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Water, Growth and Politics in Coastal California:  
THE DIABLO CANYON DESALTING FACILITY\*

by

K. N. Lee, Diane L. Fernandez,  
Leland D. Hodges, and Charles Slayman

November 1972

Water treatment } } California  
Conservation water } } Diablo canyon, Ca

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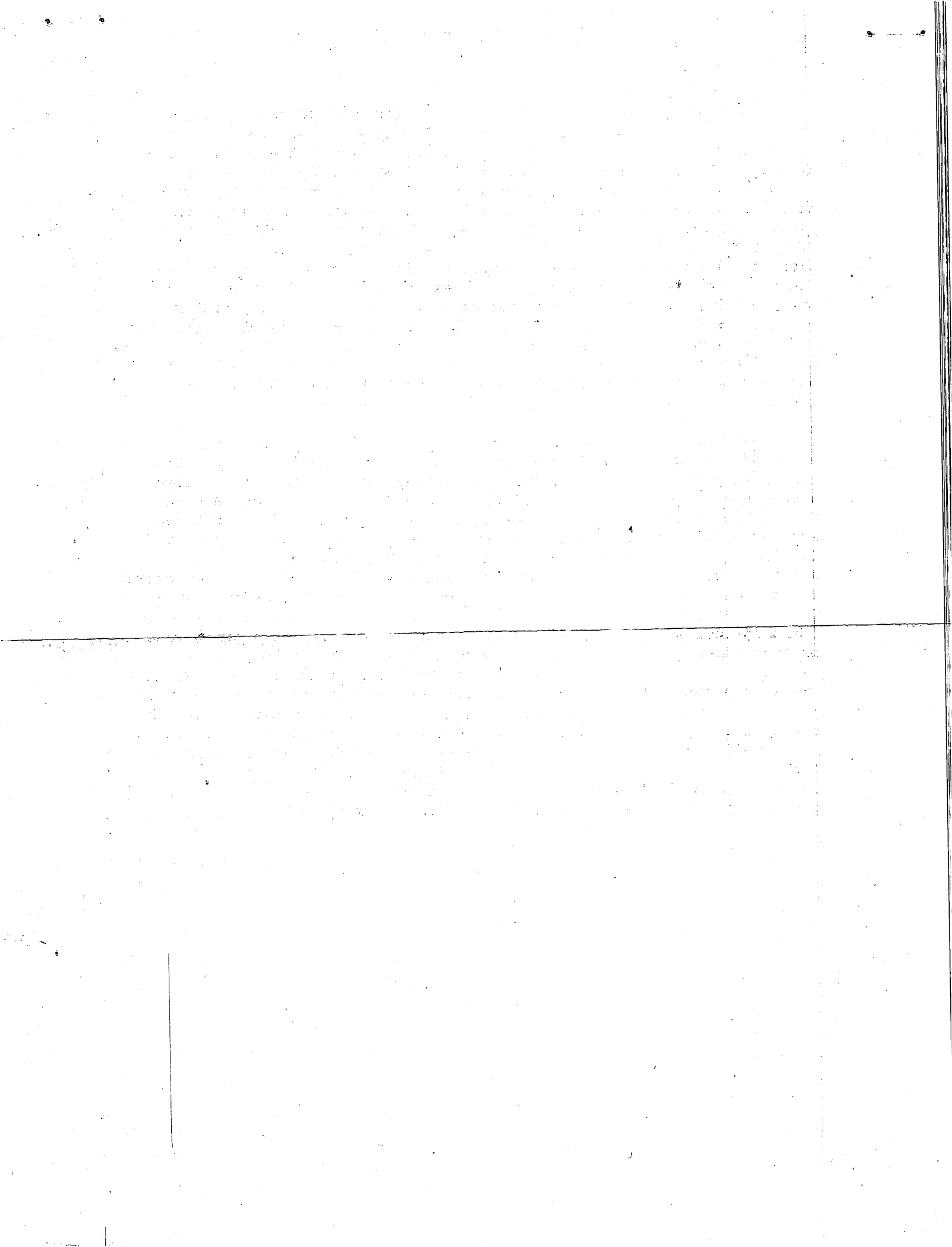
University of California, Berkeley

\* Research supported in part by the Water Resources Center, University  
of California, Los Angeles.

\*\* Research Training Fellow of the Social Science Research Council  
1971-1972.

Since we completed our data gathering for this report in October, there have been a number of further developments. Most important of these, undoubtedly, was the interim recommendation by the U. S. Office of Saline Water against a desalting plant in Diablo Canyon. Citing economic feasibility as a major problem, OSW recommended further study of desalting technology before building a large-scale demonstration plant. In the Santa Barbara *News-Press* of November 9, 1972, however, J. W. O'Meara, director of OSW, was quoted as saying that a desalting plant to serve Santa Barbara County was still a candidate for federal support. The technical situation is, as we reported, far from clear-cut, and these recent developments do little more to clarify matters. It is probably safe to say, however, that OSW's recent public statements indicate substantial federal reluctance to continue with Diablo Canyon. At the same time, federal officials are denying that environmental forces have won any kind of victory--hence the continued talk of a desalting plant.

The statements of OSW suggest a continuation of the traditional hands-off attitude toward local government issues and local population growth in particular. The voters are taking the lead here in building a consensus. In the November election both Santa Barbara and San Luis Obispo Counties helped to pass California's Proposition 20, a voter-sponsored initiative placing a moratorium on coastline development and forming a coastal development commission to "control" growth. In addition, both counties elected supervisors who had campaigned for growth limitation. James Slater and Frank Frost won seats on the five-man Santa Barbara board of supervisors, and the day after the election, the *News-Press* enthusiastically predicted that they would look for a swing vote on environmental issues. Kurt Kupper and Richard Krejsa won seats on the San Luis Obispo board, but the environmentalists missed winning an outright majority, when Anne Butterworth Caldwell lost her bid to unseat incumbent Hans Heilman. Despite the lack of an automatic majority, the strong showings of nongrowth or controlled growth proponents demonstrate that growth is an issue whose visibility in the public arena is now assured for some time. In an odd way, Diablo Canyon as a social and political event may already have done the job it could do--to raise the problem of growth and its linkage to public technological systems.





Institute of Governmental Studies

Working Paper No. 25

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## FOREWORD

No one seriously doubts any longer that technology is one of the principal social forces of the twentieth century. And it is also evident that, for all the enormous technological advances which we of the twentieth century have made, the social phenomenon of technology remains mysterious. Our lack of understanding is no more than a special case of the generally primitive state of the social sciences, a backwardness which has threatened to be the undoing of mankind since the day the atomic bomb illuminated the shallowness of our faith in Progress. Understanding technology socially--unlike technology itself--is a halting, laborious process, for--unlike technology--we have no bedrock of science, no fundamental assumptions upon which to rely. One can but stumble along, hoping for a lucky break: some instance of technological development which is unusually clear-cut, a "natural experiment" from which one can learn about the social mechanism of technological change.

The case of the Diablo Canyon desalting facility has been a lucky break for us in a number of important respects. The political reaction to the desalting plant has been remarkably straightforward, revolving around the issue of further growth in two counties in coastal California. The technological setting was also unusually clear. The concept of obtaining fresh water from the sea is relatively uncomplicated; finding an economical means to desalt is the hard part. Research and development in desalting technology has been a classic case of federal support for a technical problem adjudged to be in the national interest. Finally, the recent rise of concern about the natural environment gave us a key simplification, for the language of the ecology movement, though imperfect, provides a widely shared conceptual framework in which to understand the social meaning of a new technology. These scholarly advantages have provided an unusually fruitful opportunity for us to check our naive guesses against real responses to meaningful events.

This study, then, examines the two principal impacts of the Diablo Canyon desalting facility: its perception as a technological opportunity in the search for an effective and economical method of producing fresh water from the sea; and its surprising entry as an issue in political debate and political action. The case of Diablo Canyon is not closed yet, and the present investigation is only an initial monitoring of a learning and decision-making process which will unfold over the next several years. We hope to have provided a starting point which will prove useful to a number of audiences:

- this is, first of all, a fact-finder's report of the intentions, perceptions, and beliefs of over fifty persons who, in one way or another, have a stake in the future of Diablo Canyon;
- it is, in addition, a preliminary analysis of a dynamic situation in which a large-scale technological system has become a political issue *while it is still in the planning stage*--something startling and novel in the history of public participation in the use of technology;

--finally, this is a study of the responses of citizens and public officials to water resource development, a study which is informative not only about the politics of water but also about public policy problems involving other public commodities such as energy and clear air.

We have written the report, therefore, for three groups of readers: persons in San Luis Obispo and Santa Barbara counties who are concerned with and about Diablo Canyon; business, environmental, governmental, and academic persons with interests in public policy, technology assessment, and water resources; and engineers and scientists at work on the technical problems of desalinization.

This research began as a class project in the spring of 1972, in a course on technology as a political problem which Professor Todd LaPorte and I offered in the Department of Political Science. Professor LaPorte learned about the Diablo Canyon plant, and the interest shown in it by the staff of the University's Water Resources Center, just before the spring term began. We offered our class the chance to study the plant as a paper topic for the course, and three students took us up on the offer: Diane Fernandez and Lee Hodges, both graduating seniors in political science, and Charlie Slayman, then a sophomore physics major. In different, creative ways, each of them rose to the challenge of doing something novel. Diane, a specialist in the politics and history of South Asia, emerged as a vivacious, tenacious investigator--and perhaps a future city planner and politician of considerable mettle. Lee shared with us his diverse background in marine ecology and nuclear power plant controversies, and displayed the skills which he will bring to bear in environmental law some day. Charlie, nominally the junior member of the team, developed a prodigious appetite for water resource engineering, becoming not only our technical expert but an effective teacher to his fellow researchers. These thumbnail sketches, however, do not begin to do justice to the enthusiasm and persistence which all three of these students brought to their task. In the course of learning they taught us much.

This rich research and pedagogical opportunity would have been impossible without the generous support of the Water Resources Center, which funded an initial trip down to San Luis Obispo and Santa Barbara last spring. When the three authors of this report came back loaded down with fascinating information, we thought a longer study was justified. That longer work, which is reported here, was made possible by continuing support from the Center. We are particularly indebted to Professor Ernest A. Engelbert, Associate Director of the Center, for his tireless administrative labors on our behalf, and to Professor Alan D. K. Laird of the Department of Mechanical Engineering here at the Berkeley campus, who has tactfully guided and informed the work of some occasionally irritating social scientists.

In addition, we are grateful to those public officials, engineers, and concerned citizens who shared their views with us with consistent frankness and cordiality. Because of the rapidly changing nature of the Diablo Canyon

issue, and because we do not intend this report to be a source of recrimination, we have elected not to label persons with positions which they may no longer hold; discretion here seems the better part of honesty.

K. N. Lee

Institute of Governmental Studies  
University of California  
Berkeley

November 1972

## ACKNOWLEDGMENTS

Seldom are college students given the chance to do independent research; when they are, it is usually library or laboratory work designed as a step toward graduate school or further professional training. Our project has therefore been a doubly rare opportunity: we have been able to undertake research in the field, on a subject whose importance is broader than our own immediate, formal education. Despite the "relevance" of the work, however, it has turned out to be an unusually fruitful learning opportunity. In part our learning was encouraged by the fact that our "subjects" took us seriously; but by far the most important thing has been that we came to take our work seriously, too, in a way which more conventional schooling does not often encourage.

As we explored the reactions of people concerned with and about the Diablo Canyon Project, we saw the transformation of a rather mundane technical capability--providing fresh water for residential use--into a bundle of different social meanings. Whether as a technological experiment in desalting, or as a stimulus to further growth in Santa Barbara County, the Diablo Canyon Project will make a difference, perhaps a big difference, in the lives of a great many people. Above all, it will make a difference in the lives of people we came to like and respect, even when we disagreed with them over details of water policy, plant design, and the like. Field work is challenging because direct personal contact with what one is studying confronts the investigator with the extraordinary complexity of ordinary life. Simple generalizations--such as deciding whether or not the development of Diablo Canyon is "worth it"--which retain some measure of objectivity are incredibly difficult to make. We returned to our academic analysis with newfound respect for those who seek to understand the behavior of social groups. Diablo Canyon taught us, from a new perspective, what education is good for.

We are grateful to the Water Resources Center and the Institute of Governmental Studies for the funds and support which made our study possible. That support was secured for us by Professor Todd LaPorte and Dr. K. N. Lee, our teachers in the class in which this project began. They listened to our ideas, coordinated our efforts, and saw us through the writing of this report; their suggestions and criticisms have strengthened this report at innumerable points. A number of persons at the University helped us throughout our study. Mary Deane, the energetic librarian of the Water Resources Archives, spent much time helping us to learn about desalination and the water situation in San Luis Obispo and Santa Barbara Counties; without her assistance, assembling our background data would have been an insurmountable task. Professor Alan Laird, a leading authority on desalination and water resources, patiently led us through the technical intricacies of desalting. And Amy Alsbury, Joan Barulich, and Rose Hill, staff members of the Institute of Governmental Studies, shepherded us through the red tape of doing university research with cheerful efficiency. We thank them all.

Covering a rapidly evolving story like Diablo Canyon, however, would have been simply impossible without the cooperation we received time and again from the people we interviewed. Despite the controversial nature of



the issue, no one held back or attempted to duck our questions; we three "Berkeley kids" were amazed--and delighted. Simply to list the names of our living bibliography seems vastly unjust; we hope that the report itself will express our thanks--that it will repay in fairness the generosity we found.

D. L. F.  
L. D. H.  
C. S.

## I. INTRODUCTION

Coastal California south of Monterey Bay is a land of steep splendor, the slopes careening down to fierce white surf and the green sea. There are no major river basins, only precarious canyons where rain briefly echoes on its plunge to the ocean. It is a land of little fresh water: only what is tapped by wells, trapped in careful, costly reservoirs. And with the population growing to the boundaries of the natural water supply, the coast counties of San Luis Obispo and Santa Barbara advance upon the old dream of fresh water from the sea.

In 1970, after prolonged debate over environmental hazard, Pacific Gas and Electric began the construction of its nuclear power plant at Diablo Canyon, a remote cove west of the city of San Luis Obispo. Like all electric power plants, nuclear reactors generate a great deal of heat as a by-product. This is why the Diablo Canyon plant was built on the coast even though its electricity is destined for the Central Valley, 100 miles to the east: the extra heat can be dumped into the Pacific Ocean with minimal environmental effects. For a variety of technical reasons, this waste heat is not usable in industrial processes--otherwise, in fact, it would be used to generate more electricity. One of the few things it is good for is to boil sea water; the steam, made up of the water but not the salt and other minerals dissolved in sea water, can be collected and condensed to make fresh water. Thus, in 1971 the Federal government's Office of Saline Water and the State of California's Department of Water Resources proposed that an experimental desalting plant be built at Diablo Canyon, alongside PG&E's nuclear power plant.

At first sight, the "match" is good. There is already a slight water shortage in Santa Barbara County, 70 miles to the south, and by the time the plant begins to supply water to Santa Barbara and San Luis Obispo counties in the late 1970s, that shortage is expected to be more severe. On the technical side as well, Diablo Canyon appears to be a good opportunity. Although the dream of drinkable water from the sea is an old one, the engineering problems involved in bringing the dream to life remain formidable. With the construction of Diablo Canyon, which would be the largest desalting plant in the world, many technical questions could be asked and answered with a real-life test case.

But it is only at first sight; things are, as usual, more complicated. This report looks at some of the wrinkles. We examine here the two principal impacts of the Diablo Canyon desalting facility: its perception as a technological opportunity in the search for an effective

and economical method of producing fresh water from the sea; and its surprising entry as an issue in political debate and political action.

### *The opportunity*

Although we are but infrequently aware of it, Americans each use about 100 gallons of water per day. Only a small fraction is consumed directly in cooking and eating; the greater share goes for bathing, laundry, and sanitary uses. In addition, the processes of industrial society require large quantities of water, though not all of it needs to be pure enough to drink. The figure of 100 gallons per day shows wide regional variation as well: in south Florida, where nearly all natural water is brackish, per capita use is only about 20 gallons per day, a fifth the national average. Water resource engineers, who design reservoirs serving thousands of persons, prefer to discuss resource needs in acre-feet rather than in mere gallons; an acre foot is the volume of water contained in a "bottle" an acre in cross-section and one foot high. Our hundred-gallon-a-day figure for personal consumption may be expressed equivalently by saying that a family of four uses about one acre-foot of fresh water every year. A population increase of 10,000 persons--the kind of growth which Santa Barbara County had during each of the last ten years--requires an annual water supply equal in size to a volume 10 feet deep and three-quarters of a mile in diameter. Because reservoirs do not fill up in a year, the actual size of a reservoir sufficient to serve a city needs to be 10 to 20 times as large as its annual consumption. Water resource management is big business.

Santa Barbara County is now short of water, and the shortage has reached crisis proportions in the Santa Barbara suburb of Goleta, where the University of California at Santa Barbara is located. Goleta tripled in population during the booming sixties. With a long drought lowering supplies further, Goleta has recently begun to mine ground water, using up water which will not be replaced with even a normal year's rainfall; water mining is usually a last, desperate step before water is rationed. Worse, the NASA space shuttle, which will be developed at Vandenberg Air Force Base in the northern part of the county, is expected to attract residents in a continuing stream through the rest of the 1970s. San Luis Obispo County to the north is in better shape. The population is sparser to begin with, and the projected increase will not exhaust current supplies until the turn of the century, according to county officials. The water is not evenly spread, however, and in a number of towns shortages have forced temporary rationing. In both counties the impending water shortages will mean the end of the meteoric growth of the sixties: without more water there can be no growth, since new businesses, which all use water to some degree, will be unable to locate in the area.

The shortfall is projected to be about 36,000 acre-feet per year by 1990. Acting to prevent a growth-choking shortage, both county governments arranged during the 1960s to buy water from the State Water Project, the massive aqueduct bringing water from Northern California down to the Los Angeles basin. State Project water would be pumped through the coastal

mountains in expensive new tunnels, and the supplemental water would have been more than twice as expensive as fresh water is now. On the average, water prices in the two-county region would be raised from somewhere in the neighborhood of \$200 per acre-foot, to about \$300--a steep increase, but still not a very visible one when collected as a \$25 per monthly water bill for a family of four.

It was against this backdrop that federal and state officials proposed a desalting plant. The plant would have a peak capacity of 40 million gallons a day, a production rate which averages out to 36,000 acre-feet per year--just the amount needed by the counties by 1990. Two agencies, the U. S. Office of Saline Water and the California Department of Water Resources, would put up \$136 million to pay for the plant, part of the piping to carry the water, and also to subsidize the operation of the plant for ten years. The subsidy is set so that Diablo Canyon water would cost the same as State Project water. In this way, it was felt, the state and federal agencies would compensate the residents of the two counties, paying them for deferring State Project water while they were using water from Diablo Canyon. The citizens of Santa Barbara would be asked to pay for an extra burden, however: a \$27 million water pumping system, to be paid for by county bonds; this system would be needed in any case for the State Water Project, when it is brought into the county. All in all, it looked like a good plan: the counties would pay no more than they would have had they brought State Project water, and the state and federal agencies stood to gain much valuable experience.

All of our fresh water now comes from rain, directly in reservoirs and wells, or indirectly in streams and rivers. The natural weather system acts as an enormous desalting plant, drawing fresh water out of the oceans, condensing it first as clouds and then as rain or snow. The weather, of course, is energized by the sun's rays, which evaporate water and heat surfaces on land and sea to drive the winds. The central feature of a man-designed desalting plant is also its energy source. Diablo Canyon will be an important research opportunity in part because it will be one of the first plants to use the waste heat from a nuclear electric generating station, an arrangement expected to be of increasing importance in future large-scale desalting facilities.

In a steam turbine of the kind used in the Diablo Canyon nuclear power plant, high temperature steam is forced through a set of rotating blades: the steam turns the blades, generating electricity. What forces the steam through is a pressure difference between the ends of the turbine. The exit side of the turbine is cooled and, as the steam leaves the turbine, it cools and shrinks, creating a low-pressure region which draws more steam through. Scientists call such devices heat engines, since they are run by a difference in temperature. The greater the temperature difference, generally, the more mechanical or electric power may be extracted, so the cool end is kept as cool as possible. In a steam turbine the low temperature is about 100°F, a limit set by the fact that steam condenses to form water. At 100°F, the steam releases large quantities of heat into the water used to cool the exit side of the turbine. Much energy is wasted in this way, lost in the cooling water, but it has proved to be difficult to use the

low-temperature waste heat from a generating plant. The problem is simply that, if the heat were usable in an industrial process, then it could have been used to generate electricity--so that the very efficiency of electric generation decreases the usefulness of its waste heat.

One thing which can be done is to boil water. In the Diablo Canyon design sea water will be boiled at 250°F. That is, the exit temperature of the steam from the turbine is higher than it would normally be, so that the heat may be used for secondary purposes. Steam from the sea water is in turn condensed to form pure water suitable for drinking. This simple concept of using leftover heat from a power plant to boil sea water is complicated by a number of technical factors, as we shall describe in more detail in the next chapter; the principal difficulty is the corrosive nature of salt water, a problem which in milder form has long been familiar to car owners in seaside communities. Because of these complications, no economically feasible desalting process has so far been proven. Diablo Canyon offers an opportunity to test technical ideas, already shown feasible in pilot plants, in a large-scale plant serving a real water market. As such, it is potentially a key link in a national program for developing water resources for a growing America.

### *Competing forces*

Not everyone agrees that Diablo Canyon will be a good thing. For one thing, many people know very little about the plant. But most important, undoubtedly, is the wave of concern about environmental matters which has become a major focus of public action. Santa Barbara residents were among the most visibly traumatized ecological victims of the 1960s when the 1969 oil spill killed birds and ruined the beaches of the South Coast. Since then major alterations in the environment, even "obviously" beneficial ones, have automatically been on the agenda of public, political discussion. Diablo Canyon is one of these projects.

In principle, defenders of the environment favor desalting as a means for securing fresh water, since it does not involve damming up wild rivers to form reservoirs. But the Diablo Canyon desalting plant is part of a wider controversy, and, to activists in the area, Diablo Canyon is a symbol of the way in which industrial man has erred in living with nature. Their perceptions are guided and shaped by a bitter debate with the Pacific Gas and Electric Company, owners of the nuclear power plant which will power the desalting facility. Led by the Scenic Shoreline Preservation Conference, Inc., a volunteer organization vociferously opposed to any kind of development of the California coast, environmentalists challenged PG&E through state and federal courts, seeking to prevent the building of the nuclear power plant. The arguments marshalled in this controversy are described in Chapter IV. Their underlying assumption, in brief, was that man has no natural right to intrude upon wilderness, and therefore that such intrusions must be justified by overriding need--a need which has not been demonstrated to the satisfaction of environmentalists.

From this point of view the desalting plant is important less as a source of fresh water--or even as a threat to the ecology of Diablo Cove--

than as a political ploy. The plant, environmentalists charge, has been proposed so that the residents of San Luis Obispo will receive some direct benefit from the development of their coastline; the electricity from the nuclear plant is used in the Central Valley, not locally, and the citizens of the county might have been reluctant to run the environmental risk of having a nuclear reactor on their shores, were it not for the desalting plant. Whatever the merits of this analysis, the plant has become symbolic of mindless development and sprawling growth. If it were stopped by environmentalists, they would claim a political victory of substantial proportions: the \$136 million project represents a sizable fraction of the U. S. Interior Department's \$2 billion annual budget.

Even those not aggressively battling to prevent development have in recent years begun to have second thoughts about the virtues of economic growth. Doubts that explosive growth in cities such as Houston, Los Angeles, or San Jose has been entirely a good thing have infected government leaders and businessmen nationwide. But the value of untrammelled expansion has drawn particular fire from the white, upper and middle class residents of Santa Barbara, who already enjoy a blend of artistic, business, and cultural advantages characteristic of the urban environment, with few of the crime, welfare, and traffic problems of megalopolis. To be sure, civic leaders who for decades equated economic growth with prosperity and improvement do not reverse their stands overnight. While many favor the concept of an "optimal" population limit for their counties, the problem of determining what is optimal, not to mention implementing a limit on migration into the area, has scarcely been talked about. In the meantime, a decision to build a desalting plant at Diablo Canyon will provide water resources for substantial expansion by the end of the century.

The weight of the decision on Diablo Canyon falls most heavily, of course, on local governmental officials and office holders. Most of them are convinced that the counties will in fact need supplemental water, and thus they have tended to favor the desalting plant. Their major worry is that, at the end of the ten-year state subsidy period, the need for water might be large enough that Diablo Canyon will have to be kept operating, even though that would send water prices skyrocketing. In brief, city and county officials are trying to get the best deal--economically defined--for their communities.

Phrasing the decision in economic terms is not necessarily the best way, of course. The existing shortage in Santa Barbara County is likely to get worse rather than better, but to say that the counties will need supplemental water does not say how much water they need. The design of the Diablo Canyon plant was based upon water analyses used in the earlier negotiations for the State Water Project, and these earlier plans were based upon the assumption that local county policy would continue to encourage growth. Once a 40 million gallon a day supply is installed, however, there will be considerable economic pressure to use the capacity of the plant, lest the investment be wasted. The plant itself, that is, may spur growth, even if it is not desired by the resident population. Thus, for local decision-makers to choose between Diablo Canyon with a capacity of 40 million gallons a day and nothing is starkly a choice between

continued growth and an economically jarring halt. The Diablo Canyon plant therefore becomes a politically loaded issue hazardous to politicians however they vote.

It is only to engineers in state and federal agencies that Diablo Canyon is obviously a good thing, for to them the benefits to be gained outside the local area are of overriding importance. To federal agency technologists, desalting represents a source of water which someday will provide an unlimited supply of pure water; given the political importance of many of the desert nations of the world, including the oil-rich Arab states, American successes in developing desalting technology would give this nation a valuable advantage in international technical assistance. Moreover, the name "desalting" actually describes a whole family of methods for decontaminating water, something which we need to know how to do if we are to clear up our polluted rivers and streams. To engineers at the California Department of Water Resources, Diablo Canyon, by serving as an interim supply for the coastal counties, would allow further planning to be done to prepare for extension of the State Water Project into the two-county area. In addition, water-poor Southern California has an abiding interest in the development of desalting techniques.

Clearly, the building of a major desalting plant would provide valuable technical experience. It would also serve a more subtle, but no less important, purpose: helping manufacturers to prepare for equipping a large desalting industry. If populations continue to grow, natural fresh water will be harder and harder to obtain in quantities sufficient to supply our needs. If this long-range trend holds up, it will be both good business and good politics to have companies ready to supply desalting equipment when the prices of fresh water have risen in response to scarcity, meeting the declining price of artificially purified water.

What technical controversy there has been has centered on the detailed design of the Diablo Canyon plant. It has been argued that rigorous environmental and safety restrictions have increased costs to the point where the plant would no longer be a sound investment, since not enough would be learned from it to justify building it. The soundness of the investment, however, can only be judged as a function of the internal design of the plant; as we shall describe in the next chapter, a more innovative process than the one proposed would make the plant considerably more interesting. These fine points, however, do not take into account the political environment of the plant, even though justifications for the plant would be strongly modified by a local consensus against growth.

On balance, as we shall argue in the final chapter, our judgment is that a modified Diablo Canyon facility can be a genuine opportunity for the people of San Luis Obispo and Santa Barbara, as it already is for the engineers at work on desalination. At present that opportunity is not perceived because the desalting plant has been equated with growth. The connection between water and growth--more centrally, between *how much* water and how much growth--appears to us to be more subtle than public discussion has so far made it seem. This is where the opportunity comes in.

*This study*

The desalting plant is by no means a settled issue. If the local community rejects the plant, that will only deflect the momentum of the engineers interested in adding to our repertoire of control over the natural world; another desalting facility at another place will be proposed, with political consequences which are likely to be interesting. If the community accepts the plant, the water it purchases will enable social changes to take place, changes which will ultimately take the two-county area into a particular form of twenty-first century life, as different from today's Santa Barbara as today's city is from the pre-World War II world of Santa Barbara the agricultural center. The present study is motivated by the extraordinarily sophisticated response to the desalting plant which we found in San Luis Obispo and Santa Barbara Counties. County officials, environmentalists, and engineers working on the plant all had understandings of the social and political implications of the plant which surprised us by their complexity and subtlety; as we have noted above, these understandings are also considerably at variance with one another. The situation, therefore, is one that bears watching. This report is a baseline monitoring, a first look at a changing situation. We hope our report will be useful to those now participating in the decisions on the plant, as an outsider's summary of the competing points of view. And we hope to be useful too to future investigators, who may, through later monitorings, check and challenge our findings or our guesses. For those who may follow us, we have included more detailed descriptions than would have been needed to inform present-day political actors; we apologize to them for our redundancy.

This report examines three principal influences on the decision on Diablo Canyon: the technical setting of past research, future hopes and competing designs, covered in Chapter II; the social setting, the people and institutions who will allocate water, described in Chapter III along with a survey of the water situation which the two counties will face through the rest of this century; and the ecology movement, both as a general phenomenon and with particular focus on Diablo Canyon, which is discussed in Chapter IV. These three streams of concerns and conflict meet in the political arena, which is analyzed and then evaluated in Chapter V.

We have used sources of several different kinds, but we have placed principal reliance on the verbal reports of over 50 persons engaged in some way or another with Diablo Canyon. Their names and interests in the plant are indicated in a listing at the start of our bibliography. In addition, we have consulted engineering reports, planning documents written by officials and political activists, other analyses done by classes at the University of California Santa Barbara campus, and some of the voluminous literature on desalination technology. Throughout, we have noted our dependence upon written resources in the usual academic footnotes; we have not attributed things which we learned from our "living" bibliography. It has been our wish to preserve the anonymity of the people who confided their private views on public problems. The rapid changes in the Diablo Canyon issue tend to outflank even well thought-out positions, and our purpose in gathering the views of people who care about the plant was not to foster recriminations.



If it is built, the Diablo Canyon desalting plant will be a relatively inconspicuous building nestled in the California coastal hills. It will be run with quiet efficiency by a small crew of highly trained personnel, people who will never meet very many of the people who drink the water they produce. And too, the engineers who tend Diablo Canyon will see only infrequently those who will be learning from the experience of their plant. Despite all this mutual anonymity, Diablo Canyon will have significant effects on people all over the world: an Israeli water engineer may make a major decision affecting the water policy of his country because of Diablo Canyon; a farmer in San Luis Obispo County may decide to sell his land to a development company because the price of water has risen, and so have the property taxes, because of Diablo Canyon; a banker in New York may decide to finance a small company in Chicago which makes desalting equipment because of good news from Diablo Canyon. These are only stories but someday they might come true; if they do, there will be changes in people's lives, changes both large and small, both visible and subtle. What we should like to know before Diablo Canyon is built, of course, is which of these stories will come true and which not, so that we can have basis for intelligent choice. That is, for better or worse, not possible--an optimist would say, not possible yet.

The decision whether to build the plant will not wait for a clearer crystal ball--nor should it. Diablo Canyon now seems quite remote, both physically and intellectually, and even eventually its effects will not be equally significant. That is where the public and politics enter the scene. For after all the effects which can be known or guessed at are described to the best of scientific ability, judgments must be made. Precisely because some effects will be minor to some but major to others, the judgments will differ *even if everyone agrees upon the facts*. Usually, of course, there is some discord about the facts as well--indeed, about what kinds of knowledge are to be counted as facts at all. Our perspective, and our mission in writing this report, is shaped by our belief that politics--the orderly, if not always harmonious, process of decision-making done in public and with public, legal authority--is a proper and necessary element of man's use of his technology.

That is not to say, however, that everything is relative or that everything is a matter of values. Analysis, investigation, facts and theories can be and are usually helpful in making judgments; they are indispensable in sharing judgments with others. We have set out, therefore, to assemble the facts upon which everyone agrees, a number of opinions and speculations about matters which people disagree about, and some analytic tools which we hope will organize these things in ways which are clarifying and helpful.

## II. THE TECHNICAL SETTING

Early in the 1980s there may be a new building on the California coast a mile north of the nuclear power plant at Diablo Canyon. This long, low structure will house the Diablo Canyon desalting facility, a quiet beast with a genius for fresh water. Each day the plant will draw in about 630 million gallons of sea water from Diablo Cove, process it using 30 million pounds of steam from the nuclear reactor nearby, and produce 40 million gallons of fresh water for the communities in San Luis Obispo and Santa Barbara Counties. Forty million gallons a day, 36,000 acre-feet per year at 80% of full capacity, is enough fresh water to support about 200,000 people's direct needs, if they live at a typical American standard of affluence. Diablo Canyon can, at least potentially, make a good deal of difference to the people of the California coast. Although it will be a marked innovation, Diablo Canyon will be built into an existing complex of water supplies, water demand, and technological abilities. One of the ways into the story of the Diablo Canyon plant, therefore, is to start with the technical setting of the plant. (Those who wish to begin with social and political matters can start with Chapter III and return to this chapter afterward.)

Anyone who has used a tea bag has seen clear hot water turn into the smooth bright brown of tea. From the chemist's standpoint, the water has been "polluted" by the cluster of organic substances we call tea. The task of desalting is roughly like getting the tea back into the tea bag. Our first task is to describe several of the ingenious and complicated methods which have been developed to turn this trick. The opportunity of Diablo Canyon, to learn about how some of these techniques work in a large scale plant, can then be put in perspective. This perspective draws us further, to examine how this opportunity for a technological experiment is seen by the experimenters, the water engineers in the state and Federal agencies and in engineering firms. We need in particular to understand the process by which they secure the economic, social, and political forces at work locally and nationally. That is, we need to see how engineers attempt to act for the public benefit by transforming a social need--for water and for a way to make fresh water--into a technical design problem.

After surveying the technical parts of Diablo Canyon from the engineers' perspective, we shall turn to the broader technical dimensions of the social choice involved. A desalting plant is only one of several ways to supply water to the central coast communities of California; the merits of desalting must be judged against the comparative advantages and disadvantages of other sources of water. Similarly, the choice of Diablo Canyon as the site for a desalting plant needs to be measured against the alternatives, from economic, ecological, and aesthetic perspectives. These wider considerations, together with technical questions involving the plant itself, set the stage for political choice by specifying the alternatives among which the people of San Luis Obispo and Santa Barbara will need to choose.

## A. Desalting Technologies

There are a number of different processes which have been used in experimental desalting plants. The costs of equipment have been quite high, as is usually the case with new processes in the testing stage. And very little is known about the economics of applying any of the methods to a commercially viable plant. For all of these reasons--diversity, scale, and risk, as they are usually called--desalting is a developmental game which few private investors are willing to play. At least few have been willing given the present price of water, which is quite low compared to minimum costs for desalted water. The stage is thus set in classic terms to justify Federal intervention: the argument is that abundant supplies of fresh water will in the future be a vital element of the national interest; yet the economic and technological uncertainties make private development too risky and expensive; thus the financier of last resort, Uncle Sam, ought to pay for exploratory research. Similar arguments were made for the Apollo moon program, the Tennessee Valley Authority in the 1930s, and nuclear power plant development in the 1950s and 1960s.

The national development program in desalination has been administered by the Office of Saline Water (OSW) of the U. S. Department of the Interior. OSW serves as a research clearinghouse and it has financed research by private firms, who have given up patent rights to whatever they discover in exchange for venture capital. The hope is that they will beat their competitors to market if and when they succeed in building a workable plant. OSW has naturally had a major influence upon the character of the desalting research in this country, and we shall emphasize here those methods which have received support, since it is overwhelmingly likely that these will be the techniques used, either in a successful design or else in achieving one. Not all the ideas to be discussed here would be usable at Diablo Canyon, but we have thought it worthwhile to give the reader a wider sense of the technical possibilities.

Getting the tea back in the tea bag is a task which depends upon the physical characteristics of water and the things dissolved in it. One of the simplest ways to separate water from things in it is to filter the pollutant out. But when the pollutant is of molecular size, as in the case of tea or sea water, filtering is a tricky business. Another group of methods exploits the fact that when water changes physical state pure water can be extracted from an impure starting material. For example, plants in which hard water has been boiled are stained by minerals, the minerals which give hard water its odd taste. Since the minerals are left behind, the steam contains less contaminant than the original water. If we can capture the steam we can recover pure water. The purification of water by boiling, called *distillation*, is actually the commonest technique for desalination. Processes based upon another physical change, freezing, have also been studied in experimental pilot plants.

