RTD-111

San Luis Unit

West San Joaquin Division

Central Valley Project

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Approximately 300 miles, and 30 years, separate Shasta Dam in northern California from the San Luis Dam on the west side of the San Joaquin Valley. The Central Valley Project, launched in the 1930s, ascended toward its zenith in the 1960s a few miles outside of the town of Los Banos. There, one of the world's largest dams rose across one of California's smallest creeks. The American mantra of "bigger is better" captured the spirit of the times when the San Luis Unit first came to the drawing board. The project's size and scope forged a unique partnership between the State of California and the Federal government, as the state financed and owns 55 percent of the Unit while the remaining 45 percent belongs to the United States. Unfortunately, the San Luis Dam, the crowning achievement of the CVP, labeled by Reclamation, "the most ambitious public works project ever built," found itself lost in the social and political dramas of the day -- the war in the jungles of Vietnam, the war on poverty at home, and the race with the Soviet Union to put a man on the moon. A temple of engineering built on a foundation of controversy, the Unit's presence raised its own spate of issues after it was completed. The environment, coping with drought, acreage limitation and the dominance of agri-business are just a few of the issues the people who run the San Luis Unit face everyday. A technical marvel and a symbol of modern California at its most productive, or destructive depending on your viewpoint, San Luis deserves the designation "milestone."[1]

Project Location

In the 1860s, the leader of the first California Geologic Survey, William Henry Brewer,

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1. "Building a Reclamation Giant in California," in *Reclamation Era*, (February, 1965): 4; Stephen Johnson, Gerald Haslam, and Robert Dawson, *The Great Central Valley: California's Heartland*, (Berkeley, California: University of California Press, 1993), 212.

described the southwestern San Joaquin Valley as a "plain of absolute desolation." At the turn-of-the-century, the crusading novelist Frank Norris, pictured the valley as "bone-dry, parched, and baked and crisped" where the "day seemed always at noon." But, a century after Brewer's report, and less than a half-century after Norris' observations, it became clear that by just adding water, this vale of sterility would bloom as the nation's garden. Sixty-five miles long, averaging 13 miles in width, the San Luis Unit endures long, hot summers and brief, foggy winters. Winter-spring storms making their way inland from the Pacific provide from 3.4 to 14.5 inches of precipitation a year. Humidity is low, and evaporation rates are high on the west side of the valley, where temperatures range from 100 to 110 degrees during the summer. The average growing season lingers over 250 to 300 days from early spring to late autumn. In order to supplement nature, man draws water from the delta of the Sacramento River, sending it through a web of power plants, canals, tunnels and pumping plants to irrigate 600,000 acres in Fresno, Kings, and Merced Counties. Located at the foot of the Diablo Mountains is the project's centerpiece: the 18,600-foot-long San Luis Dam. Behind the dam, the nation's largest off-stream man-made lake, the San Luis Reservoir, can hold 2,041,000 acre-feet of surplus water gathered from the Sacramento-San Joaquin Delta.[2]

The operation of San Luis Unit reads like a road map to an engineer, but with a myriad of facilities and tasks, it can seem like a maze to the outsider. Melting snow and runoff high in the mountains of Northern California are the first steps of a trek through the heart of the state. Once in the Sacramento-San Joaquin River Delta, water is released from storage and lifted 197 feet by the Tracy Pumping Plant. The flow is then conveyed about 70 miles south to the O'Neill Forebay via the California Aqueduct (a State Water Project, or SWP, feature) and the Federal

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2. Frank Norris, *The Octopus: A Story of California*, (New York City: Signet Classics, 1981), 9-10

Delta-Mendota Canal. Delta-Mendota carries water southeasterly from the Tracy Pumping Plant, eventually arriving at the O'Neill Pumping-Generating Plant. Running parallel to the Delta-Mendota Canal, the Edmund G. Brown California Aqueduct travels directly into the O'Neill Forebay. The O'Neill Dam, Pumping-Generating Plant and Forebay are all a half mile from the San Luis Dam and Reservoir. Units of the William R. Gianelli Pumping-Generating Plant (formerly known as the San Luis Pumping-Generating Plant) raises water from O'Neill Forebay into San Luis Reservoir. Releases from San Luis Reservoir are directed into the 102.5-mile long San Luis Canal. Seventeen miles south of San Luis Reservoir, the Dos Amigos Pumping Plant lifts the water again, so the flow can continue another 85 miles across central California. Journey's end for the San Luis Canal is the Federal terminus at Kettleman City. At Kettleman City, the SWP's California Aqueduct carries on to service farms, recreational users and municipalities as far south as Los Angeles. When drought strikes California, and Delta flows cannot supply State and Federal water projects, water is released back into the O'Neill Forebay, coursing southward through the California Aqueduct. During irrigation season, water is released from the reservoir back through the pump-generator units of Gianelli to the O'Neill Forebay, generating electric power. Protecting the canal from streams crossing its path are the Los Banos and Little Panoche Detention Dams and Reservoirs. Other Unit features include the San Luis Drain, Pleasant Valley Pumping Plant, and the Coalinga Canal. The operation of the San Luis Unit is a fairly simple procedure for those brief periods when man and nature are in harmony, but both seldom have been in synchronization.[3]

Historic Setting

3. U.S., Department of Interior, Water and Power Resources Service, *Project Data*, (Denver: United States Government Printing Office, 1981), 211-2. Jack O'Neill was a San Joaquin pioneer farmer who worked for the state and Federal authorization of the San Luis Unit.

