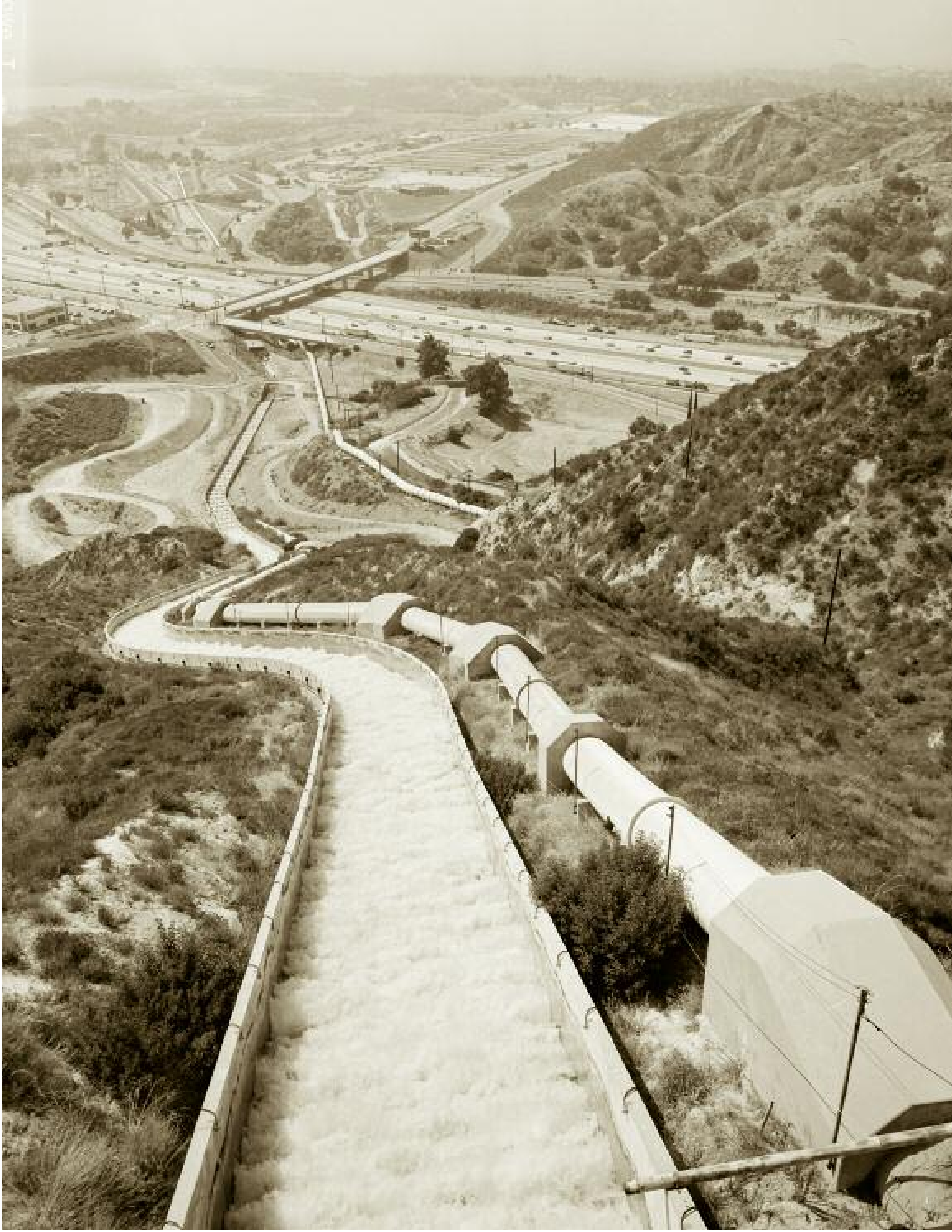
seeding california

BY JOE FLANAGAN PHOTOGRAPHS BY JET LOWE

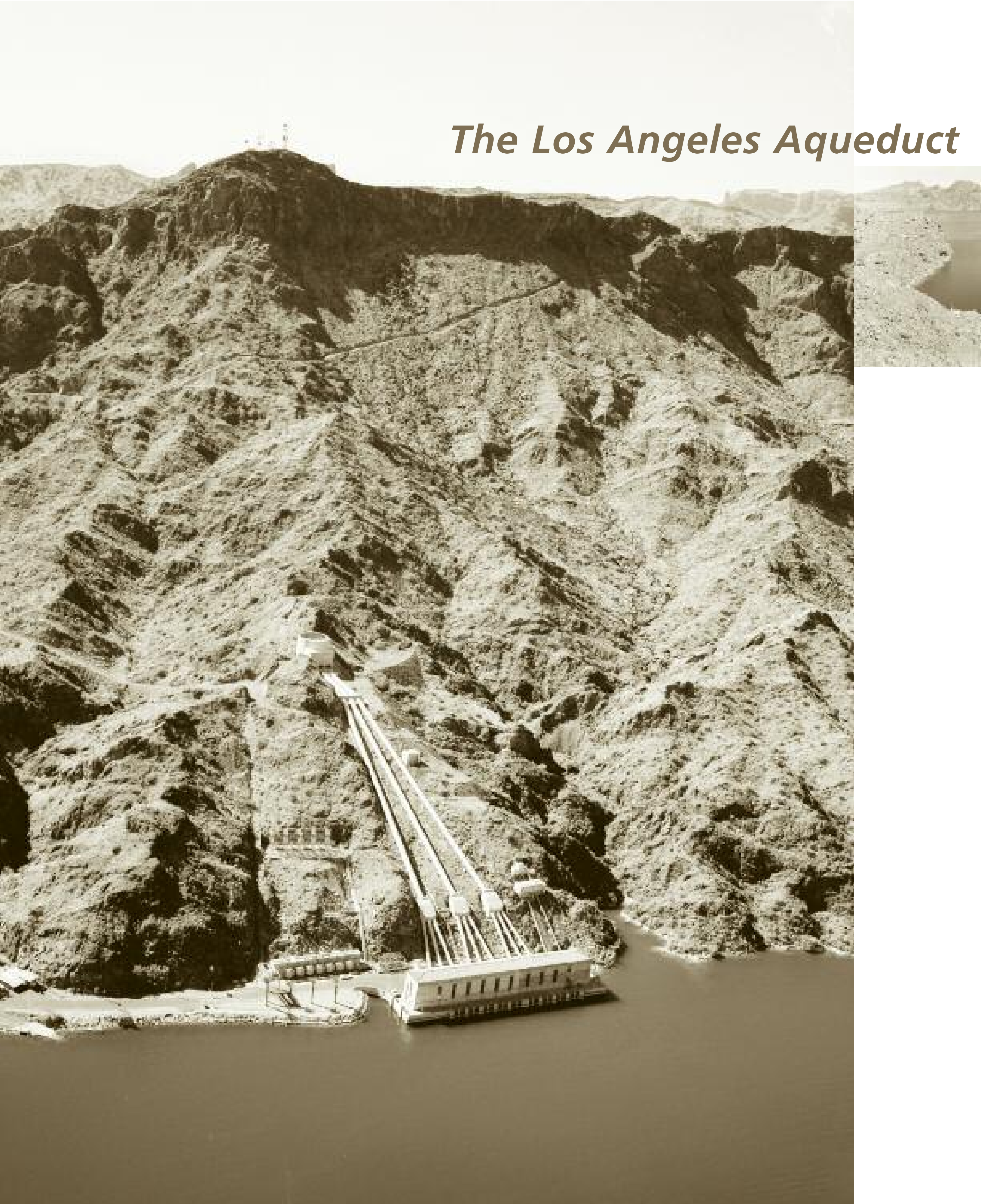
At the weary end of a six-month trek from New Spain, the settlers stopped at a place that would later be described as "a beautiful limpid little stream with willows on its banks." To the founders of the pueblo of Los Angeles, the sight of water must have been a great comfort, since they likely saw very little of it in their 1,200-mile journey from what is now Mexico. Water—its necessity and its scarcity—has been an unequalled force in shaping the face of the American West. The modern history of the semi-arid basin where the pueblo took root vividly illustrates the larger issues of populating desert lands. The vision of Los Angeles as a 20th century metropolis drove intense competition for water. It brought elaborate political maneuvering, rural-urban conflict, undying controversy, and finally, some of the most remarkable engineering feats of all time, which command respect even today.

