"The natural surface water supplies of three of our major river basins in Colorado are already largely exhausted. However, the ability of the human race to propagate has not become exhausted. Consequently the same water supply which may seem sufficient for 100,000 people today may have to suffice for a million people in the future. Better utilization, salvage and reuse of water are the only ultimate answers" ... Felix L. Sparks, Director of the Colorado Water Conservation Board, before the Senate Select Committee on National Water Resources, Denver, November 29, 1959.

The population explosion . . . what does it mean to Colorado water users?

World population is increasing at an unprecedented rate . . . about 5,400 persons every hour . . . 130,000 per day . . . 47 million a year. A number larger than the population of France is being added every year to the number of people living on this earth!

Life Magazine: "Whereas it had taken the first 5,000 years of civilization to raise Man's numbers to a billion, it took less than 100 years to double this to two billion, the mark reached in the 1920's. To double this once again to the four billions expected by 1980 will have taken less than 60 years. And if the present rate of increase (1.6% a year) is maintained, the figure will be doubling every 40 years, billions piling on billions in an explosive chain reaction of human fertility."

World population growth: 1 billion in 1830 . . . 2 billion in 1930 . . . 3 billion in 1965 . . . 4 billion in 1980 . . . 5 billion in 1990 . . . 6 billion in 2000. If this rate continues, there will be one human for every square foot of space on earth by the year 2600.

It's a geometric progression. Medical discoveries and widespread advances in sanitation have improved health, prolonged life spans, lowered death rates. Birth rates have not gone down proportionately. Even nuclear war losses--say 100 million dead--could be replaced in three years at the present rate of increase in world population.

Population mathematics: People can increase at a geometric (curved) rate, but food production increases at an arithmetic (straight-line) rate.
Population pressures are greatest in India, Ceylon, China. Mexico now has an annual birth rate of 46 per thousand population and a death rate of 13. Annual growth: 3.3% Result: 60 million Mexicans in 20 years compared with 30 million now. Many other countries have similar growth rates.

U.S. population is increasing annually at a 1.9% rate. . . . 177 million now, headed for 210 million by 1970 . . . 300 million by 2000 . . . 600 million by 2060.

How much is 33 million more people in the U.S. by 1970? It's the equivalent of ten Chicagos, or two Canadas, or more than half a Great Britain. The new people won't be distributed evenly over the U.S. They will follow the crowd to the West and to urban areas. People are expected to leave farms for the cities at the rate of 300,000 a year during the next ten years.

Where is this human flood headed? Toward a political and military problem of prime importance . . . Toward widespread sociological and religious arguments . . . Toward a serious water shortage.

U.S. News & World Report interviewed Sir Charles Darwin, distinguished British scientist on "Standing Room Only in the World". Sir Charles stated that the great limiting factor in world population growth will be water.

The water-short U.S. West is one of the world's fastest growing areas. U.S. Census Bureau's latest figures show that California had the biggest numerical gain of any state during the 1950-58 period--up 3,698,00 to 14,284,000 on July 1, 1958. Nevada experienced the biggest percentage gain: Up 70%. Arizona: Up 57%. Colorado's population increased 24.9% from 1,325,089 to 1,655,000.

Census Bureau projections for the next ten years indicate a 5.4 million increase for California--up 3.7% per year. Colorado: 1.8 million now . . . 2.2 million by 1970 . . . 2.5% annual increase.

U.S. Department of Commerce: $179 billion now invested in public and private water resource developments in U.S. based on 1958 replacement costs. Needed: $171 billion additional investment in next 15 years to meet growing water requirements resulting from population growth, industrial expansion and higher living standards.
Senator Allen J. Ellender, Chairman of the Subcommittee on Public Works of the Senate Appropriations Committee: "Between 1950 and 1958 the national income increased by 16.6 per cent. Yet, the amount requested by the Bureau of the Budget for water resource development by the Corps of Engineers and the Bureau of Reclamation in 1958 was 25 per cent below the budget request for 1950."

The times demand more than a business-as-usual, leave-it-to-the-government attitude towards Colorado's dwindling water supplies. Interstate pressures on Colorado's water resources are increasing, somewhat geometrically like the population curve. Time may be running out on Colorado's opportunity to plan and construct water projects on an integrated, state-wide basis.

Walter L. Picton of the U. S. Dept. of Commerce: "The future pattern of regional growth and development will depend on the wisdom and foresight of state and local areas in developing and allocating water for the optimum benefit."

"Foresight is the last gift of the gods to men."