Described as "tough, resourceful," the Yokuts Indian tribe foraged along the San Joaquin River in relative seclusion for generations. Harvesting acorns and seeds, fishing, and hunting ducks and tule elk, the Yokuts' way of life vanished after the tribe lost its struggle resisting Spanish attempts to convert them to Christianity. In the early 1800s, a Spanish expedition from the Presidio in San Francisco christened the area San Luis Gonzaga after Saint Aloysius Gonzaga, an Italian Jesuit of the sixteenth century. Between 1805 and 1817, Spanish explorer Gabriel Moraga named many landmarks across California's interior, including the San Joaquin Valley, while in search of new mission sites. However, few Spanish settlements flourished in Moraga's wake, as the Spanish legacy along the San Joaquin River is found in placenames, flora and fauna, and the cultural divisions that still exist in California.[4]

After their victory in the Mexican War, Americans slowly populated the San Joaquin Valley over the latter half of the nineteenth century. Western Merced, Fresno, and Kings Counties, land that one day would be the "richest this side of the Nile," was stubborn tumbleweed desert. Ranchers dug canals to irrigate great expanses of pastureland to ensure enough feed for their stock during California's dry summers and autumns. Pioneer irrigators dug crude ditches from the San Joaquin River, in addition to adapting abandoned mining ditches and artesian wells to their own use. Scrub brush and sand bags served as the first diversion barricades in the San Joaquin and usually had to be replaced every year. The first canal ran from the future site of the Mendota Dam to Los Banos Creek. Other canals were added, as the system eventually grew to 180 miles.[5]

The introduction of the first motorized pump to the valley after 1900 brought with it a

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4. Johnson, Haslam, and Dawson, *The Great Central Valley*, 28-31.
5. U.S., Department of Interior, Bureau of Reclamation, *The Contribution of Irrigation and the Central Valley Project to the Economy of the Valley and the Nation*, (1955): 8, 10; *San Francisco Chronicle*, 10 July 1949, p. 15.

agricultural revolution. Tapping California's underground aquifer, pumping saved many owners of overgrazed ranchland. One pioneer Californian, Alden Campen, recalled the state of his property before pumping: "All it was good for was sheep pasture. In a good year we got about 15 cents an acre from the pasturage. In a bad year we got nothing, because the grass didn't grow." Within two decades, this new form of irrigation drastically changed local agriculture, providing an impetus for fruit, nut, and cotton production, as grazing and grain production slowly fell out of favor. Drawing water from an unseen source quickly became a dependence for most growers. In 1922, 33,000 acres were irrigated directly from pumping. Despite the hard times brought by the Depression, by the end of the 1930s, approximately 90,000 acres received water from underground. The growers' increasing dependency on pumping led to a ten foot per year drop in the underground water table, and wells were drilled as deep as 2,000 feet beneath the surface.

America's entry into World War II placed additional stress on the water table, as the national demand for cotton, flax, wheat, and vegetables expanded. Privately, many growers were frightened by peacetime, believing the demand for their products would diminish and the half-million acres in production during the war years would revert to desert. In order to forestall that disaster, in 1942, the modern era of Westside water development began. That year, landowners in western Fresno and Kings Counties formed the Westside Landowners Association. According to a 1945 Department of Agriculture report, a select few each owned over a thousand acres in the San Joaquin Valley. These owners sought Reclamation's help in drawing Central Valley Project surface water to the west side of the valley. In 1945, Reclamation prepared a plan detailing the multiple-purpose development of the water resources of the entire Central Valley basin. The report noted the rapid growth of agriculture on the west side of the San Joaquin Valley, and the need for importation of a new water supply.

Unfortunately, much of the CVP's progress had been halted by a federal order suspending completion of non-essential projects. Westside growers returned to pumping, waiting for events as distant as the war and as close as their acreage, to turn in their favor.[6]

As long as the problem of over-pumping remained unseen and underground, it did not weigh heavily on the minds of most in the valley. But, by the early 1950s, overdraft on the aquifer was up to 500,000 acre-feet per year and a solution had to come quickly, as farmers and the Federal government searched for "a compromise between the economic advantage of adaptable crops and full utilization of the expensive and inadequate present water supply." In addition to headaches brought by a draining aquifer, studies found local groundwater contained a sodium content between 20 percent and more than 90 percent. In 1952, as overdraft problems worsened and the quality of groundwater declined, farmers on the west side formed the Westlands Water District (WWD). A 1954 Federal investigation of what could prevent the crisis from spreading recommended construction of a storage facility. Reclamation favored a site along the Pacheco Pass Highway encircled by the eastern foothills of the Diablo Mountains. The Bureau believed this spot would make an excellent location for a gigantic reservoir.[7]

Project Authorization

It had been almost a decade since Reclamation first noted the development of the west San Joaquin Valley. In December 1955, the Bureau submitted a feasibility report to the State of California bearing their proposed project name -- the San Luis Unit. In March of the following year, the State offered its recommendations on the report. California conceived their own venture, the Feather River Project at Oroville. Feather River would store water to flow down the

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6. Harry Farrell, *The San Felipe Story*, (Santa Clara Valley Water District: 1987), 16.
7. U.S., Department of Interior, Bureau of Reclamation, *Westlands Unit, San Luis Division, Central Valley Project, (Ultimate Plan): Appendix A*, (March, 1954), 23, 25-6; U.S., Department of Interior, Bureau of Reclamation, *Westlands Water District Water Supply Replacement Project*, (Sacramento: 1989), sect. 2, p. 28.

Sacramento River where the state would transfer it southward by canal. With passage by the state legislature of the Burns-Porter Act of 1959, authorizing the SWP's initial facilities, it was apparent the state needed off-stream reservoir capacity to supply the Westlands acreage already in production. California took the unusual step of offering to work with the Federal government to design a much grander facility along Los Banos Creek.[8]

The State of California was unprepared to attempt anything too grandiose, so the State Director of Water Resources Harvey O. Banks lobbied Washington for a state-federal partnership. Reclamation was cool to the idea, as Banks recalled, "Literally we were laughed out of town. The solicitor general of the Interior Department said it was impossible; there was no precedent -- 'get out and quit bugging us.'" The potential of "too many governmental cooks. . . spoiling the watery broth," had Californian backers of the project proceeding cautiously. Through persistence, the unusual notion of a national and state partnership gained increasing acceptance during Federal congressional hearings in 1956, 1958, and 1959. It took four years of politicking by Californians to get Reclamation to see the efficiency and economy of a joint undertaking.[9]

On May 16, 1960, the Bureau and state entered into an agreement for coordinated operation of the Federal Central Valley Project and the State Water Facilities, later known as the California Aqueduct. A first in Federal-State relations, the contract agreed to construction of "joint-use facilities," and a 55-45 spilt of costs between the State of California and the United States government. The San Luis authorizing act (Public Law 86-488, 86th Congress) was signed into law by President Dwight Eisenhower on June 3, 1960. In November, California's