***Right:* The Los Angeles Aqueduct ushers water down the San Bernardino Mountains toward the city.**



ALL PHOTOS JET LOWE/NPS/HAER

The Los Angeles Aqueduct



proposed to move water solely by gravity,

from a mountain valley over 200 miles away through craggy terrain and desert. The Colorado River Aqueduct aimed to exert a bit more muscle, using a series of pumping stations to get the water out of a river gorge and over more than 200 miles of difficult terrain. Both projects employed some of the most innovative techniques of the day, as well as the most basic, overcoming seemingly insurmountable obstacles and setting records doing it. The logistics and support systems alone were monumental achievements.

Two projects, the Los Angeles Aqueduct and the Colorado River Aqueduct, embody the politics of growth and the history of water in the West. But it is their technical achievements that drew teams from the NPS Historic American Engineering Record to document them in detail. California water authorities, eager to capture the magnitude and rich history of the aqueducts, sought out HAER's expertise.

The subplots that swirled around these projects are an integral part of their story, but the practical objective is compelling in and of itself. The Los Angeles Aqueduct proposed to move water solely by gravity, from a mountain valley over 200 miles away through craggy terrain and desert. The Colorado River Aqueduct aimed to exert a bit more muscle, using a series of pumping stations to get the water out of a river gorge and over more than 200 miles of difficult terrain. Both projects employed some of the most innovative techniques of the day, as well as the most basic, overcoming seemingly insurmountable obstacles and setting records doing it. The logistics and support systems alone were monumental achievements.

As milestones in the nation's engineering legacy, the aqueducts came under HAER's lens for the purposes of posterity. The group documents historic industrial and engineering sites with measured and interpretive drawings, large-format photographs, and comprehensive research. The final product, a detailed profile of a site from its smallest workings to the backgrounds of the people who built it, goes to the Library of Congress, where HAER's extensive collection is kept. Recording the aqueducts was the inspiration of former HAER chief Eric DeLony. "We were systematically recording the nation's major engineering systems," he says, "and I'd just read the famous book, *California Water*. The number one issue in the West is water."

Visions of Los Angeles

The tumultuous history of the Los Angeles Aqueduct began in a peaceful valley far to the north of the city. The Owens Valley, formed by a cleft between the Sierra Nevada and the Inyo-White Mountains, was an agricultural community with about 400 family farms at the turn of the century. Water was plentiful, running off the eastern slope of the Sierra Nevada for some 150 miles along the range. But the crude irrigation methods were wasteful, and, in the long run, destructive. Farmers simply used trenches to route the water, but much of it seeped into the earth before it got to their fields. In time, the land was waterlogged, with an excess of alkali on the surface. Once one area was ruined, the farmers would simply go somewhere else. By 1903, the damage was widespread and farmers were looking for solutions.

At the same time, Los Angeles was coming up against an obstacle that was in the way of the potential its politicians envisioned. Like the Owens Valley, the city depended on runoff, which flowed down the sides of the San Gabriel Mountains and into an aquifer. This, in turn, had an outlet in the Los Angeles River. While the supply was adequate for a small Spanish pueblo, it was not up to the task for a city with big hopes. Business and civic leaders envisioned the West Coast's answer to New York and Chicago. Hanging their hopes on the vagaries of rich and lean water years was risky. L.A. officials were aware of the abundance of water in the Owens Valley, some meeting with U.S. Senators to discuss more efficient use. The situation intensified when Los Angeles endured two consecutive years of drought.