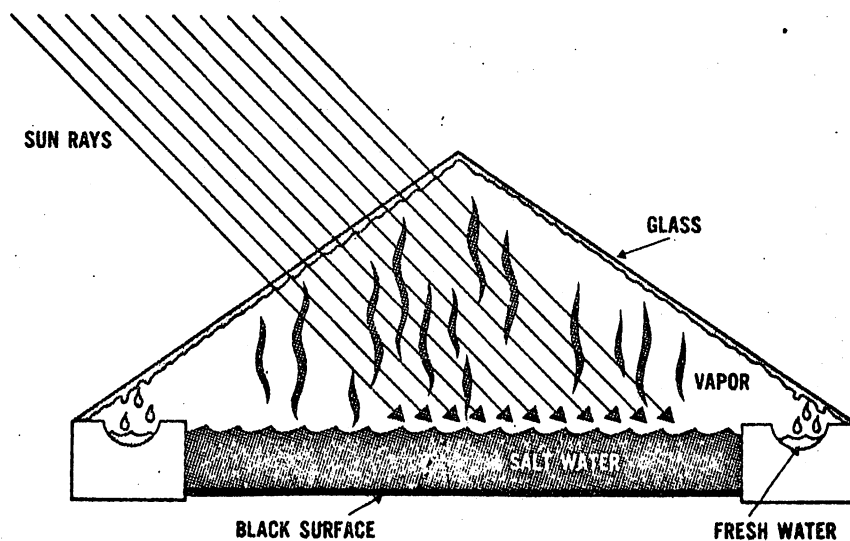
There are a large number of variations upon these basic ideas, and the literature of desalination technology is rich with plans for avoiding one or another undesirable side-effect of some basic process. We shall concentrate here upon the technical ideas which are likely to be useful in large-scale desalting operations, particularly those which promise to operate

economically. The problem with desalting is not that we do not know how to do it, but that we do not know how to do it cheaply--especially since water has traditionally been obtainable from streams free and from wells at comparatively low cost. Our survey will give us a layman's view of the kind of technical alternatives which Diablo Canyon is designed to help us learn more about.

### *Distillation techniques*

We begin with distillation, the most widely used desalination technique, and the one which would be used at Diablo Canyon. The essence of the idea, as we mentioned above, is that when impure water is boiled, *only the water boils off*. If we can capture and condense the steam, we have pure water. And in fact the impure water need not be boiled at all. For when water is left lying around, the water evaporates, leaving the impurities behind. This is the way, in fact, that clouds and rain are born: the heat of the sun evaporates pure water from the ocean, and the water vapor drifts up to form clouds, clouds which then condense to fall as rain or snow. Thus a distilling plant is essentially an attempt to imitate nature. It needs a source of heat to drive the evaporation or boiling process, a source of impure water such as the ocean or a polluted stream, and, finally, a condensing mechanism--the rain clouds of the factory--which can catch the steam and turn it back into pure water. We can now look at some of the detailed technical ways in which distillation has been harnessed experimentally on an industrial scale.

*Solar.* The simplest thing to do is recruit the sun itself as a source of heat, as shown in the greenhouse-like apparatus in the figure. Sunlight



*A simple solar still.*

This and the rest of the figures describing desalting apparatus are taken from *The ABSeas of Desalting*.

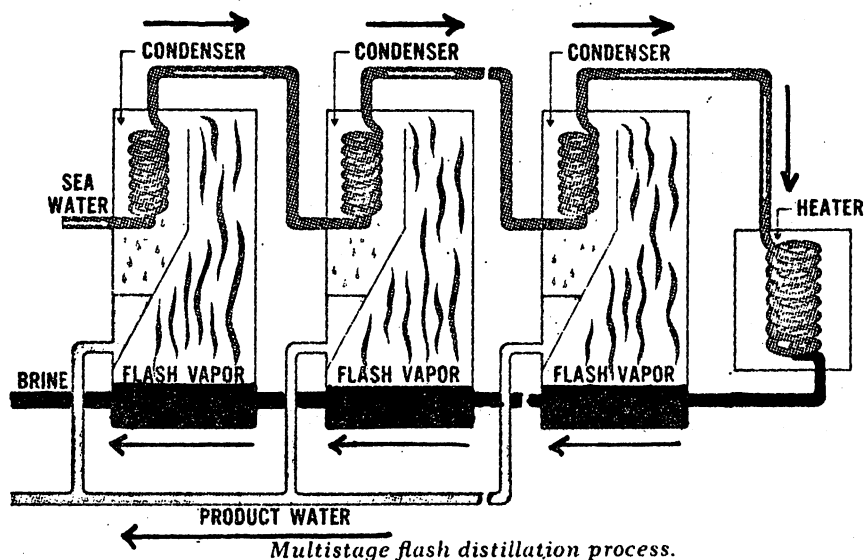
comes in through a glassed-in roof, evaporating water in a tray; the water vapor rises and is condensed on the underside of the glass roof, flowing down to be collected and used. As an added touch of efficiency, the salt-water tray is painted black on the bottom so that all the sunlight is absorbed and turned into heat. A solar still is cheap to build and to operate--the energy source, after all, is free. The basic design shown in the figure has been embellished to increase productivity without, however, conquering the basic problem. The difficulty with the solar still is that it is obviously dependent upon weather and season, even though the need for water does not vary very much. Solar stills have been used in the deserts of the Middle East, where the weather is less variable than in the United States, but even there no plants on the scale of Diablo Canyon have been proposed. Other methods seem to hold more promise--but they are also more complex.

*Multistage flash (MSF).* MSF is one of the most widely tinkered-with desalting methods. The desalination test station at San Diego operated by OSW, for example, has a one million gallon per day (mgd) MSF plant in operation. Diablo Canyon, according to present plans, will be an MSF plant, although, as we shall see, other methods may become feasible by the time a plant is actually built.

Distillation technologies are traditionally plagued by three problems. The first is that boiling water consumes great quantities of heat, heat which generally costs a lot of money to produce. There is consequently a premium placed upon using the heat as efficiently as possible; that is, to boil as much water as possible per unit of heat input. The traditional rule of thumb is that half the cost of the plant should be capital cost, the other half, operating--primarily energy--cost. The second perennial difficulty is that of corrosion: as sea water is boiled down it forms a potent brine capable of dissolving or oxidizing all but a few exotic metals. These metals, expensive to begin with, must be formed into special vessels to hold sea water for heating, and special machining costs add to the price of a desalting plant. Third, corrosion is counterbalanced by scale, the depositing of minerals in the desalting boiler. This problem is directly analogous to the stains left in pots by hard water. Again, the need to clean vessels out periodically raises the cost. The multi-stage flash desalting technique is aimed at minimizing the first and third problems--but it must still contend with the second.

The underlying idea of MSF is that water boils at low temperatures at high altitudes; that is why a three-minute egg in Denver is a bit on the soft side--the boiling water is not as hot there at 5200 feet above sea level as it is in Los Angeles or New York. At higher altitudes the air pressure is lower, and this is what lowers the boiling temperature. So if the pressure in a vessel can be made artificially low, the water in it will boil with less energy input. In an MSF plant water is heated to boiling in a pressurized vessel; part of it boils and the rest is sent on to the next chamber, where the pressure is kept lower than in the previous one. In this next chamber the water boils or "flashes" again, and part of the water is boiled off. The rest is sent on to a third chamber, where the pressure is still lower. The heat in the original batch of sea water is thus used over and over again in the various stages as the ever-cooling sea water is

made to flash again and again. At each stage, the steam which comes off is collected and condensed as fresh water.



In the design shown in the figure, the multiple boilings use the heat in the water in a sequence of steps with high efficiency. But there is even more that can be done to save heat. Note that the flash vapor or steam containing pure water is condensed against pipes holding incoming sea water. As the steam condenses, losing its heat, some of that heat is transferred to the sea water--which then does not require so much heat from the heater to be boiled.

The major technical problems in the construction of an MSF plant are corrosion and the need to maintain pressure differences. By the time the sea water has been passed through a number of stages its mineral content has been greatly concentrated, but the brine is still warm--generally in the neighborhood of 100°F in the last stage. The combination of salts and heat greatly enhances the corrosive power of the brine, necessitating expensive linings in the chambers. The need for lowered pressure in each successive chamber is also a stringent requirement upon materials and design. The MSF process will not work if the pressure drop from chamber to chamber is not maintained, and yet the pressure drop must be kept up even though there is water flowing between chambers. In short, a controlled leak--called "venting" in the trade--is necessary, and that calls for precise alignment of parts.

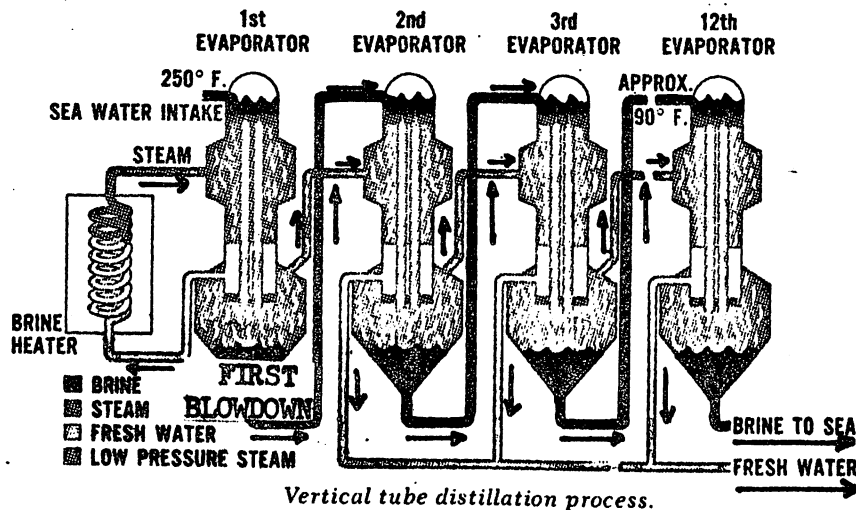
There have been a number of refinements of the MSF process, and these variations are discussed in *The ABSeas of Desalting*, a layman's booklet published by OSW.<sup>1</sup> Most of these variant processes are designed to be even more efficient in their use of heat. For instance, in one plan the stages are themselves grouped into clusters or "effects." Each effect is designed to operate in a given temperature range and flow rate, so that the efficiency of the overall system can be raised. One of these modified forms of MSF is

likely to be employed in the Diablo Canyon plant. A final design choice will not be made until November 1974, according to the current schedule, so that more technical information may be gathered from operating scale models.<sup>2</sup>

The largest desalting plant presently in operation is a five-train, 30 mgd MSF complex at Alstom in Kuwait. Each train is in effect a separate desalting plant, the trains sharing common components, such as heat source, pumps, and intake structures. The Senator Claire Engle Plant in San Diego is a 1 mgd multiple-effect MSF with 68 stages grouped into three effects.

*Vertical tube evaporation (VTE).* The MSF process can be improved upon in one dramatic way: by separating the several chambers from one another, so that the pressure drop can be more precisely regulated. This modification, which is essentially what is done by VTE, raises the thermal efficiency of the process, though it also brings on technical problems of its own.

To see how VTE works, look at the figure. As in MSF, incoming sea water is heated before it enters the first evaporator, but in contrast to the earlier method, it is not boiling when it comes in. Instead, it falls



through a bundle of tubes, tubes which are surrounded by steam from a separate heater. The tubes allow heat to flow freely between sea water and steam, so that part of the sea water boils when it reaches the lower part of the evaporator. The steam, made up of pure water, is sent on to the second evaporator where it is condensed against a second set of tubes, to make fresh water. This second set of tubes, in the meanwhile, has been filled with brine which did not boil--but is still hot--from the first evaporator.

The VTE process is a bit dizzying to talk about in words, but the basic effect is more or less like the square-dance maneuver called a grand-right-and-left. In the grand-right-and-left men and women go round the square in opposite directions, grasping the right hand of one partner, then the left

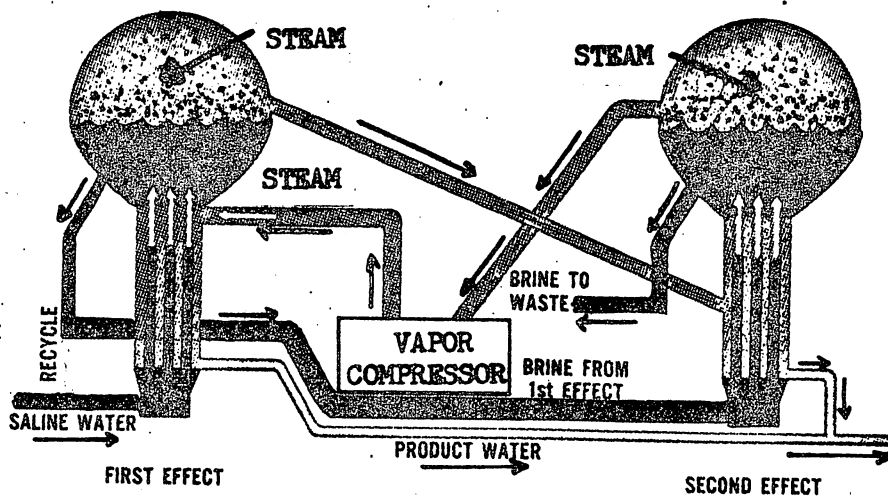
hand of the next partner, and so on around. (Unfortunately it is no easier to talk about a grand-right-and-left! But more people have seen one than have seen a VTE plant.) In the VTE process brine and steam are separated from each other in each evaporator, only to meet again--separated by the tube walls--in the next one. They trade their heat back and forth, like the handclasps of the square dance, until the brine has been concentrated and the pure water withdrawn. As the brine passes from evaporator to evaporator, it becomes cooler and cooler, losing heat to the steam in each stage. But it continues to boil because, as in MSF, the pressure is lower in each chamber than in the last.

Although VTE can be made more efficient than MSF, it is troubled by a different technical drawback, the formation of scale. As the brine falls through the tubes, minerals dissolved in the water come out of solution and accumulate on the walls of the tubes.<sup>3</sup> Long before the tubes become clogged with scale, it has so decreased heat transfer through the walls that the process no longer works. Scale can be controlled by a combination of strategies, though these again add to the cost of building and operating the plant. For example, through careful design the scale can be induced to form mostly on parts of the evaporator that are easily cleaned. Another device is to add chemicals to the incoming sea water which inhibit scale formation--but which also contaminate the brine which is ultimately pumped back to the sea.

As it happens, the problems of MSF and VTE can be minimized by combining the two processes. MSF is limited by corrosion when the brine is concentrated, but relatively cool; VTE is plagued with scale when the brine is hot. By using an MSF process for hot brine, and then transferring the still-warm water to a VTE process for further purification, one can minimize the disadvantages of both. A Federally supported experimental plant in Freeport, Texas, using 11 stages each of MSF and VTE has been running at one mgd with surprisingly little trouble. The success of the Freeport plant led to the construction of a test unit in Orange County, California, which will be capable of 12 to 15 mgd.<sup>4</sup> This module may turn out to be a test prototype for Diablo Canyon.

*Vapor compression.* There is one last distillation technique, vapor compression, which works in a significantly different manner from the others. The process is illustrated by the two-effect unit shown in the figure. Pretreated sea water is heated in the left-hand chamber, then passed through bundles of tubes in the first effect, in a manner reminiscent of VTE. Some of the brine is vaporized and drawn off into the compressor. The remaining sea water is then pumped through the tubes of the second effect; the steam produced in the first effect has in the meanwhile been mechanically compressed, a process which heats it. The compression-heated steam flows over the tubes in the second effect, boiling some of the brine inside, and condensing into fresh water in the process. Steam from the second effect is then turned around and used to drive the vaporization back in the first effect.





*Vapor compression distillation process.*

The compression needed in this technique is driven by a source of mechanical, rather than thermal, energy. MSF and VTE use only heat, usually a cheaper form of energy. VC, therefore, is significantly more expensive, and thus impractical as a desalting method when there is waste heat available, as in the case of a nuclear power plant. There is, however, an exceptional case which could arise. It may turn out to be economically advantageous to build a dual-purpose plant supplying fresh water and electric power to a given geographical region; but if the plant were to supply all of the water and electricity for its service area, it would have to be rather differently designed than Diablo Canyon and the other dual-purpose plants which have been developed.<sup>5</sup> The problem is that existing designs put out large quantities of electricity, small quantities of water--mainly because the desalting facilities have been experimental. Rather than go through an expensive redesign and retesting procedure, it may in some cases be cheaper to "waste" some of the electricity for the primary steam, using it to run a VC plant. It is for this reason that VC seems to be an important technical possibility to study. An experimental VC facility is now under study by OSW at its Roswell, New Mexico, test site.

### *Freezing*

When salt water freezes, crystals of pure water are almost always formed first. As in the case of distillation, the key physical fact is that water, and water alone, freezes before salt and other contaminants do. Therefore, if there is some means to collect ice crystals out of a partially frozen slush made from sea water, we again have a source of pure water. Here too, man is imitating nature. The polar ice caps, formed partly from sea water, are virtually pure, and polar ice has for centuries been the fresh water source of Eskimos. Indeed, recently two scientists at the Rand Corporation in Southern California proposed that polar icebergs be towed to Los Angeles to supply water--at a price which they estimated to be lower than desalting or the State Water Project.

Even if the ice is not towed but made on the spot, purification by freezing is theoretically a more efficient process than distillation. The principal gain lies in the fact that it takes much less energy to freeze a pint of water than to boil it. Either process yields fresh water, so if the rest of the procedure--collecting and storing pure water--is ignored, freezing is evidently better. The present state of technical knowledge, however, does not permit us to ignore the remainder of the process, and research on freezing techniques lags far behind that of distillation. There is at present no method by which a freezing plant the size of Diablo Canyon can even be designed.<sup>6</sup>

### *Other methods*

There are a number of other methods of desalting, which do not depend upon a change of state such as boiling or freezing. These are techniques of varying promise, though only one of them is sufficiently advanced to contemplate large-scale use in the near future.

This process is called reverse osmosis, a fancy name, as it happens, for filtration. The basic idea is that water molecules are smaller than any contaminant, so if one uses a fine enough sieve all that comes through will be pure water. The problem is with the sieve. A large number of plastic membranes have been tinkered with. They work, but they are slow, and the membranes break too easily. Research continues, however, because if it ever works, reverse osmosis will be the easiest desalting process to use. All that will be necessary will be a pump to push sea water through a membrane. When the membrane becomes clogged or saturated with dissolved salts, it can be changed with minor expense, as compared to the major cleanings needed in distillation plants. And even a not-so-perfect membrane is suitable: if the input water is too salty, one might combine the filtering power of a pair of filters to reduce the contamination level to an acceptable concentration.

Another family of methods works on the principle that most of the stuff that is dissolved in sea water is ionized or made up of charged particles. Therefore, if an electric field is applied, the ions will migrate toward the sides of a holding tank, where they can be collected and disposed of, leaving pure water behind. The methods called electrodialysis and ion exchange work on this general idea, though with different detailed implementations.

All three of these methods are presently used on a small scale to purify brackish water, and they have attracted attention as techniques which might someday be used to remove pollutants from fresh water streams. But using them to desalt sea water, which is immensely more "polluted" by salts, is presently unfeasible.<sup>7</sup>

## B. The Process of Design

Our ability to use these various technical methods for desalination has evolved through many laboratory and pilot-plant experiments over the years.

In 1958 the U. S. Office of Saline Water (OSW) and the California Department of Water Resources (CDWR) initiated a program to conduct this research collaboratively. And in 1970 this research program led to the possibility of building on an industrial scale some of the ideas which had already been tested in smaller pilot plants. OSW and CDWR proposed that a prototype plant with a capacity of 30 to 50 mgd of fresh water be built. CDWR announced its choice of a site at Diablo Canyon in its *Site Selection for a Large Desalting Plant* late in 1970. Simultaneously, Kaiser Engineers, a large private consulting firm, was commissioned to do an initial design study, and to determine the economic feasibility of the plant. These two initial moves, site selection and conceptual design, form the technical backdrop for the development of Diablo Canyon as a local political issue. As we noted earlier, what is surprising about the political reaction is that it should have been elicited by so tentative a technical setting.

### *Multiple-purpose plants*

At present prices for water and for desalting equipment, desalted water is rather expensive: it costs over \$300 per acre-foot, as compared to typical prices of \$125 per acre-foot elsewhere in the United States. One way to cut down on the cost of desalted water is to decrease the cost of the energy needed to run the plant; and here current technology is somewhat obliging. Electricity is generated mainly in steam power plants. Steam is made in large boilers by burning fossil or nuclear fuel, and then allowed to expand through a set of turbines; the force of the expanding--and cooling--steam turns the turbines, generating electricity. When the steam expands out the other side of the turbines, it has generally cooled from over 1000°F to about 200°F--it is almost back to liquid, in other words. This cooled steam is normally condensed into liquid, then sent into the boiler to go round again. The condensing process requires the transfer of large amounts of heat, most of which is wasted today. But the waste heat can, with minor modifications, be used to boil sea water. Thus, by combining electric power and fresh water production, one can save about 20% of the energy usually thrown away in the electric plant.

In addition, at the present stage of development, desalting is still an infant technology, and an experimental desalting plant can follow its steam source, being built where the steam is, rather than influencing the placement of the electric power plant. In this circumstance, one can make a sound argument that the desalting plant ought to pay for the steam it uses at what economists call a marginal rate; that is, the price should reflect the cost of the *fuel* consumed to make the steam, but not the *capital* costs of the plant in which the steam is made. Pricing agreements like this favor nuclear power plants as steam sources overwhelmingly, since by far the largest cost in the operation of nuclear reactor is paid right at the beginning for construction. In addition, nuclear power plants reject 50% more heat than do fossil-fueled ones.<sup>8</sup> And they are the coming thing: the Atomic Energy Commission estimates that by 1990 67% of the electric power generation in the United States will be done in nuclear plants.<sup>9</sup>

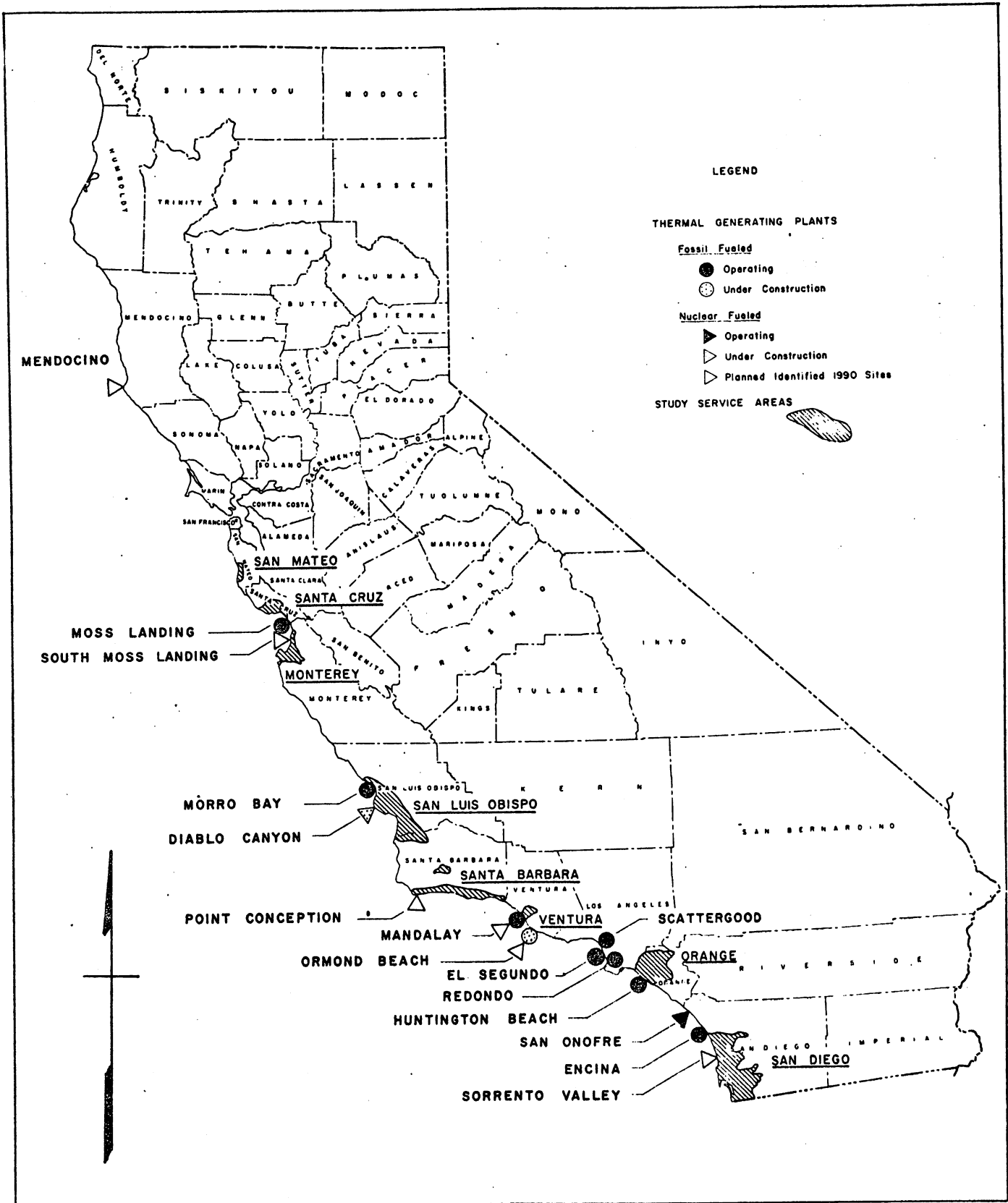
In order to maximize performance and minimize costs, a dual-purpose plant should ideally be planned as a complex, and not just as two plants run off the same energy source. This is what engineers call a systems, as opposed to hardware, approach. In research projects such as Diablo Canyon, however, the desalting plant is a Johnny-come-lately, so the hardware perspective is forced upon designers by circumstances. Although much can still be learned about desalting technologies, the cost is higher. Water resource engineers have noted that designing Diablo Canyon as an integrated system of power plant and desalting facility might have saved up to \$20 million in capital costs and \$1 million per year in operating expenses.

Electric power is not consumed uniformly, the demand being lower late at night. Since the desalted water will be stored in a reservoir, it matters little at what time of the day the desalter runs. A natural idea, therefore, is to use the desalter more heavily during off-peak hours, when the electricity demand is down. At these times, extra steam could be diverted from the turbines and sent directly to the desalting plant. In a dual plant designed from a systems perspective, this possibility would probably have been a central feature of the design right from the start, but now the situation is unclear. The daily fluctuations required by this procedure may lead to a higher rate of failure in the desalting plant or in the steam conveyance system. And it is not certain that this kind of operation would prove to be economic, since it would be necessary to operate the desalting plant at less than maximum capacity for substantial portions of each day, when the power demand is high. OSW and a group of power companies are studying the economics of dual-purpose plant operations, so that future designs may more accurately reflect a systems perspective.

Beyond the dual-purpose plant, one can envision multi-purpose plants, in which minerals can be extracted from the leftover brine. Mining the oceans in this fashion is at present economically unfeasible--the costs of obtaining the minerals are higher than their market value. Exactly the same argument, of course, used to apply to desalinization.

### *Site selection*

Once the decision to build a dual-purpose plant was made--and it was a natural choice for the kind of learning which is now appropriate in the OSW-CDWR program--the choice of a site was straightforward: the desalting plant should be close to the ocean, a source of steam, and an area with a projected water deficit of 30 to 50 mgd.<sup>10</sup> Only four electric power plants along the California coast will have sufficient steam capacity to drive a 40 mgd plant by 1978, the scheduled opening date. Two of these, Moss Landing south of Santa Cruz and Morro Bay just above San Luis Obispo, use fossil fuel; the other two are nuclear, San Onofre in Orange County and Diablo Canyon. (See map.) CDWR also estimated future water needs in six regions along the coast. Of these, San Luis Obispo-Santa Barbara closely matched the planned output of the desalting plant, and the Diablo Canyon nuclear plant was chosen as a steam source over Moss Landing for the reasons outlined earlier.



Existing and Future Coastal Powerplant Sites and Potential Water Service Areas

from California Department of Water Resources, *Feasibility Report, Diablo Canyon Desalting Project.*

It should be noted, however, that the final disposition of the desalted water has not been made. For one thing, it is not certain how much the conveyance system--the network of pipes carrying the water to final users--will cost. And, too, the actual water needs of various areas in the two-county region are also uncertain to some degree; recently, for example, the U. S. Bureau of Reclamation has cancelled the Lompoc water project in northern Santa Barbara County, making it likely that the town of Lompoc and the Vandenberg Air Force Base will need supplemental water in the near future. The present projections of where the desalted water will go, in any event, are shown in the map.

### *Conceptual design*

In their initial planning study, Kaiser Engineers chose MSF as the design technology. This does not mean that Diablo Canyon will necessarily employ MSF, but rather that for the beginning analysis it is useful to assume that a process like MSF will be used. MSF is, in any case, a natural choice at present: it is a process already proven in smaller plants, and it is by far the most advanced of the distilling technologies. The Kaiser study proposed a 43-stage design, the first 40 stages designed primarily for recovery--that is, producing fresh water--while the last three are used primarily to transfer heat from the concentrated brine to the cold incoming sea water. Based on updated--and lower--projected water consumption figures for the San Luis Obispo and Santa Barbara service areas, Kaiser also set the plant size at 40 mgd rather than 50 mgd. The plant is to be driven using waste steam from the twin nuclear power reactors nearby; the nature of the reactor design, in turn, required that the desalting plant be built as a pair of 20 mgd trains, instead of a single 40 mgd one.

This dual design offers some important advantages. First, at 20 mgd, the magnitude of production is definitely not beyond present technical capabilities--the risk is low. If the plant were built as a single 40 mgd train, there is some doubt that the plant would be able to perform as desired without additional work. In addition, the plant can produce water continuously, instead of having to close down for maintenance periods. Each of the two reactors needs to be refueled periodically, and at that time its accompanying desalting train can be inspected for premature failure of parts, and to collect data on various operating experiments. If the desalting plant were shut down each time either reactor went out of service, it would operate only 70% of the time, since each reactor requires 15% of its total operating time for refueling. Alternatively, the desalting plant could draw an extra ration of steam from the remaining reactor. This would further decrease the electric-generating capacity of the Diablo Canyon complex, a risky proposition during periods of high demand for power. Despite these disadvantages, a single 40 mgd design would offer significantly greater learning opportunities, since what is being studied is the effect of size on desalting technologies and their economic operation.

### *Technical critique*

In the rest of this report we shall deal mostly with Diablo Canyon as a source of supplemental water, with whether it will produce so much water

from California Department of Water Resources, *Site Selection for a Large-Scale Desalting Plant.*

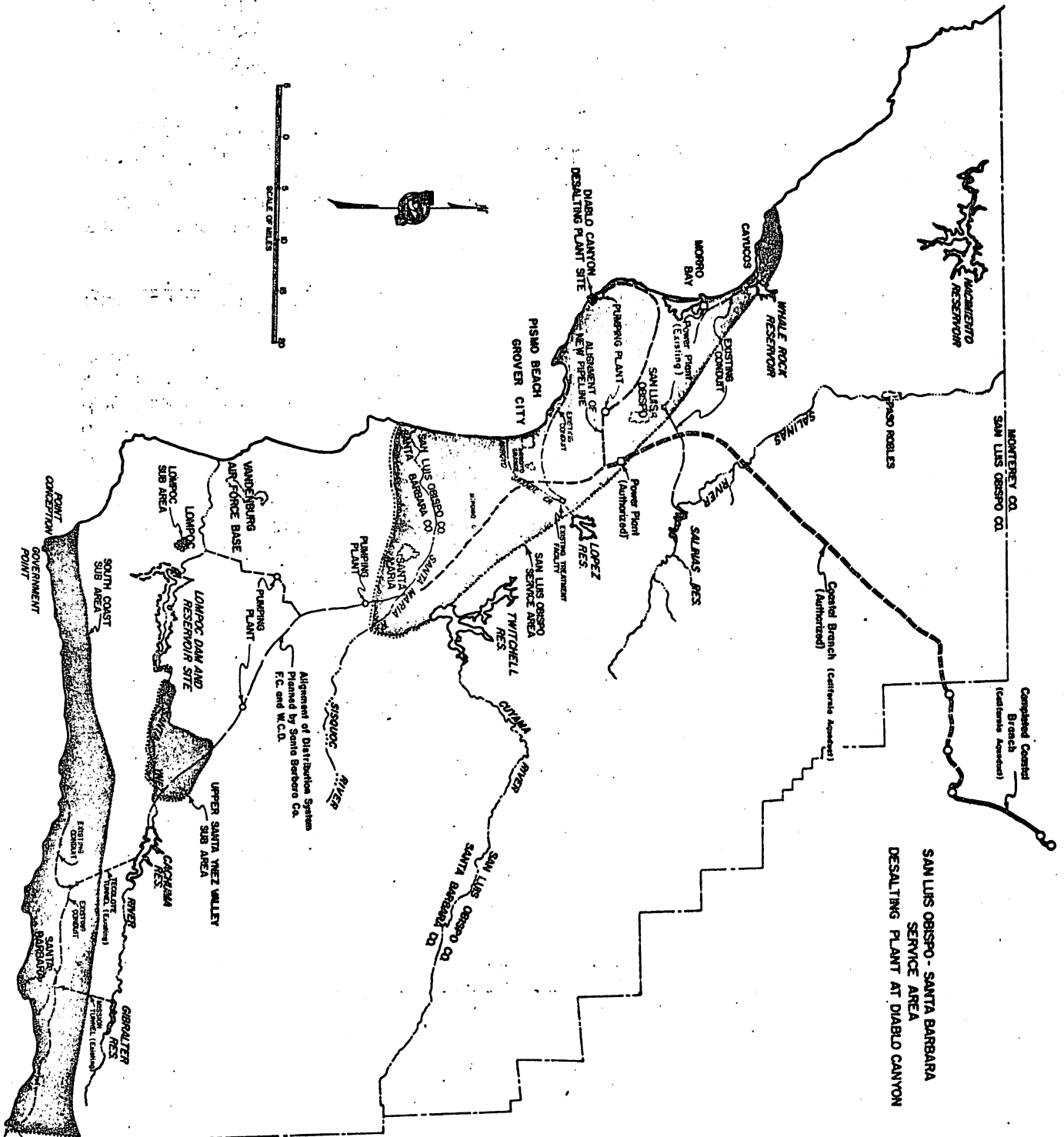


FIGURE 3

that undesirable social side-effects such as urban sprawl will be encouraged, and the like. In the end, the building of Diablo Canyon ought to be settled on wider social grounds such as these. But society has customarily had the right to demand from its engineers the best available technical solution. The separate, but quite real, question of whether Diablo Canyon is a good idea from a technical standpoint needs now to be faced. We are, of course, by no means experts, and we shall do no more than report two different kinds of criticisms of the current, tentative design. These criticisms are salient not only in terms of Diablo Canyon itself, but also in the context of the other desalting plants being built around the world--a point to which we shall return below.

The first criticism is that Diablo Canyon has not been designed from the systems standpoint. We have already mentioned this deficiency earlier, and so we will add only a further aspect of the hardware perspective. That is that it is something of an oversimplification to describe Diablo Canyon as running off the waste heat of the nuclear power plant. Only about five percent of the heat normally produced by the power plant is actually used in the desalting plant. Therefore, the ecologically threatening heat dumped by the nuclear plant into Diablo Cove is in essence unaffected by the desalting plant. For another thing, the presence of the desalting plant does decrease the efficiency of the power plant somewhat--though in the present instance by a very small amount. Technically, the problem is that steam from the power plant is used to boil water at 250°F, substantially above the temperature at which it would normally be condensed; steam at 250°F still has a lot of expansion left in it, a lot of thermal "push" which is not used to produce electricity. The nuclear power plant will be reduced in capacity by 84 megawatts of electric capacity--an insignificant fraction of the more than 2000 megawatts it is designed to produce at full power. But the point remains that the "waste" heat is not entirely free: it still carries an environmental and an engineering price tag. Proponents of the systems approach argue, naturally, that their methods of design would have lowered both these costs.

