Projected water requirements for the U.S. are drastically underrated

by Chris White

Water requirements can be assorted under three major headings. These include: household functioning, and related urban uses; the irrigation requirements of agriculture; and, the needs of power producing and industrial plant for cooling and condenser flows, and processing uses. Water withdrawals, from streamflow and ground water sources, under the latter two headings, accounted for about 80% of all U.S. withdrawals of fresh water in 1985.

Per capita, water withdrawals for all uses increased from about 528 gallons per person per day in 1900, to nearly 2,000 gallons per day in 1980. The development of modern agriculture, and the application of electrification, account for the lion's share of the increase.

Since 1980, per capita withdrawals have, for the first time in the past 100 years, gone into decline. The decline is not the result of drought. It is the result of policy choices: on one level, the collapse of manufacturing, since Federal Reserve chairman Paul Volcker's depression-causing high interest rate policy of 1979, and what the academics at Harvard hailed as the decoupling of growth, or decline, in electricity and energy supplies, from the functioning of the economy as a whole. On another level, the decline in per capita withdrawals of water also reflects investment decisions which were made, especially after 1967, and then in 1969, with the passage of the National Environmental Protection Act. This policy resulted in the rapid curtailing, and then elimination of large-scale water development and supply programs, by expanding the "cost-benefit" analysis of projects to include the so-called environmental impact of such factors as the infamous snail darter.

Deindustrialization eased water demands

The results of these policies are shown in **Table 1.** The figures for 1980 and the year 2000 were projected prior to 1965 by the U.S. Senate. That was then the view of the level of water supplies that the U.S. ought to have available in 1980 and 2000. The 1985 column is the withdrawal that is estimated to have actually occurred during that year. The comparison is instructive. The divergences, especially between the early 1960s' anticipated requirement for the manufacturing sector, and the share of withdrawals which went to manufacturing in 1985, reflect the longer-term policy shift which has taken place. Water withdrawn in the process of steam-cycle generation of electricity reflects the same, for the 1960s projections assumed that electrical generating capacity would continue to double every ten years, as it had since World War II.

Some are going to insist that the difference reflects something else. They will say that we now use water better than we did 30 years ago; that water-saving and recycling practices in the econmy show up in less water used. Such arguments can't disguise the fact that the 1960s projections of higher water use in the 1980s represented a commitment to investing in capital improvements, in the form of man-made alterations to nature, to assure the future water supply. Because these assumed investments were not made, the result has been what was foreseeable 30 years ago: the beginning breakdown of the national water supply.

Using the kind of parameters which would have been employed 30 or so years ago to assess future water requirements, we come up with a per person need of about 2,352 gallons per day for all major uses (see **Table 2**). This is a bit less than the estimates projected in the early 1960s, but more than the per person withdrawals of 1985, the last year, until this coming August, for which the U.S. Geological Survey usage estimates are available.

The total per capita requirement is about 30 billion gallons per day larger than the 515 billion gallons considered to be the dependable—in 95 years out of every 100—daily streamflow which is produced during the course of the hydrologic cycle of the country.

Does that mean we are in a national water crisis? Yes, and no. The totals presented are projected withdrawals out of the flow of the hydrologic cycle. Most of the water accounted for as withdrawn, especially that used for cooling purposes in industry, or power generation, finds its way back into the streamflow throughput. Thus, it is available for withdrawal and re-use. About 20% of the withdrawals shown in the column headed Geological Survey in Table 2, are pumped out of ground water aquifers, and are not replaced, in their entirety, from precipitation and streamflow. But if things are left the way they have been in U.S. policymaking, the

TABLE 1
Water withdrawals
(billions of gallons per day)

	1980 (proj. from 1965)	2000 (proj. from 1965)	1985 (est. use)
Municipal	29	42	38
Manufacturing	104	233	30
Steam-electric	259	429	190
Agricultural	167	184	140
Total	559	888	

Sources: "Water Shortage Is a Frame Of Mind," William Bowen *Fortune*, April 1965; "Estimated Use of Water in the United States in 1985," U.S. Geological Survey.

TABLE 2
Water requirements and use: three estimates
(billions of gallons per day)

	EIR 1990 requirement	U.S. Senate 1980 projected pre-1965	U.S. Geological Survey, 1985 use estimated
Agriculture	178.7	167	140
Municipal	22.5	29	38
Industry	112.5	104	30
Electric	275.4	259	190
Mining	0.183	—	—
Total	588	559	400
Per capita (gallons daily)	2,352	2,462	1,673

proverbial writing is already on the wall.