The federal government's involvement in the West's water issues was shaped by a series of laws intended to convert arid lands to agriculture. The Desert Land Act of 1877 offered 640 acres at $1.25 per to anyone who promised to irrigate within three years. The Carey Act of 1894 parceled out millions of acres to western states, who, in turn, pledged to promote irrigation and development. In 1902, President

***Left:* The Whitsett Pump Plant, part of the Colorado River Aqueduct. "This is the beginning of the journey," says National Park Service photographer Jet Lowe, who documented the system for the Historic American Engineering Record. "This is where the water comes out of the Colorado River." Pumps force the water up and over the steep terrain, the first stage in a series of relays. "None of it would be possible without the Hoover Dam upstream," Lowe says, the power grid an achievement in its own right. *Above left:* Copper Basin Reservoir and Dam, tucked in a crevice between red rock canyon walls and connected to intake and outlet pipes beneath the mountains. *Above right:* Moved by gravity alone, water snakes its way to the city in a concrete-lined channel of the Los Angeles Aqueduct.**

***Below left:* The Alabama Gates spillway on the Los Angeles Aqueduct. In 1924, the rural-urban acrimony found an outlet when ranchers opened the spillway to return water to the Owens River. *Below right:* In taming the Colorado River, the Hoover Dam—a national historic landmark and monument to American engineering—made an aqueduct possible. *Right:* Churning water from the Colorado River at the F.E. Weymouth Treatment Plant in the San Gabriel Valley.**

Theodore Roosevelt signed the Reclamation Act to fund irrigation projects. Scientists and engineers from the U.S. Geological Survey came to the West in numbers and, in 1903, to the Owens Valley.

It is impossible, in the story of water in the West, to avoid the themes of chicanery and influence-peddling. William Mulholland, head of the Los Angeles Department of Water and Power, was a driving force in the city's transformation. He and a number of his associates played a part in derailing a planned reclamation project for the Owens Valley, and Fred Eaton, a former city water official, bought acreage later crucial for building an aqueduct to Los Angeles. City officials allegedly had connections inside the newly formed U. S. Reclamation Service. President Theodore Roosevelt, in a letter to the Secretary of the Interior, wrote that while farmers in the Owens Valley had understandable concerns, they "must unfortunately be disregarded in view of the infinitely greater interest to be served by putting the water in Los Angeles." A 1906 act of Congress directed the Interior Department to sell land along the proposed route to the city. The aqueduct's political origins, says the HAER report, have been the subject of "intensive examination" in novels, poems, broadsides, and film, the latter alluding to the plot of Roman Polanski's *Chinatown*. In 1905, amid outcry and investigations, the *Los Angeles Daily Times* announced, "Titanic Project to Give City a River."

A Ditch in the Desert

The job was monumental, taking six years of planning, digging, tunneling, hauling, mixing concrete, blasting, and laying pipe. The design's guiding principles depended more on simple physics than technology, with the entire 235-mile length gravity-fed. "The physical dimensions of this thing are mind-boggling," says Jet Lowe, the HAER photographer who documented the aqueduct system. "But it's kind of humble too, because it's little more than a ditch in the desert." The waterway was comprised of lined channels, covered conduit, tunnels, dams, and reservoirs. It followed the course of the Owens River out of the valley, then rounded the southern end of the Sierra Nevada and crossed the Mojave Desert before it arrived at its final obstacle, the San Gabriel Mountains north of Los Angeles.

A key component was a series of hydroelectric plants that would use water flow to generate power for the city. All told, the project required 500 miles of roads and trails, over 2,000 buildings and tent houses, hundreds of miles of telephone, telegraph, and power lines. The demand for concrete would be so extreme that the city built its own plant in the foothills of the Mojave desert, where there was an abundance of natural limestone to make Portland cement.

