehan, Bechtel-ENKA program manager. "But the need now, which Bechtel is able to meet, is for practical job training and skills improvement. We are providing workers the skills they need not only for this project but for other projects in Kazakhstan's future."

Esbol Akhmetov agrees. He joined Bechtel-ENKA in 1994, five days after graduating from the Kazakh State University of World Languages. Fluent in Kazakh, Russian, English, and Turkish, Akhmetov saw the Tengiz project as an opportunity to develop Western business skills. "I had no computer skills when I came to Bechtel-

PIPEFITTING INSTRUCTOR PETER TAYLOR, LOWER RIGHT, PROVIDES MUCH-NEEDED PRACTICAL JOB TRAINING TO KAZAKHS.



PROJECT PROFILE



LOCATION

Tengiz, Republic of Kazakhstan

CUSTOMER

Tengizchevroil (a joint venture of Chevron, the Republic of Kazakhstan, Mobil, and LUKARCO, a joint venture of ARCO and Russian LUKoil)

PARTICIPANTS

Bechtel-ENKA (a joint venture of Bechtel and Turkish construction contractor ENKA)

DESCRIPTION

Operations and maintenance contract for oil field work, capital projects, and general services; revamp of existing oil processing facilities to increase capacity; Train 5, a new oil and gas processing plant, which includes an oil and gas separation unit, acid gas removal unit, gas sweetening unit, power generation, boiler plant, and utility distribution system

SCOPE OF WORK

Engineering, procurement, and construction

VALUE

Nearly \$1 billion

SCHEDULE

Service contract ongoing since 1993; debottlenecking oil and gas separation plant completed early in 1999; Train 5 completion during second quarter of 2000

ENKA,” he recalls. “I couldn’t even type.” Now, he believes his computer proficiency will give him a much-needed edge in Kazakhstan’s extremely tight job market.

An oil-field installation requires dozens of different disciplines, professions, and trades, so Bechtel-ENKA has made training of the Kazakh workforce its foremost priority.

Some people, such as Asyl Zhumirbaeva, a Bechtel-ENKA



subcontract administrator, receive one-on-one tutoring from their supervisors. Zhumirbaeva graduated from college with a degree in English and joined the Train 5 project a year and a half ago as a translator. “I quickly learned that I didn’t enjoy doing that type of work, but

that I could use my English for other things,” she says. Last December, she transferred into subcontract management. Although Zhumirbaeva knew nothing about it when she started, she is learning quickly and will be sent to

A Fountain of Oil

On his visit to the Caspian region in the late 13th century, Marco Polo described “a fountain from which oil springs in great abundance.”

The Soviet Union began developing Kazakhstan’s Tengiz field more recently, in 1979, and Kazakhstan took it over as part of its sovereign state after declaring independence from the Soviet Union.

In 1993, the independent Republic of Kazakhstan signed a 40-year agreement with Chevron to form the Tengizchevroil joint venture, which is redeveloping the field. (The joint venture subsequently came to include Mobil and LUKARCO, a joint venture between Russia’s LUKoil and ARCO.)

Tengizchevroil remains committed to developing the Tengiz field. In a recent speech delivered before the Institute of Petroleum’s IP Week Conference on Caspian Oil and Gas, Nick Zana, managing director of Chevron’s Eurasia business unit, said, “We still have solid, basic, long-term reasons to invest in the Caspian region. And these are: known oil reserves in the billions of barrels, the potential for discovering more, and government partners in new nations who are determined to harness their energy resources to help build the new national economies.”

When production began in 1993, the Tengizchevroil joint venture produced 60,000 barrels per day. It now averages more than 200,000 barrels per day. And by the year 2010, it is expected to produce 700,000 barrels per day.

Tengiz is one of the largest oil fields in the world. The United States Energy Information Administration lists proven reserves for the region at as many as 29 billion barrels, comparable to the reserves of the North Sea. But some experts believe the Caspian region holds up to 200 billion barrels—about as many as the proven reserves of Iran and Iraq combined.

“It has been a difficult transition, especially for those who grew up with the rigid Soviet system.”

England for two weeks of intensive classroom training.

Bechtel-ENKA has also trained more than 700 people in such construction trades as scaffolding, rigging, piping, welding, and vehicle maintenance. They typically spend a month in an on-site training center, where their skills are assessed and training provided to meet Tengizchevroil’s high standards, including safety. Trainees progress to the construction site, where they are assessed in the work environment. “Those who demonstrate their ability to work safely and adhere to quality standards earn a certificate and a pay raise,” says Michele Konrad, Bechtel-ENKA personnel and administrative supervisor.

The training and skill development available at Tengiz are helping ease Kazakhstan through the shift from command economy to free enterprise. “It’s been a difficult transition, especially for those who grew up with the Soviet system,” says Sheehan. “They were used to being told what to do, and having someone else make the decisions.”

Esbol Akhmetov, for one, is optimistic that Kazakhstan will prosper. “I believe our economy is developing and in the future will be much better than it is now.”

He is counting on what he is learning at Tengiz to help make that happen. 🌐



Blockbuster Production

By 1996, the increasing supply of crude from the Tengiz oil field was becoming too much to handle for Tengizchevroil’s oil and gas separation plant.