The second critique is more general and more troubling; that is that Diablo Canyon may not be worthwhile on purely economic grounds. The plant will cost \$120 million to build and to operate for a ten-year trial period. If there is some independent way to estimate how much the learning from the plant would be worth, then we can see if the benefits to be gained outweigh the costs to be paid. One might suspect offhand that Diablo Canyon would not teach us all that much, since the Alsthom Plant in Kuwait, producing 30 mgd, is already in operation using MSF technology. Alsthom is a five-train plant, each train using a 6 mgd apparatus; the 20 mgd trains at Diablo Canyon are only three times bigger, and it might seem intuitively that this modest increase in size would not be very informative. Professor Gordon Rausser, an economist at the University of California's Davis campus, has attempted to do an economic analysis to see if this intuition is borne out. His study suggests that Diablo Canyon is worth about \$13 million in learning benefits, or about a tenth the actual cost.<sup>11</sup>

Rausser and his students tried to estimate the amount of learning which Diablo Canyon might lead to by studying earlier desalination research results. This analytic method was proposed by a number of economists in the late 1950s,



in studies of assembly-line productivity in the airplane manufacturing industry. They noted that, in the weeks and months after a new industrial procedure was introduced, the output of the assembly line steadily rose; what was happening, of course, was that the workers were gradually sorting the "bugs" out, and learning how to do their jobs more efficiently. This learning process can be described statistically, and its economic benefits estimated. Thus, by looking at the past progress in desalting research, Rausser hoped to obtain an analogously useful projection of the amount of learning to be had at Diablo Canyon. His estimate turned out to be far lower than the cost of the plant. It must be stressed, however, that this kind of estimate is subject to rather large errors. Moreover, Rausser simplified the technical setting in order to facilitate his analysis, and it is not clear whether these simplifications were justifiable. For example, Rausser failed to distinguish among the various desalting techniques we have described above. But funds invested in reverse osmosis research, for example, will have no bearing on the success or failure of a distillation plant such as Diablo Canyon. This omission probably leads to an underestimate of the amount of learning to be derived from a dollar's worth of investment, and thus underestimates the amount to be learned from Diablo Canyon. In addition, Rausser made no distinction between single-purpose and multi-purpose plants. This amounts to ignoring a whole class of payoffs, learning how to operate multi-purpose complexes. Rausser's analysis also underplays the psychological effect of building a new plant. That is, the most significant thing about a new, large plant may simply be its existence, the fact that it could be done at all. OSW noted recently that

Of major importance is the requirement for construction of large prototype plant technology to show water users that desalting is a viable means of meeting water needs.<sup>12</sup>

In common sense terms: self-confidence is a vital aspect of learning; it is not easy to assign a price to this ingredient.

Despite the serious flaws in Rausser's analysis, however, it does point to a central technical dilemma in plant design. More could obviously be learned by building, say, a 40 mgd single-train plant; but that would be risky, both financially and to the people of San Luis Obispo and Santa Barbara, who would be left dry, if not high, by a technical failure. The more learned, in general, the more must be risked--nothing ventured, nothing gained. The venturing, however, must be at the level of \$120 million. How to balance curiosity against caution is a problem as old as the cat; room for differences of opinion is evidently spacious.

In the meantime, developments elsewhere have "upped the ante" technically. OSW has recently reported to Congress that the British colony of Hong Kong has committed itself to building a 50 mgd plant--one which would obviously reap most of the technical learning benefits of Diablo Canyon, and for free, as far as American engineers are concerned. If this development is carried out, Diablo Canyon will have to build as a VTE or combined MSF-VTE plant in order to justify even a nominal government subsidy. The Orange County VTE-MSF test module, modeled on the Freeport unit, becomes a critical source of design data. On a broader scale, long-range plans have been made to build a joint U. S.-Mexico plant at the mouth of the Colorado river using

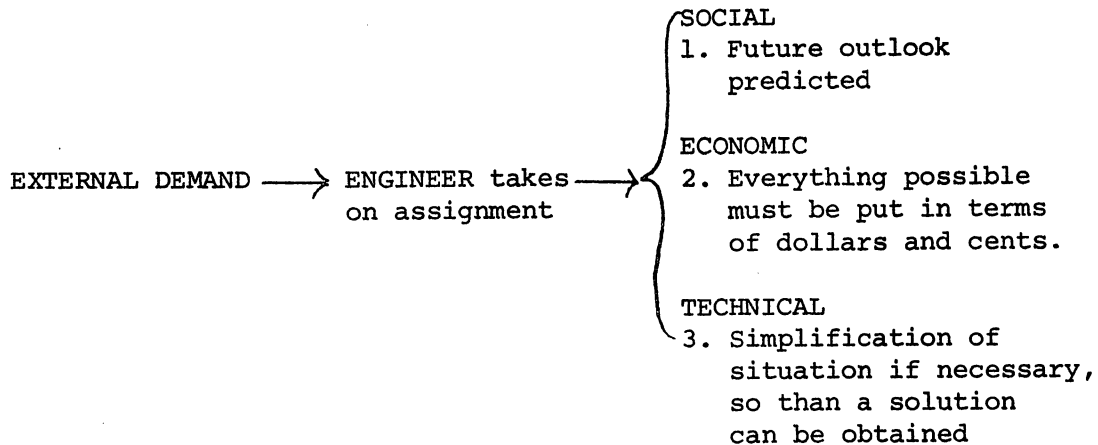
a reverse-osmosis design. Should that plant work well, it may steal the spotlight from distillation techniques altogether, even though the Colorado River water to be treated is only brackish and not close in salinity to sea water. Thus to the controversy over how to trade off risk against learning we should add the limited time period during which Diablo Canyon would provide any learning at all to the world community of desalting technologists.

In short, whether Diablo Canyon is a good technical idea is debatable and debated. We shall summarize the design and its problems at the end of this chapter. One should not conclude, however, that this is unusual, nor that the engineers have done a slipshod job. The attention focused on the desalting plant is enhanced by the large amount of money to be spent, but uncertainty is nonetheless part of the normal environment of rapidly developing technologies. What is interesting about the controversy, indeed, is that the doubts about the technical worth of the plant are perceived to be abnormal at all. None of us likes uncertainty, but we live with it in our ordinary lives with some equanimity. Why should an engineer find it so extraordinarily threatening? This interesting and important question requires a brief, but essential, digression.

#### *Engineers--a digression*

In a civilization built upon sophisticated technology, engineers serve a vital--but ill-understood--function: they are the persons who bridge the gap between human (sometimes even humane) intention and technical action. The importance of this role has in recent years been recognized informally by the high salary scales in such fields as aerospace and computer engineering. But the scholarly world of social research has paid scant attention to engineering as a social and psychological activity of importance. In reading the reports and studies related to Diablo Canyon specifically and desalination generally, however, we came across a persistent pattern of assumptions--a way of looking at the world--shared by different groups of engineers. Because there is relatively little well-formed literature on the "engineering viewpoint," we thought it of interest to share some of our observations; in addition, we hoped that our nontechnical readers could gain, if only at second hand, some of the flavor of the way an engineer sees a project like Diablo Canyon.

The table shows in schematic outline the way in which someone in the Western cultural tradition would probably respond to a problem which needed to be solved. Engineering is not only part of that long line of development but its successes has recently led Western culture toward the glorification of problem-solving as the premier activity of social life. Churches, by contrast, have traditionally concerned themselves with comforting persons in times of trial and suffering--something which may not involve "solving" their problems in the sense that we usually use the term. In the engineering style of thinking, in any event, a demand arises from some external source. In special cases, that demand may come from within the personal life of the



engineer: inventors' work is often motivated, for example, by an inner need to make something new and useful, rather than by any widespread social perception that a new invention is needed; but by and large the need is defined externally--certainly it is in the case of desalination. The engineer's job is to meet that demand.

It is already interesting that the term we commonly use here is "job," instead of "work," or even "labor." The sense of timing of an engineer's professional career is characterized by discrete pieces--jobs or tasks--which are characterized by goals or demands which are met--jobs finished. The life of other professionals, including physicians and attorneys, is similarly focused upon short-term solutions: cures, or cases litigated. The key thing is that the time perspective is short-term; short is, of course, a relative matter--in the case of Diablo Canyon the plant is planned to last for thirty years in normal use. But there is no intention of solving the water problem of the area's residents forever--as a new cathedral might "solve" an area's need of a space for public worship for an indefinite time. The notion of a limited, but quite real, time period for which the technical solution will be viable is a tremendously liberating one: instead of finding permanent, forever-style solutions, the engineer need only worry about the next thirty or fifty years. Accordingly, what is needed to do a good job is to learn enough about the things which affect the technical solution so that the design can take account of the problems which are likely to arise during the planned life of the project. There are two strategies applied to this task of "bounding the problem," quantification and simplification.

These are the processes depicted on the right side of our chart, which shows in somewhat more detail the kinds of things an engineer needs to know about the job he is working on. The social world is seen primarily in terms of the future demands which the external world will make; if the engineer is designing a dam, he will need to know how much water will be needed each year. In addition, the technical capabilities provided by existing scientific knowledge and earlier technological applications must be simplified and made to fit the conditions of the problem at hand; the dam might have to be built out of a native rock which is weaker than the kind normally used,

necessitating more concrete. These processes of simplification, patching together a solution of what exists and what is at hand, are made possible in many cases by quantification. Of central importance is the assessment of economic costs and benefits, the most elementary--and most fundamental--form of putting values in numerical form.

In order to plan, the shape of the future environment must be known as well as possible. Bookman and Edmonston, consulting engineers for Santa Barbara County, estimated the supplemental water needed by extrapolating increases in population, irrigated agriculture, and industrial growth; they also sent out a questionnaire asking water agencies in the county how much water they would buy at a price of \$100 per acre-foot. CDM, the firm employed by San Luis Obispo, used basically similar techniques going into somewhat greater depth by analyzing shifts in agricultural crops, as water prices changed. In accord with current practice, both firms relied primarily on extrapolation, the technique of continuing trends into the future, to see what the future would hold if present tendencies continue. The rapid pace of social and technical change we have experienced in this century makes extrapolation a dubious method of foretelling the future if used uncritically, but there is usually nothing better available. We simply do not understand how most social change occurs well enough to predict it. A bit is known--or assumed. For instance, per capita consumption must depend upon the price of supplemental water, when the price goes high enough. South Coast users would pay \$219/acre-foot for their water once Diablo Canyon or SWP is implemented, roughly twice the present rate, and it is certain that more customers and water agencies are going to become more cost conscious. Per capita consumption also depends upon the kind of housing being built. Apartment dwellers use less water per person, not having yards to keep up. But more apartment dwellers can live in a given area than homeowners, so that the total water needs are usually much higher in the former case. Population trends are also complex and unstable. In 1966 the state predicted its population would increase to 35 million by 1990, 54 million by 2020; just four years later these figures had been down graded to 29 and 45 million respectively.<sup>13</sup> The sizable changes here are not at all unusual--something to keep in mind as we go through the design of the desalting plant and the provisions for alternative supplies.

Even if these figures on the future were exact, however, a number of other matters are left unaccounted for in the conventional design of engineering projects. One of these, which has drawn great attention in recent years, is the problem of externalities. In quantifying the costs of technical solutions, a relatively narrow perspective has been customary. Water from a reservoir might "cost" \$30 per acre-foot, but this does not include the cost of disposal, nor does it account for the scarcity of the source. Groundwater is often the most economically desirable source because it is inexpensive; but when the supply has been used up or contaminated by minerals or saltwater, a community that had expanded using water at \$10 per acre-foot must now either cut back by rationing, or turn to large projects that could easily run as high as \$300 per acre-foot. When this happens, a socially expensive situation, such as running out of water after the area has already attracted a large population, may develop.

Externalities of an ecological sort have recently been included in cost estimates, at least approximately, as environmental codes have required more expensive equipment. For example, the Diablo Canyon plant will use titanium tubing costing \$3.5 million; titanium resists corrosion better than copper, and using the more exotic metal eliminates the emission of biologically dangerous copper into the ocean. Expenditures like this are helpful to both environmental protection and the industrial life of the plant--but they do not take fully into account the broader social dimensions, some of which cannot be embraced adequately by purely economic measures. Thus, one way to save the abalone which will be displaced by the break-water needed by the plant will be to find them a new home. Moving a group of shell fish who are at best reluctant travelers will, of course, be expensive; but one should not conclude that, once the moving costs are paid, that all the environmental damage has been "paid for," any more than simply relocating slum dwellers in an urban renewal project adequately compensates them for their lost homes.

The optimism characteristic of engineers' "can do" attitude, therefore, depends upon their ability to make a series of assumptions about the environments of their technical projects. The social environment is described by extrapolations of future needs, for example. The economic environment is managed through methods of financing the project which also meet some political goals, such as the internalizing of environmental costs. And the technical environment is handled through pragmatic technical compromises, or, in jargon, trade-offs. All of these methods of bounding the problem are bent toward a single overriding goal: transforming the social demand into a technically accessible problem. Our traditional means for doing so have been pretty successful, on balance: rather few people, given the choice, would willingly return to the "good old days," we judge. But our traditional means were and are based upon the assumption that the social and political environments of our technical projects are *simple*, that when one uses a trend to estimate need, one does not change the interest rate used to capitalize the plant, and so forth. We have been able to assume that treating one aspect of the problem at a time was enough. It is no longer certain that this underlying simplicity can be taken for granted in the increasingly sophisticated social world. As we shall see below, the sheer size of the Diablo Canyon plant--a size chosen after consulting trends for population growth--is causing considerable consternation in the political arena. In this dramatic, and unexpected, fashion, using a trend to estimate demand has indeed affected the political "capital" one needs to build the plant.

This rise in social complexity--the conscious recognition that water is related to growth, that growth is related to the quality of life of the average voter--creates some difficult dilemmas for the engineer, who is suddenly confronted with a new situation. The situation, which cannot be approached by his formerly reliable methods of bounding the problem, strikes at the very roots of the optimism which has been a fundamental part of the engineer's professional self-image, since he is face to face with a problem which cannot be bounded. Indeed, it is probably wrong to call social responses to technical development "problems" at all; they are more accurately seen as the legitimate--if often cantankerous--participation of

the people in public decision-making. If one accepts this view, then engineers cannot look to social science to provide them with neat procedures with which to bound their "problems of public acceptance," as they are often called. There is a rough truth in Churchill's famous dictum, "Democracy is the worst form of government...except all the others"; democracy is not famed for efficiency. And it was Mussolini who was brought to power on the hope that he would make the trains run on time. So the dilemma is a deep one, to which we must return later--though even then we shall provide no solution in the ordinary sense.

### C. Alternative Sources and Interim Supplies

Diablo Canyon represents one of several alternative sources of water to the San Luis Obispo and Santa Barbara areas, and so the desirability of the Diablo Canyon plant should be weighed in relation to these other sources. We undertake here a brief review of water supplies which are generally available, paying special attention to those which are important to the coastal area of California. When discussing water sources, it is helpful to distinguish between interim and permanent water supplies. Interim or temporary sources are generally employed as holding actions, trying to meet demand, if only just barely; permanent sources, such as reservoirs, take longer to build, cost more, and generally become an established part of the water supply network. If Diablo Canyon is operated for only ten years--the period during which the state will subsidize operating costs--then it will in effect be an interim source. By its size, however, it will tend to make permanent changes in the water needs of the area which it serves. In evaluating alternatives, one thing to keep in mind is the degree to which the social effects of a source of water are reversible. Diablo Canyon is designed to be shut off someday; it is unclear whether Diablo Canyon will be socially reversible.

#### *Water conservation*

Conservation is not, of course, a source of more water, but it does serve to decrease and delay the demand for water in an area. It is by far the cheapest answer to the problem of water shortage: no additional conveyance, treatment, or disposal facilities need to be built, eliminating the need for resource development and capital investment. The major shortcoming of water conservation has been that programs to save water have been relatively unsuccessful, even though concern for careful water use has long been official policy in California. As far back as 1928, an amendment to the state constitution prohibited the "wasteful use of water."<sup>14</sup> But there has been no enforceable definition of "wasteful": is it overwatering one's lawn? washing the car twice a week? Does it include a farmer who uses more water by growing alfalfa? or are we to blame economic pressures?

The technological possibilities of water conservation are somewhat better understood. In the household use of water, for example, one can

save up to 40% of the water used in toilets; flush toilets are the single largest sector of home water use, and the use of these improved designs could net a savings of 18% in individual family water consumption. Washing machines, consuming 32 to 59 gallons per 8-pound load, can be improved slightly through different, water-conserving designs, but major savings are most easily achieved by consolidating loads--two 4-pound loads use more water than a single 8-pound one. Taken together, such improvements in residential water technology and practice could cut consumption by 32% without decreasing the perceived quality of life. But at current equipment prices, the technical improvements are not economically rewarding to the homeowner--and they would not be until the price of water reached about \$260 per acre-foot. At present water is priced at about half this figure, though in Santa Barbara the price is already approaching \$200 per acre-foot.<sup>15</sup>

Agricultural irrigation is another major sector of use, accounting for 80% of the consumption in the United States. Public policy has traditionally encouraged irrigation by reducing the price of water to the user through a subsidy; water from the Colorado River, imported into the Imperial Valley of California, for example, is priced at \$2 to \$3 per acre-foot, a price which barely covers the marginal cost of transporting the water to its point of use. So long as such policies are in effect, farmers ignore the price of water as a consideration for producing cash crops. Instead of trying to optimize production per acre-foot of water used, they will naturally try to maximize the harvest per acre of land used *no matter what the water cost is*.

As in the residential case, the technology of agricultural water conservation is well-developed. There are water savings to be effected through choice of irrigation technique and choice of crop. The oldest, least efficient form of irrigation is the furrow method; a ditch is plowed along the rows of plants and filled with water. The more advanced techniques of sprinkler and drip irrigation require more sophisticated equipment, but they also save a good deal of water: 1) less water soaks deep into the soil, where it is lost to the crop plants; 2) surface water run-off is also lowered; 3) conveyance losses, such as evaporation losses in open canals, are lessened, and 4) there is no need for extensive land preparation, or for level land. The lower water costs of operating a drip or sprinkler system can save enough to make the initially more expensive system economical, so long as the sprinklers may be used for a number of growing seasons.<sup>16</sup>

Water can also be saved through the use of drought-resistant strains and more water-efficient crops. Agricultural research has in the past focused on optimizing yield per unit of land used. The availability of water is then treated as a constraint determining which crops are grown: when the price is low, crops needing large amounts of water, such as alfalfa, are profitable; as water prices increase, the tendency is to move toward higher cash-value crops such as citrus or grapes.

As in the case of energy, water consumption in the United States has probably been wasteful, and no doubt many acre-feet could have been

saved over the years. It is apparent, however, that little thought has been given to the design of water-conservation policies as a consistent matter of public concern. In part, the problem has been lack of data: very little is known about the economic repercussions of major crop shifts resulting from water shortages, for example. And in part, the problem of water waste has simply not attracted much attention. The Goleta County Water Board, for example, has tried, with little success, to check the mounting need for water by pleading for home-owner conservation, using pamphlets sent out with water bills. As in the parallel case of energy, again, study of incentives and other methods of increasing water savings is needed before this cheapest of the "supplemental" supplies can be effectively tapped.

### *Waste water reclamation*

Like conservation, reclaimed or recycled water is not truly new water. But in contrast to programs to use water carefully, reclamation does involve capital investment in a plant. There are three major forms of water recycling. In the first, natural process, waste water from septic tanks or irrigation ditches seeps deep into the ground, entering the ground-water supply. This can be done intentionally as well: sewer water which has been given primary treatment can be pumped into the ground, a technique called recharging. In both techniques the ground acts as a natural filter, and as a reservoir holding the water for reuse. The third method is essentially desalting--waste water is purified as if it were brackish water. The reverse osmosis process discussed earlier is thought now to be the most promising of the desalting techniques to use in recycling.

Artificially recharging groundwater basins with treated sewer water has been used to recycle water in Europe for many years. Israel plans to reclaim 72 mgd (81,000 af/yr) by 1990. And already 8% of California's 2 million acre-feet of municipal waste is being reclaimed for irrigation, industrial cooling, ground recharge, and artificial lakes. The major projects in California are summarized in the table below. The two largest, the Santee and Whittier Narrows projects in Southern California, have been very promising.

LOCATION	CAPACITY	USE
Golden Gate Park, San Francisco	1 mgd	Irrigation and artificial lake
Whittier Narrows, Los Angeles	14 mgd	Ground recharge
Santee Project, San Diego	8 mgd	Irrigation and artificial lake
Indian Creek, South Lake Tahoe	7.5 mgd	Irrigation and recreation

Santee, a ground-water recharge plant, treats sewer water heavily laden with viruses from human wastes. Its output water, which is used for an



artificial lake and for irrigating a golf course, is free of viral contamination. Whittier Narrows, also a ground water recharge project, uses domestic sewage from the San Gabriel Valley as input water. The ground water has proved to be safe for drinking here too.<sup>17</sup>

Despite such successes, however, it will be some time before reclaimed water will be in widespread use. The technology is still under development, and the equipment is still expensive; indeed, technically speaking reclamation ranks with desalting as a major challenge of water resources engineering. In addition, public agencies, including regulatory agencies, have been slow to experiment with this new source of water. Their reluctance reflects in part the feeling that the public may be hesitant to drink sewer water, no matter how much it may have been purified.

At least in the case of reverse osmosis, this fear of sewer water has some basis in fact. The problem is that none of the achievable methods of desalting, including reverse osmosis, has so far been able to remove all the viral contaminants from the input water. In this respect the engineers have not yet caught up with nature: ground water drawn from artificially recharged basins, which has been filtered by the soil, is free of virus. It is not altogether clear to what extent the viral contamination in desalted sewer water poses public health problems. Part of the difficulty here is that there has so far been little coordination between design engineers and physicians who help to set health standards. It may be that a combination of desalting and biological technologies will produce safe water economically.

In San Luis Obispo and Santa Barbara counties reclamation already occurs via cesspools and irrigated fields which recharge ground water basins--as noted above, an unintended, and uncontrolled, process. There have been several instances of ground water contamination, leading to wells being shut down.<sup>18</sup> An important hazard here is nitrate from fertilizers, too much of which can cause cyanosis, a disease affecting infants. When ground water is degraded in this way, the waste water must be contained in sewer systems until after it has been treated in a primary sewage plant; then, when it is safe, it can be allowed to percolate into the ground basin. As stream and ocean pollution standards become more stringent, both counties might find it economical to invest in sewage reclamation, to secure additional water, and to avoid building expensive outfall systems to release treated sewage into the ocean; at present only Vandenberg Air Force Base and the South Coast in Santa Barbara County have sewer systems.

Reclamation, however, will face substantial technical difficulties. For one thing, a recycling system based upon desalting technology cannot yet produce water which is safe for domestic consumption. It must therefore undergo further treatment before entering the local water system, or else it can only be used for agriculture--a dwindling sector of the local water economy. One might hope to avoid these troubles by using a ground water recharge system which produces biologically safe water. But land suited to percolation is in short supply, and in addition the water quality of the South Coast basins is below standard already. Mineral concentrations in three of the five sanitary districts' sewer discharges are over 1000 mg/l,

the maximum mineral level recommended by the U. S. Public Health Service. The levels in the other two are also characteristic of hard water, at 800 mg/l. This means that the water to be recharged will contaminate the ground water basin with minerals, making all of the local water hard, unless the basins are extremely large. Again, the alternative is to treat the sewage further, for example with ion-exchange resins to soften its mineral content.<sup>19</sup>

Total sewage flow in the South Coast and Vandenberg areas is now somewhat under 16,000 af/yr, while water consumption in the South Coast alone is about 42,000 af/yr; of the remaining water, about half is naturally recycled through ground recharge, and half lost to evaporation. Thus, there is a real limit on how much water can be reclaimed under the best of circumstances.<sup>20</sup> Even so, CDM recommended ground water recharge in the Upper Salinas Valley, although recycling in these communities would contribute but 7 percent of present demand. Another firm of consulting engineers has recommended water reclamation for Arroyo Grande. The coastal communities will probably follow suit in the years to come, but it is clear that water recycling by itself cannot be a solution to the water shortage problem--barring a drastic decrease in demand. Nonetheless, it can be a substantial part of any multi-source attack on water shortage.

### *Desalting*

Desalting technology shares a number of advantages with reclamation and conservation, as compared to other sources of water. Most prominently, desalting does not require the damming up of rivers to form reservoirs. But in addition, there are no problems of legal rights to the water, greatly simplifying sales and distribution. Desalination is also independent of weather conditions, something which makes it superior technically to the two methods we have already discussed. As we explained earlier, however, desalting does face formidable technical problems, primarily because of the high mineral content of sea water; the higher the mineral content, the more corrosive the brine, the more sophisticated the technology necessary to control the corrosion, and the more energy needed to purify the water. This problem, in a sense, is parallel to the virus-control problems of reverse osmosis, and it has greatly hampered the development of economic desalination processes.

Desalting is plagued with another, and quite remarkable, problem in the distribution stage: the water is too pure. The desalting processes based on distillation are chemically indiscriminate, removing everything from the input water. Natural water from streams and ground basins, of course, contain some dissolved minerals; when that mineral content is high we say the water is hard. Over the years, water conveyance systems carrying water from reservoirs to cities have accumulated hard-water scale on the walls of their pipes. If absolutely pure water is introduced into these pipes, it will start to dissolve the scale--which may fatally weaken the pipes. Thus, a new desalting

plant in a hard-water area such as coastal California might ruin the existing conveyance system! Therefore, desalted water must be mixed with mineral impurities or else diluted with hard natural water, so that it will not be corrosive to the conveyance pipes. This mixing, which would probably be done near the Whale Rock Reservoir in San Luis Obispo, itself poses some challenging engineering tasks, and this is an additional area in which Diablo Canyon would be a learning opportunity for OSW and CDWR. Indeed, the super-purity of desalted water could easily turn out to be a blessing in disguise, since it can be mixed with super-hard--and formerly unusable--ground water, thereby extending the available supplies. In fact, it is likely that a desalting plant could normally provide more blended water than its rated capacity of pure water would suggest, so that the 40 mgd of Diablo Canyon, for example, could be stretched to 60 mgd or more.

Fundamentally, therefore, desalting is promising because of its inherent flexibility. We noted earlier the limited supplies of water which can be saved or obtained by conservation or recycling; eventually, if populations continue to grow, more water must be found to support a larger number of people. The family of desalting technologies may be able to provide a variety of different ways to produce this water, to suit the different circumstances of various population centers and water supplies. For example, a small city may be able to exploit a nearby swamp with a 1 mgd plant designed to process brackish water, while a megalopolis or a major agricultural area might require a plant 1000 times larger. Both are within the eventual grasp of desalting technologies, a span wider than that of other methods. Indeed, water-resource engineers have already projected 1 billion gallon-a-day plants, 25 times larger than Diablo Canyon.<sup>21</sup> Sources of this magnitude are hard to find in nature, and in the world of man-made sources only the State Water Project approaches this size.

At present, economics is still the major barrier. In Santa Barbara and San Luis Obispo the high cost of desalted water will be paid for in part by state and Federal subsidies. Even with this subsidy, moreover, the cost of water will rise 50%, in some areas from \$200 to \$300 per acre-foot; this rise is, however, the same as that required to pay for water from the State Water Project. As costs come down and the price of other sources go up, future desalting plants may become major water sources in the area. Point Conception, the proposed site of another PG&E reactor, could accommodate a desalting unit, and there are several sites along the coast which would be suitable for single-purpose desalting plants--ones which are not designed specifically to produce electric power.

#### *Ground and surface supplies*

Most commonly, of course, water is obtained by drilling and pumping underwater supplies, or else by using water from flowing streams or reservoirs. Being the oldest supplies, ground and surface waters are the ones which are usually lacking in a water shortage. The central California coast is no exception, and, with the State Water Project nearby, it seems silly to build another reservoir when a man-made river of water is at hand to tap.

In Santa Barbara, Bookman and Edmonston have recommended overdrafting of ground water in anticipation of the State Water Project. The idea is that, when the project is completed six years hence, part of the initial flow can be used to recharge depleted ground water basins.

Limited amounts of water may also be obtained from more effective watershed management. In Santa Barbara County, up to 2000 af/yr can be added to the county-wide safe yield by controlling the kind of surface vegetation which grows in the watershed of the Cachuma Reservoir in the northern part of the county, and using Cachuma water to recharge South Coast ground basins at strategic times of the year. While useful as an interim measure, such procedures cannot serve long-term needs, unless there are radical changes in population growth.

Historically, a problem of great importance has been water rights. As water flows through land, it is not clear who owns the water itself; a landowner who dams up a stream may deprive his downstream neighbors of water. Even worse, underground waters may flow erratically and often do not follow the paths set by the overlying land. Someone who pumps water out of a well may be lowering the water table of his neighbor on the west, but not the neighbor on the east. The legal rights and responsibilities attached to ground and surface water have now accumulated into an immense body of tradition. This tradition is important in two ways. First, it forms the body of precedent which will be appealed to in the definition of new rights. For example, the legal history of stream rights has recently been invoked to assign responsibility to water polluters. There is a second, more subtle way in which the historical tradition of water rights comes into the present: the old rights, which do not apply in the case of modern technologies such as desalting plants, usually carry with them a tangled and complicated set of obligations; these can be avoided by a new system. Thus one of the advantages of a desalting plant might be that conflict over water rights would be much decreased; it should be noted, however, that water rights have not emerged as a political issue in the area of Diablo Canyon.

### *State Water Project*

The State Water Project (SWP) is the most ambitious long-distance water conveyance system ever built. It includes 21 dams and reservoirs with a combined capacity of 6.8 million acre-feet of water, water which is moved through 20 miles of tunnels by 22 pumping stations, consuming 100 billion kilowatt-hours of energy each year. The yield of SWP is presently 4.2 million af/yr, or about 4000 mgd, a hundred times larger than Diablo Canyon. SWP was begun in 1959 as the Feather River Project, with the proposal of the Burns-Porter Water Resources Development Bond Act. This bond issue was to fund the project with \$1.75 billion in general-obligation bonds. It was passed in November 1960 by the narrow margin of 3 million to 2.8 million votes. By the time construction got under way, it became necessary to supplement the bond-issue money with funds earned by the state from its offshore oil rights.

from Bookman and Edmonston, *Water Requirements of Santa Barbara County, 1967 to 1990.*



SWP draws water from the Sacramento-San Joaquin River delta and takes it 400 miles south into the Los Angeles basin. The water level along the system is kept fairly constant by a pair of large reservoirs, both in northern California. As the water is withdrawn from the Sacramento River it is deposited in the nearby San Luis Reservoir, which temporarily holds water not needed further south. When the demand exceeds that available from the Sacramento, water is released into its tributary upstream, the Feather River from the Oroville Reservoir.

Santa Barbara and San Luis Obispo would link to SWP's California Aqueduct, just south of Kettleman City in the San Joaquin Valley. From there water would be pumped through the proposed Coastal Aqueduct to Santa Maria, on the border between the counties. Before it reaches Santa Maria, water destined for San Luis Obispo will be sent first to Whale Rock Reservoir, a short distance away; like Oroville and San Luis in SWP, Whale Rock will be a holding station to level out fluctuations in demand. These fluctuations need to be monitored and smoothed out so that the pumping stations can handle a continuous stream of water. Such an uninterrupted stream is needed for technically efficient operation of pumps. Based on past experience, engineers have estimated that Whale Rock will function adequately as a regulator. Even though it is comparatively small, it can handle the ups and downs in the expected demand, and it has been estimated that each gallon of capacity in Whale Rock can smooth out four gallons' worth of demand. Water from SWP bound for Santa Barbara faces a longer, more expensive journey. It must be pumped all the way to the Cachuma Reservoir, then pumped through the Tecolote Tunnel under pressure, into Santa Barbara.

When the coastal spur of SWP was first proposed in the early 1960s Santa Barbara contracted for 50,000 af/yr, and San Luis Obispo, 25,000, the water to be delivered when the conveyance was finished in the late 1970s. By 1965 it had become apparent that the growth rate of the state was lower than originally planned--but the central coast cities were growing faster than anticipated. Santa Barbara was granted an enlarged commitment of 57,700 af/yr.

Neither community will need supplemental water in these quantities until late in the century, and this delayed demand is important in the planning of construction. The largest capital cost of the coastal water system is the Coastal Aqueduct, which, if begun today, would lead to capital service charges of \$2.5 million per year when the Aqueduct is finished; by the time it is actually begun, inflation will have raised the price substantially. Since the present residents of Santa Barbara and San Luis Obispo are not using SWP water, they do not want to pay for the Coastal Aqueduct yet. The counties have therefore negotiated a special contract with the state, according to which they pay only for the Coastal Stub, a conveyance pipe which is already in use; in addition, as a gesture of commitment, the counties pay a Delta Service Charge which is levied upon all present and prospective customers of SWP.

The delayed demand has the general effect of making it desirable to postpone construction of the Coastal Aqueduct. If this is done, there will be a larger number of taxpayers and water customers to share in the capital cost. Capital cost will be parceled out by a combination of two public works financing schemes. The *allocation method* charges off the capital cost against those who use the water--until the capital cost is paid off. This plan has the effect of charging the first users a great deal, while later customers pay only service and maintenance charges. Under the *utility method*, charges are paid by public obligation, in general a combination of taxes, bonds, and loans. Here the costs are apportioned according to tax categories, rather than by amount of water

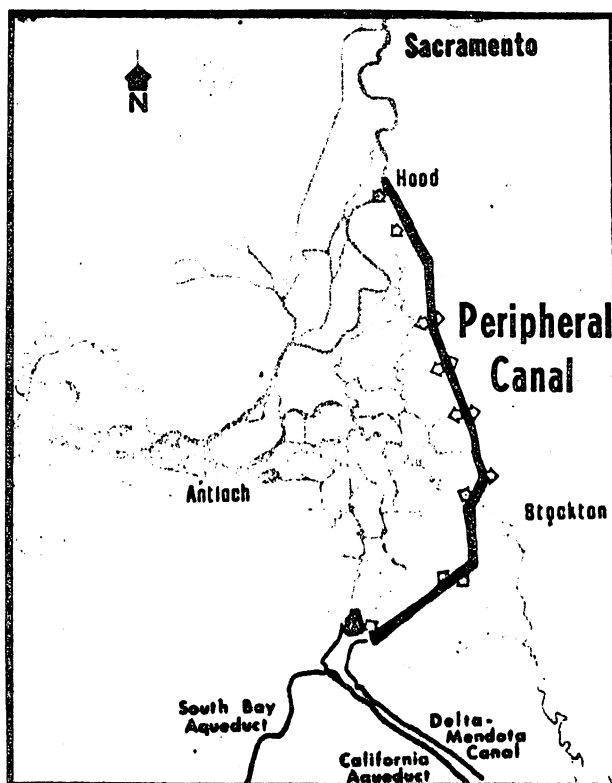
used. Each method has its advantages: the allocation method is a "pay as you go" plan which charges those who derive the *direct* benefits of water; the utility method, sharing the capital costs among all taxpayers, is best when the *indirect* benefits are spread wide throughout the community, as when public parks are paid for by taxes and bonds, rather than admission charges. Which of these categories water should belong to is a matter of some controversy. In the finance program recommended by Bookman and Edmonston, the two alternative plans are combined, so that water is considered to be a mixture of "private" and "public" good.<sup>22</sup>

Either way, it is advantageous to put off construction so that the cost can be more widely shared. Oddly, this means that conventional water-conservation methods should *not* be followed, as noted above. Instead, ground water and reservoir supplies should be carefully *used up*, in order to postpone construction for the longest time. Then, after SWP water starts to flow, the older facilities can be slowly recharged and refilled.

Diablo Canyon is another means to put off a decision on SWP, at least at first sight. For if Diablo Canyon is subsidized by state funds for ten years, local citizens could decide at the end of that time whether to link up to SWP. This breathing space is illusory, however, because Diablo Canyon requires a long water conveyance system, 25 miles of which would also be used in the Coastal Aqueduct. In order to build this conveyance system, in short, it will be necessary for Santa Barbara and San Luis Obispo to begin a major section of the aqueduct. While this is not an irrevocable commitment to SWP, local opponents charge that Diablo Canyon would prejudice the situation too strongly in favor of SWP ten or fifteen years from now. The bias is especially strong in Santa Barbara, where the expansion of the Tecolote Tunnel and the construction of the Santa Maria conduit would cost \$18 million.