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Russia is making real progress on her water and power development program. Three U.S. Senators and their advisors recently returned from an extensive fact-finding trip to Russia. Representatives of U.S. electric power interests have made two recent inspection trips to Russia. Result: Eye-opening facts on Russian progress.

Russia's Bratsk hydroelectric plant: 4.5 million KW! Under construction in Siberia. Its output will equal the combined output of the three largest hydroelectric plants in the U.S.

Russia's high voltage transmission system: 500 KV lines in operation, 700 KV lines planned! Maximum in U.S: 345 KV. High voltage permits long distance transmission and interconnection between giant power grid systems.

Russia's power capability: 53 million KW now, 110 million KW by 1965 . . . up 108%. U.S. capability: 160 million KW now, 245 million KW by 1965 . . . up 53%. Note this: Russia will have more power available for heavy industry use than the U.S. by 1965.

Russia's hydrogeneration equipment: 225,000 KW units will be installed at
Russia's dams: They're using pre-fab concrete blocks rather than poured concrete in some of their dam construction. They use concrete forms which become part of the dam structure. Several of Russia's new dams are larger than Grand Coulee. Russia is a land of new starts. The USSR is developing its water resources on a long-range basis on a crash schedule.

Russian imagineering: Construct a 43-mile dam across the Bering Straight between Alaska and Siberia at a cost of $17.5 billion. Install huge pumps at the dam to move cold arctic water southward into the Pacific. Warmer gulf stream currents would then move northward into the Arctic Ocean from the Atlantic. Result: Rise in polar region temperatures, enough to permit agriculture and other developments. Rivers of Canada, Alaska, Siberia would be navigable all year. Side effects on world climatic patterns: Not known.

Russia's weather research: Dr. Walter Orr Roberts of Colorado University's High Altitude Observatory told the Senate Select Committee in Denver that Russians are ahead of the U.S. in some ways on weather research. Dr. Roberts: "Perhaps the future will see a war of weather control . . . The nation that controls weather could create devastating floods and drouths."

Roberts: "My own personal conviction is that the problem of how we, as a nation, manage our dwindling water reserves is our most important long-range economic and social problem. For us here in the West it is easy to understand the significance of water. But it will be only a few years before other parts of the nation are also made acutely aware of this. My conviction about the central importance of water conservation lies behind my determination that we at the Observatory will push all possible constructive effort into the problem of understanding the causes of large scale weather changes, either of drought or flood. I believe that the major clues to these changing weather and climate trends will be found in studies of the way the sun's changes affect the earth's upper atmosphere."

China is designing a mammoth dam on the Yangtze River near Ichang. The power-plant will have an installed capacity of from 25 to 40 million KW. Plans and designs for the Yangtze Dam were started by USBR and Chinese engineers in Denver in the late 40's. It was considered an engineer's dream dam . . . power, irrigation, flood control, navigation on a scale dwarfing Hoover and Grand Coulee. Other big
Chinese dams are under construction. A Chinese million kilowatter is scheduled for completion in 1960.

China's Shensi Province has recently experienced its worst drouth conditions in living memory. Europe experienced severe water shortages last summer. Mighty European rivers became sluggish little streams. River traffic almost ceased on the lower Danube. The Vistula at Warsaw was lower than it has been for 100 years. Scotland experienced its worst drouth since 1785.

Drouth has also come to parts of the West. Worst drouth since the 30's has struck parts of Montana and the Dakotas. Thousands of stock-watering ponds have gone dry. Many small farmers face disaster. Los Angeles has had only $5\frac{1}{2}$ inches of rain in the past fifteen months. It's the driest weather in Southern California's modern history.

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Space research has led to a revolutionary new method of generating electricity directly from a heat source without use of moving parts. The process is called "MHD". It means magnetic-hydro-dynamic. A high-speed stream of superheated gas is driven through a magnetic field to produce electricity. No need for the steam turbine and the heavy precision-balanced mechanical generator that is whirled by the turbine. Outlook: Possibly a 25% increase in efficiency over conventional steam powerplants. Private power companies, research corporations and Los Alamos scientists are intensively studying the new method as a possible source of big-scale electric power. Arco Corp. of New York and 10 power companies are cooperating in the development of a 10 KW model MHD generator.

The Atomic Energy Commission has licensed Commonwealth Edison Co. of Chicago to bring its boiling water, Dresden (Illinois) nuclear reactor up to a power level of 315 thermal megawatts. The General Electric designed unit is the largest power reactor yet developed. Design electrical output is 180,000 kilowatts, corresponding to a reactor thermal power of 630 megawatts.
Atomic blasts have been suspended during international talks at Geneva. U.S. Bureau of Mines says this delay is a good thing for planned oil shale tests. It provides more time for careful planning.