The company called on Bechtel-ENKA in December of that year to carry out its “debottlenecking” effort. The goal: increase separation and processing capacity from 6 million metric tons per year to at least 8.5 million metric tons, maintaining nearly full production during shutdowns of one oil processing train at a time, which cost Tengizchevroil \$500,000 a day.

“When you’re working in a live plant, the research, work permits, and change modifications are incredibly complex,” says Bechtel-ENKA Program Manager Jack Sheehan. Team members had to familiarize themselves with the plant quickly—an ambitious undertaking, since there were no drawings of existing systems.

Winter temperatures plunged to minus 30 degrees Celsius. On some days, crew members could safely work outside for only a few minutes before moving to shelter, to be replaced by another crew in a series of relays.

Two of the four oil processing trains were shut down in September 1997 and completed in December, and the remaining two trains were completed the following year, along with modifications to the gas treatment plant.

“In spite of all this, there were no accidents during the shutdowns,” says Sheehan. The project went 2.8 million job-hours without a lost-time accident.

As for boosting production rates to 8.5 million metric tons per year, Bechtel-ENKA reached that milestone midway through the work. By completion, annual rates had risen to 9.5 million metric tons, the additional million tons representing a 40 percent increase in the new design capacity.

Nick Zana, managing director of Chevron’s Eurasia business unit, called this a “stupendous accomplishment.” He said, “I know that it is the commitment to excellence and teamwork, and efforts to stretch, that resulted in this accomplishment.”

Bechtel is ringing Western Europe with fiber-optic cable, and doing it in a hurry.

WHIRLWIND Tour

THIS IS the itinerary: link 1,850 kilometers of fiber-optic cable between 11 cities in Belgium, France, the Netherlands, and the United Kingdom, crossing the English Channel and the North Sea. All in less than nine months.

They said it couldn't be done. "Anything can be accomplished if you have the right team, focused on the right issues," responds Bechtel Program Manager Bill West. "And what a team ours turned out to be!"

Viatel's Circe Pan-European Network is a state-of-the-art broadband network capable of supporting voice, advanced data services, e-commerce, and multimedia applications. The network will eventually comprise multiple rings of fiber-optic cable covering 8,700

BY **SYBIL E. HATCH** ILLUSTRATION BY **STUART BRADFORD**

PROJECT PROFILE



LOCATION

Western Europe

CUSTOMER

Viatel, Inc.

PARTICIPANTS

Bechtel Telecommunications

DESCRIPTION

State-of-the-art, fiber-optic telecommunications system

SCOPE OF WORK

Program management, engineering, procurement, and construction management

VALUE

\$800 million (\$400 million Bechtel scope)

SCHEDULE

Completion by year-end 1999

route-kilometers and linking more than 42 major cities in Belgium, France, Germany, the Netherlands, Switzerland, and the United Kingdom.

“Bechtel got the first ring on-line in a hurry, brushing aside a series of setbacks and surprises with creative engineering, quick thinking, and plain old persistence,” says George Baber, general manager of Bechtel’s European telecommunications unit. Viatel awarded Bechtel the contract to build Ring One on March 13, 1998. Bechtel broke ground in July 1998. On March 15, 1999, Viatel put Ring One into operation.

In between, Bechtel crews took a whirlwind tour of Western Europe:

ENGLAND

London’s prolific gardens and majestic cathedrals hide a web-like labyrinth of buried utilities and other underground structures. Bechtel carefully placed cable alignments along secondary roadways to avoid historical structures. Despite meticulous research and planning, construction crews still had to work around several undocumented active and abandoned water and power lines, and break through old concrete building foundations.

Bechtel crews trenching near Lowestoft, England’s easternmost town, unearthed the foundations of an ancient Roman fort. Bechtel field-adjusted the cable alignment to the opposite end of the site to avoid disturbing artifacts and to get on with the work.

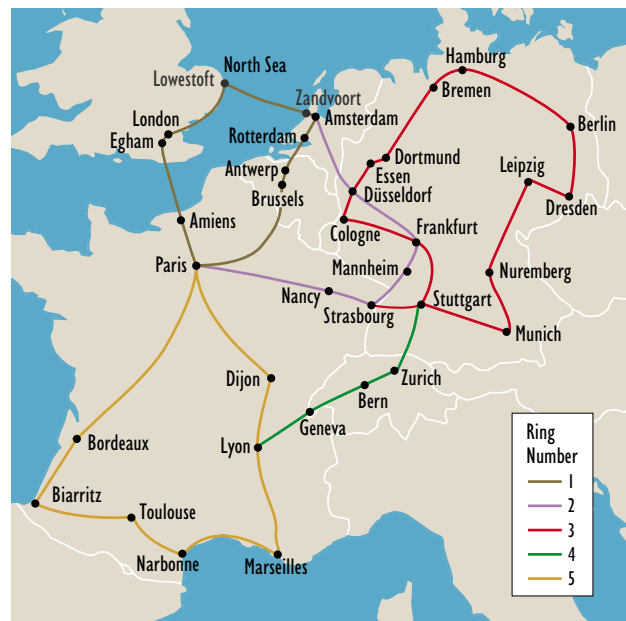
THE NORTH SEA

To meet the extremely aggressive Ring One construction schedule, Bechtel team member Alcatel Submarine Networks braved the raging North Sea in winter—not once, but twice—to lay submarine cable crossings.