These arguments about the future merits of SWP arise, however, in the context of the present heated controversy surrounding the project. Of the several water sources which we have discussed in this section, SWP is the only one which is already in existence, already exciting intense debate over its fiscal and ecological soundness. A brief glimpse into this controversy will be useful here. For the purposes of illustration, we have chosen to examine two issues, the peripheral canal and the problem of Northern California water rights.

The peripheral canal is a proposed quarter-billion dollar project to increase water flow in the major canals of SWP. It is also supposed to increase control over salt-water intrusion into the Sacramento delta. The canal, which would divert three quarters of the natural flow of the Sacramento River away from its destination in San Francisco Bay, is designed to release part of its water into the delta as it runs south toward San Luis Reservoir (see map). This controlled release is supposed to maintain fresh-water flow into San Francisco Bay at such a level that salt water from the bay will not filter back upstream. The cost of such intrusion would be quite high, ecologically, economically, and politically. The environmental impact would reach far beyond the Sacramento delta alone, since the ecological and climatic balance of the whole San Francisco Bay region is dependent upon the annual outpouring of fresh water each spring from the Central Valley



from *The Naked Delta*, published by the California Department of Water Resources (n.d.)

waterways. For example, there are seasonal variations in the phosphate content of bay water near San Jose, at the opposite end of San Francisco Bay from the mouth of the Sacramento; these fluctuations are thought to be related to the fresh water flushing effect of the river. Obviously ecological changes on this scale in a highly industrialized, heavily populated area would have important economic and political consequences.

What is surprising, then, is that the environmental impact has been treated so casually until very recently. Intensive ecological studies of the delta-bay ecosystem have only just begun.<sup>23</sup> And recently the Delta Water Agency, a special district created in 1968 by the state legislature, has rejected the present design of the canal. They have been joined by the Sierra Club, which has taken a stand through its Water Resources Subcommittee.<sup>24</sup> Perhaps most telling, the current design will release 15,000 to 18,000 cubic feet of water per second into the delta as part of the salt-water intrusion control program, but Kaiser Engineering has estimated that 30,000 cubic feet per second are necessary if major ecological damage is to be avoided in the delta. This estimate does not include indirect alteration of the San Francisco Bay ecosystem.

The controversy over the environmental impact of the peripheral canal is complicated as well by the problem of water rights on the Sacramento River. The U. S. Bureau of Reclamation (USBR) in the Department of the Interior has been a principal partner of the State of California in construction of the SWP. It has been the prime constructor,



for example, of the Shasta Dam and the Central Valley Project, a water distribution network in the San Joaquin Valley. As part of these construction projects USBR acquired *de facto* water rights on many of the rivers in Northern California. In many instances these water rights are not very high in priority; that is, USBR does not in fact own the water at all times. But it is now the principal governmental agency participating in the use of water in the river valleys of the North. In addition, state agencies charged with the protection and management of the rivers are overseen by a state legislature dominated by Southern California interests. The result is that the rivers have been developed almost entirely to benefit the water needs of Southern California, with little regard for the North. For example, the water needed to combat salt-water intrusion in the delta is controlled upstream by USBR. Delta communities, which are most heavily and directly influenced by salt-water intrusion, have no say in whether the fresh water they need is forthcoming. The point is not that USBR might someday withhold the water needed in the delta, but that the decision on whether to supply fresh water downstream rests with a Federal decision maker.

The immense scale of SWP has created a number of problems of governance which are only now coming clearly into view. The example of the peripheral canal, one of many problems to be raised and settled over the next few years, is illustrative and instructive. It shows clearly that large technological systems which have to be centrally controlled, as SWP must be now, are prone to having major undesirable impacts; in the present case alteration of the ecology of the San Francisco Bay and delta region appears to be an unwelcome byproduct of the peripheral canal. The canal, designed to deal with the ecological problem of salt water intrusion, has excited controversy over whether it will do this task. And there is the added difficulty that water for the canal is controlled by a Federal authority, USBR, adding another component of uncertainty to the question of whether water for Los Angeles will adversely affect Northern California. These difficulties with the peripheral canal are concrete examples of the way in which large-scale technological development tends to constrict the flexibility of government decision makers and planners. It is interesting to ask whether this loss of flexibility is inherent in all large scale programs. But whatever the answer--we believe that loss of flexibility is not necessary--it is something to be on the lookout for in the case of Diablo Canyon.

#### D. Technical Summary

This has been a long chapter, touching on many different kinds of technical, economic, and social circumstances which influence Diablo Canyon. The broad scope of our inquiry here has been dictated by the need to describe the desalting plant as a technical experiment and as one of a number of alternate water supplies, in a way which we hope will be sensible to laymen. Most of these issues, however, can be summarized now in the charts to follow, in which we attempt to make two sets of comparisons.

In the first, we return to the question of whether Diablo Canyon is a good technical idea. The difficulty, as we mentioned before, lies in the compromises: the good features of Diablo Canyon, to some, are bad features to others. We attempt, therefore, to describe a number of aspects of the plant from competing viewpoints. The chart, therefore, may be viewed as a capsule debate on the merits of the desalting plant.

Overlapping these questions is the issue of whether desalting is a good choice given the other sources of water available. We have therefore listed in a second chart the comparative advantages and disadvantages of the water sources which we have discussed, summarizing these costs and benefits in five variables: dependence on *weather*; complications connected with *water rights*; *water quality* of the source and its effects on existing water quality in the service area; the amounts of *energy and capital* which a given source will require; and the *flexibility of the design*, described from the viewpoint of social agencies and governmental authorities.

## TECHNOLOGICAL BENEFITS AND DISADVANTAGES OF DIABLO CANYON

Because many advantages bring along disadvantages, and *vice versa*, the aspects of Diablo Canyon are listed in pairs, together with the groups or organizations that are concerned with those particular issues. It must be noted that in the political arena an advantage to one group is often a disadvantage to a competitor.

1. Design
 

<ul style="list-style-type: none"> <li>A) MSF is proven--Counties are in favor of this</li> <li>B) VTE has a higher possible learning yield--Favorable for OSW and DWR</li> </ul>	<ul style="list-style-type: none"> <li>A) Low learning yield</li> <li>B) Not proven</li> </ul>
---	--
  
2. More water does not require growth--Ecologists
 

	<p>Allows for expansion when time arises--Real estate and developing interests</p>
--	--
  
3. Source of water for future
 

	<p>Might not really prove economically feasible in the end</p>
--	--
  
4. Increases the supply of good water--Water Boards
 

	<p>Could increase the demand and allow for inefficient use of water--Ecologists would look upon this with disfavor</p>
--	--
  
5. Environment--Ecologists
 

<ul style="list-style-type: none"> <li>A) Uses reactor waste heat</li> <li>B) Allows rivers to run free</li> <li>C) Allows for study of marine biota.</li> </ul>	<ul style="list-style-type: none"> <li>A) PG&amp;E's capacity is lowered</li> <li>B) No hydroelectric supplies</li> <li>C) Engineers' concern for the environment is superficial</li> </ul>
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6. Better water quality
 

<ul style="list-style-type: none"> <li>A) Increased drinkability--homeowners</li> <li>B) Increases the actual supply of usable water when mixed--Water Boards</li> <li>C) No need for domestic water softeners that dump more chemicals into the sewers and soils--Water Boards and homeowners</li> </ul>	<p>Increased water supply of better quality could possibly increase consumption and sewage problems--Water Boards would not want this</p>
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7. Delays the cost of SWP--  
county planners are in favor  
of this

Sets up the system and demand  
for the SWP--Ecologists
8. Spurs the need to attack related  
technical problems such as  
mixing and marine ecology--  
OSW, DWR, and Ecologists

Success depends upon the out-  
come of the solutions
9. Ground water supplies could  
be left to farmers, so they  
don't have to pay higher prices  
for water--Farmers

If they do pay the price,  
many will go out of business.  
Land will then be used for  
development--Ecologists and  
Farmers against this
10. Relatively constant supply  
of water, independent of  
weather--Water Boards

Interruption in production of  
water to refuel reactors and  
inspect plant will cut down on  
efficiency--hurts OSW and DWR

## SUMMARY OF DIFFERENT SOURCES OF WATER

### Conservation

- Weather:** Farming and landscaping are only sectors dependent on drought periods, thus making planning much simpler for local water agencies.
- Water Rights:** No question of rights is involved, making coordinated planning much easier for communities that would normally be competing; the political sphere thus would be improved.
- Water Quality:** Quality can be improved because by conserving rather than overdrafting, sources will not be degraded. Also less waste water will percolate into ground basins.
- Energy and Capital:** More conveyance, reclamation, and holding complexes are not necessary.
- Flexibility of Design:** Dependent on how much water was previously wasted, so there is a limit to how much can be conserved.

### Reclamation

- Weather:** Complicated dependence on hot and dry weather as well as wet periods. In dry weather, more water is consumed, but more also evaporates. During rain, much water seeps into the system.
- Water Rights:** No question of water rights for reverse-osmosis reclamation. Regular question of correlative rights when ground is used for recharge.
- Water Quality:** With desalting process, quality improves. With recharge, the danger exists of degrading current sources.
- Energy and Capital:** Energy is needed to pump (and purify) the waste water. Sewage systems must be constructed for areas that do not have them and are degrading their supplies with septic tanks.
- Flexibility of Design:** Recharge limited to land with necessary geologic conditions near source of water to be reclaimed. Both processes are limited by the amount of waste water. As conservation is implemented, reclamation is cut back.

## Desalting

- Weather:** No dependence on drought. This makes it ideal for dry regions--an advantage no other source shares. Operation could be timed so that periodic inspection and repair come during winter months, when needs are lowest.
- Water Rights:** No question of rights. Those who pay for the project are the ones entitled to it.
- Water Quality:** Presently a confusing situation. It must be mixed with other sources of water because quality is so good it can cause corrosion. But it serves as an excellent enhancer of supplies that normally could not be used, thus creating an actual production greater than plant capacity.
- Energy and Capital:** The only major drawback of the technology is the cost of energy and plant materials. For areas where conveyance is a major cost, small complexes can be built in several cities (even for inland communities with brackish supplies.) For coordinated regions with established conveyance systems that can handle extra capacity, mammoth projects may bring economies of scale as well as a large tax base.
- Flexibility of Design:** Plant can be designed to meet requirements of community or county. As the technology advances, the range of options will increase.

## Conventional supplies: Ground and Surface Reservoirs

- Weather:** Major flaw with reservoirs is that they are in greatest demand when they have the least inflow. Ground supplies are less influenced by periodic changes in the weather, but capacities are determined by long range conditions.
- Water Rights:** Both ground and surface supplies are a can of worms. Agencies and communities must compete for sources, thus destroying any coordination that can be gained for regional planning.
- Water Quality:** Main problems with reservoirs are eutrophication and siltation. Ground sources become degraded the more they are used and the more waste water is recycled.
- Energy and Capital:** Ground sources are generally close to point of use, so little conveyance is needed. Energy costs increase as drafting and pumping increase. Surface supplies from mountain areas far from location of consumption require conveyance. Tremendous costs can also be incurred in construction of dams.

## Long Conveyance Systems: State Water Project

- Weather:** Reservoirs used as holding supplies, so that seasonal changes have as little effect on SWP as large ground basins. However, long drought periods could have devastating effects.
- Water Rights:** Situation for SWP has yet to be adjudicated, but when it is, there will be a major legal battle.

**Water Quality:** Without the Peripheral Canal, water treatment facilities may be necessary.

**Energy and Capital:** Massive amounts of materials and funds, as well as labor and energy (pumping) are necessary to convey the water.

**Flexibility of Design:** Must be used conjunctively for optimal operation. SWP only feasible on a large scale. Expansion will be very difficult. In this process, as with conventional sources, the alternative sites decrease as time goes on.

## Chapter II. Footnotes

- <sup>1</sup> Copies may be obtained by writing to the Office of Saline Water, Department of the Interior, Washington, D. C.
- <sup>2</sup> Conceptual Design Study, p. 93. We have delayed the schedule printed there by one year to conform with events to date.
- <sup>3</sup> Spiegler, *Salt Water Purification*.
- <sup>4</sup> Saline Water Conversion Summary Report, pp. 14-17.
- <sup>5</sup> Spiegler, *Salt Water Purification*, p. 129.
- <sup>6</sup> For more on freezing, see *ABSeas of Dealing and Saline Water Conversion Summary Report*.
- <sup>7</sup> As before, the interested reader is urged to consult *ABSeas of Desalting* and the *Saline Water Conversion Summary Report*.
- <sup>8</sup> K. Dorking, *Energy Resources and the Need for Nuclear Power Plants*, p. 16. The efficiency of nuclear power plants may be raised substantially by the end of the century, as new designs are introduced.
- <sup>9</sup> This figure is based upon the thermal output of electric power plants, rather than their electricity production. Counting only the electric power produced, only about 45% will come from nuclear plants, but for present purposes it is fairer to count *all* the energy put out, in both electric and thermal forms.
- <sup>10</sup> Site Selection, p. 4.
- <sup>11</sup> Gordon C. Rausser, P. Frick, and Cleve Willis, "Learning, External Benefits, and Subsidies in Water Desalination," unpublished manuscript, University of California, Davis, 1972.
- <sup>12</sup> Saline Water Conversion Summary Report, p. 14.
- <sup>13</sup> Water for California, California Water Plan.



- <sup>14</sup>Wells-Hutchins, *California Law of Water Rights*, pp. 12-13.
- <sup>15</sup>*Future Water Demands*, pp. 7-12.
- <sup>16</sup>*Ibid.*, pp. 77-97.
- <sup>17</sup>Virus Control at Santee; Waste Water Reclamation at Whittier Narrows.
- <sup>18</sup>CDM, pp. IV-8, IV-24, IV-30.
- <sup>19</sup>Bookman & Edmonston, pp. VIII-4 and 5.
- <sup>20</sup>*Ibid.*, p. VIII-3.
- <sup>21</sup>Hammond, "Large Reactors May Distill Sea Water Economically."
- <sup>22</sup>Bookman & Edmonston, p. IX-17, Importation of State Water Project to Santa Barbara.
- <sup>23</sup>Contra Costa County Water Agency, Preliminary Report on the Peripheral Canal, p. 11.
- <sup>24</sup>*Ibid.*, pp. 2-3.

### III. THE SOCIAL SETTING

The last chapter introduced us, however unwillingly, to the technical intricacies of supplying water. But there is also demand: after the relative merits of different water sources have been nicely laid out, there is a more difficult issue to be faced--how much water *should* be supplied? As the chapter on ecological concerns will show, this question has no simple answer. Before describing the conflict over Diablo Canyon, however, we need to look at the social setting: who will need the water? Who will decide whether it is to be provided? We shall concentrate here on the decision-makers and governmental organizations which have become the center of the storm. And we shall describe the current and anticipated patterns of water use in the two coastal counties to be served by Diablo Canyon.

#### A. Some Background

Santa Barbara and San Luis Obispo both began as Franciscan missions. The Mission San Luis de Tolosa, later to become San Luis Obispo, was dedicated in 1772, the fifth of what was to be a chain of twenty-one missions along the historic El Camino Real, the road stretching from San Diego to San Francisco. The tenth of these missions was established in Santa Barbara on December 4, 1786. The two missions became the nuclei of secular settlements, and in 1850 the towns of San Luis Obispo and Santa Barbara became the county seats of the counties bearing their names, two of the original 27 counties of the new state of California.

Both San Luis Obispo and Santa Barbara continued to grow, but it was not until the late 1950s and the 1960s that growth achieved the meteoric pace we find today. The population of San Luis Obispo County rose from 81,000 to over 105,000 between 1960 and 1970--a rise of 30.4 percent, more than three percent higher than the statewide average. The city of San Luis Obispo, the largest urban center, today has about 28,000 residents. In Santa Barbara County, the population was about 98,000 according to the 1950 census. By 1960 it had increased to nearly 169,000 and by 1970, to over 264,000. The growth of the University of California campus in Goleta, on the outskirts of the city of Santa Barbara, was responsible for much of the latter gain: during the 1960s Goleta tripled its population.

In the county of San Luis Obispo, the largest employment grouping is government, which accounts for 29 percent of the working force. Trade in the county employs approximately 7,150 workers, service industries, about 5,100. The other three main areas of employment are construction, with

about 1,700 workers, 1,350 in manufacturing, and 2,700 in agriculture and fishing. Because of its heavy emphasis on government, trade, and services, San Luis Obispo County was not greatly affected by the recent economic slowdown. The county has little manufacturing, the sector most affected by fluctuations in the business cycle.

San Luis Obispo is the home of California State Polytechnic College, lying adjacent to the northeast boundary of the city. The College has the largest architectural school in the nation, and it is well known for its engineering and agricultural schools. The enrollment of Cal Poly, currently 12,000, is slated to rise to 15,000 by 1980, a figure slightly lower than the original target of 18,000. There is another institution of higher education in the county, Cuesta Community College, located three miles west of the city of San Luis Obispo. Recently begun, Cuesta is now in the process of building permanent structures; it enrolls about 3600 students. Any list of educational facilities would be incomplete without mention of the Hearst Castle in San Simeon, a monument to conspicuous consumption housing numerous works of art, and undoubtedly the best known of the tourist attractions in the county.

Santa Barbara County has an unusual employment profile. As in San Luis Obispo, there is no heavy industry; the local economy is based on electronics, aerospace-related research, and light manufacturing such as the assembly of electronic components. Other principal areas of employment include education, tourist and convention services, government, and retail and wholesale trade. The following chart gives a percentage breakdown of employment by major groupings:<sup>1</sup>

	<u>1960</u>	<u>1968</u>
Agriculture	7½	5 3/4
Mining	2	1½
Construction	8	5
Manufacturing	8	5½
Transportation	4	4
Trade	23	21½
Finance	3	3
Services	24	26½
Government	15	21

During the 1970s the economic growth of Santa Barbara is expected to continue at a rate higher than that of either the state or the nation. There are three sectors in which this growth will be concentrated: light manufacturing, particularly in high-technology areas such as electronics; educational institutions, principally the University of California Santa Barbara campus; and the development of the NASA space shuttle at Vandenberg Air Force Base in the northern part of the county.

The selection of Vandenberg by the Federal government as one of the two major sites for the development and testing of the space shuttle was

announced this past spring. While not entirely unexpected, the selection was surprising to county officials in the sense that they had done little advance planning to prepare for major population growth in the north county.

The University will be another principal focus of growth. The current development plan calls for expansion of the student body from the present 13,000 to about 15,000 in 1981. Total enrollment is expected to decrease during the 1980s in the University of California statewide, but UCSB is expected still to reach its originally targeted size of 25,000 when the master plan is completed near the end of the century. Growth is to be concentrated in the expansion of graduate education and the establishment of new professional schools. Both of these are areas of education that are highly service-intensive: only part of the growth will be due to increases in faculty and student populations; most of the expansion will come through rises in indirect expenditures for secretarial and technical services, and for food, clothing, shelter, and other goods not directly related to education. Thus the "multiplier" effect on the populations of Goleta and Santa Barbara from such growth in the University can far exceed the rise in student enrollment scheduled in the Regents' plan.

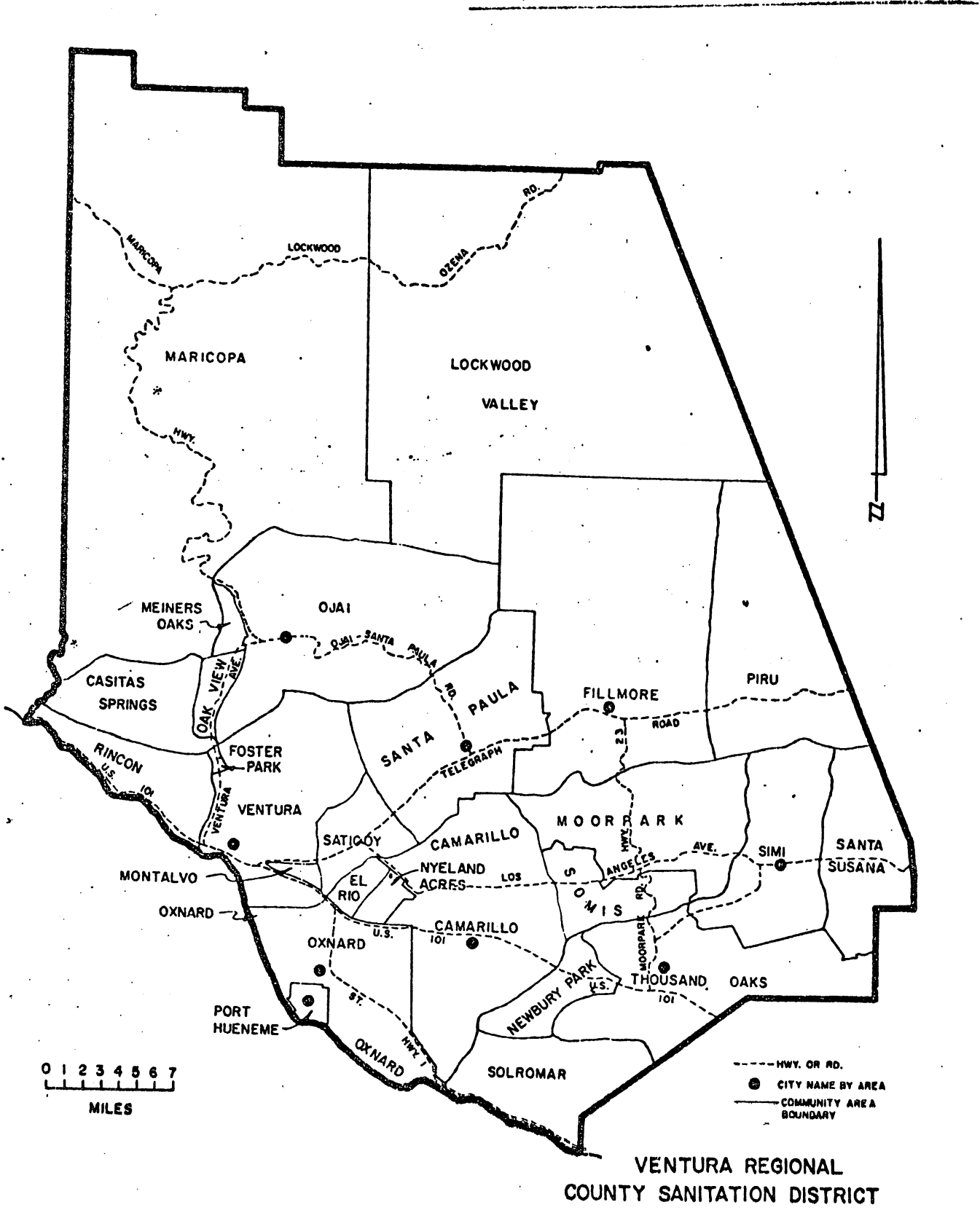
For a number of reasons, however, the University master plan may not be implemented. To begin with, it appears to be politically infeasible. In order for the campus to grow significantly California voters must approve additional bond authorization to fund construction. In addition, the state legislature and the governor must approve higher operating budgets for the university. Neither is likely. More realistically one can expect the Santa Barbara campus to increase in size gradually as it responds to continued demand. There is, moreover, a different kind of factor which may greatly affect growth of the campus. The citizens of the county are presently discussing whether to set an optimum population limit. If a limit is imposed, mandating a county population smaller than that now included in the General Plan, the county government would be forced to limit growth drastically. Holding the enrollment of the university at its present level would be a prime tactic for lowering the overall growth rate of the county.

### *Governmental structures*

To most citizens government below the statewide level is a confusing and mysterious tangle of overlapping jurisdictions. The maps shown below are taken from a recent study of the public services provided in Ventura County,<sup>2</sup> and they illustrate a problem which is found in most of the 50 states. The maps all show the same region of the California coast, just north of the Los Angeles basin. In the first map, we see outlined the Oxnard Harbor District, in the next, the South Ventura Resource Conservation District; in succeeding maps, we see the county sanitation district and one of many municipal water districts. None of the four public services are delivered over the same geographical area; neighbors on adjacent blocks may live in totally different service areas, even though they are, for voting purposes, ruled by the same government. Even though state laws have brought some uniformity to such districts, it is still the rare citizen who knows in which districts he lives, how much each costs him in taxes,







0 1 2 3 4 5 6 7  
MILES

--- HWY. OR RD.  
● CITY NAME BY AREA  
--- COMMUNITY AREA BOUNDARY

VENTURA REGIONAL  
COUNTY SANITATION DISTRICT





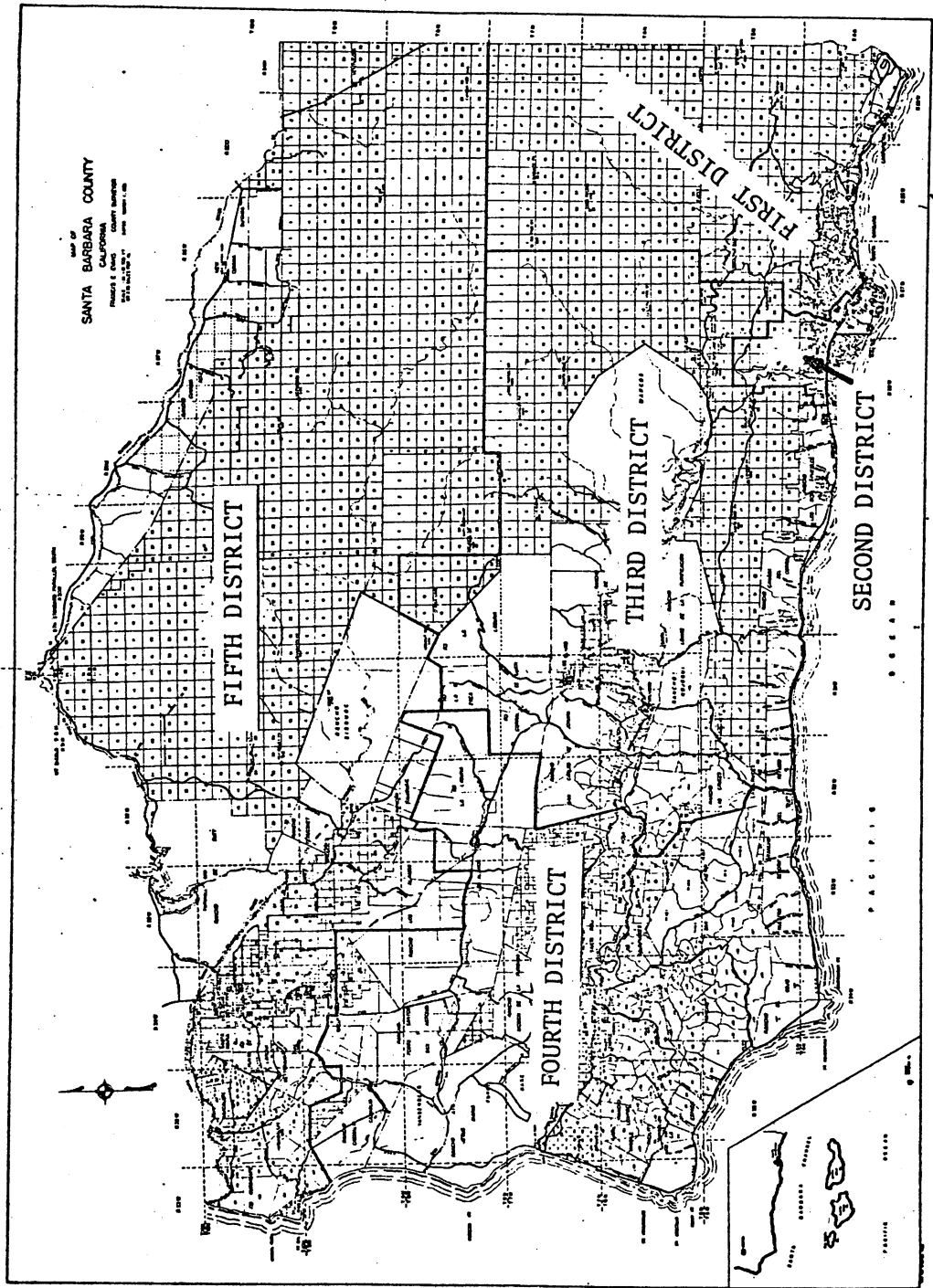
or what those taxes are supposed to provide him in services. It goes without saying that the directors of public service areas, and the meetings which they hold, remain untasted mysteries.

These patchwork bailiwicks, evolving over a century's haphazard growth, reflect the reluctance of American politicians and voters to create "big government." What has happened instead is that the multitude of special service areas, designed to meet public needs such as schooling or water, has created a kind of no-government. In describing the governmental structures of San Luis Obispo and Santa Barbara Counties which play important roles in providing water, therefore, we are of necessity describing a special case; it is likely that no other community in the nation distributes its water in the same way. By the same token, however, the case of these particular counties is typical: it has been, and continues to be, a recurrent complaint that there is no effective regional government charged with co-ordinating the various services required by the people of a geographical region such as the San Luis Obispo-Santa Barbara area.

*Governments.* In California the highest county government is the county board of supervisors, a legislative and administrative body in charge of all unincorporated areas of the county. In both Santa Barbara and San Luis Obispo, the board is composed of five supervisors elected on a non-partisan ballot, one from each supervisorial district. Elections are held in June of even-numbered years, at the same time as the California primary. If there are several candidates in a district and no one candidate receives a majority of the votes cast, a run-off election matching the two leading vote-getters is held in November. The supervisors serve four-year terms, two supervisors being elected in one year and the other three in an election two years later. In 1972, three supervisorial positions are being contested in each of the two counties of Santa Barbara and San Luis Obispo.

Santa Barbara, besides being the county seat, is also an incorporated city with its own jurisdiction and government. The city is ruled by a seven-member city council, which appoints a city administrator as its chief executive. Council members are elected to four-year terms, each council nominee running from the city at large. Legal authority to set city policy in all governmental matters, including water policy, is held by the council.

Such legal authority does not, however, extend beyond the city boundaries, and much of the governmental function of an urban center such as Santa Barbara involves coordination or contractual arrangements with other jurisdictions. As noted above, this kind of coordination is at present difficult or impossible to achieve because of the fragmentation of governmental agencies. Control of this fragmentation is the responsibility of LAFCO, the Local Agency Formation Commission. LAFCO was created by the California State Legislature in 1963 in order to standardize the methods of consolidating, dissolving, or creating special districts throughout the state. The commission consists of two county supervisors, chosen by the board; the mayors of two cities in the county, chosen by the mayors in office; and one citizen chosen by the four official members. All changes in special district areas, annexations, incorporations, detachments or combinations of existing governmental entities must be approved by LAFCO. The idea is



Supervisory Districts in Santa Barbara County

that, with LAFCO, fewer special districts would be formed, and eventually those which already exist could be consolidated into fewer multi-purpose districts. In short, LAFCO is a way to move from the fragmentation of a special-district form of providing services, toward a truly regional government. The hope of this kind of change is that regional government will be able not only to plan more effectively for the future development and needs of the region, but that it will also be more responsive to the will of the electorate.

The Federal government has also tried to encourage regional coordination by putting restrictions on Federal fund requests. Before funds can be granted by the Department of Housing and Urban Development (HUD), two requirements must be met. First, a development plan for the surrounding area (usually the county) must exist. In Santa Barbara and San Luis Obispo, this requirement is met by the counties' General Plans. The second requirement is that an area planning council be established. As applications for HUD funds are submitted, they must first be presented to the area council. The council acts as a local clearinghouse with power to keep applications from being forwarded to HUD.

*Special districts.* Despite such encouragements, the refashioning of governmental structures is slow work at best. The prevalent form of public service agency in California is the special district, and it is the water district which plays a key role in the case of Diablo Canyon. A special district is a unit of government established to perform a particular service for a specified area. Both size and purpose may vary greatly; they may be very small, as in the case of a pest-abatement district, or as large as the entire county. Special districts are either voted into existence by the residents of the proposed district, or sometimes they are created by order of the state or county. Since the special district is usually defined by a quite specific mission or purpose, its boundaries do not coincide with those of other governmental units. We have noted above the confusion which is a frequent by-product.

For all their difficulties, special districts carry the unique legitimation of a long history in California--the first special districts were formed to control mining during the gold rush. Since that time, the special district has continued to be a way to handle local problems which fall outside the existing limits of government responsibility. The special district, in other words, has been a way to build stop-gap governmental structures: during the gold rush, for example, "there was no other authority available to make and enforce decisions on questions of claims, filing, and operations."<sup>3</sup> Following the establishment of mining districts, the California State Legislature authorized school districts in 1851. These were followed in 1887 by irrigation districts, created by the Wright Act. From these modest beginnings, the special districts have continued to increase in importance. Despite the establishment of LAFCO, which was intended to slow the proliferation of special districts, they have continued to multiply. In 1950, there were 1,650 special districts in California; by 1967, the number had increased to 2,168.<sup>4</sup>

Special districts may be divided into three general types. The first type, the school district, is governed by regulations in the State Education

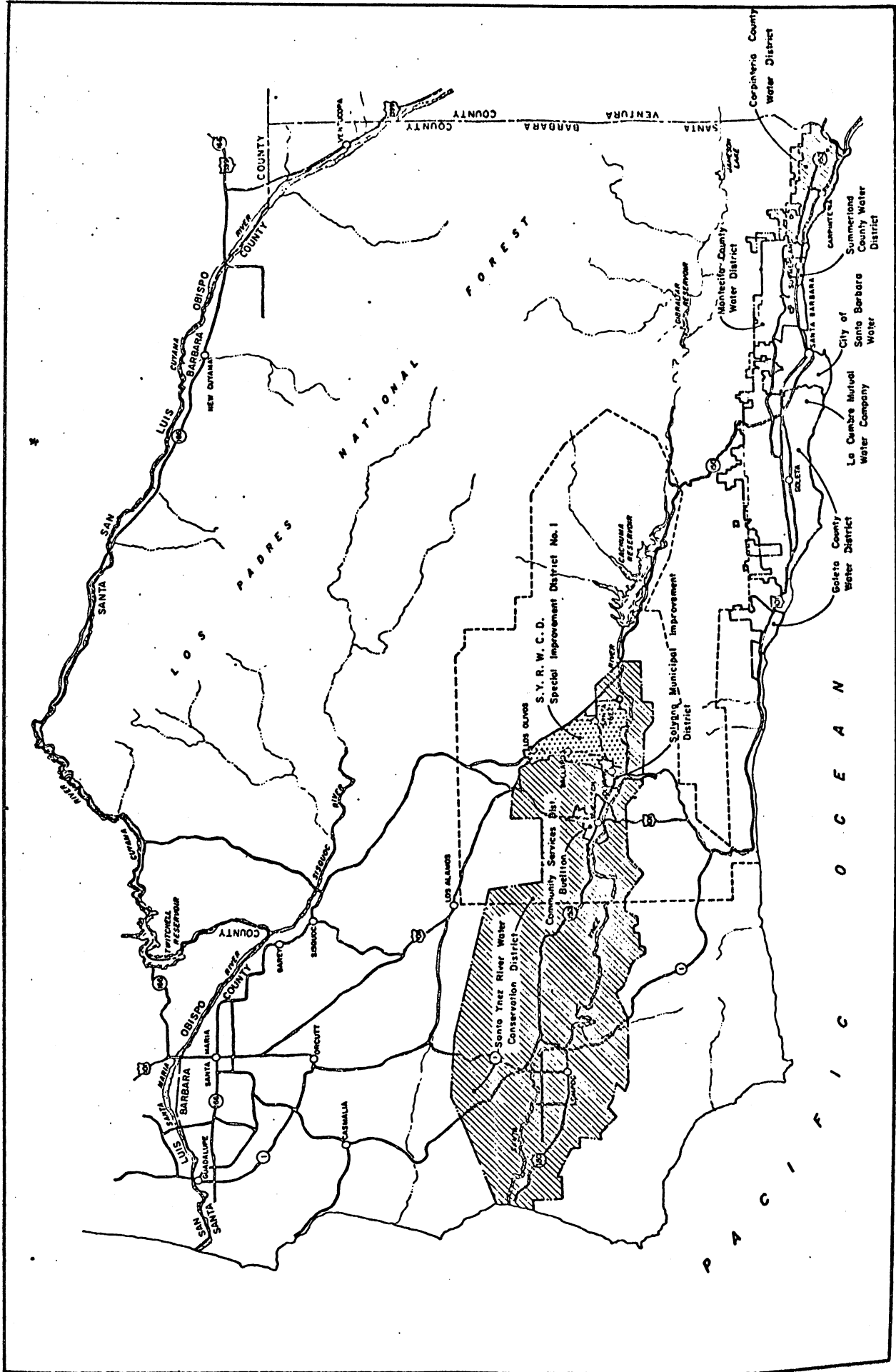
Code. Self-governing districts, which make up the second type of district, are autonomous organizations governed by their own boards of directors. The directors are usually elected by district residents. Airport, cemetery, fire, recreation, and sanitary districts typically fall into this category. And the most important self-governing district, for this discussion, is the water district. In Santa Barbara County, there are five such water districts, (see map) in San Luis Obispo, eight districts. The third type of special district exists under the management of the Board of Supervisors. There are two special districts of this variety in Santa Barbara County pertinent to water resources.