The "dependable" streamflow limit is only a relative natural limit. It is also a limit which reflects what can be done with capital improvements either accomplished to this point, or left undone. It should point our attention in the direction of considering that expansion of what is considered to be "dependable" streamflow, by organizing more of the approximately 1,400 billion gallons per day streamflow that falls on the coterminous 48 states, ought to be a top priority.

This can be done through introducing water from outside the lower 48 states, as in the case of the almost 30-year-old North American Water and Power Alliance (Nawapa) proposal of the Ralph Parsons Engineering Co. to bring water from Alaska into the lower 48 states. If that had been done, as it could have been, in the 1960s or again beginning in 1982, then the "dependable" daily limit would have been well surpassed, and there would now be no problem anywhere in the country. Or, dependable supplies can be increased, on a smaller scale, by desalination of sea-water, by inter-basin transfers within the river systems of the coterminous states, and more local projects. Water can, in addition, be used, and re-used, more effectively, and less wastefully. For example, ultraviolet or nuclear waste processing of sewage and waste water can produce fresh, clean, drinkable water.

Water demand zooms as depression ends

Water requirements were estimated as follows. For household and related types of uses, 90 gallons per day was taken as the basis for estimation. This figure comprises 1 gallon per day per person for drinking and cooking, 30 gallons per day for laundry, face and hand-washing, and toilet flushing, 30 gallons per day for a six-minute shower, 15 gallons per day for other sundry household uses, and 15 gallons for street cleaning and fire services in built-up areas. Fifteen gallons have to be added to the 90 to allow for leaks and system losses.

The values are derived from base-line studies of the U.S. Geological Survey done in the 1950s which provided for between 50-60 gallons per person per day (see K. A. MacKichan, "Estimated Use of Water In the United States," USGS 1955, and Ackerman and Loff, "Technology and American Water Development").

Thus, a family household comprised of two adults and an average of slightly more than two children, sufficient to provide for future population growth, would require 378 gallons of water per day, without including the margin for system leaks and losses. This family would be occupying about 2,500 square feet of living space, on a lot of between one-quarter to one-third of an acre. Such families, with such living space, vanished during the 1970s, along with the earlier plans for water development.

Without considering the still-developing effects of the AIDS-HIV virus, and other forms of epidemic disease, like tuberculosis and hepatitis, spreading as a consequence of depression-produced poverty and misery, the U.S. government's nonsense version of the future envisions the U.S. population increasing by 2 million per year, over the next decade, and rather less in the first decade of the next century. The increase is assumed to be made up, primarily, of an aging population, living longer, complemented by some immigration. The government does not envisage any reversal in the collapsing birth rates which have characterized the last generation, nor any shift of female employees, forced into the work force in the scramble to make ends meet, back into the household. The government perspective is that household size would continue to fall from its present 2.6 people per household. But the needs of posterity would dictate the opposite. Sane policy ought to consider providing for, say, 4 million new Americans per year, over the next 20 years, or an increase in water supplies for increased numbers of households of about 360 million gallons per year.

One way to think about what this would mean is the following. If the government's projection of the future were a serious one, then we ought to be providing for the construction and provision of the equivalent of one new city, about the size of the present Washington, D.C., every year. A growth rate that would result in actual growth, would require provision for the equivalent of two new cities equivalent in size to Washington, D.C., or one new Philadelphia. The area of Philadelphia is about 470 square miles.

Agriculture and irrigation

Agriculture is the area of economic activity where the decision to stop capital improvements in infrastructure has already gone past a point of no return. Over the century, arid, or even desert areas of the country, like California and Arizona or even the High Plains states, have been turned into productive sources of food and other agriculture products through improvements including irrigation. Once desert and arid zones have been so upgraded, the improvements have to be continued, otherwise disaster ensues, as is happening in California. Lack of investment jeopardizes the ability to maintain the accumulated generations' worth of man-made alterations to relatively inhospitable nature through capital improvements, which have permitted the existence of some of the most productive agriculture in the world on some of its most unproductive land, and threaten catastrophic short-term effects on the food supply of the country.