Alcatel burned out two of its ship’s thrusters trying to stabilize the vessel against immense North Sea swells, while a remotely piloted underwater plow buried cable a meter deep in the sea floor. The cable-laying barge exerted 6 metric tons of pressure on the towline pulling the plow.

THE LOW COUNTRIES

Zandvoort is situated beside a long stretch of North Sea beach. Thousands of land mines were buried here during the world wars to discourage coastal invasion. Many remain. Before installing the Zandvoort beach chamber, a 27-metric-ton concrete box where the cable comes ashore,



local ordnance experts discovered and removed over a hundred land mines.

The historic Zandvoort railroad station houses the network regenerator site, where the laser signal is reconstituted after its journey across the North Sea. It's a fine example of brick-and-stone Victorian architecture. To meet local planning officials' concerns that building modifications be as unobtrusive as possible, Bechtel built a separate regenerator building below the railroad station, independently supported by piles, with its own concrete slab and walls.

The Netherlands and Belgium are called the Low Countries, for good reason. Amsterdam is built around a network of concentric and radial canals, crossed by about 400 bridges. Two-thirds of Belgium is flat, drained by the Meuse and Scheldt rivers.

Each river, stream, or canal crossing is an engineered design in which local conditions are studied, engineering recommendations made, and local authorities' approval sought. Bechtel engineers designed nearly 20 water crossings for Ring One alone. Fiber-optic cable was installed below waterways using directional drilling techniques.

FRANCE

To cross France, Bechtel relied on optioneering—exploring every possible design option and specifying several contingency plans and fallbacks. Crews placed cable in roadways. In canals. Along canal banks. In sewers. In subways. Along freeways. Under rivers. All told, Bechtel ran 503 kilometers of new fiber-optic cable in a long loop through northern France.

In Paris, Bechtel constructed two points of presence (where a fiber-optic mainline connects to local telecommunications networks), one

of them inconspicuously installed within a historic building near the Bastille. Bechtel engineers knew that the building needed strengthening to hold the equipment, so they specified a new steel floor designed to be supported by the existing structure. But when the time came, all the contractor found was a decayed timber frame, filled with rubble and coated with plaster. Bechtel quickly redesigned a new independent steel frame to be contained within the building's gutted interior, maintaining the distinctive exterior.

Ring One was only a prelude. Bechtel finished Ring Two in July 1999 and will complete Ring Three by year's end. Viatel appreciates the alacrity. "Bechtel did an outstanding job for us with the construction and engineering of Circe's first ring," says Michael J. Mahoney, Viatel's president and chief executive officer. "Their hard work and dedication has enabled Viatel to meet the very tight construction timetable we set for ourselves without sacrificing our extremely high standards for quality." 🏆

Bechtel Telecommunications



Over the past 30 years, Bechtel Telecommunications has completed more than 80 world-class telecommunications infrastructure projects worldwide. Bechtel's telecommunications group was formed in 1969 to support major Bechtel construction projects and has since developed into a market leader. Today, Bechtel Telecommunications provides design, engineering applications, project management, and construction management services for all types of innovative telecommunications systems, including fiber-optic and cellular system installations.

When it comes to getting a telecommunications system up and running, each additional 24 hours means a revenue opportunity lost and another day of exposed capital. With decades of experience in meeting and beating deadlines, Bechtel Telecommunications has a reputation for completing telecommunications projects on time or ahead of schedule. Accomplishments include expanding phone service across 2.1 million square kilometers of Saudi Arabia for the Kingdom's TEP 6 project, erecting 800 PCS installations across the United States for USWest, and installing 80,000 phone lines in and around Manila for Globe Telecom.

According to George Conniff, president of Bechtel Telecommunications, "Building strategic alliances with suppliers and subcontractors, mobilizing quickly, taking advantage of every opportunity to reduce critical path items, and bringing talented resources to bear on all our projects allows us to provide the absolute best service to our telecommunications clients."



Dreamtime Down Under

Deep in the Australian outback,
Bechtel is wielding software tools
with hard-edged skill.

BY **THOMAS ULRICH** PHOTOGRAPHS BY **JOHN CRAWFORD/LIAISON INTERNATIONAL**

ABORIGINES BELIEVE that the Australian outback was created during a mythical age called Dreamtime. For the unprepared, the region can seem more like a nightmare. Brutal, isolated, and unforgiving, the outback dictates its own terms.

Bechtel is redefining those terms. At the Pasmaingo Century mine in north-west Queensland, the project team cut costs and schedule with a combination of software tools that brings Bechtel's most advanced resources to bear on the remote frontier.

"With this project, we've brought the electronic world into the construction business," declares Project Director Dave Copeland.



Pasmaingo Century is a typically Australian undertaking—that is to say, oversized. The installation is the world's largest zinc mining and concentrating operation. Beginning production at press time, the mine will start to yield 450,000 metric tons of zinc and lead each year, some

30 percent of Australia's annual zinc production. Two years ago, Pasmaingo tapped Bechtel to build a zinc and lead concentrator, village, infrastructure, airport, 300-kilometer slurry pipeline, and port facilities.

Mines are located where the ore is, and that's usually a long way from civilization. There wasn't much anyone could do about the physical distances involved. Pasmaingo and Bechtel established the main office for the



LOCATION

Queensland, Australia

CUSTOMER

Pasminco Ltd.