First is the Santa Barbara County Water Agency, established in October, 1945. When Cachuma Dam was constructed, the Agency was established to wholesale the water from the project to the districts and distributors; they were to collect payments from the users and make repayments to the United States Bureau of Reclamation for the county's share of costs of the construction and operation of the dam. The county supervisors serve as directors of this agency.

The second special district in this category is the Flood Control and Water Conservation Agency, formed in 1955. The supervisors also sit as directors of this agency, determining when flood-control or water conservation projects should be authorized. One of the most important functions of this agency, in addition, is to contract with the State of California for water from the State Water Project. San Luis Obispo County also has a county flood control district. Its purpose and structure parallels that of Santa Barbara.

*Planning and water policy.* Another facet of government important in the discussion of water is planning. Both Diablo Canyon and the State Water Project represent large financial commitments which are expected to be needed for growth in the counties; water is one resource which must be available for the new residents. County-level planning is done by the planning commission and the planning department. The planning commission is composed of nine members from the county, who are appointed by the board of supervisors. The commission is expected to advise the board on the form and content of the General Plan, zoning, and subdivision ordinances. The commission also has jurisdiction over variances and conditional-use permits, although the decision can be appealed to the board of supervisors. The planning department is the staff of the commission; it provides the data and advice necessary for both the commission and the board of supervisors to make their decisions concerning planning and zoning. The county planning commission and the county planning department are only responsible for and in control of the unincorporated areas of the county. The cities have independent control of their water distribution and city-level planning; they too have similar planning commissions and departments.

Both counties' boards of supervisors have formed water-policy advisory committees as forums to represent various sectors of the community. The Santa Barbara County Water Advisory Committee was established in June of 1970 by the county water agency. The committee, a voluntary organization with about 20 members, is expected to give advice on matters concerning water acquisition or distribution for the county. They have no schedule



Water District Boundaries in Santa Barbara County

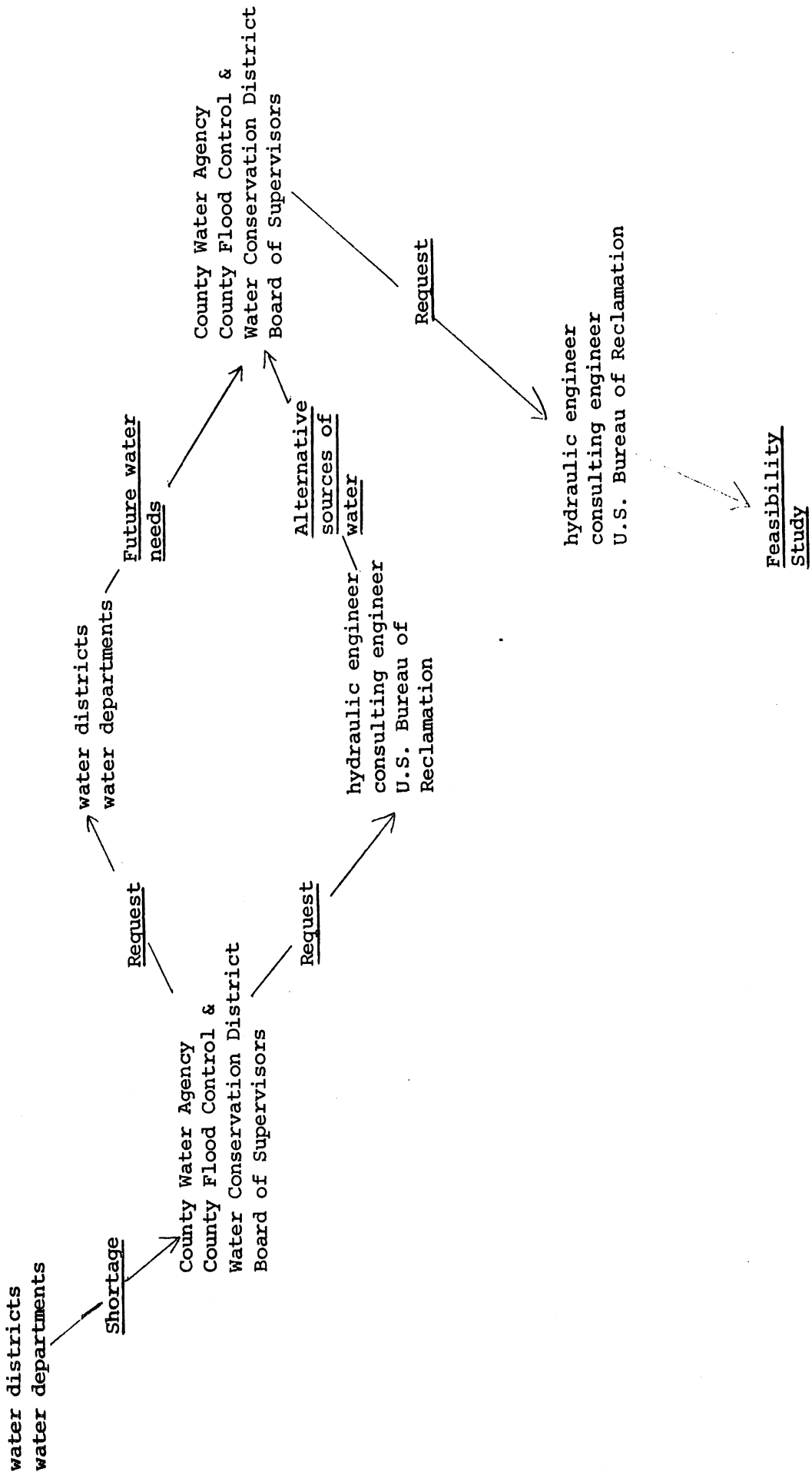
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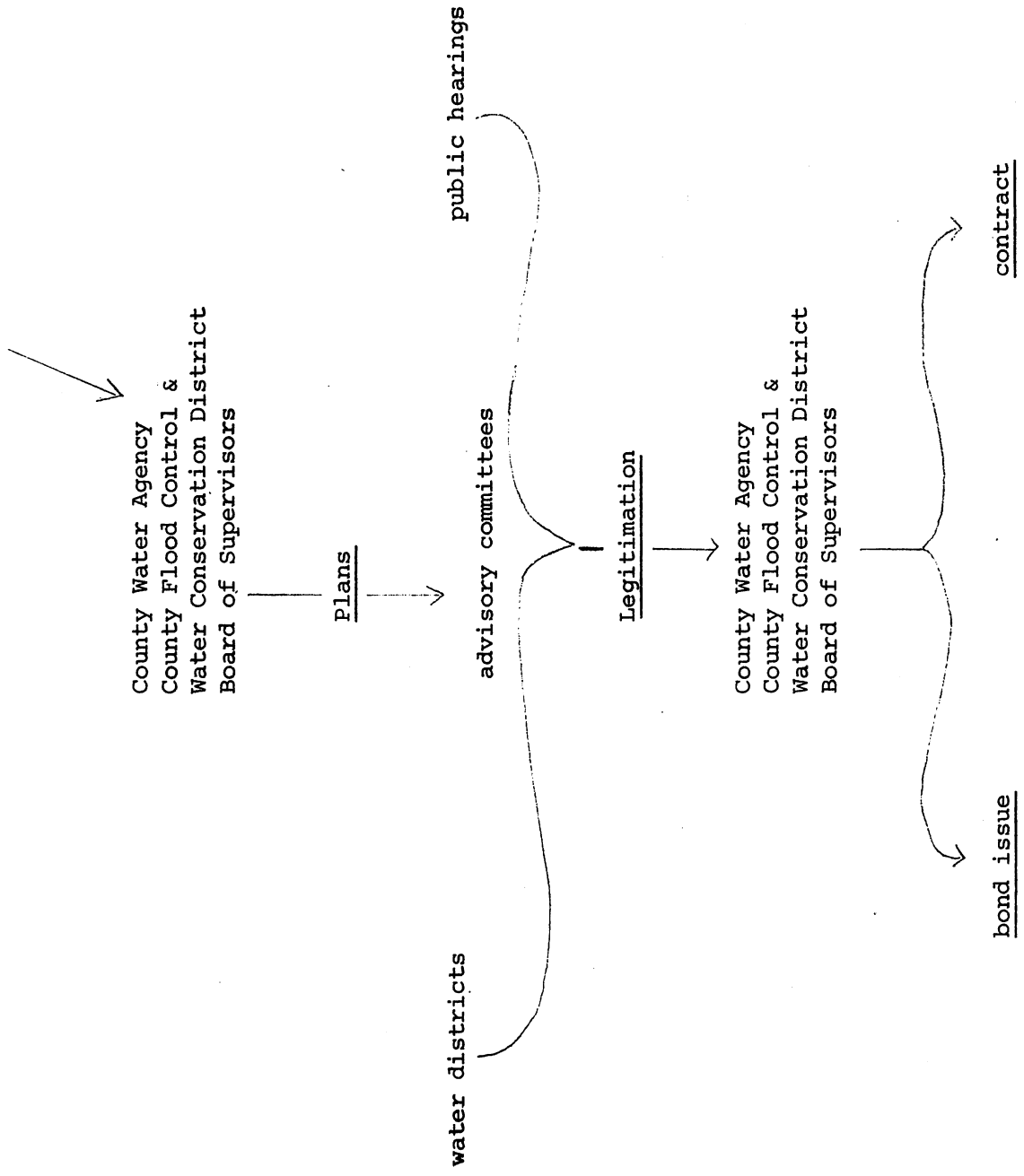
of meetings, but convene at the request of the water agency. The committee was originally formed to study (and approve) R. M. Edmunston's report on a program for importation of State Project water to Santa Barbara County, and to suggest a time schedule for future importation. Since then, however, it has become embroiled in the question of Diablo Canyon.

In San Luis Obispo, the County Board of Supervisors has appointed two advisory committees. The first is the Water Resources Advisory Committee, a voluntary committee of sixteen members nominated by the Board and the city councils of the county and established in 1952. The second committee is the Conservation Advisory Committee, composed of thirteen members appointed by the Board of Supervisors and representing a cross-section of the economy. This committee advises on conservation questions related to proposed projects in the County, including the desalting plant at Diablo Canyon.

*A sample decision.* To see how these governmental units fit together, let us follow a typical--though hypothetical--decision. As water becomes short in the county, either due to growth of the population or a continued drought, the water districts and city water departments request the county water agency (or, in San Luis Obispo, the board of supervisors), to study sources of water for the county. Such sources normally include large projects (such as dams) which a single district cannot undertake by itself. The water agency then commissions a study of alternative sources of water by the county hydraulic engineer, a private engineering firm, or a Federal agency such as the U. S. Bureau of Reclamation. While the study is under way, the agency might request water districts and departments to submit their projected water needs, broken down into yearly totals. This information, normally provided by each district's hydraulic engineer, is computed by combining projected population growth with a figure for consumption of water per person. Once the water agency has this information, it can choose between possible future water sources on the basis of needs and economic cost. When the outside study is completed and sent to the water agency, the supervisors choose which, if any, project is to be embarked upon, and they authorize an engineering feasibility study of the project chosen. When the feasibility study is completed, it is evaluated by the water agency, its advisory committees, and possibly even the water districts and departments. The water agency makes a final decision on the project after reviewing the advice submitted by the different committees, departments, districts, and whatever citizen voices may have been heard.

The water agency has several means of funding the project, most prominently the county-wide bond issue, which is voted on by the citizens during a regularly scheduled election. The nongovernmental and "nonpolitical" character of the water agency makes for an odd exercise of power in these financial decisions. If a particular water district does not want to participate in some county-wide project, it can opt out of paying for its proportional share of the water. But it cannot opt out of paying for its part of the capital investment, because the whole county is obligated for its bonded debt. The reluctant district, therefore, would reap no benefits, while paying a share of the costs. The water agency, therefore, gains considerable compliance from the districts which it nominally serves, since its decisions on bond issues bind the water districts financially.





4 e 7



Notice, in addition, that throughout the decisionmaking process there are a number of consistent and persistent assumptions made. The *basis of response* is assumed to be clearly known: a water shortage prompts the actions of the county agency. Already the problem is defined as one of water and water alone. Indeed, as we track through the decision process we see that its focus throughout emphasizes that water is the key public policy issue. The *public interest* is also assumed to be clear; this is how the policy question is transformed into a technological one. That is, if it became apparent that growth, and not water, were the central concern, it would no longer be obvious what could be meant by a "best" alternative source of water. In the present system it is only at the stage of the bond issue, when voter approval is finally solicited, that the problem of water can acquire all these "political" colorations. But there is little reason to believe that the political interests involved--both favoring growth and opposing it, for example--are injected only at the end. The appearance of a non-political situation (everyone is against a water shortage), in other words, masks the reality of conflict which is at least latent (not everyone is in favor of continued growth). But of such conflicts, more later.

## B. The Water Situation

Before the current water supplies and future demands of the two counties can be understood, it will be helpful briefly to cover a few basic elements of any water plan. First, the capacity or size of a given water supply must be known. Second, the ownership must be ascertained. And third, current and future demand must be calculated to determine how long a source will be sufficient.

### *Preliminaries*

*Safe yield.* In order to insure that a water supply is properly used and not prematurely depleted, the *safe yield* needs to be known. For surface supplies such as reservoirs, the engineer must determine the maximum drought period (the greatest number of consecutive years with little or no rain) and the total amount of water the reservoir can hold. The drought period may be estimated from historical weather records, often supplemented by guesses made using the closest and most similar region with sufficient information. Of course, there is always the possibility, hopefully unlikely, of a record dry period. To determine the total capacity of a project, the volume of space bounded by spillway of the dam and the shores of the reservoir is calculated. The capacity is then divided by the drought period to give the amount of water that can be released each year, while lasting through the drought. This is the safe yield, usually given in terms of acre-feet per year.<sup>5</sup>

Determining the safe yield for a groundwater basin is more difficult. Water from rivers and rainfall percolates into the soil and lower layers of ground, until nonporous formations halt the flow. This allows the water to build up, as it would in a tub. The U. S. Geological Survey is the primary source of data on groundwater basins. First, the amount of rainfall is

ascertained for the basin area. The quantity trapped and evaporated from trees, shrubs and grasses, as well as the surface runoff (measured by the flow of streams out of the area) are then subtracted to give the amount of water that remains. To check this data, the contour and depth of the basin can be calculated to give a rough estimate. At best, the figures reflect highly refined guessing. Usable capacity of a groundwater source is the volume stored above sea level, in regions where salt water intrusion can occur. More generally, it is the amount of water than can be pumped without drastically affecting water quality. The safe yield of a groundwater basin is the quantity that can be drafted without severely lowering the water table. A drought period is not normally used in these estimates, since underground basins are usually so large that they can effectively smooth out the year-to-year variations in rainfall. Of course, during a drought the water table will decline with only normal use, but this using up of water can be adequately allowed for in safe-yield estimates.

*Water rights.* The ownership of water resources is a tangled legal matter determined by a combination of traditional or common-law precedents and state laws. Ownership is an important issue to the water engineer primarily in those cases in which a new water source, such as a reservoir, changes the distribution of water ownership, for example by damming up a flowing river. As noted in the last chapter, the desalting plant avoids much of the conflict over who owns the water in a given region by producing new water from the ocean. The basic principle of ownership is the *riparian right*, which permits a landowner to do what he wishes to water lying within or flowing by his property. This basic water right is modified by a number of rights of other claimants; for example, a landowner may not arbitrarily pollute a waterway. In the Western states, which have historically been water-poor, the riparian right has long been curtailed by rights based on the public interest. Thus the *pueblo right*, a carry-over of a colonial Mexican principle, allows a settlement or municipality first call on water for its residents--over the claims of surrounding farmers or ranchers.

These principles applying to surface waters such as lakes and streams are supplemented by a body of precedent and law for underground sources. Generally speaking, land ownership is again the basic claim: owners can use water found under their land in whatever ways they wish. With the development of modern geology, however, it was recognized that underground basins might not follow property lines, and the California Water Code, for example, now protects the right of an owner whose water is pumped out from under him by a neighbor.

Rights such as these are claimed in water disputes, which are settled by courts and by special water boards which function as judicial bodies. Beyond the primary claim of ownership, there are claims which are basically like "squatters' rights" which can be argued for against property owners. For example, the so-called *prescriptive right* to water is conferred by past use: if a rancher has traditionally used water flowing through a neighbor's property, he cannot be summarily thrown out.

*Existing supplies, current use, and projected demand*

The counties of San Luis Obispo and Santa Barbara have in the past drawn their water mainly from ground reserves, and to a lesser degree from man-made reservoirs. Because of the wide variation in both natural terrain and density of human settlement, a water shortage in any one place does not mean that there is a shortage in other communities.

This does not mean, however, that some form of coordinated plan cannot work. In this section we present a concise summary of two extensive engineering studies, one for each county. These surveys give a rough sketch of the present water situation--who is using how much and where. But they also serve a more future-oriented goal--the need to plan for new sources of water. It is not the purpose of this report to deal in depth with the water situation. Therefore, only obvious discrepancies between the two studies will be noted, and no attempt will be made to analyze the data in any detail. Arguments about whether, when, and where there will be a water shortage must, in the end, come back to this information.

The surveys were conducted by CDM Inc., Environmental Engineers, a subsidiary of Camp, Dresser & McKee, Consulting Engineers, and by Bookman and Edmonston, Consulting Civil Engineers, who have worked with Santa Barbara since 1959.<sup>6</sup> What both firms have done is to assemble massive amounts of data on safe yields of ground and surface supplies calculated by the State Department of Water Resources, the U. S. Bureau of Reclamation, the U. S. Army Corps of Engineers, and the U. S. Geological Survey. Population trends were obtained from such agencies as the U. S. and State Census Bureaus. Other data were extrapolated from present trends, including lands to come under irrigation and the types of crops that will be grown. CDM and B & E divided the counties into study areas that coincide with groundwater basins or groups of basins. Then the total safe yield of each areas was matched with current use and future projections. Tables 1 through 4 summarize the safe yields, while Tables 5 and 6 describe current and future use. Maps 1 to 4 give an overview of the situation. For example, on Map 3, the Upper Santa Ynez Valley is indicated to have a surplus of supplies presently. We see from Map 4, however, that the area will be in overdraft by 1980 if no future supplies are developed. Table 6 indicates the size of the surplus or shortage in each study area.

The maps fail to convey some of the details of the water distribution. That is, though a study area might have a total surplus of water, certain localities could be in deficit. For example, the South Coast area of San Luis Obispo is shown having sufficient supplies through 1990 on Map 2. However, if current water allotment of Lopez water changes, users such as Pismo Beach and Grover City will not have sufficient supplies to meet their needs in 1990.

In addition, the tables and maps also do not show the discrepancies between the reports, and they do not adequately represent the difficulties encountered in analyzing the existing reservoirs. On page 12 of Bookman & Edmonston's *Projected Water Requirements for Santa Barbara*, the safe yield of the Cuyama Valley is placed between 12,000 and 13,000 af/yr. CDM quote

TABLE 1

SUMMARY OF GROUNDWATER BASIN CHARACTERISTICS  
IN SAN LUIS OBISPO COUNTY<sup>1</sup>

Study Area	: Total : storage capacity:	: Useable storage : above sea level :	: Safe yield : AF/year
North Coastal			
San Carpoforo Creek	1,800	600	0
Arroyo de la Cruz	6,600	2,200	430
San Simeon Creek	4,000	1,300	320
Santa Rosa Creek	24,700	6,000	<u>630</u>
		Subtotal	1,380
Central Coastal			
Villa Creek	6,500	2,200	1,030
Cayucos Creek	4,000	1,300	630
Old Creek	4,600	1,500	330
Toro Creek	2,900	1,000	530
Morro Creek	7,600	2,000	1,700
Chorro Creek	9,600	2,500	1,700
Los Osos	95,000	9,000	<u>1,000</u>
		Subtotal	6,920
San Luis Obispo Bay			
San Luis Obispo	67,000	22,000	<u>2,250</u>
		Subtotal	2,250
South Coastal			
Pismo	30,000	10,000	2,000
Arroyo Grande	700,000	40,000	<u>6,500</u>
		Subtotal	8,500
Nipomo Mesa			
Nipomo Mesa	1,000,000	-	2,500 <sup>2</sup>
Santa Maria			<u>11,200</u>
		Subtotal	13,700
Upper Salinas			
Paso Robles	30,000,000	30,000,000	45,000 <sup>2</sup>
Pozo	2,000	2,000	1,000
Miscellaneous	-	-	<u>1,300</u>
		Subtotal	47,300
Cuyama-Carrizo Plain			
Cuyama	-	-	6,600
Carrizo Plain	-	-	<u>600</u>
		Subtotal	7,200
		Total	101,250

1. State of California, State Water Resources Board Bulletin No. 18

2. Portion within San Luis Obispo County

T A B L E 2  
Surface Supplies of  
San Luis Obispo County

Project	Capacity (af)	Safe Yield (af/yr)
Twitchell	240,000	18,000 <sup>a</sup>
Salinas	26,045	5,500 <sup>b</sup>
Lopez	51,800	6,230
Whale Rock	39,500	8,900 <sup>c</sup>
Nacimiento	<u>350,000</u>	<u>23,000<sup>d</sup></u>
TOTAL San Luis Obispo Allotment	****	41,030

NOTE: SLO's allotment of total capacity has no meaning for Twitchell or Nacimiento because only their safe yields are apportioned.

From CDM, compiled throughout Chapter IV.

- 
- a) SLO's entitlement is 16% of the total safe yield, or 2,900 af/yr.
  - b) The question of water rights might render this source inoperable.
  - c) The actual yield is probably 40% or 50% of this safe yield estimated by the Department of Water Resources.
  - d) SLO's entitlement is 17,500 af/yr.

T A B L E 3

Ground Supplies of  
Santa Barbara County

Study Area	Useable Capacity	Safe Yield (af/yr)	Current Use
Santa Ynez Valley			
Lompoc Plain		14,400	20,900
Upper Santa Ynez		<u>28,400</u>	<u>28,000</u>
Subtotal		42,800	48,900
South Coast Basins			
Carpentria	32,600	3,400	3,200
Montecito	97,000	2,000 <sup>a</sup>	300
Santa Barbara	184,000	2,000	2,000 <sup>b</sup>
Goleta	60,000	5,800	2,000
Elwood-Gaviota		<u>6,000</u>	<u>2,500</u>
Subtotal		19,200	10,000
Cuyama Valley <sup>c</sup>		12,000 to 13,000 <sup>d</sup>	14,700
Santa Maria Valley	1,800,000	70,000	109,500
San Antonio Valley		7,000	7,200
TOTAL		<u>152,000</u>	<u>190,300</u>

From B&E, compiled throughout Chapter 3.

- a) E. D. Wheeler's figure is 1,200 af/yr.
- b) 3000 af/yr has been used historically, but the City plans to decrease withdrawal after an alternative source is implemented.
- c) SB's portion only.
- d) Safe yield is probably closer to 14,000-15,000 af/yr, but the valley is still in overdraft.

T A B L E 4

Surface Supplies of  
Santa Barbara County

Project	Capacity (af)	Safe Yield (af/yr)
Cachuma	205,000	28,400 <sup>a</sup>
Gibraltar	13,500 <sup>b</sup>	4,000 <sup>c</sup>
Jameson	6,750	1,700 <sup>d</sup>
Twitchell	<u>240,000</u>	<u>18,000<sup>e</sup></u>
TOTAL Santa Barbara Allotment	*****	49,200

NOTE: SB's allotment of total storage capacity has no meaning for Twitchell because only the safe yield is apportioned.

From B&E, pp 13-14.

- 
- a) 30,400 af/yr with conjunctive use of South Coast ground sources. Original safe yield estimated at 33,000 af/yr.
  - b) Current total storage capacity probably closer to 9,400 af due to siltation.
  - c) Estimated by the City of Santa Barbara. Another figure is 3,700 af. Estimates tend to vary from 300 af for Gibraltar to 600 af for Cachuma.
  - d) Estimated by the Montecito County Water District. Estimates from other agencies would be somewhat lower. An extra 300 af is gained from the Doulton Tunnel.
  - e) SB is entitled to 84% of the safe yield which is used in Santa Maria Valley, 15,100 af/yr.

TABLE 5

PRESENT AND PROJECTED WATER DEMANDS FOR SAN LUIS OBISPO COUNTY<sup>a</sup>

Study Area	1970			1980			1990			2000		
	Safe Yield	Consumptive	Surplus+	Consumptive	Surplus+	Consumptive	Surplus+	Consumptive	Surplus+	Consumptive	Surplus+	
North Coast	1,880	1,880	0	2,330	-450	3,300	-1,420	4,540	-2,660			
Central Coast	6,830 <sup>b</sup>	6,830	0	9,140	-2,220	12,440	-5,520	15,840	-8,920			
SLO Bay	8,790 <sup>c</sup>	8,790	0	12,670	-830	18,560	-6,720	24,480	-12,640			
South Coast	14,730	9,230	+5,500	10,520	+4,210	12,200	+2,530	14,130	+600			
Nipomo Mesa <sup>d</sup>	13,700	11,770	+1,930	13,380	+320	14,670	-970	15,220	-1,520			
Upper Salinas	47,300	43,770	+3,530	51,560	-4,260	59,270	-11,970	66,940	-19,640			
Cuyama-Carrizo Plain	7,200	16,030	-8,830 <sup>e</sup>	17,970	-10,770	19,120	-11,920	21,710	-14,510			
TOTAL <sup>f</sup>	100,430 <sup>g</sup>	98,300	+2,130	117,570	-14,000	139,560	-35,990	168,860	-59,290			

<sup>a</sup> From CDM Tables IV-5,10,17,22,25, 29 & 33

<sup>b</sup> Increase to 6,920 af/yr in 1980

<sup>c</sup> Increase to 11,840 af/yr in 1980

<sup>d</sup> Includes SLO's portion of the Santa Maria Valley only

<sup>e</sup> CPM has incorrect figure of -9,830 af/yr

<sup>f</sup> True total deficit would be greater due to the fact that surpluses cannot be economically shared

<sup>g</sup> Total safe yield increases to 103,570 af/yr in 1980



TABLE 6

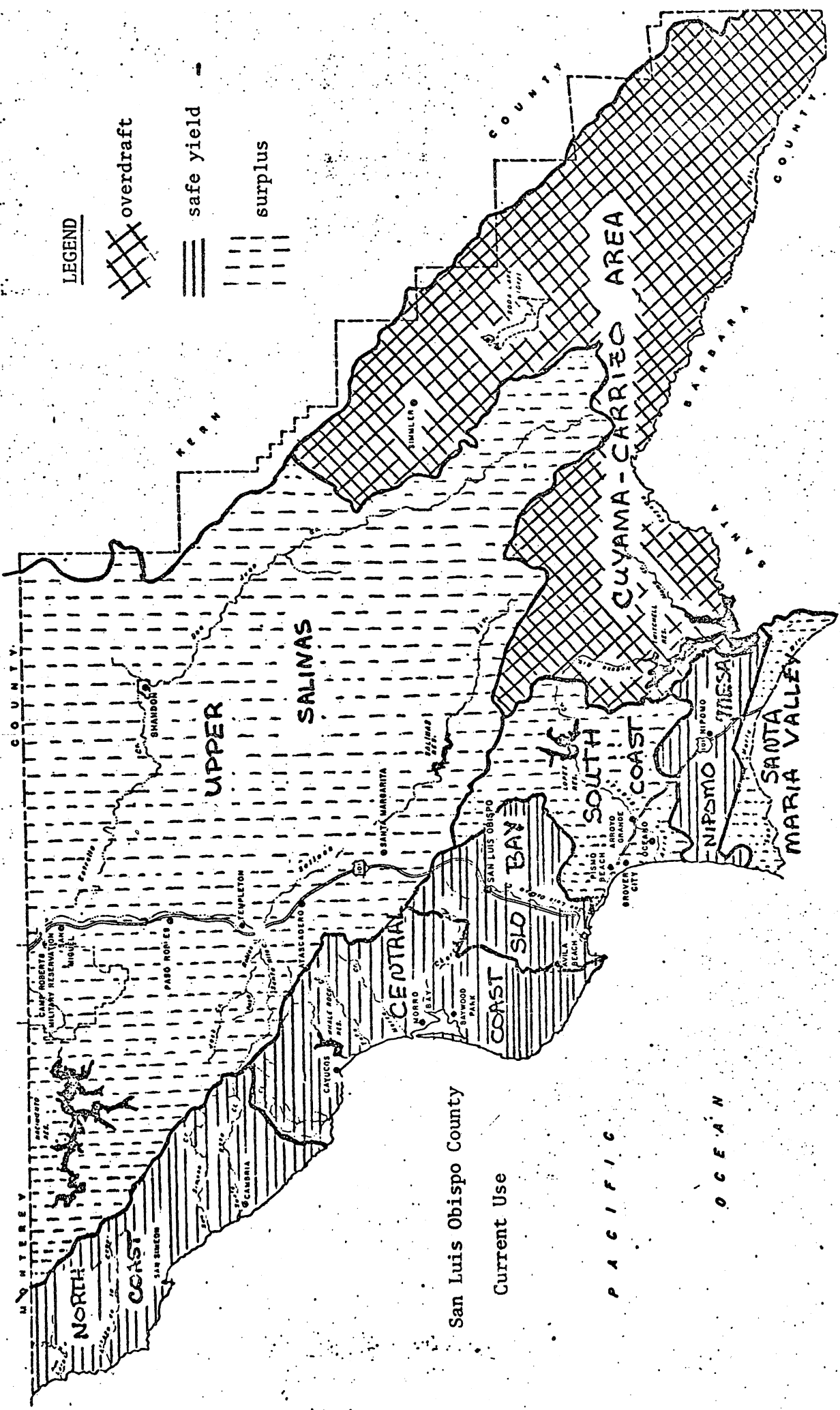
PRESENT AND PROJECTED WATER  
DEMANDS FOR SANTA BARBARA COUNTY

Study Area	1970		1980		1990		
	Safe Yield (af/yr)	Consumptive Use	Surplus (+) Deficit (-)	Consumptive Use	Surplus (+) Deficit (-)	Consumptive Use	Surplus (+) Deficit (-)
Santa Maria <sup>a</sup> Valley	51,000	80,000	-29,000	82,000	-31,000	83,900	-32,900
Cuyama Valley <sup>a</sup>	8,000	14,700	-6,700	14,800	-6,800	14,900	-6,900
San Antonio Valley	7,000	7,200	-200	7,300	-300	7,300	-300
Santa Ynez Lompoc Plain	14,400	20,900	-6,500	23,400	-9,000	27,400	-13,000
Upper Santa Ynez	31,300	28,000	+3,300	33,000	-1,700	33,100	-1,800
Subtotal	45,700	48,900	-3,200	36,000	-10,700	60,500	-14,800
South Coast Goleta	16,100	15,900	+200	21,100	-5,000	25,800	-9,700
Santa Barbara	16,200 <sup>b</sup>	13,800	+2,400	16,400	-700	19,300	-4,100
Montecito	4,600	4,200	+400	4,900	-300	5,900	-1,300
Sumerland	400	200	+200	200	+200	300	+100
Carpenteria	6,500	5,700	+800	6,100	+400	6,500	0
Remainder	2,500	2,500	0	2,500	0	2,600 <sup>c</sup>	0
Subtotal	46,300	42,300	+4,000	51,200	-5,400	60,400	-15,000
TOTAL <sup>d</sup>	156,000	193,000	-37,000 <sup>e</sup>	212,000	-56,000 <sup>e</sup>	227,000	-72,000 <sup>e</sup>

<sup>a</sup> Includes only the portion in Santa Barbara County <sup>c</sup> Safe yield up to 2,600 also in 1990

<sup>b</sup> Safe yield decreases to 15,700 in 1980, 15,200 in 1990 <sup>d</sup> Rounded to nearest thousand

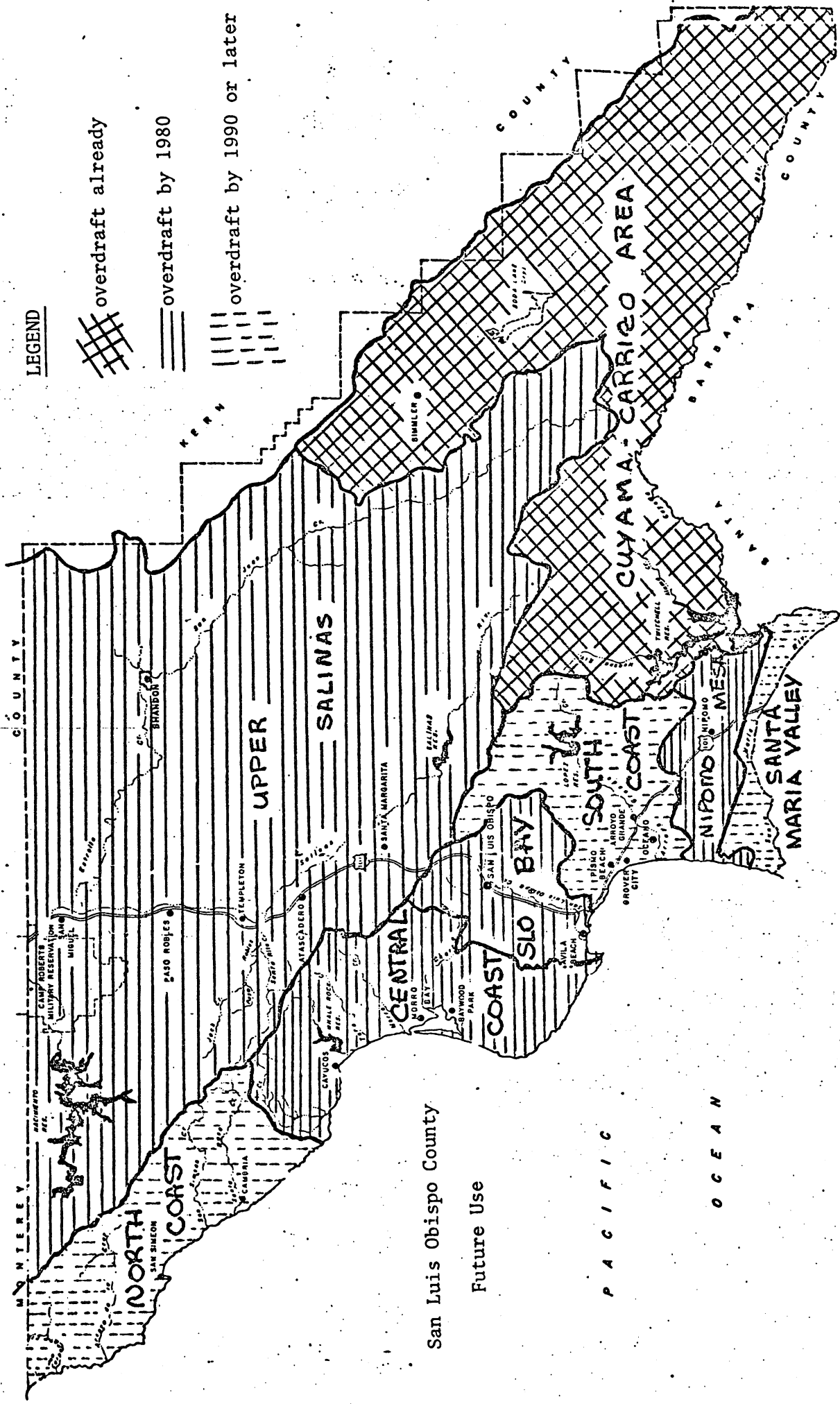
<sup>e</sup> True deficit would be greater since surplus cannot be shared practically




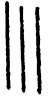
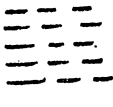
San Luis Obispo County

Current Use

PACIFIC OCEAN



LEGEND

-  overdraft already
-  overdraft by 1980
-  overdraft by 1990 or later

San Luis Obispo County

Future Use

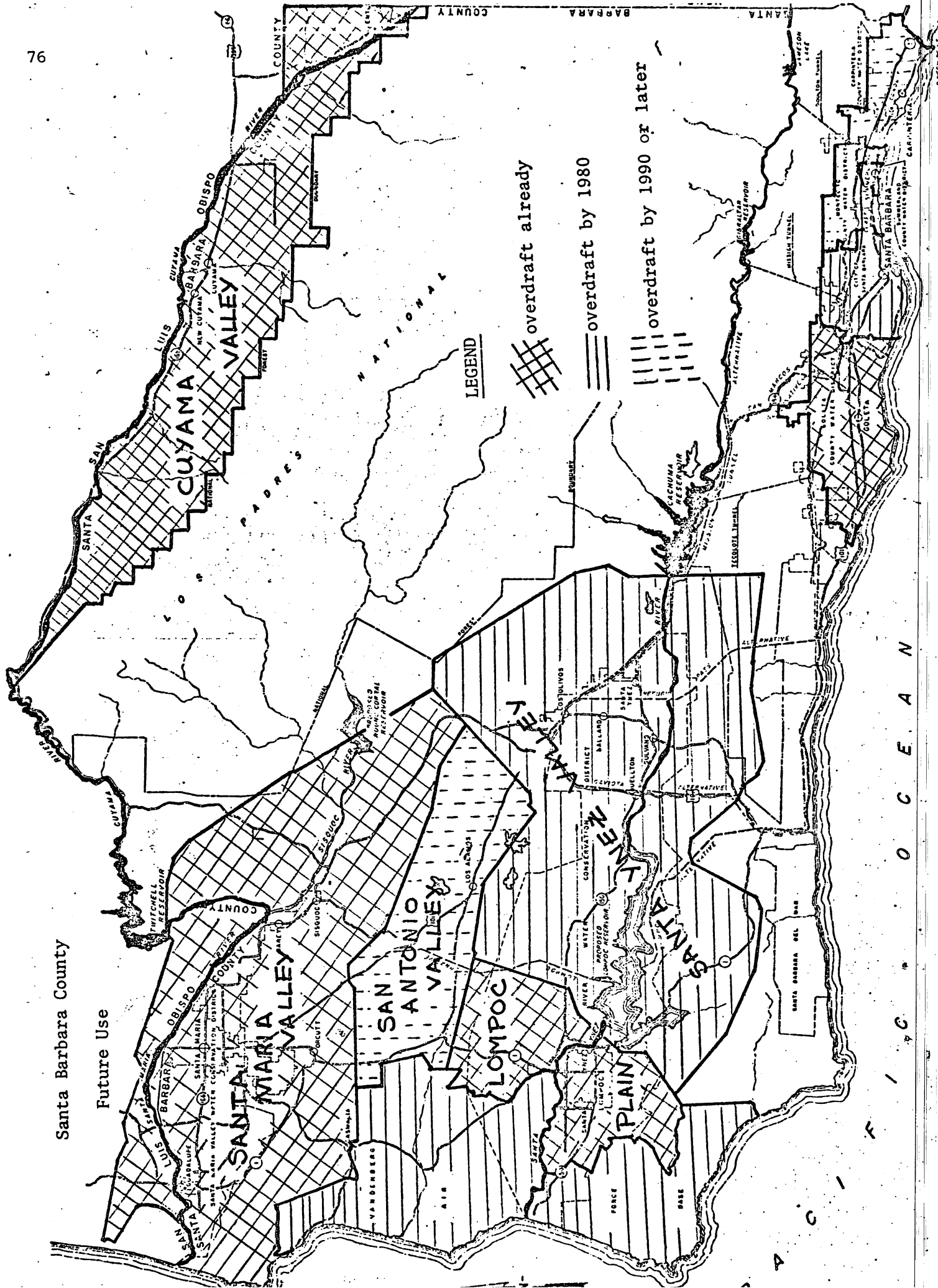
PACIFIC

OCEAN


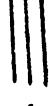
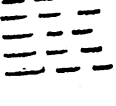


Santa Barbara County

Future Use



LEGEND

-  overdraft already
-  overdraft by 1980
-  overdraft by 1990 or later

A G I F I C O C E A N

more recent figures of between 14,000 and 15,000 af/yr, so B & E's tables were modified to accommodate this new data. This is not critical, since the valley remains in overdraft in either case. On page 26, Table 7, B & E claim San Luis Obispo users in the Santa Maria Valley are consuming 29,500 af/yr, for an overdraft of 10,500 af/yr. However, CDM states on page IV-30, Table IV-23, that San Luis Obispo consumes only 9,270 af/yr, for a 2,000 af/yr surplus.