Irrigated agriculture ought to be increased by about 12% to provide for the national short-fall in fresh fruits, vegetables, and potatoes, defined relative to the U.S. Department of Agriculture's family-promoting nutritional standards of the 1950s. This is based on a per capita annual requirement of 532 pounds of fruit and vegetables per person per year, as against 1988 apparent consumption of 346 pounds per person per year; it envisions expanding domestic production to account for the replacable imports of fruit and vegetables, which are included in the consumption figures. Then, productivity ought to be organized to continue to increase to

LaRouche's campaign for water technology

"Won't You Please Let Your Grandchildren Have a Drink of Fresh Water?" This was the title of a report commissioned by Lyndon H. LaRouche, Jr. in 1982, and given mass circulation by the National Democratic Policy Committee, the political action committee of the LaRouche wing of the Democratic Party. The document called for using "plain common sense" to advance nuclear desalination technologies and the North American Water and Power Alliance program (Nawapa).

In the preface to the pamphlet, LaRouche wrote:

"Next to a general thermonuclear war, the greatest single environmental danger to the American people over the coming two decades is the danger that whole regions of our nation will simply run out of usable fresh-water supplies. . . .

"This problem has been seen coming, at least by more far-sighted people, for most of the postwar period. Unfortunately, the general public has been kept in ignorance of this policy issue, and certain among influential political circles have sabotaged sound policies and programs, for a variety of reasons.

"Now, unless we act quickly, the Great American West is going to die, suffocated by a swirl of dust and sewage. Already much of our agriculture is in danger, as the drought of 1980 ought to warn us. A few more years ahead, the water shortage will grow to become the most acute environmental danger to many facets of our life, as well as our nation's supplies of food and fiber."

Then in his 1984 presidential campaign platform, LaRouche wrote: "During the indicated twenty- to twenty-five-year period [1985-2010,] the United States must create an additional ten or more new cities. If we are sensible, some of the new cities will spring up in what has been called 'The Great American Desert,' the broad band of arid and desert land reaching from the eastern slope of the Rocky Mountains to the mountain ranges of our western coastal states. The possibility of developing new urban centers in this region is indicated by the established feasibility of transporting water from Alaska and Canada down through the arid and desert regions of the United States, the project known as Nawapa. . . .

"By increasing greatly the density of chlorophyll of growing plant-life in these arid regions of our nation, we moderate the climate. If we accomplish this on a large scale, we foster the development of rainfall systems within the region. As we develop the conditions for expanded agriculture in such regions, we create the opportunity and need for establishment of new urban centers.

"If we are sensible, we shall integrate the implementation of the Nawapa water-management system with other elements of our national water-management system. Fresh water and energy are the cornerstones of terrestrial life; an abundant and secure supply of both predetermines the degree to which life can be supported. These are the preconditions for developing high potential relative population-densities."

TABLE 3
Irrigated acreage required
(thousands of acres)

	Present	Increased total
Vegetables	2,024	3,805
Fruits	3,343	6,920
Potatoes	812	1,404
Total	6,179	12,129

Sources: *EIR* estimate; Census of Agriculture; USDA 1987.

TABLE 4
Crop yields: dryland farming vs. irrigated agriculture, 1982

Crop (bushels)	Dry per acre	Irrigated per acre	Ratio I to D
Corn for grain	106	137	1.29
Wheat	32	69	2.16
Sorghum (grain)	54	93	1.72
Barley	48	81	1.69
Cotton (bales)	0.9	1.7	1.89
Soybeans	31	36	1.16
Potatoes (cwt)	83	333	4.01

Source: "Alternative Agriculture," National Research Council, 1989.

TABLE 5
Harvested irrigated cropland and pasture, 1982

Type of land	Irrigated (thousand acres)	% Total crop irrigated
Cropland		
Corn	9,604	12.3
Sorghum	2,295	17.0
Wheat	4,650	6.6
Barley, oats	2,098	11.8
Rice	3,233	100.0
Cotton	3,424	35.0
Soybeans	2,321	3.6
Irish potatoes	812	64.0
Hay	8,507	15.0
Vegetables & melons	2,024	60.7
Orchard crops	3,343	70.4
Sugar beets	550	53.2
Other*	2,428	17.9
Sub-total	45,289	13.4
Pastureland	4,499	0.9
Total	49,788	6.1

* Includes peanuts, tobacco, edible beans
Source: "Alternative Agriculture," National Research Council, 1989.

keep pace with the increase of population. The anticipated 1% increase in population would require 1.8 billion gallons of water per day more each year for irrigation, and would more than double if we had the sense to turn around the collapsed birth rate.