Small settlements sprung up along the aqueduct's course: offices, mess houses, shops, barns, cook shacks, and sawmills. Everything was portable. Structures were simply taken apart, loaded on a wagon, and moved further down the line. Thousands of workers from around the world converged on the project. It was, as the HAER history puts it, "back-breaking work in a desperately inhuman climate."

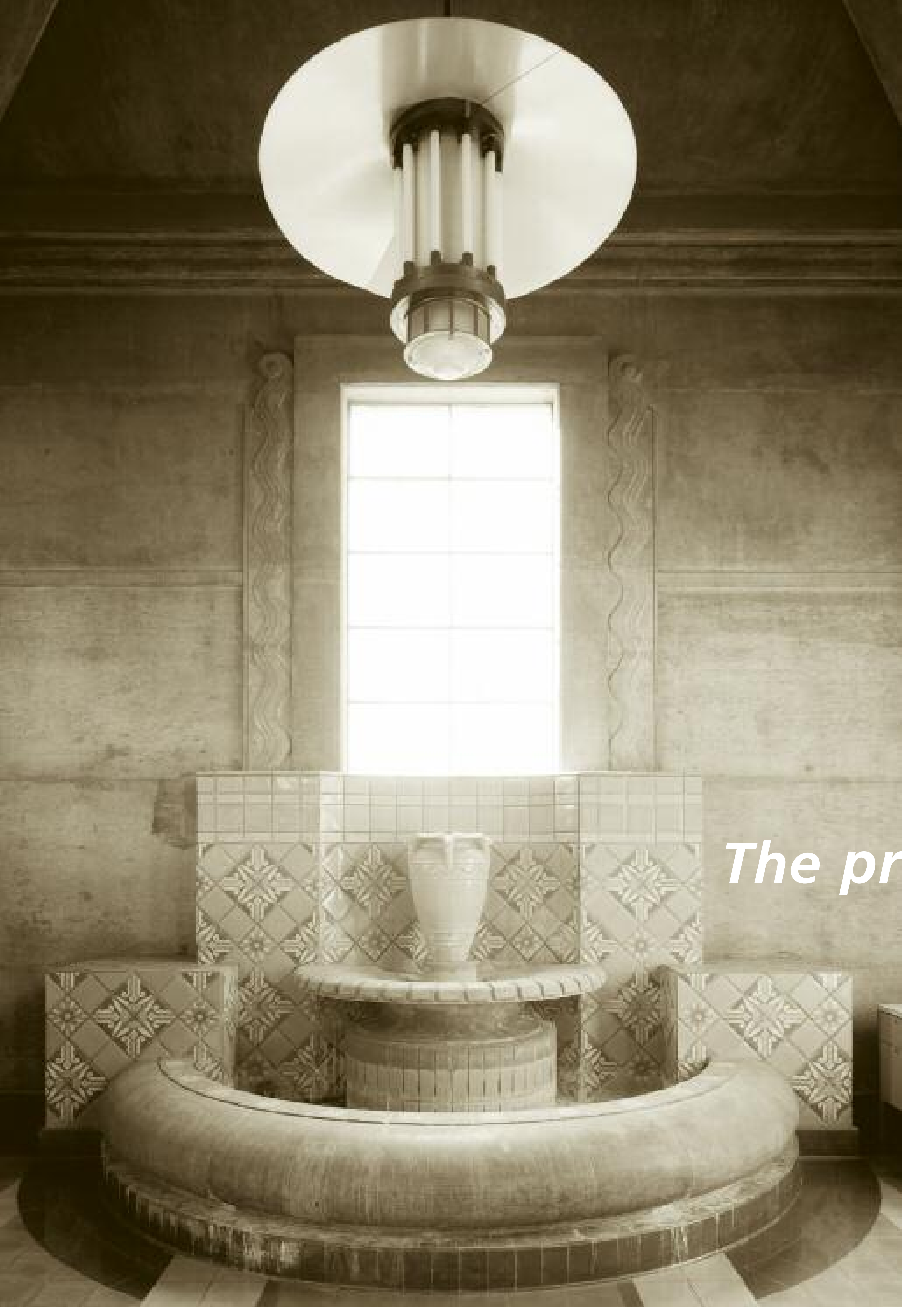
Most of the aqueduct is a concrete channel, with an average width of 12 ½ feet. To maintain gravitational pull over long stretches, the pitch was prolonged: At some places, the water is heading downhill toward Los Angeles at a mere 18 inches per mile. It had to cross a number of gorges and canyons, and to do this, engineers used siphons, a technology that goes back to ancient Rome. Builders sent pipelines down into gorges and canyons and then up the other side.