Of the eight reservoirs in the two counties, four have had their safe yields revised because of difficulties due to weather, siltation, or water rights. The safe yield of Whale Rock, in the Central Coast Study Area, was originally estimated by the Department of Water Resources at 8,900 af/yr. However, because the drought period was underestimated, the safe yield is probably about half that figure according to CDM. Yield was so low that no water was delivered at all to the City of San Luis Obispo in 1970.

The Salinas Reservoir, on the Salinas River in San Luis Obispo, has run into water rights difficulties. Recently the town of Paso Robles filed a complaint with the State Water Resources Board, the adjudicator of water claims in the state, that Paso Robles was not receiving the 1000 af/yr to which they are entitled by the terms of their contract with the Army Corps of Engineers, the owners of the reservoir. Subsequently the Water Resources Board ordered the Corps to release water from the Salinas Reservoir. This order, however, has now been challenged by the city of San Luis Obispo, which operates the reservoir under a contract from the Corps. Obviously the legal interplay can become complicated quickly.

In Santa Barbara the safe yield of the Cachuma Project was lowered from 33,000 to 28,400 af/yr in 1967 by the U. S. Bureau of Reclamation, which used a longer drought period. If the new figures are correct, unfortunately, then Cachuma was overdrafted last year because of an administrative error by USBR.

The problem of water rights at the governmental level is an object lesson interdependence. The city of Santa Barbara draws much of its municipal water supply from the Gibraltar Reservoir on the headwaters of the Santa Ynez River. After a series of forest fires during the 1940s decreased the ability of the ground cover in the Gibraltar watershed to hold water, Santa Barbara raised the height of the reservoir dam, so as to increase the holding capacity of the reservoir. By doing so, it decreased the flow downstream, and so Santa Barbara contracted with downstream interests to release a certain quantity of water each year. Over the years, however, the Gibraltar Reservoir has slowly silted up, and its capacity has slowly dropped; estimates are that the safe yield, 4000 af/yr in the early 1950s, will be down to 3400 af/yr by 1990. This decline in safe yield has come at just the time that Santa Barbara's water needs were rising, and in recent years it has not released the amounts downstream which it has been obligated to do. As shortages develop downstream in the Santa Ynez River Valley, Santa Barbara will be forced to release water from Gibraltar. In order to make up the supplies, it will then have to claim its entire share of Cachuma Project water--in which the city also has an interest. When this happens,

there will be a water crisis, not in Santa Barbara but in Goleta, which is now using part of Santa Barbara's share of Cachuma water. This complex chain of dependencies, weaving together water engineering, legal rights, and political pressures, is further complicated by water-rights controversies on the Santa Ynez River. But, mercifully, we need not detail those further problems.

## Chapter III. Footnotes

- <sup>1</sup>Bank of America, "Focus on Santa Barbara" (San Francisco, 1970).
- <sup>2</sup>County Executive, Ventura County (California), *Study of Special Districts in Ventura County (1972)*. We are grateful to Karen Chase of the Institute of Governmental Studies for finding this report for us.
- <sup>3</sup>Will Baugham, "Special Districts in California," *The Tax Digest* Vol. XXII, No. 7 (July, 1944), p. 235, cited by the Institute for Local Self Government, *Special Districts or Special Dynasties?* (may 1970) p. 5.
- <sup>4</sup>U.S. Bureau of the Census, *Governmental Organization* Vol. 1, 1967.
- <sup>5</sup>An acre-foot is the amount of water necessary to cover an acre a foot deep. The average family of five people consumes one acre-foot per year.
- <sup>6</sup>The reports cited are CDM, Inc., *Report on Master Water and Sewerage Plan*, (San Luis Obispo County, 1972), Bookman and Edmonston, *Water Requirements of Santa Barbara County 1967 to 1990* (1968) and Bookman and Edmonston, *Program for Importation of State Project Water to Santa Barbara County*, May 1970.



#### IV. ECOLOGY -- THE LOYAL OPPOSITION

The last two chapters have described the Diablo Canyon desalting plant from two positive perspectives. If it is built, the projected water needs of two rapidly growing counties will be met; and furthermore, engineers trying to solve the difficult problems of large-scale desalting will have a valuable opportunity to observe and to learn from a large operating unit. Despite such apparent benefits to the local community and to the nation as a whole, Diablo Canyon has attracted opposition, some of it fervent. In part, as we have described above, controversy swirls around whether the benefits of sufficient water and sufficient learning would in fact be achieved. But there is also dispute about whether more water and more mastery of nature are benefits at all: there is also the matter of ecological balance.

A decade ago "ecology" was a high school vocabulary word, learned over breakfast, forgotten by lunch. Today it is enshrined in science and social studies curricula, embraced by businessmen, discussed by worried citizens. The recent emergence of ecology as a public byword has, of course, done some violence to its prim, scientific definition ("the branch of biology that deals with the relations between living organisms and their environment"). Before describing the ecological concerns which Diablo Canyon has drawn forth, therefore, we need briefly to describe the various expanded, sometimes contradictory meanings which "ecology" has taken in public discussion. We shall then be ready to plunge into Diablo Canyon's effects on the natural and social environment.

##### *The varieties of ecological experience*

Biology is not simply the study of living things; it is also the study of how living things get along with each other. Thus while the study of plants and animals is essential, so also is the study of how animals eat plants, how they eat other animals, all the while maintaining a stable balance of different species in a natural community. The division of biological science which investigates the workings of such communities is called ecology.

Long before man's influence on his surroundings became cause for human concern, naturalists had observed the checks and balances of natural systems. At its simplest, the population of an animal species is held in check by its food supply: when there are too many to be fed, some starve. For all its harshness, there is a certain elegance to this law of the jungle, and we call it the "harmony of Nature." Man alone of all the animals escapes this harmonious competition, living outside the bounds of his purely biological constraints--living literally by his wits, through the social orderings we call civilization. We have evaded the balance of

nature for many generations, longer than any other species, but we may not evade it forever--the world is only so big, and eventually we shall have to limit the growth of humanity either by design or by war, pestilence, or pollution. So long as man remains an animal the laws of ecology, however modified, will reassert themselves eventually.

Nonetheless, "eventually" can be a long time coming. Ecology came to the public eye by the efforts of many others besides scientists and bird-watchers. The ecology movement of the late 1960s and early '70s has drawn major sustenance from aesthetic dismay. The sight of smog-filled skies, scummy rivers and lakefronts, and the sound of industrial engines has brought to public attention the sad unfulfillment of America the Beautiful. This aesthetic concern mirrors the sense of harmony implied in the concept of a balanced ecological system. Progress, once our most important product, seems to tarnish a bit along with the family silver, blackened by sulfur dioxide from a nearby power plant.

To be sure, those in a position to appreciate the harmonies of nature are not the ones unduly pressed by the struggles needed to maintain that harmony. As a number of environmental advocates have noted, the ecology movement has so far failed to attract those whose personal environments are most severely damaged--the urban poor. The irony is that our affluence, and our appreciation of natural beauty, is founded upon the industries which pollute. There is uncomfortable symmetry in the richest of the world's nations producing both a heightened awareness of virgin wilderness and an unquenchable hunger to pave it over. It is a problem which is shared by neither the poorer nations nor the poor of our own country--though they show every intention of imitating our flawed path to development.

Imitation in this case is not simply a form of flattery, but points to a deep division of principle about man's relationship to his environment. Notice that we said above that man had evaded the constraints of his natural environment. This interpretation is open to question, since part of man's equipment is his brain, and therefore his capacity to communicate and to create social organization. It is possible to interpret civilization as a *natural* phenomenon. From this point of view man's exploitation of the natural world is, like that of a predator such as the wolf, part of the functioning of a very special, but no less natural, species. In particular, it can be convincingly argued that man's obligation is to manage his world to benefit his kind. Of course this management might include aesthetic features such as the preservation of wilderness areas for recreation, meditation, or simple solitude. Progress, from this standpoint, does not necessarily lead to pollution; indeed, since pollution has been recognized as undesirable, it should be eliminated as quickly and as cheaply as possible. This rather different point of view may be routinely seen in the attitude of ecologically aware businesses, though their awareness seems at times a bit self-conscious.

There are, then, at least three uses of the word "ecology": it can describe the scientific study of biological communities; it can describe an attitude which emphasizes the need for humanity to accommodate

to the needs and limits of the natural world in which we live; and finally it can describe an attitude stressing the role of man as the controller and coordinator of the natural world. The Greek philosopher Archimedes, so the story goes, once said, "Give me a lever long enough and I will move the world." With three overlapping, but also contradictory, meanings one can already generate a lot of confusion. The heated surroundings of American political debate do not help much.

For example, there is the oft-remarked way in which ecology has become a "motherhood issue": being openly against the preservation and improvement of the natural environment is somewhat akin to being against motherhood. (It should perhaps be noted that motherhood is no longer so sacrosanct as it was only a few years ago.) But in the words "preservation" and "improvement" there are the seeds of disagreement, since it is far from obvious that preservation of a wild area is an improvement for private, public, or even wilderness interests. Once again, we have the sense of "ecology" as preservation of natural balances, versus the sense of "ecology" as rational management.

So the conflict rages. But, it is worth emphasizing, the political process, with all its faults and distortions and outright failures, is about the best we can do at present. The scientific meaning of "ecology" is very much restricted to the animals and plants of the wilderness. There is no scientific theory which prescribes man's activities in using and misusing his world, though science can help one to understand and to predict the effects of human intervention into an untamed area. So politics, however messy, is needed in a democratic society as a method for ensuring that the desires and perceptions of persons living in the land may make a difference. Our natural environment is not something which can be left solely to "experts," whose judgments that a new power plant will have "no significant effect" on the environment may ignore things which are indeed significant to someone else less knowledgeable in the technical details.

Despite distortion and contradiction, the word "ecology" has done yeoman service as it has risen into the everyday vocabulary. The popularity, if not the clarity, of the word signals the development of an awareness that technological development is not necessarily beneficial to all, that people who are not direct consumers of a product must also live with the litter and other consequences of a product's use, that publicly funded development such as Diablo Canyon needs to be scrutinized in public view.

#### A. The Natural Environment

That public view first became available as a result of the National Environmental Policy Act of 1970, or NEPA as it is usually called. NEPA has become the cornerstone of law suits seeking to protect the environment from private and public encroachment and development. In addition, it gave birth to a new Federal apparatus to deal with environmental matters in the executive office of the President. NEPA itself authorized the creation of the Council on Environmental Quality (CEQ), a policy-

making body of advisers to the President. The Council is responsible for overseeing Federal programs to see that they conform to the requirements of NEPA and it also draws up national policies for environmental protection.

In December, 1970, a year after NEPA became law, President Nixon established an enforcement agency, the Environmental Protection Agency (EPA), to carry out the protective policies set forth by CEQ. EPA monitors pollution levels in a number of urban areas, investigates complaints, and enforces environmental codes. Most spectacularly, as in the case of DDT and phosphates in laundry detergents, EPA can take independent action to ban certain types of pollutants entirely.

By far the most potent provision of NEPA, however, is a relatively little-noticed provision which came to ever-wider attention after the law was passed. Section 102(C) of NEPA requires that, whenever Federal funds are to be spent upon a project which alters the natural environment in any significant fashion, the agency supervising that expenditure must submit a detailed environmental impact statement to CEQ. The purpose of the statement is to spell out in precise detail the kinds of environmental costs incurred by the project, including the following five specific areas:

- 1) the environmental impact of the proposed action;
- 2) any adverse environmental effects which cannot be avoided if the proposal is implemented;
- 3) alternatives to the proposed action;
- 4) the relationship between local short term uses of resources and the maintenance and enhancement of long term productivity;
- 5) any irreversible and irretrievable commitments of resources which would be involved in the proposed action.

Before the statement is submitted to CEQ for clearance to proceed, it is circulated to other Federal agencies with overlapping interests or jurisdictions *and to the public*. In other words, NEPA requires a declaration of intent to alter the environment, a declaration in public.

The rest is history. By a succession of landmark court cases, environmental lawyers opened up the potential in NEPA to delay, and in some cases to obstruct, development. Their primary tool was Section 102. In case after case, Federal agencies were so hasty and careless in the preparation of their environmental impact statements that courts halted whole projects until environmental studies of adequate depth could be done.<sup>1</sup> Note that these challenges were mounted on *procedural* grounds, not substantial ones. In other words, the courts have expressed no opinion on whether development of the natural environment is a good or bad thing. They have found only that agencies did not comply with NEPA's specific requirement for an adequate environmental impact statement.

Procedural grounds, though they are occasionally petty, are the heart of a legal system, and the defense of the environment through NEPA has been a soundly fought legal battle, with a strong advantage in the ecology camp. But the very strength of their case has had some interesting and subtle effects on the ecology movement as a whole. The central point is that

litigation has focused upon points 1, 2, and 5 in the list above--areas in which it could convincingly be argued that data were available, so that if these points were not well covered the agency seeking to build had a weak case in court. As we shall see in describing the ecological controversy surrounding Diablo Canyon, points 1, 2, and 5 have become the *only* matters of concern to ecology-action enthusiasts. NEPA has effectively set the terms of discussion.

Elsewhere in this report we cover points 3 and 4, the alternative supplies of water available and the problem of growth. In this chapter we shall concentrate on the ecological critique, a set of arguments which use scientific data to argue that the environmental side-effects of Diablo Canyon may be much more grave than the plant's designers had intended. A good deal of this argument involves the power plant which will power the desalting facility, so we need also to deal with nuclear power and its dangers. What the ecological debate reveals, interestingly, is that, to environmental advocates, "protection of the environment" means leaving it alone--no alternatives to the proposed action are suggested except for not doing it at all. Moreover, the perspective of a long-range enhancement of "productivity" is anathema to the ecological interests. What seems to be at stake here is an implicit notion that nature can regulate itself, heal itself--if only we give it a chance. To such generalizations and their political implications we return below.

### *Engineering versus biology*

What kinds of impact will Diablo Canyon have on its natural surroundings? The question is deceptively easy to ask. The desalting project includes the desalting plant, a nuclear power plant serving as a supply of heat, and a conveyance system to distribute the desalted water. Each component will have some side-effects which will change the surrounding environment; that much is sure. But about the desalting plant the California Department of Fish and Game said,<sup>2</sup>

The intake and processing of seawater will result in some degree of unavoidable marine resource damage which cannot be precisely predicted as to extent and consequence at this time. However, it is not expected to result in the elimination or serious reduction of these resources in this area.

Throughout the available literature there is little quantitative prediction of the degree of damage to the environment. Such changes are described as "minor disruption and elimination of marine habitat,"<sup>3</sup> or typically we find, "The relatively small grassland area of the proposed plant site will be permanently eliminated as a wildlife habitat. Installation of the product water conveyance system will have a less permanent impact."<sup>4</sup> All one knows for sure is that, at the plant site, the natural environment will be eliminated, and that the pipelines will have an effect that is less than total elimination. One has no way to tell how significant the effects of the pipelines and pumping stations will be.

Complaints of this type, however, are too easy to make. The people at Fish and Game are not stupid; there is really very little to know. Ecology, though a science with a long history, is comparatively undeveloped in comparison to a sophisticated discipline like chemistry. And for good reason. The natural world is extremely complex, and we understand very little about the ways in which species depend upon each other. In consequence, it is easy for opponents of a large-scale project to score debate points against those who propose to alter the natural environment. But it is not so easy to tell whether these are more than debate points, whether it really matters.

In the end, judgments must be made (though it is doubtless preferable that these judgments be made openly). At the present stage of ecological understanding, the best one can do is to point to potential ecological disruptions. Even here there is scientific controversy. Let us begin with the terrestrial effects, those that will change the land around the pieces of the Diablo Canyon project; the sea is somewhat harder to tackle, as we shall see.

*Terrestrial effects.* The impact of Diablo Canyon on the land will be confined to the elimination of several acres of land at the plant site, as well as the land along the right-of-way of the water transport system. In these areas, animals and plants which had formerly formed natural communities will be removed or relocated; in most cases, the displacement of the natural community is thought to be relatively harmless. Wildlife experts at the Department of Fish and Game have noted five areas of special concern:

- . the salt marsh near Morro Bay;
- . the habitat of the Morro Bay kangaroo rat;
- . plant growth along natural waterways;
- . a grove of Bishop pines on the Lompoc Branch of the water transport system;
- . a small wilderness area at Los Osos Oaks.

In all five cases, the experts judged that the project would not permanently damage unique or valuable wildlife. But not everyone agrees. It has been objected by some that the kangaroo rat, a species in danger of dying out, may have difficulty finding a new home near the water transport system--and that very little has been said about how it can be protected. To others, the places at which the water conveyance system crosses existing waterways and streams are points of worry. Construction and maintenance of the water pipes will require the clearing out of waterside vegetation near the pipes. These clearings, some have noted, will reduce the shade canopy which helps to regulate the temperature of the stream. In addition, construction at stream crossings could stir up large quantities of mud which would drift downstream, disrupting ecological patterns away from the construction site. Proponents of the desalting project argue that, with sufficient care in construction practices, such severe disruptions will not occur--and the extra care will be taken. Both sides, in any case, agree that the

environmental impact of Diablo Canyon on land will be slight and relatively unimportant.

*Marine effects.* By contrast, the effects on the marine habitat are much less certain, and therefore more threatening. There has been comparatively little work done in marine ecology. Such studies require many divers, lab personnel, and taxonomists to identify the different species. Underwater survey work is time consuming and expensive. Also, the marine environment changes at night, and in order to have a complete study, all tests and organism counts must also be done at night--an almost impossible task. Underwater searchlamps scare many creatures into hiding, affecting the counts of some species. Despite these difficulties some marine surveys are planned at Diablo Cove after the plant is built.

Part of the damage to the marine environment occurs when organisms are sucked into the desalting process. Of the seawater that enters the plant for desalting, about 185 cubic feet per second will be taken into the plant for processing (about 16 million cubic feet per day). Organisms which pass through the 3/8-inch mesh intake screens will be heated by about 27 degrees fahrenheit. Three quarters of them will be drawn into the main desalting chamber, where they will be deprived of oxygen and heated to 250 degrees fahrenheit. Also, periodic chlorine treatments will be used to remove mussels and encrusting algae from the intake system. According to the environmental impact statement,

it is reasonable to assume that nearly all organisms conveyed into the desalting plant proper would die as a result of one or a combination of these factors.<sup>5</sup>

Because the amount of water drawn into the intakes is a small fraction of the water in the intake cove, the plant is not expected to reduce the population of marine life significantly. But, since the intake is at a fixed depth, it will have a greater effect on life forms that characteristically live at that depth--with potentially serious consequences. Monitoring studies made once the plant is in operation will measure the significance of the damage.

Another potential danger to the marine community comes from the chemicals being used in the desalter. The chemicals include sulfuric acid, chlorine, sodium sulfite, and silicon. As of March 1972, the predicted effect of these chemicals was unknown:

A more explicit chemical and physical description of the waste and its behavior in the receiving water during discharge will be necessary before environmental impact can be precisely defined.<sup>6</sup>

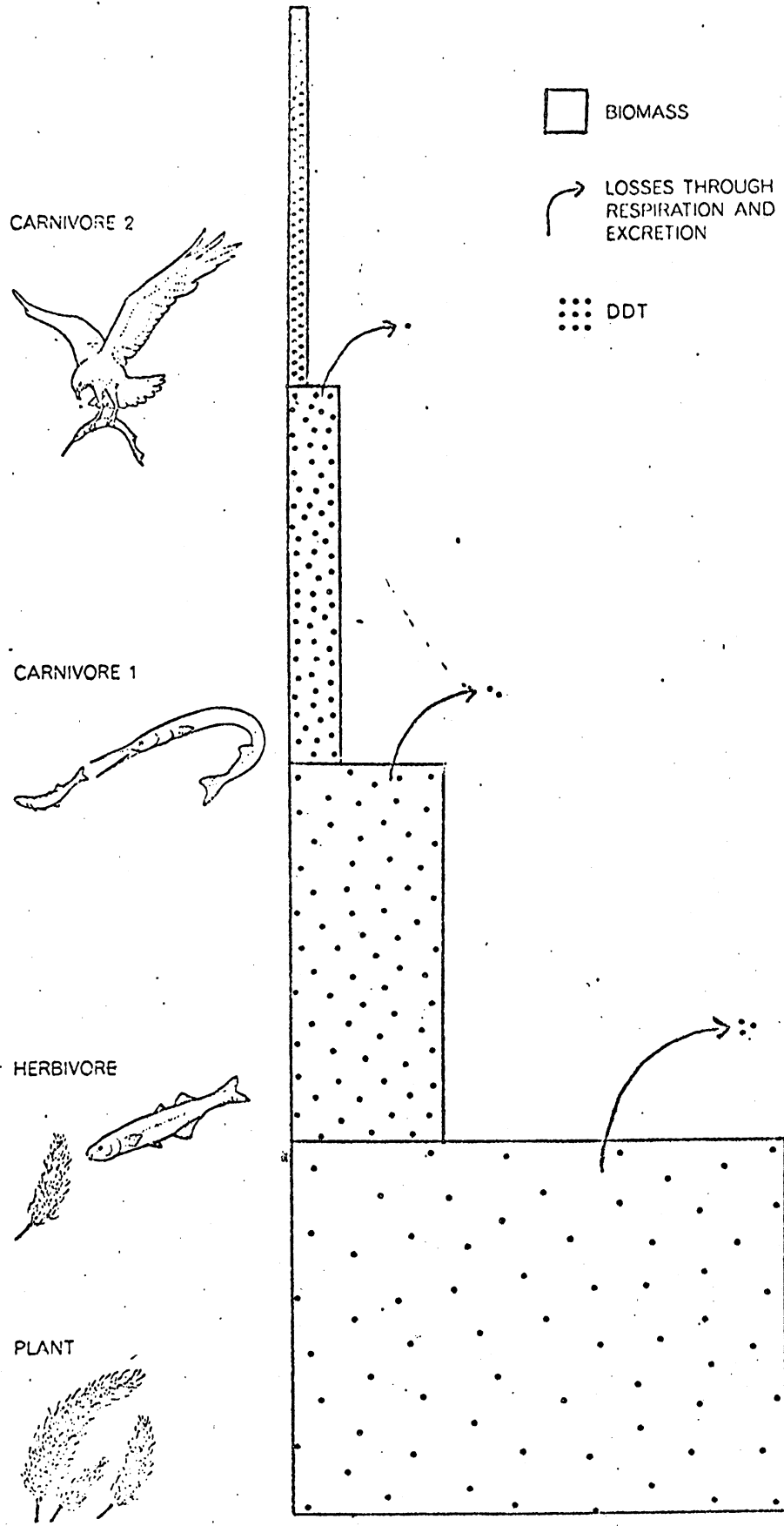
Even if the chemicals added are not sufficiently concentrated to be toxic, however, environmentalists insist that one must consider the ability of organisms to concentrate substances to toxic levels as they

progress up a food chain. As one animal eats another, the material of the consumed animal is incorporated into the predator. More than half of this new mass is lost through respiration and excretion. Toxic substances, however, are *not* excreted in nearly as high a proportion. So the concentration of these substances increases, sometimes by factors of thousands, as they move through the food chains. The highest concentrations often end up in carnivorous sea birds, who are at the top of many marine food chains. For example, in a study conducted along the south shore of Long Island, near New York City, it was observed that while plankton in the water contained only .04 parts per million (ppm) of DDT, a carnivorous scavenging bird (a ring-billed gull) contained about 75 ppm in its tissues.<sup>7</sup> To say that concentrations of chemicals released from the plant will be at safe levels is not enough to assure that there will be no subsequent damage. The ability of organisms to concentrate these substances to dangerous levels must also be considered. Unfortunately, food chains are intricate. Very little is known about the diet of each species.

Another difficult issue is that of the increased saltiness in the outfall area. Marine organisms are in a state of delicate equilibrium with the seawater in which they live. The salinity of the water surrounding an organism is normally slightly greater than that of the organism itself. Osmotic pressure develops and water is drawn out of the organism and into the surrounding water. The organism counteracts this outflow by various means, such as having impermeable body coverings or ingesting large amounts of water. Some scientists have claimed that increased salt concentration near Diablo Canyon will put a greater strain on organisms trying to adapt to it, and will severely weaken or kill them.

Another source of ecological damage from the plant is from thermal pollution. Water from the outfall, according to design projections, will be no more than 4 degrees Fahrenheit hotter than the water taken in. This criterion is consistent with the latest policy of the California State Water Resources Control Board for discharges into coastal waters. This 4 degree rise in temperature is not expected to cause any significant damage to the marine community near the outfall. Again, environmentalists point to the words "not expected to"; it is not really known what the effect will be. Thermograph monitoring and comparison with a survey conducted before the plant was put in will show if there has been any major change. Opponents of the plant argue that waiting until the change has happened is waiting too long. In addition to the effects of temperature at the outfall, there is also the problem of hot desalted water being pumped into the reservoirs of the area. Product water will leave the plant at about 85° F, and water this hot might cause serious damage to the life forms in the receiving reservoirs, especially Whale Rock, which also serves as a cold water fishery. A rise in temperature puts stress on organisms, especially those used to environments that vary only slightly in temperature throughout the year. Environmentalists point to several dangers to aquatic life from thermal change. A rise in temperature speeds up metabolism, and this increase in the biological pace of life can shorten the organism's life span. Reproductive ability may be cut back or altered (for example, above a certain temperature a small crayfish called





CONCENTRATION of DDT residues being passed along a simple food chain is indicated schematically in this diagram. As "biomass," or living material, is transferred from one link to another along such a chain, usually more than half of it is consumed in respiration or is excreted (arrows); the remainder forms new biomass. The losses of DDT residues along the chain, on the other hand, are small in proportion to the amount that is transferred from one link to the next. For this reason high concentrations occur in the carnivores.

from G.M. Woodwell, reference 7.

*Gammarus* produces only female offspring.)<sup>8</sup> And in severe cases, the stress can kill the animal outright. In the long run, a change in temperature that affects an animal's vital functions may be more subtle but no less harmful to the ecological community it belongs to. There is a precise balance among the components of a food chain, and a change in the life cycle of only one organism can upset the entire web of food chains to which it belongs.

*Summary.* It is clear that the environmental impact of the desalting plant cannot be precisely specified. There is room for doubt, and for disagreement, as to the facts of the matter, and contrary claims are rushed into the gaps of knowledge. On the one hand, governmental experts from offices such as the Department of Fish and Game note that Diablo Canyon will conform to the rules for minimizing environmental impact which have prevailed in the past. On the other side, environmental advocates protest that the problem is that past measures to protect the environment have not proved sufficient. Both are correct. The crux of the matter is the judgment of how much ecological damage is too much. Scare stories (which may be true) from the preservation minded are thrown into the balance against scare stories (which may be true) about water shortages from the development minded.

What is interesting about the ensuing controversy is that the desalting plant has not been the primary focus of argument at all, despite the potential disagreement which we have outlined here. To environmental advocates the desalting plant is a political ploy to justify the neighboring nuclear power plant: one of the environmental consequences of the desalting plant, from this point of view, is that it requires a source of heat--in Diablo Canyon a hotly controversial one in its own right.

### *The nuclear issue*

Nuclear power plants have excited much public debate. They provide a means of generating large amounts of electric power without using dwindling fossil fuel supplies. They burn with none of the heavy smoke of a conventional power plant. But they do produce pollution, pollution which is invisible to our unaided senses. All nuclear radiation is harmful to some degree, although a reasonable standard of danger is set by the level of background radioactivity from radioactive ores and natural radiation; nonetheless, less radiation means less damage, not no damage. In addition, the consequences of a major nuclear accident would be severe indeed. Nuclear accidents, fortunately, have been extremely rare by the standards of more conventional industries, and there have only been a few deaths, none of them in commercially licensed plants. Although the odds against a major nuclear power plant accident are enormous, the destruction it would cause in lost lives and contaminated property are huge as well. These are some of the underlying reasons for the controversy surrounding atomic power generation.

*Atomic accidents.* A nuclear plant cannot become an atomic bomb; the isotope of uranium used in nuclear weapons is not present in sufficient quantities to cause an explosion. There is, however, considerable danger from the release of radiation. The nuclear fuel is heated to about 4000° F when the reactor is running at full power. If one of the pipes carrying cooling water were to rupture, the hot fuel could cause serious trouble. The reactor would automatically shut down, but the tremendous heat still contained in the fuel would be enough to melt through nearly anything. There is, in addition, the possibility of a pressure explosion. The heat from the fuel rods could build up the pressure in the reactor vessel too fast for it to be let off. In each of the large reactors at Diablo Canyon, there are 39,372 fuel rods, with fuel weighing in at 218,530 pounds. If cooling were interrupted suddenly, these fuel rods could build up pressure fast enough to cause an explosion that, while not a nuclear explosion, could release large amounts of radioactive material to the environment.

Somewhat less serious is the meltdown of some of the fuel rods and subsequent release of radiation, a process called an excursion. Because of the large amount of shielding around a reactor, radiation is unlikely to get to the outside. Some radiation may escape from the reactor vessel itself, but it would probably be confined by the containment structure. While both these types of accidents are improbable, both have occurred. At the Atomic Energy Commission's National Reactor Testing Station in Idaho, "three men were killed by radiation and an explosion of steam when Stationary Low Power Reactor Number 1 (SL-1) underwent a nuclear excursion."<sup>9</sup> A meltdown occurred at the Enrico Fermi reactor near Monroe, Michigan. An entire fuel column melted, requiring five years to repair, and the repairs cost more money than would have been needed to build a new reactor. Fortunately, in neither case did a large amount of radiation escape outside.

Since then, there has been further intensive development of systems designed to prevent such accidents. These systems, termed emergency core cooling systems, have become a focus of controversy themselves. Opponents of nuclear power plants note that it is not certain how effective these systems are, since there have been no full-scale tests run yet. A series of scaled down tests have been run and some have shown promise while others have failed. Obviously, a full scale test on a multi-million dollar reactor is likely to be very expensive--especially if it does not work.

*Atomic ashes.* Another issue concerning power plants is disposal of wastes. Environmentalists claim that the clean appearance of nuclear plants is deceptive. It is true that there is no soot, ash, or sulfur dioxide pouring out of a nuclear smokestack. But the wastes are there, and they are becoming a serious problem.

Nuclear wastes are classified into two categories of danger. Low-level wastes are generally released into the environment for disposal.