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8. State of California, Agricultural Extension Service, *Impact of San Luis Unit on Fresno County*, (March, 1965), 1; William R. Gianelli, interview conducted by George Petershagen and Donald Seney, Tape 4, conducted in Pebble Beach, California, 23 September 1994.
9. Farrell, *The San Felipe Story*, 29, 35.

voters agreed to a $1.75 billion general obligation bond issue to begin building the Project's dams, pumping plants, and aqueducts. The State Water Project, like the CVP, takes surplus water from northern California streams and redirecting it toward the thirsty croplands and communities of the south. Now in partnership with the state, Reclamation increased the reservoir's design capacity to twice the size originally contemplated. In 1961, final blueprints for San Luis Dam were delivered to the state and Federal government. After review, both parties estimated the construction contract would total $433 million. Governor Edmund G. "Pat" Brown okayed the San Luis Agreement in San Francisco on December 29 of that year. Secretary of the Interior Stewart Udall signed for the Federal government the following day.[10]

The bidding process to select a contractor to build the dam and reservoir required a joint venture. Three companies working in tandem would complete the structures according to specifications developed in Reclamation's Mid-Pacific office in Sacramento and the California Department of Water Resources. The Morrison-Knudsen (M-K) Company Inc., of Boise, Idaho; Utah Construction and Mining of San Francisco, and Brown and Root, Inc. of Houston, won the contract with a low bid of $85.9 million in early 1963. Tilting the scale in the trio's favor was that their joint offer was some 32 percent under Reclamation's and the state's preliminary estimate of $127 million.[11]

Construction History

All California productions demand a spectacular premiere, and the beginning of construction on San Luis Dam was no exception. The still morning of August 18, 1962 grew warm as the sun rose over 15,000 people driving the two-lane Pacheco Pass Highway leading to the site of the San Luis Dam. They gathered to view President John F. Kennedy as he presided

10. *The San Felipe Story*, 36; *Impact of San Luis Unit on Fresno County*, 2.
11. "California's San Luis Dam Project," in *Engineering News-Record*, (February 3, 1963): 50.

over the dam's groundbreaking ceremonies, and at 11:30 a.m., the presidential helicopter landed near the 100-foot-long speakers' platform. In a good spirits after a night spent at Yosemite, Kennedy opened his remarks with a quip, "It is a pleasure for me to come out here and help blow up this valley in the cause of progress."[12]

The President, and California Governor Edmund Brown, proceeded to push separate brass plungers, touching off an explosive charge. Two puffs of smoke rose three-and-a-half miles apart marking the future shoulders of the dam, igniting a line of smoke grenades along the dam's axis. Green, red, and purple smoke raced from each side to meet at the dam's midpoint. At that moment, a helicopter flew across the canyon trailing red smoke 320 feet above the floor, "with the precision of a draftsman's pencil" to show the crowd how high the dam would stand five years hence. A rainbow of smoke hung in the air for 20 seconds before the breeze carried it away. The effect provided a "show never forgotten by anyone who was there."[13]

The first contract on the San Luis Unit, awarded the same month as the groundbreaking, went to reroute the Pacheco Pass Highway around the reservoir site. By then, the men responsible for guiding the contractor's and government forces were in place. John Buchholz led Reclamation as construction engineer, based in the project office in Los Banos, and T. P. Bixby served as the field engineer. Morrison-Knudsen's Harold L. Gourlie was the contractor's project manager and Alfred M. Petrofsky served as project engineer. A year into construction, in 1963, prevailing wages ranged from $3.32 an hour plus 25 cents fringe benefits for common laborers to $4.76 an hour plus 39.5 cents fringe benefits for heavy machinery operators. The greatest number of people hired on the San Luis Unit was 2,304 in October, 1965. In the mid-1990s, a number of veterans in Reclamation's Sacramento office remembered their first jobs with the

12. *The San Felipe Story*, 37.
13. *Ibid*.

Bureau were at San Luis. Their memories of the endless summers of 1965 and 1966 were of working days where the hours reached the double-digits and of often times being paid more in overtime than what they took home in regular salary.[14]

An impressive stockpile of machinery dug, lifted, and compacted the dam into shape. Resembling a giant amusement park ride, a wheel excavator burrowed and loaded more than a hundred tons of earth a minute for the embankment's core. Designed by Bucyrus-Erie of Milwaukee, the 30-foot-diameter excavation wheel was similar to those used in strip mining. Each of the wheel's ten bucket shovels scooped more than 2.5 tons of earth.

The dirt, for zones 1 and 3, dumped onto the first of two 84" conveyors on the excavator. The first conveyor pivoted around the machine with the digging wheel, while the second remained in a fixed position over a truck loading station. It dumped into a flop chute that alternately fed one of two truck loading lanes. 100-ton trucks were thus able to be loaded continuously at 50-second intervals.

Rock for zones 4 and 5 on the upstream face of the dam were extracted from a quarry at the top of nearby Basalt Hill. The quarry-run rock was excavated with a 15 cubic yard electric shovel and transported by 75-ton trucks to a rock separation plant. This plant separated the rock into plus-and-minus nine-inch sizes. Huge bar screens directed the larger size rock into a hopper that loaded the zone 5 material into 60-ton rear-dump trucks. The trucks had special baking systems for hauling safely down the steep access road. The smaller zone 4 rock dropped onto a 3,200-foot long conveyor down the hillside. This ended on a cantilevered tower over a 100-foot high stockpile at the bottom. There was a drive-through tunnel under the pile that allowed 100-

14. U.S., Department of Interior, Bureau of Reclamation, *Annual Project History, Central Valley Project*, Vol. 39, 1967, 3; Dan Fults, interview with Dr. Brit A. Storey, Tape I, conducted in Sacramento, California, 17 November 1993; John Budd, interview with Dr. Brit A. Storey, Tape I, conducted in Sacramento, California, 25 May 1994; "California's San Luis Dam Project," in *Engineering News-Record*, (February 7, 1963): 50.

ton trucks to be loaded in two minutes. The conveyor was started with an electric motor, but, once loaded, gravity took over and the 900 horsepower motor became a generator and supplied power to the plant and shovel.