Irrigated agriculture hasn't simply fallen through the cracks, as it were. It has been under deliberate attack, as part of an effort to force down food production to impose genocidal austerity. This was referred to by the National Research Council in its 1989 study "Alternative Agriculture." "Federal efforts to reduce production are often hampered by programs or policies that encourage irrigation and its resulting high per acre yields," it read.

Irrigation of crops accounts for about 85% of the consumptive uses of water in the economy; those are the uses which result in evaporation, or other relatively permanent transformation of the water's physical state. Some 94% of agricultural use is for irrigation, 4% for needs of livestock, and 2% for farm households.

In 1985, agriculture's average use was 140 billion gallons per day. Average daily consumption is as misleading, as average national "dependable supply" might be. Daily use by farmers, for example during the growing season, can exceed 500 billion gallons per day, or 90% of what is considered to be the dependable daily supply. Though irrigation methods are applied in the eastern part of the country, the method is necessitated where transporation or transvaporation from plant life and vegetative cover is below about 12 inches per year.

There is much more at stake. Irrigated farmland is about 12% of all cropland in the country; about 10% of the working farmers cultivate it. **Table 3** shows our estimate of irrigated acreage needed. The output of the irrigated 12% of all farmland is about one-third of the annual cash value of all national farm production. (**Table 4** contrasts the high crop yields from irrigated land as opposed to dry-land farming.) Thus, the 10% decline in irrigated acreage since the late 1970s is a national catastrophe from the standpoint of food security, as is reflected in the collapsing production of orchard fruits and fresh vegetables (see **Table 5** for percentage of total acreage of various crops irrigated). The production is geographically restricted. California, Washington state, and Florida account for about 85% of the country's irrigated fruit-producing acreage, and about 62% of the irrigated vegetable-producing acreage. Irrigated acres produce 60% of the vegetables in the country and 70% of the fruit. About 94% of irrigated acres are in 17 Western states and three Southeastern states: Louisiana,

TABLE 6
Ground water as percent of total withdrawals

State	1980	1985
California	38	30
Arizona	25	48
Colorado	19	17
Idaho	30	22
Kansas	85	84
Nebraska	59	56
Oklahoma	55	44.7
Texas	33	29.2
Florida	19	23.5

Source: U.S. Geological Survey, "Estimated Water Use in the United States," 1985.

Florida, and Arkansas. The top five states—California, Nebraska, Texas, Idaho, and Colorado—account for 55% of irrigated land between them.

Agriculture water crisis already severe

Where is the increased water for the increased acreage to come from? This is where the water crisis already exists. Between 1940 and 1978, irrigated farm area more than doubled. However, the increase was made possible by tapping ground water supplies, which source increased 160% between 1945 and 1980 (see **Table 6**), while use of surface water increased less than one-third as rapidly. By 1984, irrigators obtained roughly equal amounts from underground and surface water supplies. Mining of ground water, at rates faster than aquifers are replenished by the flow of the water cycle, is creating problems which jeopardize the very existence of such agricultural practices, such as salt-water intrusion into the aquifers of California and Florida, or the exhaustion of supplies.

The present so-called drought crisis in California is a foretaste of where each of these states is headed. Continued mining of ground water is no answer, and transfers from neighboring river basins are no answer because for each of the states west of the 100th meridian, with the exception of the Pacific Northwest, water shortages now prevail. And basins with surpluses on paper, such as the Great Basin and Upper Colorado, are tapped out providing for southern California, Arizona, and New Mexico. This was the foreseeable crisis that Nawapa was designed to avert.

Presently, each American requires about six acres of agricultural land—two for crops, four for pasture and related uses. Even the government's nonsensical low growth rate would therefore require either the addition of 12 million acres per year, or productivity increases on existing cropped and pastured acreage commensurate with the assumed growth in population. Double that figure would be required for the kind of population growth which would permit actual growth. Irrigation happens to be the most readily available means of increasing productivity, and the land required to sustain population growth would be reduced to 1.5-2 acres per person, 6 to 8 million acres per year.

Industry and power generation

The projections for both industrial water use and the requirements for power generation were developed by assuming a full employment profile for the economy. This has two aspects. The population of labor force age is growing in such a way that about 1 million workers are added to the labor force each year. Thus, about 20 million work places would have to be created over the next 20 years. Then, we must take into account the mis-employment of the work force. Assume, opposite to the dominant practice of the past generation, that goods producers in manufacturing, mining, construction, and transportation, make up 50% of the employed labor force, and that 60% of the population of labor-force age will be employed. The approach ought to be to pay our own way in the world by producing our own requirements, and exporting into expanding markets outside the country. No more free-loading through stealing the produce of those who cannot afford to defend themselves from our genocidal looting. To support the ability to turn around collapsing birth rates, the base for estimation is a labor force of about 114 million people, freeing up about 20 million women to return to the household, with about 57 million operatives in the cited industries, of whom, it is assumed, 41 million can be employed in manufacturing.