These wastes, made up primarily of gaseous fission products such as tritium, krypton, xenon, and iodine, are generally released through tall stacks so that by the time they reach the ground, they have thoroughly mixed with the surrounding air and are in legal concentrations. Environmentalists claim much of this gas emission can be prevented, but it is not because it requires expensive filtering equipment. The power companies' reply is that filters are not necessary because the plant is not releasing more than it is legally allowed to. Small concentrations of other fission products, such as strontium-90, also escape. While the metal cladding of the fuel rods generally presents an impermeable barrier to the escape of fission products, about .2% of the rods in a reactor are customarily defective. In a reactor containing 40,000 fuel rods, like Diablo Canyon, this amounts to about 80 defective rods. By this means, radioactive particles can escape into the primary coolant surrounding the fuel rods. Radioactivity also appears in very limited quantities in the outfall of the secondary water coolant. This radioactivity is caused by neutron reactions with products of metallic corrosion; moreover, in pressurized water reactors (such as the ones being built in Diablo Canyon), fast neutrons react with boron compounds, producing tritium which becomes part of the radioactive water molecule HTO. However, due to the fact that the primary coolant is contained in a closed loop of sealed high pressure vessels, piping, pumps, and heat exchangers, the amount of radioactivity that leaks out is extremely small.

High-level wastes are a much more demanding problem. High-level wastes accumulate inside the fuel rods as the uranium fuel is burned. A 1000 megawatt water reactor has to be refueled about every three years. Often this is done in segments--for example, refueling one-third of the core each year. At Diablo Canyon, each reactor will have to be partially refueled every six months. The possibility of radioactive releases is most hazardous after the old fuel rods are withdrawn from the reactor. Immediately upon withdrawal, the spent fuel rods are placed underwater at the reactor site for a minimum period of 120 days. This allows the isotopes with short half-lives, such as uranium-237 and iodine-131, to decay to a level labeled safe by AEC regulations. After this storage period the wastes are sealed in shielded, cooled containers and shipped to a waste reprocessing plant. Wastes from Diablo Canyon will be shipped to New York by rail. The long distance increases the risk of an accident, of course, but the Atomic Energy Commission stands firm on its claim that the containers are sufficiently strong to prevent radioactive spillage even in the event of severe crashes.

At the reprocessing plant the zirconium alloy skin which holds the fuel is stripped off and the fuel pellets are chemically processed and refined, eventually yielding reusable plutonium and uranium. During this process more radioisotopes are released through tall stacks, notably krypton-85 and tritium. Some additional tritium is released as HTO to surface water. Non-reusable wastes, now in liquid form, are pumped into storage tanks holding from 300,000 to 1,330,000 gallons.<sup>10</sup> The liquid waste is kept circulating in the tanks in order to keep the temperature uniform throughout, so that hot spots capable of melting the tanks do not

develop. The amount of high-level waste produced at this time is several hundred tons per year. The exact amount is classified information because there is a close correlation between quantities of radioactive waste and the number of nuclear warheads a nation possesses. (Some reactors are specifically designed to produce plutonium for warheads, but the wastes are treated in the same manner as for commercial reactors.) In order to keep our nuclear strength secret, it is necessary to keep secret the quantity of our wastes.

The waste-disposal problem is not severe today simply because the quantities involved are small. At the 1971 Atoms for Peace conference in Geneva, however, Soviet physicist N. N. Bogolubov warned that by the end of the century yearly wastes will have mounted to 50,000 tons.<sup>11</sup> New storage techniques will have to be developed, particularly since the tanks now used to store high-level wastes last only about 30 years. The radioisotopes will in some cases last thousands of years, and the wastes will eventually reach such massive proportions that transferring them to new tanks every 30 years will be impractical.

*Reactors at Diablo Canyon.* As might be expected in this context, most of the controversy about the Diablo Canyon nuclear power plants is connected with radiation hazards. In addition, there is debate about whether the desalting plant can be used to study the environmental impact of desalting plants in general, when it is built so close to a nuclear power plant with major environmental impacts of its own.

The principal worry is undoubtedly radiation hazard. Environmental opponents claim that safety devices are inadequate to prevent a catastrophe if an accident should occur; this claim, however, has little technical support. More substantially, they feel that normal radiation releases may already be unsafe. The opponents cite the figures and arguments of John Gofman and Arthur Tamplin, both medical physicists formerly employed by the Atomic Energy Commission. Gofman and Tamplin stirred great controversy several years ago when they claimed that the radiation levels labeled safe by the AEC were actually dangerous. They performed statistical analyses purporting to show that, if the average exposure of the American population were to reach the legally permissible limit, eventually there would be a death rate of over 32,000 per year from cancer and leukemia, attributable to the high radiation dosage.<sup>12</sup> The AEC has cited contrary estimates, which suggest that current levels are safe, primarily because they are no higher than natural background levels. The nuclear industry designs their plants to meet Federal safety standards, and they are required to monitor emission levels constantly, so that they may be strictly controlled. The question of whether the allowed releases are safe, however, seems at present to be unanswered: there are too many conflicting scientific interpretations for any definitive conclusions to be drawn.

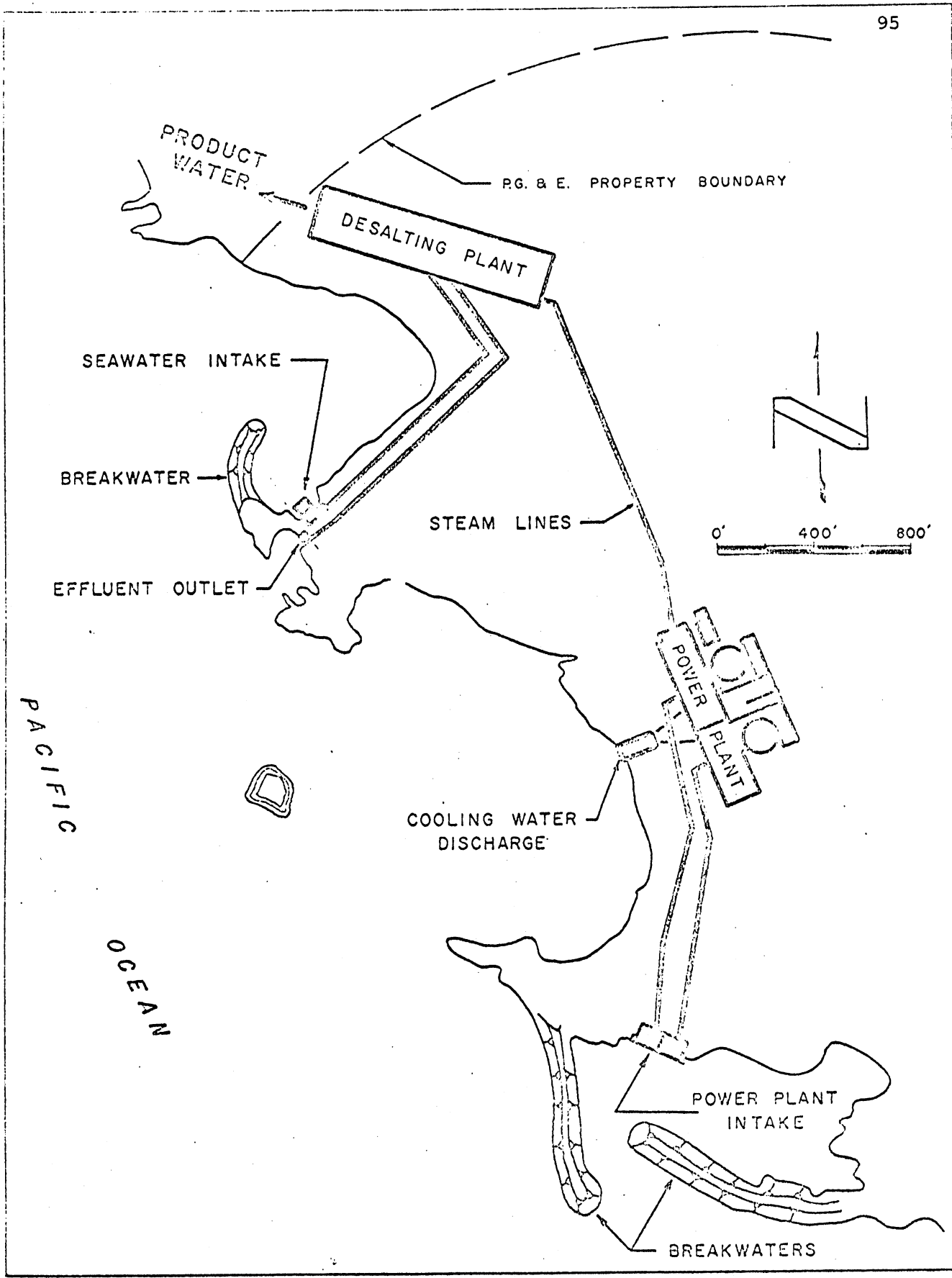
Local environmental activists also complain that they are being asked to assume the risks and costs of the Diablo Canyon plant without receiving any benefits from it--unless the desalting plant is built.

The electric power from the power plant will be used in the San Joaquin Valley, about 100 miles distant. To this complaint proponents bring forth the familiar argument that economic benefits will accrue, since jobs for constructing and operating the plant will be created. This benefit, the mainstay of many justifications of technological development, seems to us especially weak in the case of a nuclear power plant: the construction of a nuclear power plant is in large measure a highly specialized task requiring skills which are not likely to be found in a community such as San Luis Obispo; even in the operating phase, there is not much need for persons with the job experience and training typically found in a small city devoted primarily to education and agriculture. The direct economic impact of the Diablo Canyon plant, therefore, will benefit newcomers to the area, and it is only as they begin to spend their earnings in the region that economic benefits will be realized. These more diffuse effects seem particularly hard to balance against the low-risk but high-cost possibility of a major radioactive spill accident.

A separate argument over Diablo Canyon is the environmentalist claim that low-level radioactive wastes, under certain conditions, could be funneled into the intakes of the desalting plant. Normally winds in the area are from the northwest, but an occasional southerly wind might drive the waste coolant water from the reactor's outfall to the vicinity of the desalting plant. From maps and existing reports on currents, it is difficult to determine the gravity of this threat. Under normal conditions, the artificial breakwaters would not allow such cross flow to happen, but since there is no wind analysis available, opponents claim that abnormal conditions pose a real danger and that statements that the plants would be safe under normal conditions are mostly conjecture.

One biologist in the area also expressed concern over ocean currents spreading the warmer water from the nuclear plant into a thermal plume several miles long lying on the top of the colder ocean water. Such a plume could generate a large bloom of plankton that would deplete the water of oxygen. The oxygen would be used up in respiration while the plankton lives, and by decay following its death. In the oxygen-poor environment there would be increased algae growth, which would clog the filtering apparatus of shellfish, killing them. Finally, it could lead to an increase in certain undesirable species such as jellyfish and moray eels.

In addition, the fact that the nuclear facility and the desalting plant share the same site is significant environmentally. Since the facilities were not studied together to determine their combined impact, the effects may turn out to be somewhat different than had been anticipated. For example, the intake into the desalting plant would be about 150 million gallons per day; each of the twin nuclear reactors, by contrast, requires over a *billion* gallons of cooling water each day. It is known that the mortality rate of organisms drawn into the desalter would be very high, since the water is heated to such high temperatures. The reactors, which do not heat seawater by nearly as much, will also have large effects in the area because they use so much water. The synergistic combination of the two effects may be far more destructive than either would have been alone.



Plan view of the Diablo Canyon plants.

from State of California, the Resources Agency, Department of Water Resources; and U.S. Department of the Interior, Office of Saline Water, "Feasibility Report, Diablo Canyon Desalting Project," March 1972, p. 10.

One of the purposes of building the desalter is to determine its environmental impact. If this information is scrambled by effects of the nuclear plant, then information of major importance to future desalting plants will not be obtainable. Proponents argue that any desalter will have to work in conjunction with a heat supply, so that it is reasonable to assess the two together. Further, heat sources for desalting are likely to be nuclear power plants, both because they produce 50% more heat than comparable fossil fuel plants, and because nuclear power plants will be increasingly used in the future.

One of the hoped-for advantages of a desalting plant is that it might be able to use a significant portion of the waste heat from a power plant. In the case of Diablo Canyon, however, this benefit will not be realized, as the plant will use only five percent of the heat rejected by the nuclear reactors. Although the reactors will discharge a lot of heat into the sea, the discharge water will be within the range allowed under the January, 1971, ruling of the California State Water Resources Control Board. This means the outflow will not exceed the temperature of the surrounding water by more than 20° F. Again, this heat load, coupled with the heated effluent from the desalting plant, environmentalists charge, could do great damage to the marine community. After the plant is in operation, monitoring studies will determine how great an effect the two facilities have on the environment.

In short, many of the same biological questions raised by the desalter were raised earlier by the Diablo Canyon nuclear facility. The two sides are still far apart on the issues. Some environmentalists claim that the Pacific Gas and Electric Environmental Report on its nuclear reactors is wrong, some view it with cautious skepticism, and others are quite satisfied with it. P G & E's position is, of course, that its environmental studies are extremely thorough and complete. Professor Wheeler J. North, a distinguished marine ecologist at the California Institute of Technology, was the consulting biologist in charge of the marine ecology study. Opponents of the plant repudiate his findings, but North's unquestionable expertise on kelp bed communities such as those found in the Diablo Cove area lend his findings considerable authority.

### *The natural environment as a political issue*

The discussion of the last few pages has repeated a pattern which has become increasingly familiar in American politics over the past few years. A concerned, often impassioned group of environmental activists bands together to halt development, development which they equate with destruction of the natural environment. Their tactics are familiar: angry letters, demonstrations, speaking out at public hearings, and, as we shall see below, "working within the system" by campaigning for political candidates running on environmental-protection platforms. To those charged with technical development--especially, as in this case, development which is or was defined to be "in the public



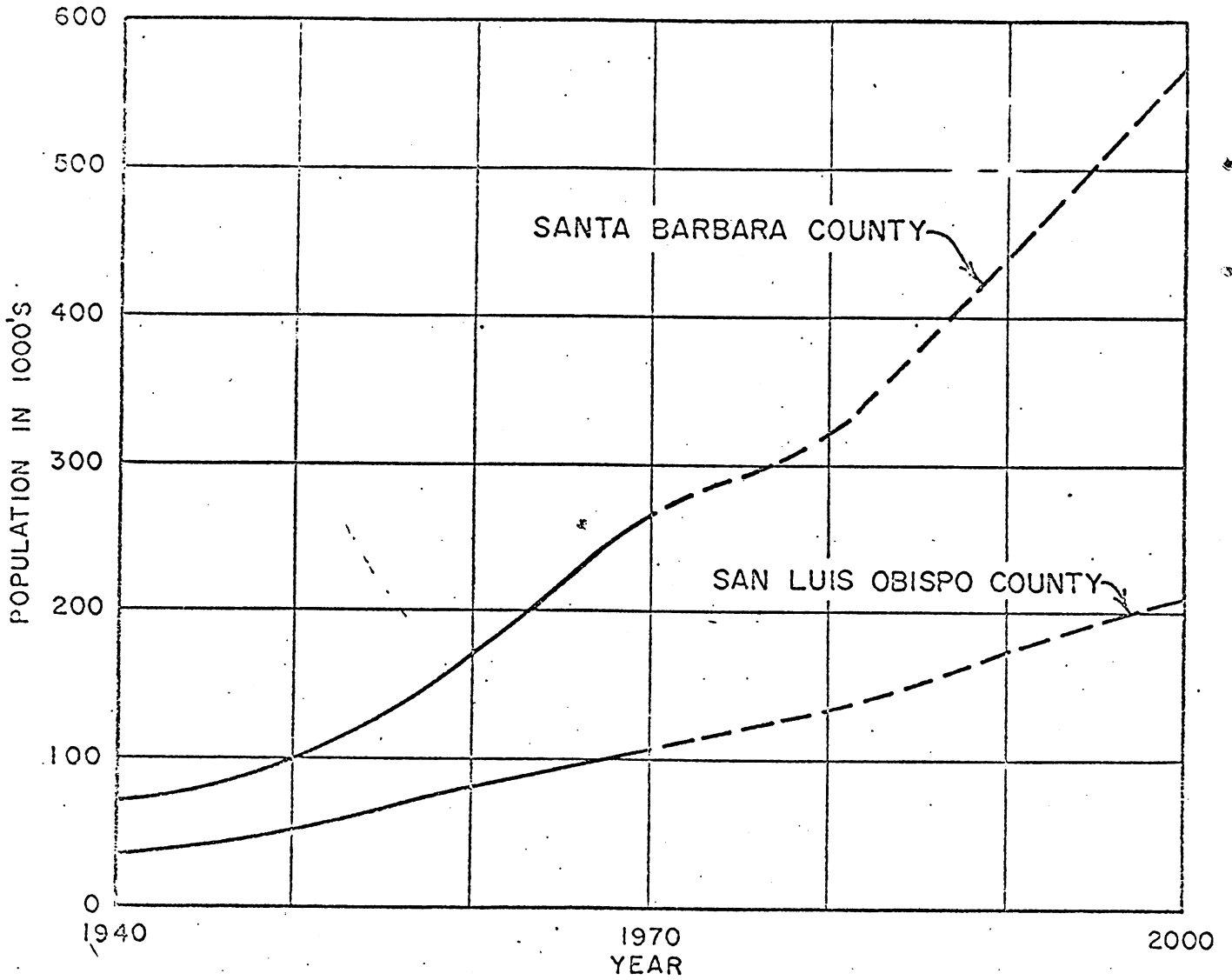
interest"--the ecology movement has often appeared to be simply obstructionist: they seemed to believe that any progress is bad. To a degree the exaggerations of passion and the hyperbole needed to win public attention have made apparent obstructionism a necessary part of ecology-action rhetoric. But such explanation does not excuse, and there are good grounds on which to chastise environmentalists for irresponsibility and extremism.

But the guilt does not all lie in one camp. What we have tried to do in this chapter is to outline the merits of the arguments of each side, and we have emphasized that there is substantial room for disagreement because there is so little known about the web of natural life in a particular geographical area such as Diablo Canyon. As our description has attempted to make clear, the scientific arguments of the environmentalists are, by and large, not answered *scientifically* by those who urge building the nuclear plant and the desalting plant. Instead, concern for ecological balance is weighed against the needs of the society to be served, and the plants and animals wind up losing in the judgments of those who are charged with development. As outside observers, we do not argue that the plants and animals have any intrinsic, inviolable rights, but the question of how man can respect and use his environment seems to us worth raising and dealing with. If the ecology-action "obstructionists" have raised that question, their pro-development opponents seem not to have dealt with it.

This lack, however lamentable, is thoroughly understandable. For the question of how to deal with the natural environment leads one straight to a harder and perhaps unanswerable one--how we ought to deal with the social environment. Proponents of Diablo Canyon are indeed on the right track, as are their opponents: what is worth sacrificing in the natural environment for human purposes? Their difference of opinion reflects, as we noted at the beginning of this chapter, different evaluations of the place of man in the scheme of things. But the scheme of things includes man himself, and so the key question of the environment turns out to be a concern for the human environment as well. We shall therefore take a brief look at a more directly social aspect of the environmental controversy, the problem of population growth in the South Coast area, an issue which takes us directly into an analysis of the politics of Diablo Canyon.

## B. Population Growth and the Human Environment

The California coast is one of the fastest growing areas in the country today. Both Santa Barbara and San Luis Obispo have projected that their populations will double by the year 2000. There is presently a small surplus of water in San Luis Obispo County and a slight shortage in Santa Barbara County. Neither county can support twice its present population without further water-resource development. These population predictions, of course, may not prove to be correct; they can be no more than intelligent guesses. Moreover, even if the projections are



Population projections for Santa Barbara and San Luis Obispo Counties

from California Department of Water Resources and Office of Saline Water, "Feasibility Report," op.cit., p. 22.

based on the best data available, there is the problem of how to take into account the declining penchant for growth in the affected communities.

Public concern over population growth is part of the growing awareness of the effects of environmental changes. Simple overcrowding can be environmentally deleterious, a possibility most readily apparent in the inner-city ghetto areas. The problem, however, is not confined to the big cities; it is simply more intense there. The land development boom is reaching every part of California.

In Santa Barbara, the immediate issue is the development of open land for housing. Large acreages of open land have been bought up and subdivided by developers, a phenomenon which is also occurring, though to a lesser degree, in San Luis Obispo County. In Santa Barbara, rapid growth in the last decade was triggered by the expansion of the University of California campus in Goleta. Now, in the wake of development, the area has become desirable: the geographical setting is beautiful; the climate is comfortably warm, with only a few rainy winter days each year; the city is large enough to have the conveniences of a large city, yet still small enough to avoid the problems of a metropolis. If the area were to double in population, many fear, it would lose its charm and develop many of the problems facing larger cities. Smog, for example, is a relative newcomer to the area and its recent appearance led a number of people in agencies and voluntary organizations to examine the population growth situation more carefully.

Much of the current argument over water-resource development is thus directly linked to population growth: if more water is not provided, Santa Barbara and San Luis Obispo *cannot* grow. The issue of growth, however, has arisen before and it is instructive to consider the competing forces in the earlier case.

### *El Capitan*

In 1970 a private developer sought approval from the Santa Barbara County Board of Supervisors for a large development which became known as El Capitan. El Capitan, located on the outskirts of the existing city of Santa Barbara, was to be a residential and recreational development including planned open space, apartments, single-family dwellings, and a campground. Initially, the board of supervisors and the county planning commission were both favorably impressed with the careful design of the project.

There was some in-house opposition, however, from the county planning department. The department supplies the planning commission with technical information and evaluation of plans which require rezoning of property. In 1965 the county had adopted a general plan which outlined the then-existing and future boundaries of development

in Santa Barbara County. El Capitan did not conform to the General Plan, lying as it did five to seven miles away from the nearest development. This placed it outside the "urban envelope," the area specifically zoned for urban development. To the professional planners at the planning department the location was of major importance. A large increase in population requires many services such as water, sewage, and fire protection, which have to be provided by local government, and the cost of such services would be extraordinarily high for El Capitan. Regardless of how well El Capitan was designed as a new unit of development, the planners felt, its location made it a costly project to local government--one which needed public approval.

Public approval was not easily won. The Sierra Club mounted a county-wide campaign against El Capitan, charging that the new development was an attempt to leap-frog the boundaries of the urban envelope of Santa Barbara so that further sprawl would be possible. The campaign took shape around a ballot referendum to decide whether El Capitan would be rezoned. The measure was voted on in November 1970 and the El Capitan development was defeated in all five districts of the county.

The Sierra Club campaign, it is worth noting, took the planners' position, but for slightly different reasons, stressing the aesthetics of suburban development rather than any need to adhere strictly to a general plan. The campaign also capitalized on the legal position of the planning commission, which had sought to approve El Capitan without seeking ratification of a change in the legally defined General Plan--a tactic which avoided public hearings on the effects of El Capitan on the surrounding area. While this process avoided public confrontation, it left El Capitan in the position of being classed officially "non-urban." According to the guidelines of the Agricultural Preserve Program, as interpreted by the planning department, "non-urban" means no more than one residence for each hundred acres of land. The legal conflict between the design of El Capitan and the provisions of the General Plan set the stage for a ballot initiative, with the clear political advantage to the opponents of development.

Even beyond the legal maneuverings, however, El Capitan served an important political function. The widely publicized conflict over land development alerted many citizens to the possibility that growth could be detrimental to the social environment of their city. Political debate, in short, has taken a technical violation of the General Plan and transformed it into a wide-ranging reexamination of the underlying economic assumptions of the whole community. The process, it should be stressed, is not logical--something that should not detract from its legitimacy. It is, in fact, similar to the manner in which each of us becomes aware of a problem in our own lives--a search procedure that goes by fits and starts and sometimes by leaps. The solutions to problems are often arrived at logically, but finding the problems to begin with is usually a less tidy matter.

*Growth and water*

Diablo Canyon, in any case, has now become another opportunity for the community to assay its feelings about population growth--and to decide how Diablo Canyon can serve these desires. Note that this interpretation of the social significance of the desalting plant looks beyond the immediate problem of water shortage in Santa Barbara, and it ignores the opportunity for technological learning, which carries benefits to those outside the immediate area. The situation puts those who favor the plant, either because it would alleviate the water shortage or because it would provide learning benefits, in a curious bind. They are forced to take a position on growth even if they do not have an opinion either for or against growth. Political sense and common sense come to a parting of the ways. This dilemma would be expected to lead to considerable ambivalence on the part of proponents of the plant. Consistent with such a guess, we found that opponents of the plant had much to say about why they opposed it, while proponents tended to fall back on stock arguments which seemed less than convincing even to those who put them forth. We shall return to this point below.

To environmentalist opponents, anyway, the issue is clear cut. A plentiful supply of water will make it possible for large numbers of people and industries to relocate in the area, and Diablo Canyon will supply more water than is needed by the present population. The desalting plant, in other words, will prompt further growth. Water from the State Water Project, as noted earlier, would have the same effect, and so it is opposed as well. In addition, opponents point to a "suspicious" coincidence: a portion of the Diablo Canyon conveyance system would also be used to deliver State Project water. Diablo Canyon, they reason, will obligate the area to tie in to the State Water Project in the future. Such forms of analysis have led opponents to take positions which some have labeled extreme. One of the leaders of an ecology-action group in Santa Barbara, for example, wants to stop Diablo Canyon cold. He opposes the desalter, the power plants, and all other nuclear power plants as well. His opinion is that the environmental situation is bad enough now, and that power plants, industry, and other large developments must be stopped immediately before the situation deteriorates further. The people on the other side of the argument admit that the environment is damaged, but add that it can be repaired only with more technological development. They point out that machines such as scrap-metal compactors and reverse-osmosis plants for filtering water require large amounts of electrical energy, so that to stop power plants is to consign the environment to further destruction.

Positions are less intransigent in San Luis Obispo, primarily because the county has an adequate water supply for the present. The towns of Paso Robles and Atascadero, however, are already drawing more water out of the ground than can be supplied naturally, an indication that a water shortage in these places may be imminent. Also, the Bay-

wood area has begun to ration water. County officials continue to claim, nonetheless, that with careful use their present resources will meet demand until the year 2000.

But concern about growth is also on the upswing in San Luis Obispo County. The north end of the county is apparently trying to attract people to the area, although one person in Atascadero claimed that this was definitely not the wish of everyone in the area. He explained that many people in the area liked the large expanses of open land and wanted to keep them that way. Throughout the whole county, most of the opposition to growth comes from long-time residents of the area who own a lot of land and do not want to see any major influx of people. Although it would be a long time before this area would be heavily developed and industrialized, opponents to growth do not want to see it start: aesthetics is very much a part of ecology here. Even if there would be minimal, strictly biological damage resulting from growth, development by itself scars the landscape, in this view.

Francis Bacon once wrote, "We cannot command Nature except by obeying Her." Some people interpret this to mean that Nature is not to be tampered with in any way. But is all human intervention bad? The housing developer would reply that he ought to make the environment pleasing to the people living in his homes. People have to live somewhere, and why not in desirable locations? To him, being ecologically responsible means supplying a pleasant place to live. He claims he is not contributing to *uncontrolled* growth since his development is carefully planned, and in any case he is only meeting the demands of people who wish to buy homes. The ecologist responds that housing construction by itself creates a demand and encourages people to come into the area, taking up open land which should be preserved.

### *Cures*

It is important to stress, nonetheless, that ecology is not a primary concern of the great majority of the population. To many people, there are other problems which come first, and, for now at least, they can live with the environment as it is. Some of these are people who oppose environmental protection because they are afraid of losing their jobs. The opposition to Proposition 9 in the 1972 statewide election capitalized on this point--apparently to good effect since the initiative was soundly defeated. In more general terms, almost any industry is vulnerable. Even if the clean-up procedures themselves do not bankrupt a company, they may absorb a large part of the corporate profits. The investment market is very sensitive, and, if a company is not showing good financial progress because it is making large outlays to protect the environment, investors will take their capital elsewhere.

The "obvious" solution is the one most often proposed: that government should intervene to pay for the cleaning up of the environment. Whether this approach solves anything is as yet unclear; certainly it pushes directly into the political sector the difficulties and confusions which we have attempted to lay out in this chapter. It is time now to see how the political process provides a forum for dealing with Diablo Canyon.

## Chapter IV. Footnotes

- 1 For a polemical survey of these landmark cases, see Philip Herrera's half of John P. Holdren and Philip Herrera, *Energy* (San Francisco: Sierra Club, 1971).
- 2 "Impact on Fish and Wildlife of a Large Desalting Plant at Diablo Canyon," State of California - The Resources Agency, Department of Fish and Game, March, 1972, p. 1.
- 3 *Ibid.*
- 4 *Ibid.*
- 5 "Draft Environmental Statement, Proposed Diablo Canyon Desalting Project," United States Department of the Interior, State of California - The Resources Agency, March 2, 1972, p. 61.
- 6 "Impact on Fish and Wildlife of a Large Desalting Plant at Diablo Canyon," State of California - The Resources Agency, Department of Fish and Game, March, 1972, p. 2.
- 7 G. M. Woodwell, "Toxic Substances and Ecological Cycles," *Scientific American*, March, 1967, vol. 216, no. 3, p. 31.
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## V. POLITICS--SUMMARY AND ANALYSIS

In the ideal world of the political philosopher, the political arena is a public space in which members of society assemble to make joint decisions about their lives together as citizens. But while we still associate the word "politics" with the *power* to decide, it is the rare citizen who claims for politics the *wisdom* to decide well. Today's hardbitten democrat acknowledges--perhaps too readily--that public decision processes do not cope with the range of facts needed for accurate judgment, much less that they are able to embrace the wide span of conflicting values. There are, however, glimmers of hope, if no solid optimism. Some have seen in the rise of the environmental issue a sign that citizens are becoming sufficiently involved to revive political debate. A recent study of the Santa Barbara oil spill concluded bravely that

The importance of the...oil spill and its local aftermath lies...in its clear illumination in the public limelight of the emerging political competition between old and new economic and ecological lifestyles.<sup>1</sup>

The good intentions and guardian angers stirred up by the oil spill and the specter of further urban blight, however, will not by themselves solve the problems of water for growing populations, of managing research programs in desalination, of population growth, and of allocating local and national power for social decision-making--problems which our earlier chapters have brought up. For these feelings are not so much the substance as the setting of politics, of joint decisions. In this concluding chapter, therefore, we shall analyze Diablo Canyon as a joint decision, as a political problem.

Our examination of the desalting plant has led us far afield. Diablo Canyon turns out not to be a single story, but a tangled bundle of stories. The initial task of our analysis is to summarize, to pick out what is meaningful and useful in explaining the political evolution of Diablo Canyon. What emerges, as we shall see, is the separateness of different views on the desalting plant. To local citizens the problems which the plant might cause, even the benefits which it might bring, are vastly different from the problems and benefits which interest the state and Federal proponents of the plant. To local citizens the problems which the plant might cause, even the benefits which it might bring, are vastly different from the problems and benefits which interest the state and Federal proponents of the plant. This divergence of perspectives, which has been a prominent feature of the settings we have described in earlier chapters, permits us to identify several problems of communication which will, in our judgment, shape decisions on the plant. These difficulties and pitfalls are the subject of a concluding evaluation.

### A. Analysis

Without the common coathanger, the closet would be a mess. In our attempts to think about the mass of data we have collected, we have found

a number of conceptual coathangers quite useful. In an important way, the ideas to be introduced here make up a theory, our theory of the manner in which social interactions take place. But we intentionally call them "coathangers": the emphasis is on neatness rather than on the sweeping explanations brought to mind by the grand word "theory." Unlike the chemist, the social scientist can only rarely call upon the uncommon sense of high-powered mathematics and sophisticated experimental data. We do have a measure of common sense, however, and when the coathangers have done their work, a long-lost item sometimes turns up on the closet floor.

To begin with, then, we shall make two distinctions which together help to get us started.<sup>2</sup> We have talked about Diablo Canyon as a technology, but it can be analyzed more closely than the single word technology permits. It is useful to distinguish between the *technical capacity* of a technology and its *implementation*. A desalting plant does a number of things: it produces fresh water, most importantly; but it also uses up some waste heat from its accompanying power plant, it heats up sea water in its immediate vicinity, it makes new jobs for its home community, and so forth. Any technology, therefore, may be split up into a bundle of technical capacities: fresh water, waste heat utilization, waste heat rejection, employment, and so on. These various capacities are not, in general, all concentrated at a single geographical location. The fresh water from Diablo Canyon will be pumped through a two-county area, for example. Thus, the capacities which comprise a technology are implemented in a specific pattern. So far as social significance is concerned, both the technical capacities of a new technology--for instance, its environmental side effects--and its implementation--where the environmental damage will occur--are important. That was, indeed, why the hazard of an oil spill (a capacity of offshore drilling technology) became a *cause célèbre* when the spill dirtied the beaches of a prosperous and densely populated region.

Not only are capacity and implementation distinguishable, but obviously each is differently *perceived* and *responded to*. These two distinctions now allow us to summarize the concerns of four principal groups of political actors: engineers in the Department of Water Resources and the Office of Saline Water; county officials; ecology-action activists; and backers of the current patterns of growth. As the chart shows, each of the groups stresses

#### PERSPECTIVES ON DIABLO CANYON

	technical capacity [action]	implementation [intention]
perception	engineers	ecology action
response	county officials	<i>status quo</i>

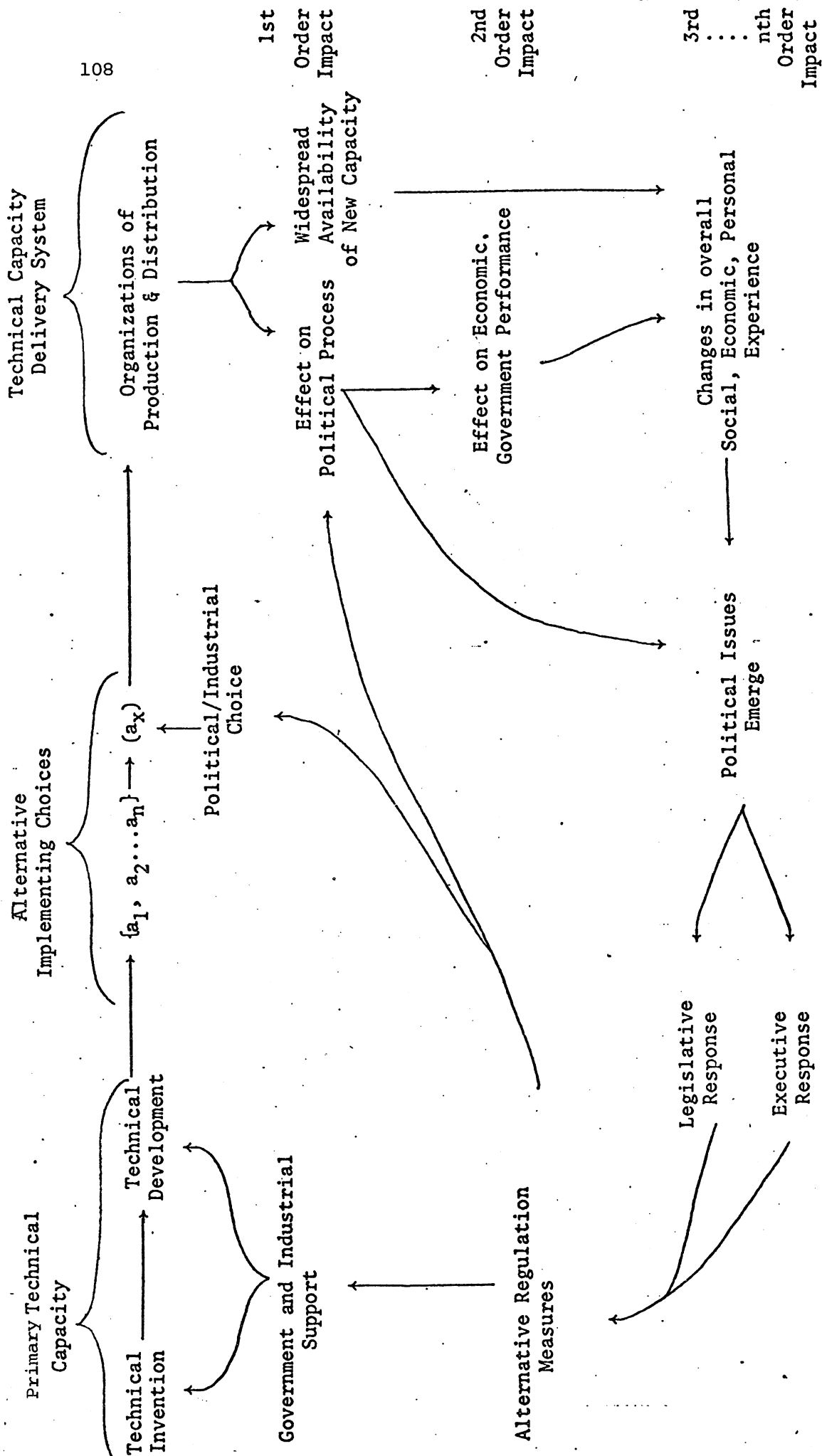
a different view of Diablo Canyon not only in substance but in form. The mutual misunderstandings which we found are partly traceable, therefore, to this tendency of different actors to speak *different conceptual languages*.