While the uphill climb would seem insurmountable, hydrostatic pressure and water's propensity to find its own level actually produced a siphon effect. Once the water starts flowing in quantity, it flows uphill. Both aqueducts used dozens of siphons along their respective courses. Says Tatiana Escobar, historian for the HAER documentation, "Certain parts of the aqueduct, especially when it flows in open channels, seem so small and idyllic that it's hard to imagine that it is one of the main water systems for such an immense city." She points out that the building of the aqueduct coincides with the rise of another institution that drove the city's emergence, Hollywood.

What Mulholland and the other leaders didn't

expect was how fast Los Angeles would grow.

They had projected 260,000 residents by the time the project was finished in 1913. In fact, there were almost twice as many. Though 260 million gallons a day were rushing through the desert to the coast, it would not be long before the search was on for more water.



The project

Workers blasted through mountains to build 142 individual tunnels. The five-mile-long Elizabeth Tunnel was one of the project's greatest feats. Running as deep as 250 feet below the surface, it served as an outlet for the Fairmont Reservoir, carrying water literally through the mountains. Workers set a speed record for hard rock mining, excavating more material faster than had ever been done before. Veterans of the Elizabeth Tunnel were sought for similar projects in other parts of the world because of their experience.

In the fall of 1913, the valve gates were opened during a festive ceremony full of hope for the future. William Mulholland presided, with some 40,000 onlookers in attendance. The aqueduct broadened the city's horizons immeasurably. What Mulholland and the other leaders did not know was how fast Los Angeles would grow. They had projected 260,000 residents by the time the project was finished in 1913. In fact, there were almost twice as many. Though 260 million gallons a day were rushing through the desert to the coast, it would not be long before the search was on for more water.

The '20s were both a period of explosive growth and prolonged drought. Mulholland and other officials planned to extend the aqueduct further up the valley to a large lake at Mono Basin. Once again, they enlisted the help of the U.S. Reclamation Service to acquire the land. There was a great deal of lingering bitterness from residents over the aqueduct, and news of an extension—to divert still more water to Los Angeles—provoked violence. Things came to a head when, in 1924, someone dynamited a spillway gate. Explosives were used repeatedly to sabotage the waterway. In the end, Los Angeles offered to buy out residents and pay for the water rights. They created jobs for locals to maintain the aqueduct. The so-called Mono Extension lengthened the aqueduct to 338 miles. The aqueduct was expanded again in 1970, increasing its capacity 50 percent.

William Mulholland's career suffered an irreversible setback when, in 1928, a dam collapsed. Part of a series of reservoirs built after the initial aqueduct was completed, the St. Francis Dam—about 40 miles northwest of L.A.—showed signs of trouble shortly after it was built. Several reasons were cited for the failure, among them hasty construction. When it let go, a giant wall of water surged all the way to the Pacific. Over 400 people were killed. It remains one of the greatest engineering disasters in American history. Mulholland, who had inspected the dam just hours before it gave way, took full responsibility and retired.

Insatiable Thirst

As early as 1923, Mulholland and his colleagues were eyeing the Colorado River. The vision this time was regional: reliable water not just for Los Angeles but for all southern California. Other towns joined Los Angeles to form the Metropolitan Water District of Southern California, an entity sanctioned by the state to pursue another aqueduct. Like its predecessor, the new aqueduct was surrounded by subplots that remain an indelible part of the story. It, too,

required 500 miles of roads and

trails, over 2,000 buildings and tent houses, and hundreds of miles of telephone, telegraph, and power lines. The demand for concrete would be so extreme that the city built its own plant in the foothills of the Mojave desert, where there was an abundance of natural limestone to make Portland cement.