PARTICIPANTS

Bechtel Mining & Metals

DESCRIPTION

Zinc concentrator, village, infrastructure, airport, slurry pipeline, and port facilities

SCOPE OF WORK

Engineering, procurement, construction, and management

VALUE

US\$650 million

SCHEDULE

Completion in September 1999

project 1,900 kilometers away in Brisbane, where engineers designed the infrastructure, airport, and village. They located an office 2,300 kilometers away in Melbourne for designing the zinc concentrator, pipeline, and port facility. Construction offices were established at the mine, along the pipeline, and 300 kilometers northeast at the port of Karumba on the Gulf of Carpentaria.

Despite the empty expanses, the project team collaborated as if they were sitting across a conference table. Satellite technology relayed information between headquarters, field offices, and construction sites at the speed of light. The project's most distant team members were only a split second apart. Relying on video conferences to share ideas, construction crews kept pace with design engineers.

Once construction had begun, engineers at the Melbourne and Brisbane offices and personnel at the

construction sites worked as a team using the best engineering, design, and scheduling tools available. "The use of 3-D-CADD, together with *ProjectWorks*, a suite of design and scheduling programs, has really enhanced our performance," Copeland explains. "We reduced rework to a level never before seen for a mining and metals project."

The 3-D designs provided a computer model that allowed construction crews to better establish the sequence of steps to build the plant before they started construction.

Using the 3-D designs and *ProjectWorks*, the team assembled 5,600 metric tons of structural steel and 45 kilometers of pipe in the concentrator with virtually no rework.

Advanced planning allowed the team to employ aggressive just-in-time delivery and assembly policies. Installation occurred almost immediately after material arrived at the work site, and engineering groups

At Home in the Outback

Queensland contains the largest population of indigenous people of any state in Australia. Fifty-thousand Aborigines live in remote Queensland, a state that measures 1,727,000 square kilometers—and a number of them staffed the 1.8-square-kilometer Pasminco Century job site.

Sometime before recorded history, Aborigines crossed the land bridge that once connected Queensland to New Guinea. For 40,000 years, their livelihoods revolved around hunting and gathering. Things changed in 1867, when European immigrants discovered gold in Queensland. During the last 150 years, Queensland has evolved from an isolated outpost into a commercial hub. Exports include cattle, sheep, cotton, bauxite, aluminum, coal, copper, gold, silver, lead, and zinc.

There was virtually no infrastructure in the area when work began on the Century mine. Power systems, roads, telecommunications, an airport, and a village had to be built from scratch.

It was a massive endeavor, providing broad opportunity for education. Aborigines learned valuable trades and organizational skills at Pasminco Century. They formed an important part of the project workforce, taking a hand in furthering their ancient homeland's industrial development.



From Mine to Market

Exhausting the Pasmaico Century mine's ore deposit will take some 20 years. Annual production is projected to average 5 million metric tons of ore, producing 780,000 metric tons of zinc (and silver) concentrate and 70,000 metric tons of lead concentrate. The zinc concentrate will yield 450,000 metric tons of zinc metal per year—30 percent of Australia's zinc production.

The miners moved 75 million metric tons of earth to expose the ore body and make it accessible for open-pit mining. The final pit covers 300 hectares, extending some 340 meters below the surface at its deepest point.

Once it's out of the ground, ore-bearing rock will go through traditional mineral processing—crushing, grinding, flotation, and thickening—yielding mineral concentrate. Additionally, zinc concentrate will be ground to 7.5 microns in order to separate silica, which

is very finely interspersed with the zinc mineral sphalerite.

A single pump station at the mine site will propel slurry—a mixture of mineral concentrate and water—300 kilometers along an underground pipeline to a dewatering and loading facility at the port of Karumba on the Gulf of Carpentaria. Plate and frame pressure filters will remove water from the mineral concentrate, followed by treatment in a rotary dryer. Dry concentrate will be stored in a shed with capacity for 80,000 metric tons and built to withstand cyclones and floods.

From there, a covered transfer vessel will haul 5,000 metric tons of zinc or lead concentrate daily to ocean freighters moored 45 kilometers offshore. Pasmaico will ship half the concentrate to its Budel smelter in the Netherlands, and the remainder to producers in other parts of Europe, as well as in Australia and Asia.

and construction crews maintained schedules that were weeks—sometimes days—apart. Pipe was installed at a rate of three worker-hours per meter instead of the four and a half worker-hours per meter required elsewhere in the industry for the same type of pipe. The concentrator took 12½ months to construct instead of the standard 14 months, and when construction was finished, there was very little surplus material left in the laydown yard.

“*ProjectWorks* ensured that accurate design information reached the fabricators,” says Dave Weber, Bechtel’s site manager.

Superintendents, foremen, lead-hands, and engineers mastered several other programs from the *ProjectWorks* suite. Field engineers used *InfoWorks* to review the latest

The concentrator took 12½ months to construct instead of the standard 14 months—without a single lost-time injury in 1998.

revision of construction drawings. Construction crews depended upon *TeamWorks* to report the daily progress of the mechanical equipment, piping, and structural steel installation. They relied on *SETROUTE* to install 370 kilometers of cable.

Effective safety and leadership programs led the concentrator workforce in 1998 to log 1.2 million hours without a single lost-time injury. Unapproved absenteeism was a mere 0.25 percent, compared with an Australian norm of 10 percent. Lost time

Bechtel in Australia

Bechtels this year celebrates its 40th anniversary of permanent presence in Australia. The company has worked there on the design and construction of more than 250 projects, including some of the world’s largest mining and minerals-processing facilities.