Overall, there were about 200 pieces of heavy equipment, valued at $13,000,000, used to build the dam. Production averaging 100,000 cubic yards per day and up to 130,000 cubic yards per day was achieved in 1964. The equipment pool included thirty-three Caterpillar 100-ton bottom dump trucks, the largest yet used in the United States. Four 75-ton and twelve 60-ton Caterpillar rocker dump trucks handled the larger zone 5 rock. Twenty Euclid twin-powered scrapers and a 4500 Manitowac dragline handled excavation of the two 100-foot deep core trenches. There were ten cranes ranging from 200-ton crawlers to 5-ton rubber-tired rigs. The four 284 foot high intake gate control towers were constructed using two heavy duty tower cranes, the first such use on heavy construction in the United States. An electric drill punched 10-inch holes for quarry blasting. Ten air-track drills, compressors, and two belt loaders were used in excavating for the tunnel portals and powerhouse. Sixteen bulldozers, five road graders, and four self-propelled twin sheepfoot rollers were used. The four 2,150 foot long, with an inside diameter of 17.5 feet outlet works tunnels passed through three major faults, requiring steel supports for their entire length. About 18% of the tunnel length required special "breastboard jumbos" to support the face while setting the steel ribs. The major equipment suppliers, Bucyrus-Erie, Caterpillar, and General Tire, stocked about $250,000 of spare parts in jobsite warehouses to minimize repair downtime.[15]

According to original specifications, the dam would contain 75 million cubic yards of

15. "3,500-Cu.-Yd.-an-Hour Digging Wheel Makes Debut at San Luis," in *Engineering News-Record*, (May 7, 1964): 29; "Conveyor Hauls Rock, Generates Power," in *Engineering News-Record*, (August 29, 1963): 46; "Moving 100,000 cu. yd. Per Day," in *Western Construction*, (January 1964): 47-51. Reclamation's thanks to Alfred M. Petrofsky, PE, who enlarged upon and corrected the technical information in the three preceding paragraphs. Mr. Petrofsky was the contractor's project engineer.

earth. However, as digging and placement progressed, a good sized embankment of 77,656,000 cubic yards of clay, sand and stone rose. That material forms a crest 18,600 feet long and a hill 382 feet high. The dam's crest is 30 feet thick with a maximum base width of 2,420 feet. In the United States, only the Army Corps of Engineers' Fort Peck and Oahe Dams along the Missouri River Basin carry greater mass. Five layers, or zones, of material make up the San Luis Dam. The core of the embankment, Zone 1, consists of 41 million yards of clay, silt, sand, and gravel. Twelve passes by tamping rollers compacted the conglomeration into six inch layers. Zone 2 comprises sand, gravel and cobbles compacted to 12-inch layers. Shale, sandstone, conglomerate fragments, clay, silt, sand, and gravel tamped by rollers into 12-inch layers formed Zone 3. Zone 4 is made up of rock fragments ranging between 3/16 to nine[16] inches compacted by a crawler-type tractor in 12-inch layers. The outside surface, Zone 5, is more than 3 million cubic yards of rock fragments ranging from 9 to 36 inches, taken from nearby Basalt Hill. San Luis Dam is near two seismic faults: twenty-eight miles from the San Andreas Rift, and 23 miles from the Calaveras-Hayward Faults in the earthquake hexed Hollister Valley. Designed to withstand the effects of an earthquake comparable to the one that leveled San Francisco in 1906, the dam's core material is resistant to progressive erosion and its appurtenant structures were built on a firm rock foundation.[17]

A hydraulic junction point for both Federal and State waters, the San Luis Reservoir serves as a forebay for the Gianelli Pumping-Generating Plant. The dam's spillway incorporates an ungated morning-glory hole, shaft, conduit, chute, stilling basin, and riprap-lined channel.

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16. Alfred M. Petrofsky, PE, informs us that the original specification for this rock was up to eight inches, but the nature of the construction materials required consultation with Reclamation's project engineer, Tom Bixby, and alteration of the specifications to nine inch material instead.

17. U.S., Department of the Interior, Bureau of Reclamation, *Central Valley Project, 1967 Annual Report*, 10; U.S., Department of Interior, Bureau of Reclamation, *San Luis Unit, Technical Record of Design and Construction, Vol. I*, (Denver: November 1974), 18, 48; "Major Features Completed," in *Reclamation Era*, (November, 1967): 92.

Flow in the San Luis Creek is insignificant except for spring runoff, so the spillway functions as a safety device to release any excess storage. Excess is a consequence of flooding when the reservoir is at normal water surface elevation, or by continued pumping after the reservoir fills. The entire inflow design flood of 24,500 acre-feet can be stored in two feet of excess reserve in the reservoir. On misty days common to central California, the 7.5 mile reservoir is "like an ocean, with seagulls, five-foot waves, and its horizon lost in infinity." The hilly, 65-mile shoreline, marked with inlets and coves, is dotted with such colorfully named landmarks as Honker Bay, Dinosaur Point and Catfish Flats.[18]

Work on the San Luis Dam concluded two months ahead of schedule in August, 1967. The price tag for all of the San Luis Unit's joint-use facilities reached $312.5 million, well under the $433 million estimated for construction. Reclamation credited the savings to competitive bidding for construction and equipment, substitution of a siphon for an additional detention reservoir, plus good weather, and quick planning and execution. The split of this bonus amounted to a savings of $66.3 million for the State and $54.2 million for the Federal Government. The Bureau's economists also predicted that for every dollar spent in construction, operation, and maintenance, the Unit would return more than $6. Lamentably, the project's value was diminished by six worker fatalities between 1963 and 1965.[19]

In an era when the national sense of wonder redirected itself from earthfill and concrete to liquid nitrogen rocket fuel, Reclamation could only describe the magnitude of the San Luis Canal in the reflected glory of another major Federal endeavor. In the mid-sixties, the Bureau explained to the nation the canal would be "one of the few manmade structures expected to be

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18. U.S., Department of Interior, Bureau of Reclamation, *San Luis Unit, Technical Record of Design and Construction, Vol. II*, (Denver: November 1974), 61; *The San Felipe Story*, 38.
19. "Goliath CVP Grows, San Luis Dedicated," in *Reclamation Era*, (August, 1968): 56-8; "Major Features Completed," 92-3.