***Left:** Fountain at the F.E. Weymouth Treatment Plant. The buildings and facilities are expressive of their time, says Lowe—"Art Deco with a lot of technology-affirmative imagery." He calls an enormous relief valve he shot "both iconic and primitive." **Above:** The plant's control room. The water has to be constantly mixed, balanced, purified, and monitored. "The workers are real chemists," says Lowe, "almost artisans in the way they handle it."*

was a sprawling, ambitious undertaking very much in the spirit of westward expansion, using technology to conquer the land.

Today, the American Society of Civil Engineers classifies the Colorado River Aqueduct as one of the seven wonders of American engineering. The project employed as many as 10,000 people in the depths of the Great Depression.

The aqueduct begins its 242-mile course at Lake Havasu on the California-Arizona border, formed by the Parker Dam. Then it crosses the Mojave, skirts several mountain ranges, follows the southern edge of Joshua Tree National Park, traverses the north end of the Salton Sea, and crosses the San Jacinto Mountains near Palm Springs before arriving at Lake Matthews near Riverside, California.

Before the journey begins, however, the water has to be pumped out of the river and propelled upward over the mountainous terrain. Engineers designed five powerful pumping stations to drive the water up in relays, from one station to the next, until it could flow by gravity. At the time, it was the world's most advanced water conveyance system.

There were obstacles to navigate even before building began. Colorado, New Mexico, Nevada, Utah, and Wyoming all claimed a right to the river. In addition, there was disagreement over a proposal to build the colossal Hoover Dam, intended to aid agriculture in California's Imperial Valley. Negotiations led to the Colorado River Compact, which apportioned water to each state annually.

The dam remained a thorny issue, however. The aqueduct would depend on electricity from it, and other states failed to see the benefit. Mulholland went to Washington to appear before the House Committee on Irrigation and Reclamation. As with the earlier aqueduct, the new project was pitched as a matter of survival. "This committee has got to come to our relief," Mulholland pleaded, "and give us the means of a larger and more secure water supply or we are ruined." In 1929, Congress approved $165 million. Los Angeles promised to buy hydroelectric power from the federal government to offset construction costs.

City officials launched a publicity campaign to drum up support. The water department inserted promotional material in the envelopes with monthly water bills. An early talking picture, *Thirst,* drove home the necessity of water for southern California. In 1931, voters approved a $220 million bond issue. Construction began two years later.

The Hoover Dam, like the Grand Coulee, became a monument to the New Deal, feeding a public infatuation with technology that gave hope to a nation weary of the Depression. The projects seemed to revel in their own scale, what historian Donald C. Jackson calls "a celebration of mass." Though not as large as some other dams of the era, the Hoover was a behemoth that went 235 feet down to bedrock. At the time, it was the largest concrete structure in the world. The Bureau of Reclamation designed space for the hundreds of thousands of tourists who came, adorning the structure with plaques and mosaics.

The California Institute of Technology designed massive pumps to get the water over the mountains, the largest run by a 12,500 horsepower motor. The pumps had their own power system. Steel towers marched across the desert carrying power lines to the stations, one of many dramatic changes to the landscape. The water, sent from one station to the next, traveled through a large conduit that bored through mountains. From its origin, the water was lifted over 1,600 feet until it flowed down with a gentle pitch to Los Angeles.