Bechtel Australia’s nearly 900 nonmanual people are working on six major projects out of key offices in Brisbane, Melbourne, and Perth. The total cost of these six exceeds US\$4 billion.

Current and recent Bechtel undertakings include:

- **WMC’S OLYMPIC DAM COPPER-URANIUM EXPANSION PROJECT.** Underground mine, process plant, and infrastructure development in South Australia, one of the world’s largest and most complex such efforts.
- **WMC’S QUEENSLAND FERTILIZER PROJECT.** US\$500 million phosphate fertilizer installation in northwestern Queensland.
- **PASMINCO’S CENTURY PROJECT.** US\$1.1 billion job to establish the world’s largest lead-and-zinc facility, in northwestern Queensland.
- **WORSLEY ALUMINA EXPANSION PROJECT.** US\$600 million facility in Western Australia that will be one of the world’s largest and lowest cost alumina producers.
- **CADIA MINING PROJECT.** US\$300 million copper and gold plant boasting the world’s largest semiautogenous grinding mill and flotation cells.
- **STUART OIL SHALE DEMONSTRATION PLANT.** Technology showcase in Queensland, designed to produce 4,500 barrels per day of shale oil.
- **WESTERN UNDERGROUND GAS STORAGE FACILITY.** Underground storage and gas treatment plant, a fast-track project to improve Victoria’s gas delivery infrastructure.
- **MILLMERRAN POWER PLANT.** Two-unit, 785-megawatt coal-fired power station in Queensland, the state’s first fully privatized power project, undertaken by Bechtel affiliate InterGen.

due to industrial disputes was just 0.04 percent of direct worker-hours, compared with an Australian industry average of 5 percent.

In September, the Pasminco Century team completed the complex two months ahead of schedule and millions of dollars under budget. Once they’re done, their efforts will live on as a legacy of continuous improvement. The project team has found ways to refine Bechtel’s electronic tools. Engineers have revised the method for measuring their progress and improving the accuracy of 3-D design. Team members have

created a logbook containing lessons learned from the design and construction of Pasminco Century as a guide for other large projects.

According to those on the ground, though, the biggest lesson to be learned from Pasminco Century is attitude. “We identified the critical elements for meeting our schedule and focused on building, not rework,” notes Phillip Marshall, area manager for the concentrator. “The commitment our construction team made to quality and productivity was the most important element in the success of this project.” 🏆

M I L E S T O N E S

A W A R D S • A N N O U N C E M E N T S • A P P O I N T M E N T S

WAREHOUSES FOR ONLINE GROCER

USA Bechtel has been selected by Webvan Group, Inc., a provider of groceries on-line, to build automated ware-



houses in 26 U.S. markets over the next two years.

Under the \$1 billion contract, Bechtel will replicate Webvan's original automated 31,000-square-meter distribution facility, located in Oakland, California, throughout the United States.

DABHOL SECOND PHASE

INDIA Dabhol Power Company has named affiliates of Bechtel, Enron, and General Electric as the primary construction team for the \$1.9 billion second phase of India's Dabhol power project. The project closely follows completion of Dabhol's first phase, designed and built by Bechtel (*Bechtel Briefs*, December 1998).

When complete in late 2001, the second-phase expansion will increase total power output at Dabhol to 2,450 megawatts, making it one of the world's largest private power plants.

DISMANTLING NUCLEAR WEAPONS

UKRAINE The U.S. Defense Threat Reduction Agency has selected Bechtel for two

Naval Nuclear Propulsion

USA Bechtel has acquired from CBS Corporation two industrial divisions, formerly part of Westinghouse Electric Corporation, that provide supplies and technical services for the U.S. Navy's Nuclear Propulsion Program. The 335-employee Machinery Apparatus Operation is located in Schenectady, New York, and the 550-employee Plant Apparatus Division is headquartered in Pittsburgh, Pennsylvania.

additional contracts dismantling nuclear weapons in Ukraine. On one assignment, Bechtel will neutralize, dismantle, and demolish two fueling facilities and nuclear weapons storage areas under a \$5.3 million contract. On the other, Bechtel will develop systems to neutralize missiles under an \$8.1 million contract. Work is scheduled for completion by June 1, 2004. The assignments are the latest in a series for Bechtel, and part of the Strategic Arms Reduction Talks treaties reached between the United States and former Soviet governments.

EXCELLENCE IN SAFETY AND INNOVATION

USA The National Erectors Association has awarded Bechtel its highest honors for excellence. Bechtel earned the Thomas J. Reynolds Safety Award, taking first place among NEA members working more than 1 million job-hours. Three Bechtel

craftworkers were recognized as well for innovation, receiving Craftsman of the Year, First Runner Up, and Honorable Mention awards.

HIGHWAY CONSTRUCTION

JAPAN The Japan Highways Public Corp. has selected a Bechtel joint venture to provide construction management services for the Yokkaichi Highway Junction. Bechtel is a 40 percent partner in the two-firm joint venture, led by Konoike Construction. The project includes 1.3 kilometers of highway and the substructure of bridges and ramps associated with the junction. Completion is expected in April 2002.