identifiable by astronauts who reach the moon." Back on earth, the biggest earth-moving project in Reclamation history remains impressive. The San Luis Canal is the federally-built and operated section of the California Aqueduct, extending 102.5 miles from the O'Neill Forebay, near Los Banos, in a southeasterly direction to a point west of Kettleman City. At a cost of about $90 million, the 257-foot-wide channel cut 36 feet deep through the brown hills of central California. The excavation of 57 million cubic yards of earth and rock was the equivalent of digging a 16.5 foot wide, 10 foot deep trench from Denver to Boston. The 32.5-foot deep trapezoid is 40 feet wide at the bottom, 138 feet at the top, and lined with concrete, and able to carry 13,100 cfs of water.[20]

The San Luis Canal was constructed in five separate reaches. The longest reach, No.3, ran for 65 miles. The Guy F. Atkinson Co. of South San Francisco won the initial "$1 million a mile" contract to build the first reach. Atkinson's bid of $16.5 million for the 15.8-mile-long Reach 1, covered an area from the O'Neill Forebay to the Dos Amigos Pumping Plant. The trade journal, *Engineering News-Record*, predicted in May 1963, excavation of "3 million yards of clay will be the contractor's headache on this section of the job."[21]

In the Bureau's Denver headquarters 900 miles to the east, a systems computer lessened the blows of those predicted migraines, printing out engineering and construction data for crews digging the canal. Before computers, field surveyors and engineers spent the better part of a day converting a mile's worth of raw field data into working cross-sections and engineering material. Eighty survey stations for each mile along the canal allowed crews to compile cross-sectional field notes before sending the data to Denver. Key-punch cards and magnetic tape fed into the computer cut the calculating time down to less than a minute, saving an estimated 26.6 man-

20. "Goliath CVP Grows, San Luis Dedicated," 56-8.
21. "San Luis Canal Costs $1 Million a Mile," in *Engineering News-Record*, (May 16, 1963): 62-3.

years of labor. Overall, some 738,000 pieces of information were processed during construction. Three stages of labor -- muscle, machinery and technology -- brought the first release of water from the O'Neill Forebay to the initial reach of the canal on April 13, 1967. Water pumped from Dos Amigos Pumping Plant into the second reach started in October of that year, and by December, water reached Kettleman City at the end of Reclamation's canal. At that point, the conduit becomes the State's California Aqueduct.[22]

As impressive as San Luis Dam, Reservoir and Canal are as individual features, they would be helpless giants without a litany of essential support structures. Flush against the dam, the William R. Gianelli Pumping-Generating Plant houses eight pump-turbines with a maximum lift of 10,000 gallons of water at 320 cubic feet per second (cfs). When the flow of water is reversed, the plant's dual purpose pump-generator can generate up to 424,000 kilowatts, immediately becoming California's largest hydroelectric plant at its completion in 1967. Morrison-Knudsen, Utah Construction Co., and Brown and Root won the pumping-generating plant contract in 1964 with a bid of $38.3 million. O'Neill Dam and Forebay is a joint Federal-state facility a half-mile downstream from the San Luis Dam. O'Neill Dam is a zoned earthfill structure standing 87 feet tall with a crest length of 14,300 feet. Containing 2.8 million cubic yards of material, the dam was completed in 1967. The O'Neill Forebay Inlet Channel extends 2,200 feet from the Delta-Mendota Canal to deliver water to the O'Neill Forebay. The forebay holds 56,000 acre-feet, part of which is used for regulator storage to permit off-peak pumping and on-peak generation. Six pumping units of the O'Neill Pumping-Generating Plant lift water 45 to 53 feet into the forebay. Construction of the plant lasted from 1964 to 1967.[23]

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22. *San Luis Unit, Technical Record of Design and Construction, Vol. 1*, 65; "Computer Paces Canal to Finish Line," in *Engineering News-Record*, (November 17, 1966): 133.
23. *San Luis Unit, Technical Record of Design and Construction, Vol. I*, 127-32.

Two zoned earthfill detention dams along the canal control the flow of streams crossing the conduit's path. Los Banos and Little Panoche Detention Dams are situated southwest of the town of Los Banos on identically named creeks. Located in a narrow gorge of Los Banos Creek above the San Luis Canal, Los Banos Detention Dam is 167 feet high with a 1,370-foot long crest, providing 34,500 acre-feet of flood control capacity with a maximum controlled release of 1000 cfs. The dam controls flood water which would otherwise endanger the San Luis Canal. The Los Banos Reservoir contains a capacity of 34,600 acre-feet. Approximately 20 miles south of the town of Los Banos, the Little Panoche Detention Dam detains floodwater collected over 81.3 square miles of mountainous drainage area, and also prevents damage to the San Luis Canal. A little more than a million yards of earthfill formed the 151 feet high embankment. The dam's crest length is 1,440 feet, and it is 30 feet wide. The like-named reservoir's capacity is 5,580 acre-feet. Completed in 1965, final cost of the Los Banos Detention Dam came in at $5.1 million, while Little Panoche totaled $3.3 million at its completion in 1966.[24]

Dos Amigos Pumping Plant is on the northwest edge of the San Joaquin Valley, 17 miles south of the O'Neill Forebay. First known as Mile 18 Pumping Plant, it was renamed to commemorate the partnership between Federal and state governments. The plant lifts San Luis Canal flows 125 feet, permitting the water to travel southward by gravity for irrigation and municipal water supplies. The plant lies at the foot of the Laguna Seca Hills, and contains six pumping units, each capable of delivering 2,200 cfs combining for a total capacity of 13,200 cfs. The plant's foundation was first excavated in 1963, and by the time it was finished five years later, it cost $23 million.[25]

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24. U.S., Department of Interior, Bureau of Reclamation, *San Luis Unit, Technical Record of Design and Construction, Vol. VII*, (Denver: November 1974): 131, 149, 175-6.
25. *San Luis Unit, Technical Record of Design and Construction, Vol. I*, 97.