USBM, AEC and the oil industry are working jointly on plans for underground atomic explosions designed to free oil shale from mountainous areas of the West. It will take a year to prepare for a test after the go-ahead is obtained from high-level government officials.

AEC is embattled with the potash industry over side effects of their proposed experimental 10 kiloton nuclear blast 1200 feet underground in New Mexico. Fears: Possible damaging effect on nearby potash mines . . . Possible adverse effect on ground water. AEC says "no serious danger" and refuses to shift the operation to another area.

Five underground atomic blasts last year in Nevada have jarred engineering geologists. Half the heat generated by the atomic blasts still remains in the ground. Flow of underground water was stopped at many points in the blast area.

Colorado's oil shale reserves are split about 50-50 between federal and private ownership. Navy officials are seeking a way to reserve, or set aside, decreed storage rights for eventual development of federally owned oil shale deposits in Western Colorado. Navy's desired water reservation isn't permitted under Colorado water law. Possibilities of interim use of Navy water for irrigation are being considered.

Evaporation research . . . big losses, big stakes. An estimated 13 million acre feet are lost annually by evaporation from the larger lakes and reservoirs in the West. The Bureau of Reclamation has been researching application of hexadecanonal (powdered whale oil) to small reservoirs, including Oklahoma City's Lake Hefner, USBR's Rattlesnake Reservoir west of Loveland and Denver's Ralston Reservoir.

USBR evaporation research is now shifting to Lake Mead and to Lake Sahuaro on Arizona's Salt River. New tests will be aimed at determining behavior of the thin film of protective chemical under various climatological conditions. Hexadecanonal will be dusted over the water surface. Its movement will be traced by aerial observation.
Los Angeles is expanding its groundwater recharge program. In a special election, L.A. County voters approved creation of a water replenishment district designed to restore groundwater reserves and stop salt water intrusion. L.A.'s estimated groundwater deficit: 700,000 acre feet. Groundwater levels have dropped 100 feet in some places. The new district will operate on a $1.2 million annual budget (about $300,000 more than the state of Colorado's total water budget). It will buy Colorado River water from the Metropolitan Water District of Southern California at a minimum cost of $12 an acre foot. Recharge will be accomplished by large water spreading operations and by discharging into wells.

The City of San Jose and the Santa Clara Valley Water Conservancy District of California are considering augmenting their domestic water supplies by reclamation of waste sewage. Thoroughly purified sewage effluent would be pumped back underground to replenish depleted domestic groundwater supplies.

Dow Chemical Co. has developed a new chemical—Separan AP 30—that seems to aid groundwater recharge. One of the problems in recharging underground aquifers with surface water is clogging of the recharge well-screen openings by silt. Separan flocculates and deposits solids in pre-recharge ponds, leaving clear surface water for diversion into recharge wells. One pound of Separan clears an acre foot. It can be spread over lakes by crop-dusting methods.

Groundwater is becoming increasingly important to industry. Pacific Power and Light Co. recently spent $500,000 in a successful 5-year search for industry-attracting water for Southwestern Oregon. Result: Location of a reliable 30 million gallon a day groundwater supply.

Reading of water, gas and electric meters by dialing the customer's telephone without his knowledge may someday replace present meter reading practices. Northern Illinois Gas Co. and Illinois Bell Telephone Co. are developing a substantially automatic telephone gas meter reading plan for industrial plants. If successful it will be applied to residential metering.
Saline water conversion: Processes have been selected and designs are underway for three of the five federal demonstration plants authorized by Congress. The first plant will be constructed at Freeport, Texas and the second at San Diego, California. Each will have 1.0 MGD capacity. The third plant will be brackish water conversion, located either in the Great Plains or in the Southwest, capacity 250,000 gallons per day.

Competition for demonstration plant sites has been intense, with petitions received from 175 cities. The field for the brackish water plant has been narrowed to 16 cities: Nebraska - 1, S. Dakota - 3, N. Dakota - 2, Texas - 5, N. Mexico - 4, Arizona - 1. Question: Why isn't a Colorado site in contention?

Brackish water wastes from mines are going to be purified in a new 2.5 MGD conversion plant nearing completion in South Africa. Biggest salt water conversion plant in the world is on the Dutch Caribbean island of Aruba. It converts 3.5 MGD of sea water at $1.75 per thousand gallons, less revenues from 15,000 KW of by-product electric energy generated from high-pressure steam used in the conversion process.