LABORATORY MANAGEMENT

USA The U.S. Department of Energy has selected Bechtel as the new management and operations contractor for the Idaho National Engineering and Environmental Laboratory.

The facility is a 1,400-square-kilometer science-based and applied engineering complex located in eastern Idaho. The contract will run until September 30, 2004.

POWER FOR MEXICO

MEXICO Mexico's Comisión Federal de Electricidad has announced that InterGen Aztec Energy VIII B.V., an affiliate of Bechtel Enterprises-Shell joint venture InterGen, has been awarded a contract for the power project known as El Bajío. The 700-megawatt natural gas-fired, combined-cycle plant will be built in San Luis de la Paz in the state of Guanajuato. The project is scheduled to reach financial close in November 1999, and commercial operations are projected for November 2001.

OIL SANDS DEVELOPMENT

CANADA A group of lead-ing Canadian energy, engineering, and construction firms, including Bechtel and Canadian affiliate Bantrel Inc., have joined in an alliance for the US\$1.3 billion expansion of Suncor Energy Inc.'s Project Millennium oil sands development, near Fort McMurray, Alberta. The job will add 90,000 barrels per day to production at

M I L E S T O N E S

the Suncor plant, to reach a production target of 220,000 barrels per day in 2002. Full-scale operation of the facilities is slated for January 2002.

PIPELINE IN THE GULF OF THAILAND

MALAYSIA AND THAILAND

Bechtel has been selected to provide engineering, procurement, and construction management services for the \$600 million Trans-Thailand-Malaysia gas pipeline project by joint-venture customers Petroleum Authority of Thailand and Petroliam Nasional Berhad. The project includes a 256-kilometer offshore pipeline in the Gulf of Thailand and 340 kilometers of onshore pipeline in Malaysia and Thailand. Completion and commissioning of the Trans-Thailand-Malaysia pipelines and other facilities are expected by the fourth quarter of 2001.

TAIWAN POWER DEMAND

TAIWAN A consortium consisting of Bechtel and General Electric has been awarded a contract to build the Hsin Tao power project, a 628-megawatt combined-cycle facility approximately 50 kilometers southwest of Taipei, adjacent to a substation on the slopes of a tea farm. Taiwan has a critical need for low-cost, highly reliable sources of electrical power, due to its current low reserve margin and high growth rate.

UNTANGLING TRAFFIC

USA Under the terms of a four-year construction management contract with the Virginia Department of Transportation, Bechtel and a joint-venture partner will undertake the first phase of a massive rebuilding of a Washington, D.C.-area highway intersection known locally as the Mixing Bowl. The project involves the construction of 30 ramps, 50 bridges, and 66 kilometers of roadway. With more than 375,000 vehicles a day, including 40,000 trucks, the Springfield intersection is the nation's second-busiest interchange.



JOHN DUTY

Bechtel Petroleum & Chemical

USA Senior Vice President John Duty has been named president of Bechtel's Petroleum & Chemical global industry unit. During his 30-year Bechtel career, Duty has served extensively in field engineering and project management for a variety of efforts in the petroleum industry. He has also led Bechtel's engineering function and figured prominently in the firm's continuous improvement initiatives, as well as managing regional offices. Most recently, Duty led the Atlantic LNG project in Trinidad.



DON GUNTHER

Bechtel Group, Inc.

USA The Construction Industry Institute has selected former Bechtel Vice Chairman Don Gunther to receive the Carroll Dunn Award for contributions to the engineering and construction industry, and for his support of the institute and its goals. The award was presented at a dinner in conjunction with the Annual CII Conference in August. Gunther, whose career spanned 37 years, oversaw efforts in petroleum and chemicals, mining and metals, environmental remediation, and technology consulting, as well as leading Bechtel business units and regions worldwide. Gunther retired from line duties in 1998.



STEVE WEYEL

InterGen North America

USA Steve Weyel has been named president of InterGen North America, the recently formed Bechtel Enterprises-Shell joint venture to develop power generation facilities in the United States and Canada. Weyel most recently served as senior vice president for Dynegy Marketing and Trade. He had previously been vice president of marketing and integrated energy for Dynegy's Electric Clearinghouse subsidiary. Earlier in his career, Weyel was founder and president of Resource Technology Corporation, an evaluator of global energy commodity reserves.