America was undergoing a process of painful transformation in the spring of 1968. The nation's mood and sense of excitement had changed since the San Luis Dam's groundbreaking six years previous. On April 20, three thousand people -- a fraction of those who witnessed the spectacle presided over by President Kennedy -- attended the dam's dedication. In the same spot where Kennedy spoke six years earlier, the dedication crowd heard Secretary of the Interior Stewart L. Udall claim, "Nowhere else has the Federal Government co-operated so closely with the government of a State on so large a development," and predict "I anticipate there will be other such joint ventures." However, the ceremonies surrounding a dam lacked the spark of anticipation for even greater achievements that charged the air in April 1962. Almost a year before the dedication, the reservoir first began to take on water. The first water delivered by the State Department of Water Resources through the California Aqueduct reached the O'Neill Forebay in January 1968. It took two years until the man-make lake was finally filled on May 31, 1969. The sense of stability provided by a massive dam and a secure source of water were at last in place. But, the stability and security San Luis promised during its construction would be tested by an increasingly demanding and anxious populace.[26]

Post Construction History

By 1969, world events obstructed the Unit's development and completion. Repayment Specialist John Budd of Reclamation's Sacramento office, said after the major components of the San Luis Unit were completed, the purse strings were drawn a little tighter. "Expenditures on Vietnam were still very, very high, and money was tight," Budd recalled, "We weren't getting anywhere near the appropriations to maintain a decent construction schedule. There was $8 to $10 million for distribution system construction when we needed $20 to $30." Budd explained

26. "Goliath CVP Grows, San Luis Dedicated," 57-8.

Reclamation needed that additional funding to hire as many people as possible, bringing the remainder of the San Luis Unit in at minimum cost. An examination of the Unit's funding shows the most intensive years of construction coincided with the largest expenditures. In 1966, the year the most money was appropriated for construction, a little over $33.6 million flowed from Federal coffers. Budd's interpretation is partly correct as Unit budgets did dip to $12.4 million in 1968 and $934,000 in 1969. The war may have had something to do with shrinking finances, but the numbers also correspond with the realization on Capitol Hill that the great features of San Luis were built and only the completion of the carriage facilities remained.[27]

For most of this century, you had to be rugged and resourceful to live in Coalinga, California. The community should have been a ghost town, but the surrounding oil reserves, the world's largest deposit of asbestos, and the nation's largest supply of commercial chrome ore, made this piece of Fresno County too valuable to abandon. The only disadvantage to those gathering the underground riches was that the town's water was hard on machinery and people. Coalinga's municipal water carried salts, sulfates, and minerals, so dangerous to taste, that most homes had three taps -- hot, cold, and drinking. In order to sustain the mining industry, stimulate local agriculture, and provide a safe drink of water, Reclamation built an intake channel from the San Luis Canal to a pumping plant connected to a municipal filtration-treatment plant serving Coalinga. Originally named the Pleasant Valley Canal, Coalinga Canal took from 1968 to 1973 to complete. Beginning at mile 74 of the San Luis Canal, the 11.6-mile system includes a 1.6 mile intake channel to the Pleasant Valley Pumping Plant. The canal's initial capacity is 1,100 cfs decreasing to 425 cfs at its southern terminus. The nine unit, 1,140 cfs-capacity Pleasant Valley plant lifts water 180 feet through a 1.3-mile-long discharge line, and cost $6.4 million

27. John Budd, interview by Dr. Brit A. Storey, 25 May 1994, Tape 1, conducted in Sacramento, California; U.S., Department of Interior, Bureau of Reclamation, *Report to the Commissioner need rest*, 54.

when it was finished in 1970. After the canal first went on line in May 1973, Glenn H. Marcussen, Coalinga's city manager and engineer, hoped the days when faucets dissolved after a few years use and homeowners were afraid to wash their windows with water that was strong enough to etch glass were gone.[28]

Born in 1952, Westlands soon grew to 600,000 acres -- the largest water district in the nation. A major step in reaching that pinnacle came in December 1965, when the government signed a $193 million contract for construction of the Westlands distribution and drainage system. Westlands purchases most of its surface water from the Bureau, receiving its CVP water at several turnouts along the San Luis Canal. As a result of the new distribution and drainage system, Reclamation anticipated crop values would reach $210 million a year. At the turnouts, a 1,034-mile network of underground pipelines and ground-level regulating tanks delivers water to users. The pipes from the canal to individual farms keep seepage loss at a minimum. Big and controversial, Westlands is viewed by advocates as the produce aisle of the nation, and seen by detractors as a faceless empire of federally subsided, corporate "farmers" poisoning the land with chemicals in order to increase their crop yields.[29]

In April 1968, the same month as the dedication of the San Luis Dam, construction began on the 188-mile-long San Luis Drain. The 300 cfs capacity drain was designed to collect subsurface drainage flows from 8,000 acres in the San Luis service area, transporting them north for disposal in the west Delta. The concrete-lined canal extended from the town of Five Points to a series of twelve shallow ponds formed by earthen dikes. The collection of ponds outside of the town of Gustine in Merced County was called the Kesterson Reservoir. Reclamation

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28. Joyce Hoff, "Water for Coalinga," in *Reclamation Era*, (November, 1968): 86-7; *San Luis Unit, Technical Record of Design and Construction, Vol. I*, 107.
29. "Goliath CVP Grows, San Luis Dedicated," 58; Jones & Stokes Associates, Inc., *Draft Environmental Impact Report/Statement, Westlands Water District Supply Replacement Project*, (Sacramento: 1989), S-1.

planned Kesterson as a regulating reservoir to hold flows from the San Luis Dam until they could be flushed into the Sacramento-San Joaquin Delta during the winter. In 1975, eighty-five miles into the job, construction halted due to mounting costs and environmental concerns over what kind of elements were in the agricultural drainage going to the Delta.[30]

In 1981, the drainage system became Kesterson's sole source of water. Soon after, shocked Californians saw the TV pictures and read the news reports of sick and mutated waterfowl suffering and dying along the reservoir. Headlined in the *San Francisco Examiner* as a "poisonous mess," Kesterson's runoff contained high levels of salts, pesticides and trace minerals, including highly toxic selenium. In the mid-1980s, state officials warned pregnant women and children not to eat waterfowl from the San Joaquin Valley. By the end of the decade, Reclamation warned migrating flocks away with sirens, fenced in the surrounding area, and covered the reservoir with dirt, keeping the surface level so no water can stand long enough to attract waterfowl.[31]

In addition to tainted runoff, the water's own salinity choked the yields of local crops, especially cotton, in the San Joaquin Valley by the early 1990s. Large amounts of sodium are naturally present in return flows, and by the time water reached Kesterson, it was "saltier than sea water," according to John Budd. The Bureau estimated it would take a hundred train carloads a day to carry away the salt that ran through the valley in a day. The toxins carried by drainage water contributed to a financial climate where bankruptcies were on the way up, and lenders believed CVP irrigators too great of a financial risk.[32]

After plugging of the drainage collection system and terminating flows, Westlands Water

30. Jones & Stokes Associates Inc., *Westlands Water District Water Supply Replacement Project*, sec. 2, p. 57.
31. *San Francisco Examiner*, 11 February 1985, p. B-2.
32. Interview with John Budd, 25 May 1994, Tape 2.