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The label "world's thinnest dam" was pinned on France's Malpasset Dam when it was constructed in 1952-53. Maximum thickness: 22 feet. Height: 185 feet of steel and concrete. Beautiful irrigation dam . . . until it failed in December 1959, under the burden of five days of steady rain, drowning 265 persons.

Earthfill dams received a big boost last summer when Hebgen Dam near Yellowstone Park experienced a severe earthquake and remained virtually intact. Hebgen . . . 300,000 cubic yards, 87 feet high, 45 years old . . . supports the viewpoint that well-built earth and rockfill dams are able to adjust to extreme foundation stresses. The Yellowstone earthquake caused fluctuations in well water levels as far away as Florida and Hawaii.

Concrete giant: Glen Canyon Dam, 700 feet high, will be second only to 726-foot Hoover Dam among Western Hemisphere dams. In concrete volume it will rank third, behind Grand Coulee and Shasta. Glen Canyon Dam will back water 186 miles
up the Colorado, forming the world's third largest man-made lake. 254 square miles of surface area, 580 foot maximum depth. The reservoir will be named Lake Powell, after explorer-geologist John Wesley Powell. He first explored the wild unknown canyons of the Colorado River in 1869. He travelled the entire length of the Colorado River twice. He also founded the U.S. Geological Survey.

**Dam controversy:** The Colorado Game and Fish Commission recently voted to spend $57,514 to rebuild Georgetown Dam on Clear Creek, west of Denver. Failure of the previous $19,000 dam resulted in damage suits against the state totaling $280,000. A battle is developing among fishlifers over merits of the dam. Objectors say that mine tailings make it a biological desert. G & F says it will remove mine tailings from the lake bed. Another Game & Fish Dept. problem: The $131,000 dam at Lake John, near Walden. Water is seeping through cracks in the concrete spillway.

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**Fast stepping Texans** are becoming impatient with their Board of Water Engineers. Trouble: Lack of progress on water resources planning.

Governor Daniel called a special session of the Texas Legislature in 1957 to create a water resources planning division within the State Board of Water Engineers. Legislation was enacted and ample funds were provided over $2 million for the biennium ending in 1961. But planning efforts have been slowed by lack of unanimity on the Board of Water Engineers.

One member of the Texas BWE put it this way: "We haven't moved a peg since last December on State water planning." **Water Congress question:** How many pegs has Colorado moved on statewide water planning?

The Texas Water Development Board recently sold the first $10 million of State bonds to assist political subdivisions in Texas in constructing water projects. It's part of the $200 million financial aid amendment to the Texas Constitution passed in 1957. The first loan will be $3 million to the Lower Nueces River Water Supply District to complete a $21 million dam to supply water to Corpus Christi.
Loan repayment contracts have been approved by the USBR for three small projects in California. Loans are authorized by the federal Small Projects Act. Interest is paid on that portion of the loan attributable to domestic, municipal and industrial use and to irrigable land held in excess of 160 acres in a single ownership. No interest charges for irrigation projects within the 160 acre limit. Largest of the three California loans was $3.8 million. The local water district contributed $121,000 cash to the development.

The no new starts policy appears to be quietly dying. Decisive congressional overriding of the public works veto seems to have convinced political prognosticators that the no new starts label means election year trouble in the West. New reclamation starts in 1960 could be used as political assists in key congressional races. Water Congress prediction: Curecanti appropriations will be voted next year.

Construction will begin next spring on the Smith Fork Project in Delta County. It was one of the few reclamation projects to break the 1959 no starts barrier. It's one of five western Colorado irrigation projects authorized for construction as participating units of the Colorado River Storage Project. Key features: 13,600 acre foot reservoir, nine miles of canal. Benefits: Full irrigation supply for 1,320 acres, supplemental supply for 6,920 acres. Cost: $4.4 million. Completion: 1963.

The Curecanti fish battle ... Note this realistic appraisal by Wayne R. Seaman, Fish Manager of the Colorado Game and Fish Department ...

Seaman: "It (Curecanti) will eventually come to pass. It may be ten years, but when it is completed, it will support so many more fishermen than it now does. Further, some of those waters are now closed, but when the project is completed it will be open to all. Probably the return per manhour of fishing won't be so great, but we'll all be entitled to fish in those waters. The rainbow and the brown will be there just as they now are and I'm sure kokanee salmon will be placed in the reservoir. The kokanee is a fine reservoir fish ... We can't stop progress. That (Curecanti) is progress. Water is one of our most valued resources in the West for many reasons, all unselfish."

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