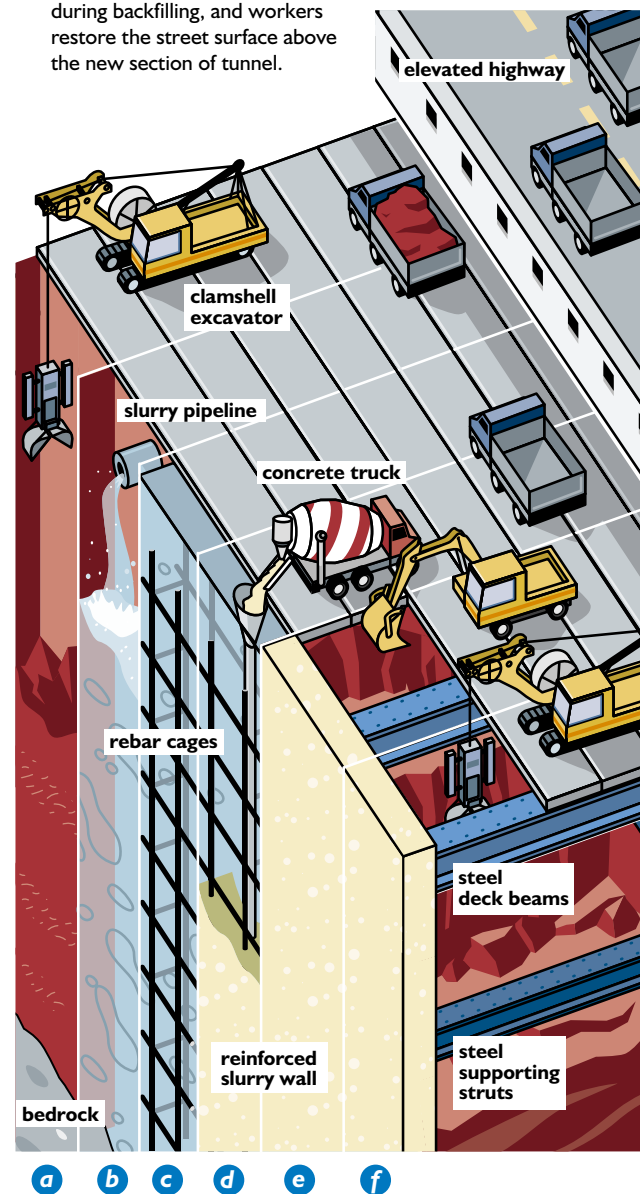
DETAIL DESIGN

The Big Dig!

How do you replace Boston's old, inadequate Central Artery highway with a new 8–10-lane roadway and not disrupt the city's flow of commerce or traffic? Build it underground, beneath the current highway. With construction work just past the halfway point, a Bechtel joint venture and the Massachusetts Turnpike Authority are making it happen.