District received 38 statutory damage claims from farmers and landowners within a 42,000-acre service area. They alleged closing the drain cost them $90 million in diminished property values and lost crops. Westlands Board of Directors reject their claims, and by 1995, the case was still pending. The District has done nothing to dispose of the drainage. Reclamation's own estimates for clean-up started at $26 to $50 million in the mid-eighties before zooming to $100 million by decade's end. In 1991, Reclamation proposed using the San Luis Drain to funnel wastewater into the San Joaquin River instead of allowing it to evaporate at Kesterson. No action on the Bureau's proposal has been taken, and the drainage problem will likely continue to fester before a resolution pleasing all parties is found.[33]

The greatest catastrophe to strike the San Luis Dam began with a "knocking noise in the penstocks." Before it was all over, Reclamation faced a major landslide across the dam's embankment. During the summer of 1981, a Reclamation team conducted a routine five-year inspection of the dam, finding nothing out of the ordinary. After a reservoir drawdown later that season, 400,000 cubic yards of embankment slid 177 feet down along a 1,100 foot section near the crest. On September 15, a state maintenance crew first discovered movement on a hill butted against the dam. Three days later, the weight of the rocks and dirt continued to creep down the dam's face. Reclamation's Mid-Pacific Regional Director, Mike Catino, described the potential of a disaster at San Luis as "a one in five chance of happening, but his first impression after watching rock trailing down into the reservoir reminded him of "furls of lava in Hawaii." Repairs required 1.4 million cubic yards of select material to stabilize the embankment. Working under a $6.1 million contract, Peter Kiewit and Sons Co. completed the restoration in

33. Interview with John Budd, 25 May 1994, Tape I; *San Francisco Examiner*, 11 February 1985, p. B-2; *Sacramento Bee*, 13 March 1985, p. A-1; *Westlands Water District Water Supply Replacement Project*, sec. 2, p.59; Johnson, Haslam, and Dawson, *The Great Central Valley*, 222.

August 1982. Reclamation moved quickly on clean-up and repairs, and according to Catino, "not one acre-foot of water was lost to the farmers." An additional predicament arose two years later, on July 30, 1984, as a crack opened along the embankment. The seam stretched parallel to the dam's centerline, but it eventually stopped of its own accord. No other movement or cracks have been reported at the dam since 1984.[34]

The eighties closed with honors for two California politicians, reaffirming the state and Federal partnership of the San Luis Unit. On May 12, 1989, California renamed the San Luis Dam, the B.F. Sisk San Luis Dam, and the San Luis plant was designated the William R. Gianelli Pumping-Generating Plant. B.F. "Bernie" Sisk represented Fresno as a Congressman from 1955 to 1979. Sisk introduced legislation authorizing the San Luis Unit as part of the Central Valley Project. William Gianelli served as a director of the California Department of Water Resources during the critical years of construction between 1967 to 1973.

Settlement of the Project

Behind the productive image of "The Cadillac of American irrigation districts," is a troubling reality. Described in the 1993 book *The Great Central Valley*, Westlands Water District is a place where "spacious, depopulated spreads of corporate agribusiness dominate," appearing "nearly empty of human settlement -- vast tracts with no farmhouses or barns visible." People do work, but just barely exist, as there is considerable hardship to go around. The two largest towns in the district, Cantua Creek and Huron, are primarily populated by Hispanic laborers. Many of these inhabitants are employed by the gigantic agri-business concerns that dominate the region. However, neither town has a high school, and per-capita income in both

34. "Slide Crimps Calif. Water Storage," in *Engineering News-Record*, (September 24, 1981): 13; Mike Catino, interview with Dr. Brit A. Storey, Tape 2, conducted in Sacramento, California, 2 September 1994.

Cantua Creek and Huron are among the lowest in California.[35]

The society supported in part by the San Luis Unit is unlike any other touched by the Bureau of Reclamation. The historical inequities between rich and poor were in place long before the Bureau's arrival, but the economic imbalance in the Central Valley has cemented, in the words of native essayist, Gerald W. Haslam, a "pyramid" society. The elite of the Central Valley stand at the top, a small middle-class provides services, and "the bulk of the structure and its indispensable foundation" are marginal-to-poor people.[36]

Marc Reisner, in his critique of Western water projects, *Cadillac Desert*, wrote the CVP "was fundamentally different from every earlier Reclamation project. It did not create many new irrigated farms. It rescued thousands of farms that were already there, including a good many that were far larger than the law allowed." Reclamation saved many farmers in trouble across the west, working with project owners whose livelihoods were threatened by drought and poor drainage. But, across the other 16 reclamation states there are few farms where 2,000 and 3,000 acres are the norm, and where 30,000 acre spreads are not unusual.[37]

Uses of Project Water

Historian M. Catherine Miller researched the fractious early legal history of the Central Valley in her book *Flooding the Courtrooms*. Miller determined that "the shift from private to public control," one of the original goals of the CVP, resulted in "only limited change" to the valley's class structure. The consequence of the CVP is "Some who had been excluded gained access to water, but power stayed in the hands of the largest landowners." Control of water in the West is control of power. Miller believed power and water in places like the Westlands

35. *The Great Central Valley*, 143.
36. Gerald W. Haslam, *The Other California: The Great Central Valley in Life and Letters*, (Santa Barbara, Calif.: Capra Press, 1990), 24.
37. Marc Reisner, *Cadillac Desert: The American West and Its Disappearing Water*, (New York: Viking Penguin, Inc., 1986), 349, 502.