That will raise objections too. After all, it is insisted, we have moved beyond the phase in which we actually produced for ourselves. We're in the post-industrial society, don't you know? We steal some of what we need from everybody else, some we produce, and some we do without.

Fifty percent of those employed working in goods production is what used to be the practice before the rot set in during the 1960s.

Table 7 compares the decline of goods-producing employment, since 1940, with the number of manufacturing employees, and horsepower of factory-deployed prime movers, manufacturing electricity use, industrial water use, and estimated industrial land area. Engineers employ such parameters to arrive at determinations of water usage. For example, the American Water Works Association prepared a study entitled "Water Requirements for Industrial Development," authored by K.L. Kollar and P. MacAuley. The study was published in Vol. 72, No. 1 of the *Journal of the American Water Works Association*. Employing 1979 employment data, by manufacturing sector, the study's parameters provide for a water requirement, per manufacturing employee, of 12,790 gallons per day. If such a standard were adopted,

TABLE 7
Employment, power, water, and area, 1940-87

	Goods producers % employment[1]	Manufacturing employees[1] (millions)	Factory horsepower[2] (millions)	Factory Kwh[3] (millions)	Water[4] (billion gallons/ day)	Area[5] (million acres)
1940	50	13.2	21.7	83.3	28.9	—
1950	49.7	18.4	32.9	181.3	37.9	0.8
1960	44.9	20.4	42	361.9	61.0	—
1970	39.4	23.3	54	573	62.9	1.5
1980	24.8	18.3	64	794	45.0	1.5
1985	22.3	17.4	65	824	30.0	—
1987	21.3	17.4	65	847	—	—

Sources:
[1] Bureau of Labor Statistics, U.S. Department of Labor
[2] "America's Needs and Resources," Twentieth Century Fund, New York; John A. Waring, Arlington, Va.
[3] Bureau of Census, U.S. Department of Commerce; Edison Electric Institute, Washington, D.C.
[4] U.S. Geological Survey
[5] "Land Uses In American Cities," Harland Bartholomew; "America's Land and Its Uses," "Resources for the Future"; *EIR* estimates.

for an employed work force in manufacturing of 41 million, then about 520 billion gallons per day would be required for manufacturing alone. Or, for 1980, four times more water ought to have been available for industry than was.

The first is more than the "dependable" daily runoff of 515 billion, and about as much as peak growing season irrigation use.

Per horsepower applied, for factory-based prime movers, an engineering estimate for cooling feed, and boiler "make-up" water, runs in the order of five gallons per horsepower. This would come to 325 million gallons per day, for the reported 65 million factory horsepower of 1987.

Again, estimates of feed water requirements for cooling and condensing in electricity generation run from 10 gallons per kilowatt-hour to 40 gallons per kilowatt-hour.

The water used for such purposes can be recirculated. It has to be cleaned, almost to the standards of drinking water, to prevent scaling and other fouling of working surfaces, so why not re-use it, rather than pump cleaned water back into the dirty source from which it was extracted? Water is re-used in this way, seven times and more. That part lost in the process of generating steam, through evaporation, has to be replaced, called "make-up" water. In electricity generation, it can amount to 5% of the throughput.

The variabilities depend both on the thermodynamics of the process employed, and on the method chosen for the heat-sink. Some 60-70% of the heating value of the fuel employed to power an industrial boiler system, or an electricity generating station, is not converted in the process, and has to be vented as waste heat. In U.S. practice, where water has been relatively plentiful, and cheap, this has either meant, once-

The 'nuclear option' for electricity and water

Following are excerpts from a presentation to the American Power Conference in Chicago April 29-May 1, by General Atomics officers R.W. Schleicher and C.J. Hamilton, titled "Exploiting the Nuclear Option for Both Electricity and Water."

. . . In many regions of the U.S., an acute need for new sources of fresh water is emerging as a consequence of sustained drought conditions, high local population growth, and deterioration of existing water supplies from contamination and overuse.