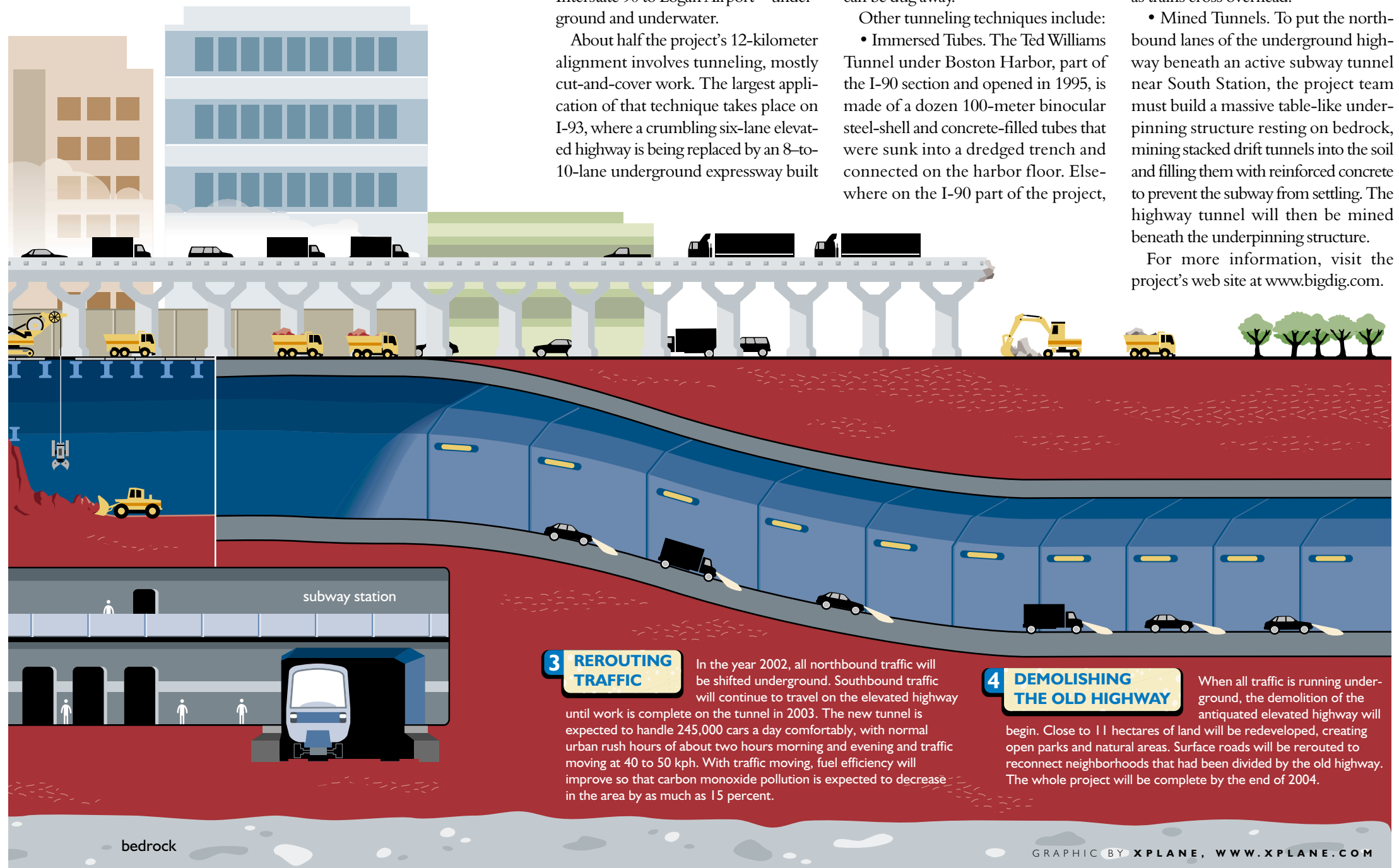
1 DIGGING THE TRENCH

The old Central Artery winds a narrow path through downtown Boston, and there is nowhere to dig but directly below. Walls of the new replacement highway tunnel are built first, 1 meter thick, 6 meters at a time, in trenches down to bedrock up to 37 meters deep **a**. A slurry of clay suspended in water is pumped into the trench during excavation **b**, exerting pressure that keeps the trench's sides from caving in. Structural steel beams or reinforcing bars **c** are lowered into sections of trench, and workers pour in concrete **d**, which displaces the slurry. Excavation **e** proceeds in a stair-stepping manner, with workers setting supporting struts as the digging continues downward **f**. Crews build a base slab, ventilation chambers, and a roof of reinforced concrete. Supporting struts are removed sequentially during backfilling, and workers restore the street surface above the new section of tunnel.



2 BUILDING THE HIGHWAY

An 8–10-lane expressway is being built in the Central Artery's 12-kilometer corridor, about half in tunnels. This scene shows the underground Artery at its shallowest point, where the highway passes over Boston's Blue Line subway at State Street. Here the roof of the highway is the street overhead.



The Lowdown on Tunnel Town

Boston these days is a tunneling technology showcase. Managed by a joint venture of Bechtel and Parsons Brinckerhoff, the city's \$10.8 billion Central Artery/Tunnel effort is replacing part of Interstate Highway 93 through downtown and extending Interstate 90 to Logan Airport—underground and underwater.

About half the project's 12-kilometer alignment involves tunneling, mostly cut-and-cover work. The largest application of that technique takes place on I-93, where a crumbling six-lane elevated highway is being replaced by an 8-to-10-lane underground expressway built

directly underneath. How to keep the old highway in service while the new one is excavated below? The elevated highway's entire weight is being shifted to slurry walls (see graphic) so that footings for the existing highway, all in the path of the underground expressway, can be dug away.

Other tunneling techniques include:

- Immersed Tubes. The Ted Williams Tunnel under Boston Harbor, part of the I-90 section and opened in 1995, is made of a dozen 100-meter binocular steel-shell and concrete-filled tubes that were sunk into a dredged trench and connected on the harbor floor. Elsewhere on the I-90 part of the project,

immersed tubes of concrete are being used to cross a narrow harbor channel.

- Tunnel Jacking. To bring I-90 under railroad tracks near Boston's South Station rail terminal, the project must jack up three huge concrete tunnel sections under the right-of-way even as trains cross overhead.

- Mined Tunnels. To put the northbound lanes of the underground highway beneath an active subway tunnel near South Station, the project team must build a massive table-like underpinning structure resting on bedrock, mining stacked drift tunnels into the soil and filling them with reinforced concrete to prevent the subway from settling. The highway tunnel will then be mined beneath the underpinning structure.

For more information, visit the project's web site at www.bigdig.com.

3 REROUTING TRAFFIC

In the year 2002, all northbound traffic will be shifted underground. Southbound traffic will continue to travel on the elevated highway until work is complete on the tunnel in 2003. The new tunnel is expected to handle 245,000 cars a day comfortably, with normal urban rush hours of about two hours morning and evening and traffic moving at 40 to 50 kph. With traffic moving, fuel efficiency will improve so that carbon monoxide pollution is expected to decrease in the area by as much as 15 percent.

4 DEMOLISHING THE OLD HIGHWAY

When all traffic is running underground, the demolition of the antiquated elevated highway will begin. Close to 11 hectares of land will be redeveloped, creating open parks and natural areas. Surface roads will be rerouted to reconnect neighborhoods that had been divided by the old highway. The whole project will be complete by the end of 2004.

GRAPHIC BY XPLANE, WWW.XPLANE.COM

LIFE'S WORK



Students at the Yuri Gagarin School in Kulsary, Kazakhstan, had to put learning on hold last winter. Classes were suspended indefinitely because the school's heating pipes had frozen solid. Temperatures outside were well below freezing, and it was almost as cold inside classrooms.

Word reached nearby Tengiz, where Bechtel and its joint-venture partner ENKA are modernizing and expanding the vast Caspian oil field for Tengizchevroil (see page 8). The project team dispatched a crew to thaw out the pipes, but the ice proved impenetrable.

Program Manager Jack Sheehan (seated, second row) noticed a building 200 meters away with smoke coming out of it. "Sure enough," he recalls, "it was a brand-new boiler room." Sheehan suggested tapping the boiler to heat the school. Authorities told him that was impossible—the boiler belonged to the railroad.

Undeterred, Sheehan enlisted the governor's support and, with project teammates including John Ross (front row), obtained backing for their plan from no fewer than 15 government agencies.

Tengizchevroil would provide some 2,800 meters of piping, and Bechtel-ENKA would supply insulation, manpower, and equipment, as well as reimburse the railroad for diverted steam.

Consensus came on a Saturday. Work began Monday. A week later, school was back in session.

PHOTOGRAPH BY
ADAM LUBROTH/LIAISON INTERNATIONAL