Water District, is held only by a few, and loosened only with much difficulty.[38]

In 1963, Westlands Water District signed a 40-year water service contract with the Federal government. In accordance with the San Luis authorization, Reclamation notified Westlands a drainage system would be available by 1980. Since then, Westlands has paid 50 cents per acre-feet drainage charge for all water delivered. Westlands continues to pay this charge even though drainage service ended in 1986 subsequent to the closure of Kesterson Reservoir. Another major change in the rules was the activation of the Reclamation Reform Act (RRA) of 1982. The Act increased the acreage limitation from 160 to 960 acres, but critics accused the Bureau of allowing lands in excess of 960 acres to receive subsidized water as long as they were held in trusts or other partnerships. While recognizing its critics concerns, Reclamation believes it has enforced the RRA. By the mid-1990s, all Westlands acreage holders had agreed to abide by the provisions of the RRA. Water pricing in the wake of RRA has changed for all CVP water users, but within Westlands, the cost of water varies on category of service. In 1988, six years after the enactment of RRA, water cost Westlands users $42.03 per acre-foot including capital, operation and maintenance and interest. That same year there were 584 Westlands water users spread over a total irrigable acreage of 528,718, averaging 905 acres per user.[39]

Long-standing agreements over water allotment and use between Reclamation and Westlands is another area undergoing changes. In 1994, a Los Banos dairy farm and the powerful Metropolitan Water District (MWD) of Southern California submitted an application to the Bureau proposing the first transfer of irrigation water from the CVP to an urban area outside

38. M. Catherine Miller, *Flooding the Courtrooms: Law and Water in the Far West*, (Lincoln, Nebraska: University of Nebraska Press, 1993), 173.
39. *Westlands Water District Water Supply Replacement Project*, sec. 2, p. 44; sec. 2, p. 60.

the project. The dairy planned to transfer about 32,000 acre feet of water to MWD over a 15-year period. The estimated selling price was $175 per acre foot, plus $25 an acre-foot for environmental restoration. A battery of state and Federal agencies will have to accept the arrangement, and if approved, this transaction could lead toward a flood of similar requests between Unit irrigators and outsiders looking to use some of their water.[40]

Perhaps the most unpredictable issue surrounding water use involves the whims of nature. A lingering, punishing drought during the late-1980s through the early-1990s sucked dry all of central California's reservoirs. By 1992, the state's supply of stored water dipped to its lowest level in 15 years. Experts in the study of tree rings, known professionally as Dendrochronologists, consulted the grooves as far back as pre-Mission, mid-sixteenth century, California to find a drought as severe as this one. The historic average of 1,086,400 acre-feet stored in San Luis was just a distant statistic by October 1992, as the reservoir's stored water was down to 413,400 acre-feet. Just when it looked like the drought would never end, in October 1994, a storm track situated itself over California, and for the next six months saturated the Central Valley. The dark rings lining the hills around the San Luis Reservoir, previously exposed by the drought, were submerged by the rising water. The Sacramento River ran 112 percent above average, and the state had enough storage in their reservoirs to fulfill the needs of California into 1996. Relief is a momentary feeling, as those aware of the fickle nature of California's weather realize the next dry spell is always just around the corner.[41]

During dry and wet cycles, produce of all varieties still thrives in Westlands. The highways that link one end of the state to another pass fields in the Central Valley nurturing the

40. *U.S. Water News*, September 1994.

41. *San Francisco Chronicle*, 19 October 1992, pp. A-1, A-8; U.S., Department of Interior, Bureau of Reclamation, *Water Supply Conditions for Bureau of Reclamation Project Areas*, (April 1995), 1, 8; State of California, Department of Water Resources, *Report to the California Water Commission on the Activities of the Department of Water Resources*, (August 4, 1995), 1.

familiar (lint cotton, tomatoes, and garlic) and the obscure (jojoba and eucalyptus). Fifty-three varieties of crops were marketed in Westlands in 1992. The following chart lists the five most valuable for that year:

1992 Crop Production Report/Westlands

Crop	Acres	Average Yield per Acre	Gross Crop Values
Cotton-Lint-Acala	195,658	1,569.0 lbs.	$213,743,552
Tomatoes-Processed	75,811	34.2 tons	$116,387,928
Cantaloupe	15,997	521.3 cartons	$33,940,691
Lettuce-Spring	8,747	732.8 cartons	$33,266,870
Cotton-Lint-Pima	29,237	1,317.5 lbs.	$25,237,029

(Source: *State of California, Department of Water Resources, San Luis Field Division*, 1992).

Westlands also produced $16.5 million worth of almonds; $18.3 million in garlic; and $11.5 million in wine grapes. Add together the value of all the crops grown on 570,552 acres, and total production in 1992 came to $614.8 million. Westlands touches every American who buys grapes, lettuce, canned tomatoes, or wears clothing made of cotton. The lifestyle the Westlands creates and sustains, has felt a backlash from some who are concerned about corporate farming, growth, and the resultant disregard for the environmental of the valley. Supporters, on the other hand, look with pride to the "monumental feat of engineering that made the desert bloom," while fearful of losing any part of what the Federal-state partnership created. This debate has developed a life of its own, and a comprise just as monumental as the Federal-state agreement that brought San Luis to life in the first place, is not likely in the near future.[42]

Conclusion

Complex and controversial, the San Luis Unit opened a new chapter in the history of the CVP that is still in the process of being written. However, that chronicle becomes distorted depending on the perspective of the person telling the story. Staunch defenders of free enterprise

42. State of California, Department of Water Resources, San Luis Field Division, "Farm Revenues Show Slight Recovery Over 1992," press release; *San Francisco Chronicle*, 22 February 1992, p. A-15.

are the recipients of some of the largest Federal subsidies; plutocratic farmers who claim to love the land poison it with chemicals, and all involved want little bit more from the valley than what they took away the day before. The rains of 1995 reaffirmed the necessity and wisdom of constructing the San Luis Unit, as its place in an increasingly enigmatic California can only gain in significance.

Suggested Readings

"Goliath CVP Grows, San Luis Dedicated," in *Reclamation Era*, (August, 1968): 55-8;

U.S., Department of Interior, Bureau of Reclamation, *San Luis Unit, Technical Record of Design and Construction, Vol. I through VII*, (Denver: 1974);

Harry Farrell, *The San Felipe Story*, (Santa Clara Valley Water District, 1987).

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