The plants and pumping stations were an ornate hybrid of Art Deco and Spanish Colonial Revival, with some classical references thrown

There was a great deal of lingering

***Far left:* Lines coming out of the Whitsett pumping plant on the Colorado River. *Near left:* The Los Angeles Aqueduct traverses the terrain, gravity-fed from start to finish; its builders came up with ingenious methods to overcome geography. *Right:* Oasis of green alongside the Los Angeles Aqueduct. Tiny communities of maintenance workers sprouted up along its course.**

bitterness from residents over the

the aqueduct, and news of an extension—to divert still more water to Los Angeles—provoked violence. Things came to a head when, in 1924, someone dynamited a spillway gate. Explosives were used repeatedly to sabotage the waterway.

in. "Little desert communities ran the pumps and guarded the water," says photographer Lowe, "amazing little oases" of green grass amidst the barren landscape. J. Philip Gruen, the project historian for HAER, describes a night spent at one of the pumping stations: "Everything was silent . . . You didn't have a sense that anything was going on, which gives you an idea of how efficiently the aqueduct was designed. There was just this low hum in the desert. Everything was working without any effort at all."

The construction of the aqueduct itself was much like that of its predecessor—a combination of concrete-lined channels, tunnels, and conduit. A veritable army of workers toiled for eight years, the support and logistics staggering in scale. As with the Los Angeles Aqueduct, they found ingenious ways around obstacles. "The scale of this project is apparent whether you're driving the length of it or flying," says Gruen. What is not visible to drivers is the water flowing freely through the desert. "Flying over the aqueduct in a helicopter, it's amazing to see these blue streaks running through the arid expanse," says Gruen. "There's extraordinary visual allure." And irony. When water finally flowed in 1941, it wasn't needed. The shortages never materialized, and consecutive rainy seasons filled reservoirs to overflowing. In the aqueduct's first five years, the Metropolitan Water District used only six percent of its capacity. The demand for power from the Hoover Dam didn't materialize, either. But the postwar boom changed things as subdivisions spread across southern California. By 1952, officials had to add more pumps and another hundred or so miles of pipes and tunnels. A third system, the California Aqueduct, was added in 1970, bringing water over 400 miles from the northern part of the state.

Mulholland's single-minded quest may

Above: ***Part of a 1970 upgrade to the Los Angeles Aqueduct as it runs through Pine Tree Canyon.*** ***Right:*** ***Pipeline in the vicinity of Jawbone Canyon, in the Mojave Desert. Of the aqueduct's many siphons, Jawbone may be the most impressive. Running for a total of 7,096 feet, it carries water up canyon walls at a slope of 35 degrees.***

be repeated soon as climate change and

development combine to create increasing demand for dwindling supply. U.S. Department of Energy scientists project that in winters of the future, mountain ranges like the Sierra Nevada will see more rain than snow. The flow will change from a steady, well-paced supply to an unpredictable pattern of storms and floods—followed by drought.

The Flow of the Future

At the turn of the 21st century, the Colorado Aqueduct was supplying water to approximately 18 million people, and the Los Angeles Aqueduct was still the main source of water for its namesake city. Mulholland's single-minded quest may be repeated soon as climate change and development combine to create increasing demand for dwindling supply. U.S. Department of Energy scientists project that in winters of the future, mountain ranges like the Sierra Nevada will see more rain than snow. The flow will change from a steady, well-paced supply to an unpredictable pattern of storms and floods—followed by drought. In the wet season, water managers will have to release water from overflowing reservoirs. In the dry months of spring and summer, there will not be enough.

In the meantime, water keeps flowing through the open desert and dark tunnels, down to California's coastal plain with its lush lawns and golf courses. The creation of William Mulholland and his engineers remains vital. It is also part of the lore of the modern West, a tale of backroom dealing, environmental plunder, and audacious can-doism. What gets lost is one of the drama's most compelling acts: the one that played out in the hard rock, gullies, and escarpments, a long-forgotten epic of ingenuity, sweat, and vision to which the West Coast megalopolis owes its life.

For more information, contact Richard O'Connor, Chief of the National Park Service Heritage Documentation Programs Division, at richard_o'connor@nps.gov, Jet Lowe of the National Park Service Historic Engineering Record at jet_lowe@nps.gov, or former HAER Chief Eric DeLony at pontist@ comcast.net.