Concomitant with the need for new fresh water is the need for new electric power sources. Both population growth and industrial development bring about increased energy utilization, particularly in the form of electricity.

Although desalination has been a major water source for Middle East countries and island nations, it has not been a significant source of water in the U.S. However, the need for both water and electric power is a significant problem in populous regions with high growth projections, particularly Southern California and Florida.

In Southern California, which is in the fifth consecuthrough coolant and condensing cycles for plants located on ocean coastlines or rivers, or recycling coolant and condenser feed from plant-dedicated ponds and lakes. Phoenix, Arizona, powered from desert-located nuclear plants, uses treated and recycled municipal waste water as the source for coolant and condenser feed-water to the plants.

The waste-heat can also be air-cooled, through cooling tower arrangements. As long as technologies, such as magnetohydrodynamic (MHD)-based direct generation of electricity from coal, for example, are not developed, cooling and condensing needs of steam-cycle generators and boilers are going to be with us.

Given the variability, we estimated requirements simply by, in the case of industrial use, increasing the 1980 manufacturing withdrawals of water by a factor of 2.5 to reflect a full-employment policy. We also assumed that industrial use of electricity would increase proportionally, by the same factor, and then took an industry standard, 40 gallons per kilowatt-hour (kwh), as the cooling and condensing requirement for all electricity. Household uses of electricity were based on the 9,025 kwh per household, 1980 requirement to power the array of appliances, lighting, and heating functions, which such a household ought to have. The results are 112.5 billion gallons per day for the manufacturing industries, and 275.4 billion gallons per day for steam-electric generation.

In the government's nonsense view, the labor force is supposed to increase by about 1 million per year. Under actual population growth, such a margin of increase could easily be doubled, but the increase will not be reflected in the employment profile until about 20 years after we convince ourselves that such a change would be in order, if we are to survive. Meanwhile, the question becomes, how rapidly can resources be mobilized to create the capital improvements, including expansion of the water supply, which can begin to shift the country back to producing its own way in the world. For each such million jobs in the productive sector, about 2.5 billion gallons of water will be required per day, 48 million kwh per year, and 60,000 acres of land at current per worker productivities. What happened between 1940 and 1970, as reflected in Table 7, ought to provide some idea of how such parameters might change over that 20-year period.

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tive year of drought, recent water authority demands for 50% cutback in water use have raised interest in the possibility of desalination for urban water supply. Desalination represents not just a short-term solution, but a long-term water source to cope with the high population growth and loss of existing water supplies.

Florida is in a similar position. Despite a large annual rainfall, the topography and soil structure induce excessive runoff . . . [and] drawdown of the water table has permitted seawater intrusion into the coastal water supply. Hence, brackish water and seawater desalination solutions are being developed. With respect to power needs, Florida is already in a critical situation. . . .

The MHTGR: an ideal source

Nuclear power is the ideal energy source for meeting the new demand for water and electricity. . . . Nevertheless, to be a practical reality for desalination, nuclear power must overcome several barriers which have interrupted development for the past 12 years in the U.S. These are: 1) achievement of exceptional safety characteristics; 2) economic competitiveness, with water and power production costs equal to or lower than alternative new sources; 3) acceptable financial risk for prospective owners and/or investors.

The Modular High-Temperature Gas-Cooled Reactor (MHTGR) is an energy source for both water and power production which has the potential to overcome the above barriers. The MHTGR features inherent safety characteristics, tolerance of operational transients, and benign environmental impact, all of which have the potential to make it an ideal candidate for water and power production at sites near coastal population centers.

A study initiated by the Metropolitan Water District of Southern California, in conjunction with the Department of Energy and private companies in the energy and desalination fields, has evaluated the technical and economic viability of using the MHTGR for desalination in Southern California. The major findings are:

1) Growth in normal water demand in Southern California requires development of about 460,000 acre feet per year (AFY) of new reliable water by the year 2000. By the year 2010, a total of 890,000 AFY must be developed. There is a corresponding need for additional large sources of electric power after the year 2000.

2) A dual-purpose MHTGR desalination plant consisting of four 350 megawatt modules with a multieffect distillation desalination system supplied with backpressure steam from the MHTGR can produce 106 million gallons of fresh water per day (MGD) in addition to 466 MW net electric power output.

3) The MHTGR will meet all established safety, environmental, and seismic criteria for siting in Southern California.

4) The institutional issues, which include public acceptance and demonstration of a means of waste disposal, loom as the most significant factors affecting viability of MHTGR desalination.