To the state or national engineer, Diablo Canyon is perceived as an opportunity to learn from the technical capacity of a large-scale plant. To the county officials who need to provide water for their growing communities, Diablo Canyon's ability to produce fresh water is one of a number of responses to a water shortage, one of which they must choose. To environmentalists fearful of ecological damage, what is foremost in their worry is the kind of environmental insult which will follow the construction of plant and conveyance system; their activities, moreover, have focused on sharpening community perception of the ecological costs which they fear Diablo Canyon will entail. To those who favor continued growth, however, these fears are of minor consequence, so long as the human population is adequately served; they point to the projected needs and present-day shortages in Santa Barbara as the only justifications which count. Notice, finally, that those who are concerned with the technical capacities of the plant are those who are most intimately involved with action--the building of the plant and its operation; those worrying about the implementation focus upon the intentions behind the plant--what it is meant to do, and what it might lead to. Thus, those in the right side of the chart are implicitly more concerned with legitimacy, and thus with politics; those on the left are professionally involved, which is to say that they worry about administrative problems of the desalting plant.

### *The flow of social interaction*

This preliminary sorting of the principal actors lays the groundwork for understanding their conflicts with one another. The timing of these conflicts is often decisive for the outcome, as we noted in the case of the El Capitan development. We may organize our data along the lines of the accompanying chart.<sup>3</sup> The chart is in a number of important respects oversimplified; nonetheless, it provides us with an indispensable bird's eye view.

*The pattern of interaction.* Consider first the way in which new water supplies are developed and delivered to a community--and how the community can react. In following out this example, we shall be able to identify the channels of political communication which characteristically inform and shape decision-making in large-scale technologies financed or licensed by public bodies. The upper left corner shows the first stage in the development of technical capacity, the conceptual outlining of the technical possibilities. It is important to note that here "technical capacity" includes a number of different technological options. Thus, a community which is running short of water may be able to choose a number of different strategies--conservation, mining of ground water, desalting--each of which provides the primary capacity, fresh water for the community. Each differs, however, in its costs and in its side effects; for example, a new reservoir may have to be sited on a major landowner's property, but he is too wealthy and powerful--and too reluctant to move--so that the "cost" to the community of a new system of wells may be lower, when one counts in the delays of litigation, the penalties suffered by public officials, and so forth. Even in cases in which one technology, such as a major dam and reservoir,



(Governmental Process)

PATTERN OF TECHNOLOGY - SOCIETY INTERACTION

is clearly best, the details need to be worked out. This usually done through an engineering feasibility study, in which professional engineers attempt to give an economic and technical estimate of what it would take to build the dam. For example, a study just completed in 1972 by the U. S. Bureau of Reclamation analyzed six possible sites for a dam in what is called the Lompoc project. After considering the advantages and disadvantages of each site, the Bureau recommended one particular site as the best place for dam construction. Often such technical recommendations are accepted by some public body such as a county board of supervisors, which then authorizes construction and the taxes needed to pay for it.

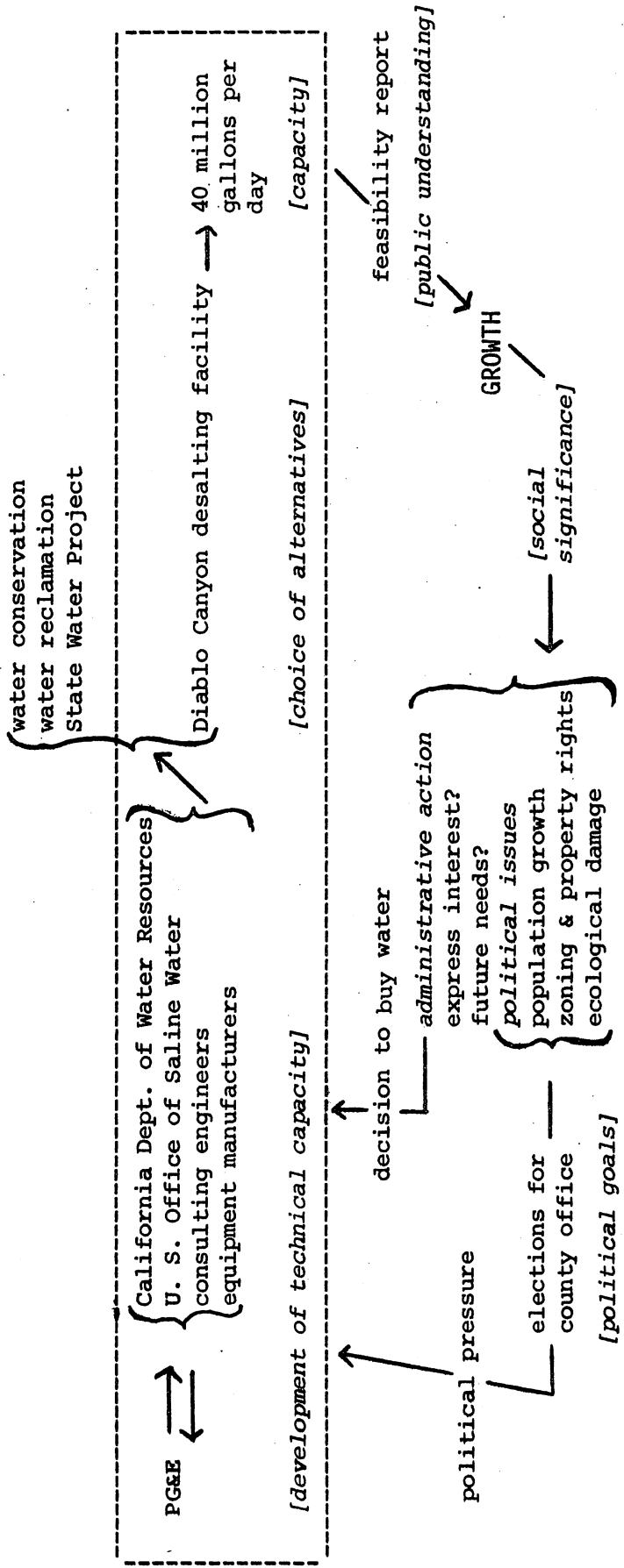
Once such a choice among alternative implementations has been made, the focus shifts to the upper-right corner, the building and operation of the technical capacity. The widespread availability of new water has a number of direct, or first-order, impacts. Obviously, for example, it will alleviate any existing water shortage, and in the process it will probably increase the relative importance of governmental bodies--the tendency toward "big government" so much decried by conservatives. For example, the Cachuma dam was built by the U. S. Bureau of Reclamation, which took on the responsibility of drawing up contracts with the county for the distribution and sale of water from the reservoir. Two new local agencies were born as well. The Santa Barbara County Water Agency, created by a special statute in the California Water Code, was set up to collect payments from water users--the individual water districts and departments--and to make repayments to the U. S. Bureau of Reclamation for the county's share of construction and operation costs. As explained earlier, the county supervisors serve as directors of this agency. In addition to a financial body, an administrative one was also called into being by the new dam, the Cachuma Operation and Maintenance Board. The board is a nonelective body charged with day-to-day upkeep tasks, including the maintaining of water flow. A single dam, therefore, created new agencies and gave new powers to existing bodies into the political "ecosystem" of Santa Barbara County.

In the second order of impact, economic and government performance are affected. For instance, water from a large project would tend to increase water prices throughout the county. If the increase were large enough portions of the society would be priced out of the market. Farmers, for example, might be forced to change to crops which consumed less water or to sell their land to a large landowner, either for continued agriculture or for residential and commercial development. Also, an abundant source of water in an area tends to attract industries which need the water in their production process. Consequently, either type of social and economic readjustment could cause an increase in urbanization. As far as the government is concerned, one would expect some confusion and indecision in the political process while the new agencies sorted out their responsibilities. The government would probably find its revenue increased slightly, but the increased taxes are in many cases swallowed by the need to increase public services. The responsibilities of governing a new project demand time, energy, staff, and money.

The impacts continue to ripple out into many sectors of society. Some of the effects are felt by individual citizens. They would probably see an increase in their water rates, and perhaps in their property taxes, so that the bond issue used to finance the project may be paid off. As citizens begin to sense these indirect changes, political issues emerge. If urbanization were a result of the increased water supply, for example, the government may now feel pressure to deliver even more supplemental water to the community in order to meet the needs of a growing population. In order to delay another costly project, the government may begin a water conservation or rationing program. This would give them time to conduct further studies aimed at finding other sources of water. Their interest might tend to encourage industry to develop new technology to provide fresh water. If there were no new technical concepts ripe for development, the government would make a choice from the alternatives already available. Their experience with a dam would be likely to influence their next choice heavily. And their decision might also be affected by the economics of building a regionally supported source of water. In Santa Barbara, the Cachuma Project was the first large-scale water supply developed to serve a large portion of the county's population. If a regional program proved to be economical, the board of supervisors might well look for another large-scale project for their next source of fresh water.

*Diablo Canyon.* In the case of the proposed desalinization plant at Diablo Canyon, something very unusual has happened. Instead of following the traditional pattern of social interaction, political issues began to emerge in the area *before the plant was actually chosen* from among the various alternative means of supplying water. The mere possibility of introducing an additional forty million gallons a day of fresh water into the area has caused a wide debate in the public sector and some pointed issues have been raised. The following chart is a concrete version of the previous one. In this flow diagram, the boxes have been filled in with appropriate names and issues.

The dotted box represents the first two steps of the original chart, the outlining of potential technical capacity and the choice of one of the alternative implementing systems. The persons and institutions enclosed by the dotted line make up what are usually thought of as the people who carry out the technology: a utility company, state and Federal agencies, equipment manufacturers and resource-planning engineers. Notice that the interactions leading to the proposal that the plant be built included only people at the state and national level--the citizens of San Luis Obispo and Santa Barbara were left out of the initial design phase, in which such matters as the size of the plant were decided. This practice of including local or community interests only after the design process has mostly been completed is by no means unique; indeed, it is the rule rather than the exception. Major public technologies, such as nuclear power plants and the Bay Area Rapid Transit system, we have long agreed, should be designed by politically neutral experts who "know what they are doing." That kind of knowledge, however, is by itself insufficient to inform wise actions; it is enough only if the things included in the dotted box are *relatively unconnected* to matters outside. That is, an expert can only know what he is doing, with regard to a large-scale technical project



Diablo Canyon: the process of decision

like Diablo Canyon, if his engineering task is truly distant from the everyday lives of the people who are affected. In Diablo Canyon, as we have seen, the issue of growth has made the technicalities of desalinization politically important. In such an atmosphere even the alternatives to Diablo Canyon are closely scrutinized. And it is no longer possible to divorce technical from political considerations.

The early going, nonetheless, was smooth enough. Work on a large-scale demonstration desalting plant was initially authorized by two laws. California's Cobey-Porter Act of 1965 and the U. S. Saline Water Conversion Act of 1971 allocated funds for planning studies, which were started in May 1970. Under the terms of the Federal act, the Secretary of the Interior was to report on the studies to the Congress by July 1972, and he was at that time to recommend a prospective site for the desalting plant. As we detailed in Chapter II, the engineering criteria set for the plant included the ready availability of heat to run a dual-purpose plant and a market for supplemental water of about 50 million gallons per day by 1980; of the markets and power plants in California which were studied, the Pacific Gas and Electric power plant at Diablo Cove and the San Luis Obispo-Santa Barbara water market were clear leaders. A feasibility report was then commissioned; it was published in March 1972.

At this point, copies of the reports were sent to the supervisors of San Luis Obispo and Santa Barbara counties and the decision process began. The time schedule in the two counties has been basically the same, although the processes differ somewhat in detail, as we shall note below.

On April 7, 1972, a month after the feasibility report was published, there was a meeting of the California Water Commission in San Luis Obispo. The meeting was the first public discussion of the report and there to answer questions were representatives of the California Department of Water Resources (CDWR) and the Office of Saline Water (OSW), including J. W. O'Meara, OSW's director. Copies of the feasibility report were also made available to citizens who attended the meeting. A week later the two counties received requests from William R. Gianelli, director of CDWR, for a statement of interest in the desalting plant. Both CDWR and OSW felt a concrete expression of interest was necessary before the Secretary of the Interior could return to Congress to recommend a desalting plant. By an expression of interest, the boards would not obligate themselves to purchase water from the plant; purchases can only be arranged through contracts formally negotiated between the county water agencies and the Federal and state governments, the legal owners of the plant. But by declaring their interest, the counties would nonetheless commit some political resources to making the plant a public benefit in the eyes of the voters.

In deciding whether to express interest, the boards sought consensus. They requested statements on Diablo Canyon and on future water needs from public officials concerned with water. In Santa Barbara letters were sent to the ten local water districts. In the meantime, the Santa Barbara



County Water Advisory Committee resolved at their May 4 meeting that they supported an expression of interest on Diablo Canyon. By the middle of June, the replies were in. Of the ten districts only the Santa Maria Valley Water Conservation District felt they would have no market for supplemental water in the period 1978-1988. (Presently the Santa Maria district is relatively inactive, making no surface deliveries or sales of water in their area.) Concluding that the extra water from Diablo Canyon had found "buyers," the Flood Control and Conservation Board adopted a resolution expressing interest on June 27.

In San Luis Obispo, the procedure differed somewhat. On April 27, the Conservation Advisory Board on Environmental Impact made public a statement in which they opposed Diablo Canyon on the grounds that San Luis Obispo had no buyers. In the wake of this statement, the board of supervisors requested studies on water use from the water advisory board, the planning department, the planning commission, and the engineering department. On May 9, the engineering department and the planning director sent out a joint request to the major water users in the county for estimates of supplemental water needs to the year 1987. Along with letters they also sent a draft of the board's resolution on Diablo Canyon in which interest on the project was expressed. At the end of June, the engineering department had still not received answers to their inquiries; the incorporated cities in the county were still studying their future water needs and attempting to assess the available water resources. Since the engineering department wanted to wait until the studies were completed, San Luis Obispo informed OSW that their statement on Diablo Canyon would be late.

These governmental negotiations, however, were beginning to gain public visibility--and they were translating the supplemental water to be supplied by the plant (its primary technical capacity) into a socially meaningful quantity: growth. There is no question that the desalting plant would allow more people to live in the two-county area. The relatively high cost of the water, moreover, would encourage residential uses rather than agricultural ones since farmers depend upon cheap water to grow their crops. Still, permitting further expansion is not the same as legislating it; if uncontrolled growth is bad, perhaps Diablo Canyon is a warning that growth ought in some ways be limited. Unfortunately, it is not just a matter of passing the appropriate laws: limiting growth is a policy fraught with controversy. It is not easy to see how one can control either immigration into an area or natural growth in the indigenous population. Do the present residents or their representative government have the right to restrict others from moving into or out of the area? What kinds of regulation can government legitimately apply to business or private land development? When does the individual's action infringe the rights of the larger community? And ecologically, a growing population is likely to burden further a natural environment which is already damaged. Ought man be allowed to destroy his own and other creatures' basic life support?

Through local elections, one begins to see some tentative choices being made on these deeply difficult issues. No single ballot will be completely or permanently authoritative, to be sure, but priorities will emerge. The California primary on June 6, 1972, provided one such point of decision. In both San Luis Obispo and Santa Barbara Counties the election included contests for three of the five seats on the county board of supervisors. Stands on the question of growth were taken with evident gusto, but one should perhaps note too that supervisorial seats are somewhat less powerful than they sometimes seem to the aspiring county politician. The job is demanding, and the rewards are hardly commensurate, as is the case for a great many county and municipal positions across the country. In any event, experienced county supervisors estimate that a two-year breaking-in period is needed by most new supervisors, before they are familiar with the political and administrative environments of their positions. Thus the elections ought to be taken as indications of value shifts in the electorate, rather than a measure of impending shifts in local governmental policy by a new generation of anti-growth officials.

In Santa Barbara county, the election involved the first, third, and fourth districts. The first district includes the cities of Montecito, Summerland, and Carpinteria; the third contains part of the city of Santa Barbara as well as the city of Goleta; and the major city in the fourth district is Lompoc. In the first and third districts, the incumbent was not running for re-election. In both districts none of the candidates received a majority in the primary, so that runoffs will be necessary in November. In the fourth district, incumbent Supervisor Beattie received an outright majority with 5,191 votes.

In the first district the two leading vote-getters were George Bliss, with almost 8,800 votes, and Frank Frost, with over 6,500. Neither candidate garnered a majority, however, and so these two leaders proceed to a runoff in November. Bliss is a businessman active in county affairs; he has been president of the Santa Barbara Sheriff's Civil Service Commission. He acknowledges concern about further growth by arguing that careful, responsible planning can be used to shape the growth of the county to the needs of its people. In essence, Bliss favors the use of zoning regulations to steer development. Frost, a history professor at the University of California, is adamantly ecology-minded, and he is a strong proponent of population limitation. Frost too would like to use zoning as a tool for controlling growth, but he defends the current General Plan as the basic document. The General Plan has in the past been readily modified when special interest groups wanted to develop a given area; El Capitan, had it gone through, would have been an example of this free hand with a variance. Frost would end this laxity and, even more stringently, he proposes to allow county residents to lower the legal density of population in selected regions of the county by public referenda on the General Plan.

In the third district, Michael Morisoli and James Slater were the top two contenders. Morisoli took a stand in favor of continued growth, while Slater advocated "controlled" growth. Slater called for careful assessment of water needs, and for a study of alternative water supplies, including

Diablo Canyon. Since the primary, Morisoli has withdrawn from the race, and Slater is virtually certain to become the new supervisor in the third district.

It now appears that the November 7 election could bring two non-growth or slow-growth supervisors onto the Santa Barbara board. This is not a majority, however, and it is doubtful that these supervisors could force through substantial changes in growth policy. Such changes will have to await 1974, when two more supervisorial seats will be contested.

In San Luis Obispo, there are also three supervisors to be chosen. In all three races no one won a majority in the primary, and there will be runoffs in all three districts. Because of a recent redrawing of district lines to reapportion representation, the incumbent supervisor in the fifth district is running in the first district this year. The first district includes the northern portion of the county. In the primary, Supervisor Hans Heilmann received 2,288 votes and his leading opponent, Anne Caldwell, received 1,850 votes. Heilmann argues that government does not have the legal or moral right to keep people out of an area, though attempts to regulate can be legitimate. On the other hand, Caldwell is concerned more with the preservation of the natural environment, and she would like to see growth in the area slowed down. However, she is running mainly on the issue of making local government more responsible to the public.

The third district includes one-half of the city of San Luis Obispo and the area south of it, including Avila, Pismo Beach, and half of Grover City. The incumbent retired in this district. In the primary, George Harper received 1,292 votes, and Kurt Kupper, 1,313 votes. Both candidates took similar stands on some issues including opposition to further uncontrolled growth and favoring more participatory government. There is another candidate in this district who is staging a late write-in campaign. In the primary, Clell Whelchel received 1,066 votes. Normally he would not continue onto the November election, but he filed as a write-in candidate in the runoff. Mr. Whelchel took a stand favoring growth in the primary, as did several others who finished farther back. He continued onto the general election, he says, because he felt the voters needed to have a choice on growth.

The fifth district includes the northern and eastern portion of the city of San Luis Obispo. The incumbent also retired in this district. In the primary, Emmens Blake, a printer, received 2,392 votes while Richard Kresja, a professor at Cal Poly, led with 2,457 votes. Kresja is on record advocating slowed growth.

Therefore it appears that in San Luis Obispo, three supervisors may be elected who would like at least to slow growth; this would be a majority on the board and substantial changes in policy may be forthcoming. A marked change in the ideological makeup of either county's board of supervisors, in turn, could affect future decisions on Diablo Canyon. The newly-elected supervisors will be taking their seats in

January of 1973 when Diablo Canyon will probably be presented to Congress. And, of course, they will be sitting on the Board when and if a contract is negotiated on the project. Besides making specific decisions on such topics as Diablo Canyon or the General Plan, supervisors make appointments to the planning commission. The commissioners' term of office run concurrently with those of the supervisor in their district; therefore, as the makeup of the Board changes, the makeup of the Commission will change. And people who advise the supervisors, of course, can have much influence.

By such tangled means do the mundane decisions to buy supplemental water acquire political significance. Indeed, the public awareness which has been aroused in Santa Barbara and San Luis Obispo by the controversies of broadly environmental significance--the oil spill, the El Capitan development, the nuclear power plant and desalting plant in Diablo Canyon--may be enough to put growth on the dissecting board each time a major public project is brought forth.

What is unusual about Diablo Canyon, then, is that so much political debate should arise over a plant which does not yet exist even as blueprints. The diagram above has been "short-circuited," and the social consequences of the plant--primarily those associated with growth--have been anticipated by political actors. As we have noted earlier, however, the meaning of these social consequences has had relatively little impact on the engineers and state and Federal officials who have planned Diablo Canyon--just as the local citizenry and county officials have had little appreciation of the technical learning benefits of the plant. The short-circuit, in brief, has not meant better communication between local and national government.

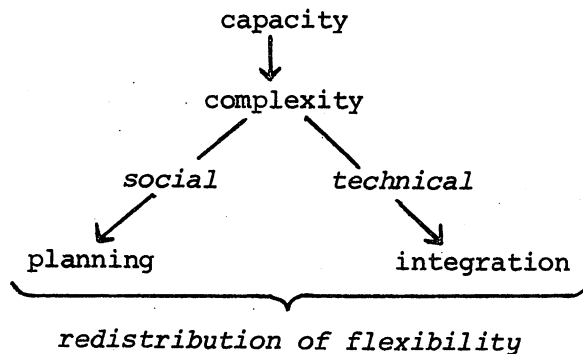
### *Planning and flexibility*

Better communication is inhibited for a number of reasons, some of which we have described earlier in Chapters II and IV. As we noted in Chapter IV, by and large the ecology movement is less interested in communication than in halting the destruction of wild territory; in their judgment, stopping development is the first priority. This single-mindedness, however, is matched by the structured inability of many engineers to respond to environmentalist complaints, a point explored in Chapter II. These observations may now be combined and analyzed as part of the general process by which technological development has led to the increasing prominence of planning.

*Redistribution of flexibility.* The rise of planning was discussed five years ago by the political economist Robert Heilbroner:<sup>4</sup>

...we find as a general indirect effect of all modern technology an increasing complexity, size, and hierarchical organization of production which gives rise in turn to a growing need for public intervention into and coordination of the economic process itself.

What Heilbroner saw then is aptly illustrated by Diablo Canyon, as we see in the diagram. The desalting plant will provide a new technical



capacity, a major source of fresh water. That capability can only be built and maintained through increases in social and technical complexity. The plant, if built, would tie up a large amount of money and other resources, which cannot be used for other things. That means that it is important to assure its success, and so more precise planning is required by the prospective water users; more precise planning means closer coordination among plant designers, local governments, and water users-- more social interdependence, in short. The success of the plant, however, hinges upon technical factors as well and this too means growth in complexity, through the process called technical integration. We have described, for example, the role played by careful husbanding of heat in the design of the plant: the plant, to be economical, must be highly sophisticated, with all parts working smoothly together.

The important point here is that by creating more complex social and technological interrelations, a new technical capacity leads to a *redistribution of flexibility*. In the case of Diablo Canyon, for example, the plant will *increase* the flexibility of engineers and governments concerned about water resource technology. They will learn from the desalting facility, and presumably be in a better position to develop future water supplies throughout the world. By contrast, the plant will *decrease* the flexibility of local officials if it encourages further, unwanted growth, or if it commits the counties to using supplemental water from the State Water Project. These redistributions were also spotted by Heilbroner:<sup>5</sup>

The local community, faced with large-scale problems of unemployment or ecological maladjustment brought about by technical change, has no recourse but to turn to the financial help and expertise available only from larger governmental units....In a word, technology in the modern era seems to be exerting a steady push from many levels and areas of the economy in the direction of a society of *organization*.

In short, the redistribution of flexibility which occurs as a side-effect of technological development tends inevitably to reinforce the powers of centralized authority. Our discussions of Diablo Canyon and the State Water Project bear out this general tendency. But, as we shall argue below, a closer look at the desalting plant indicates that this centralization of control *need not have occurred*. For it would have been possible *intentionally to enhance the flexibility of local government* by choosing a different design for the desalting plant. This possibility will be discussed further below, though it is worth mentioning here that we are not suggesting that a desalination plant should be used to guide development.

*Public agencies in a bind.* To talk of technologies as means for re-distributing flexibility may seem rather odd, but that is because we are unused to talking about the social side-effects of technical systems. In an age in which local governments are called upon to deliver an ever-widening menu of social services on an ever-shrinking tax base, any room to maneuver is precious. We can gain an improved sense of the value of flexibility--and the importance of knowing how a new project will alter that flexibility--by looking at the constraints on public decisions taken by a water agency. To do this, we shall examine conceptual and institutional constraints: limits, roughly, on what one knows how to do, and on what can be done within the organizational and political framework of a public agency. We shall play off the distinction between conceptual and institutional constraints against our earlier dimensions of analysis.

Consider first the limits on perception and response. If a water agency is to perceive a water shortage in time to act, it must have some means for predicting water needs in advance. As we have noted earlier, this knowledge is not easily gained, particularly in regions such as the

#### CONSTRAINTS ON WATER AGENCY ACTION

	<u>Constraints</u>	
	conceptual	institutional
perception	future needs?	no water market
response	time horizon too short for planning	no regional coordination

California coast, where the major population changes are caused by migration. This conceptual difficulty in perception is reflected in the problem of acting to provide more water: the time available to plan new water supplies may be too short to secure those supplies; it takes at least five years, say, to build a dam, but there is already a shortage, which will rapidly worsen. These difficulties in ascertaining the magnitude of the problem are matched by institutional difficulties. Some short-term water shortages, for example, might be smoothed out by sales of water across district lines--as we shall see below, this does occur. But by and large, there is no water market, so that surpluses go unused, shortages unmet. Water sales are hampered by poor information exchange, which in turn is the result of lack of coordination among agencies.

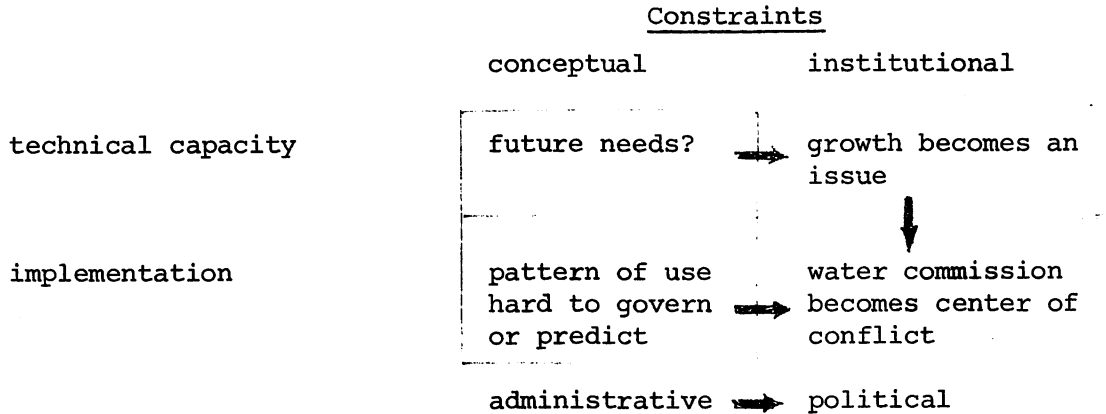
One should add, however, that this lack of coordination, while it undoubtedly causes much unnecessary grief, also has benefits. Water districts already have a number of serious problems which regional coordination would not help much, such as the difficulty of estimating demand, and in some cases a coordinated effort might actually be worse. One can imagine, for example, erroneous estimates of safe yield causing a county-wide drought, instead of one concentrated in one or two districts.

All these problems, and more, are now being experienced by the Goleta County Water District, the agency which serves the University of California Santa Barbara campus. Goleta is now experiencing a critical water shortage. In order to meet demand during the summer of 1972, the district water engineer began to mine water; that is, the district drew ground water which is not normally replaced by rainfall. Mining groundwater, as we mentioned in Chapter II, is ordinarily a last resort. The shortage is only partly brought on by drought; it is primarily a long-range consequence of the institutional arrangements for distributing water in Santa Barbara County. When the Cachuma dam was built in the late forties, water districts in the county contracted for portions of the safe yield of the dam. These allotments, based on projected water demand, were not fully used for many years after the dam was delivering water. Goleta was the first of the county's water districts to use up its allotment, as it tripled in size during the 1960s. Other areas in the county did not grow at such an explosive rate, and Goleta managed to get by on surplus water bought from its neighboring districts. By 1970, however, the rest of the county had grown to the point at which they needed all of their allotment; Goleta was thrown into a crisis, with less water, suddenly, than it had had for a number of years. Although it is popular to blame the Goleta shortage on the lack of coordination among county water districts, an examination of our chart shows that each of the problems noted there shows up in the history of water use in Goleta.

The point of all this is that Diablo Canyon, as it is presently planned, will not affect the problems of local water districts directly, except by providing water. Goleta, among others, is desperate for water, to be sure, but it is nonetheless to be emphasized that Diablo Canyon would be at best a mixed blessing. For the desalting plant would encourage public agencies to delay further a major overhaul of their already antiquated procedures for disbursing water. And in the next water shortage, which might come as early as the phasing out of the state subsidy for the desalting plant, the repercussions on the residents of the area are likely to be worse than is now the case in Goleta, if only because more people will be affected.

We can understand things better if we examine how the constraints we have described are related to the technology of delivering water. The conceptual problems of building a water delivery system are similar to the ones we discussed above: it is difficult to estimate the future needs and their geographical distribution well enough to insure that limited funds are spent well. But now let us do something different from what we have done with our earlier charts and follow the constraint as it evolves from a conceptual one into an institutional one. That is, we ask what happens when we impose a

## CONSTRAINTS ON WATER SYSTEM DESIGN



conceptual constraint: what sort of institutional constraint is built to deal with it? The plausible answers here are instructive: if future needs are hard to estimate, then growth can emerge as a political issue; and as it does, the water district commissioners begin to feel some political heat. That is, the conceptual problems are ones which can be described as *administrative*; and as they emerge in institutional form, they become *political*. Now, note that Diablo Canyon would not affect the underlying conceptual constraints--and it is already part of the institutional conflict over growth. Socially and politically, Diablo Canyon is part of the problem, not part of the solution.

Interestingly, Goleta has also experienced the conflicts shown in this second chart. In November 1971 three new water commissioners were elected to the Goleta County Water District. During the campaign, all three had taken a firm stand against growth, though none of them declared any intention to restrict water supplies to limit growth. Before they could wield their new majority power, however, one of the commissioners was transferred to a job outside California. The original three-out-five majority was reduced to a two-all deadlock: the issue of growth had drawn so much heat that the two senior commissioners, both of whom favor growth, formed an effective coalition. The water district commissioners have power to appoint a fifth member to fill the vacancy--but since the fifth member would have had the deciding vote, neither side would yield to the other's candidates. After several months, a pro-growth commissioner was finally appointed by the board of supervisors, though in the interim some damage had already been done: the district hydraulic engineer, Bob Watson, became so frustrated by the mutual obstructionism in the district that he resigned. The district now faces a water shortage and drought without a professional water engineer to handle the day-to-day problems of securing what water there is to be had.

To be sure, the link between growth and water supply is by no means an obvious one. The emergence of political conflict in the normally quiet area of water resources depends in a crucial way on the development of an environmental consciousness. But once this awareness emerges, the task of the water district becomes qualitatively different. District commissioners cease



to be neutral public officials whose principal concern is efficient public service; instead, they become advocates for specific points of view--and eventually policies--regarding growth. A nonpolitical "solution" to a water crisis is no longer available. Thus, however regrettable the conflict in the Goleta Water District may appear, simply removing the water shortage will not eliminate the conflict over growth. By the same token, the notion of "rational" planning as a cure for the political conflict over growth needs careful scrutiny, since what is at stake in the Goleta Water District is not *how* to provide water but *whether* to provide it. A plan cannot be formulated in the absence of shared values. If one is, it can be no more than the prelude to political debate.

*State and Federal influence.* The politicization of local government over the immediate issue of growth in Santa Barbara and San Luis Obispo Counties strikes a broad resonance in state and national policy. Little of that debate, however, has been visible in the discussion of Diablo Canyon--partly because the plant is in such an early phase of design. When and if it comes time to pay for the plant, however, the issue of the so-called "discount rate" will probably have major bearing on the fate of the desalting plant.

The social discount rate is the critical ingredient of a cost-benefit analysis. Since large-scale water resource projects were first undertaken on a large scale in the 1930s by the Army Corps of Engineers, the Federal government has required cost-benefit analysis in most of its major expenditures, except for the military ones. The underlying idea here is certainly a sensible one: it is obviously stupid to spend money on a project which returns less benefit than it costs, so the cost-benefit ratio clearly should be checked out before a project is approved. The problems come, however, when one tries to reduce all costs and benefits into dollar terms. For example, it is obvious the benefits conferred by a dam and reservoir can depend very strongly upon whether or not there is a drought during its useful lifetime, and the probability of a long drought is not accurately known. Regardless, the value of cost-benefit analyses overshadows their difficulties: a written cost-benefit analysis provides visible evidence--though certainly not proof--that someone thinks the public expenditure is at least not foolish.

The popularity of these analyses, in consequence, has led economists to devise simple ways of estimating benefits, including the rate of discount. The basic idea is that the project will use up some resources, such as concrete for a dam, which could have been used somewhere else in the economy to produce goods; for example, the concrete could have been employed to build an apartment house which would yield rental income. For simplicity one can assume that the resources would return earnings at some rate of interest. On this assumption, the public project is worthwhile only if it can produce benefits at a rate which is higher than the rate the resources would have earned in private industry; this important break-even rate is the social rate of discount. It is called a *discount* rate because one uses it to compute the value *today* of benefits to be gained *in the future* from the project; if the project yields benefits worth \$1 million ten years from now, those benefits are worth less today because one does not have them at hand--the future benefits are discounted.

Now the hitch. There is no logical way to determine what the discount rate should be. The precise reason for this problem is a matter of some dispute among professional economists. But one symptom of it is that the rates paid on government bonds are so low; the government-bond interest rate is one measure of the discount rate, for technical reasons--but it is very low compared to the rates commanded by bonds in private industry, and one would expect the discount rate to be at least as high as these. The arguments are rather technical, but their result is not: choosing a rate of discount must be a political matter, since there is no simply rational method of choosing. Evidently, the *higher* the discount rate, the *faster* future benefits are discounted--and therefore the *lower* the net benefit from a given project. Thus, higher discount rates tend to discourage public projects, because their costs need to be quite low in order to be lower than the estimated benefits. By the same token, low discount rates encourage public projects. In the past, discount rates have tended to be below the middle range of the various estimates of the proper rate, and we found ourselves in a period in which government delivery of public services was on the increase. For a variety of political and fiscal reasons, including the rise of the ecology movement, there is now a great deal of discussion about raising the official discount rate--something which would drastically alter the economic feasibility of a great many government projects, including Diablo Canyon.

Opponents of Diablo Canyon will of course hope that the discount rate is raised, and indeed there are a number of strong arguments in favor of raising it. But the discount rate is hardly a finely discriminating tool of policy; when the discount rate is raised all government investment is discouraged. Most of those who oppose Diablo Canyon on environmental grounds would want a government subsidy to be applied toward ending pollution, but investment in sewage treatment plants, for example, is equally depressed by a higher rate.

Indeed, the discount rate shares with current policy a tendency to be crudely unresponsive to local social, economic, and political conditions. Another visit to our theoretical categories will help organize the argument. Our discussion in Chapter II has already made the point that, to federal and

#### STATE AND FEDERAL TECHNOLOGICAL POLICY

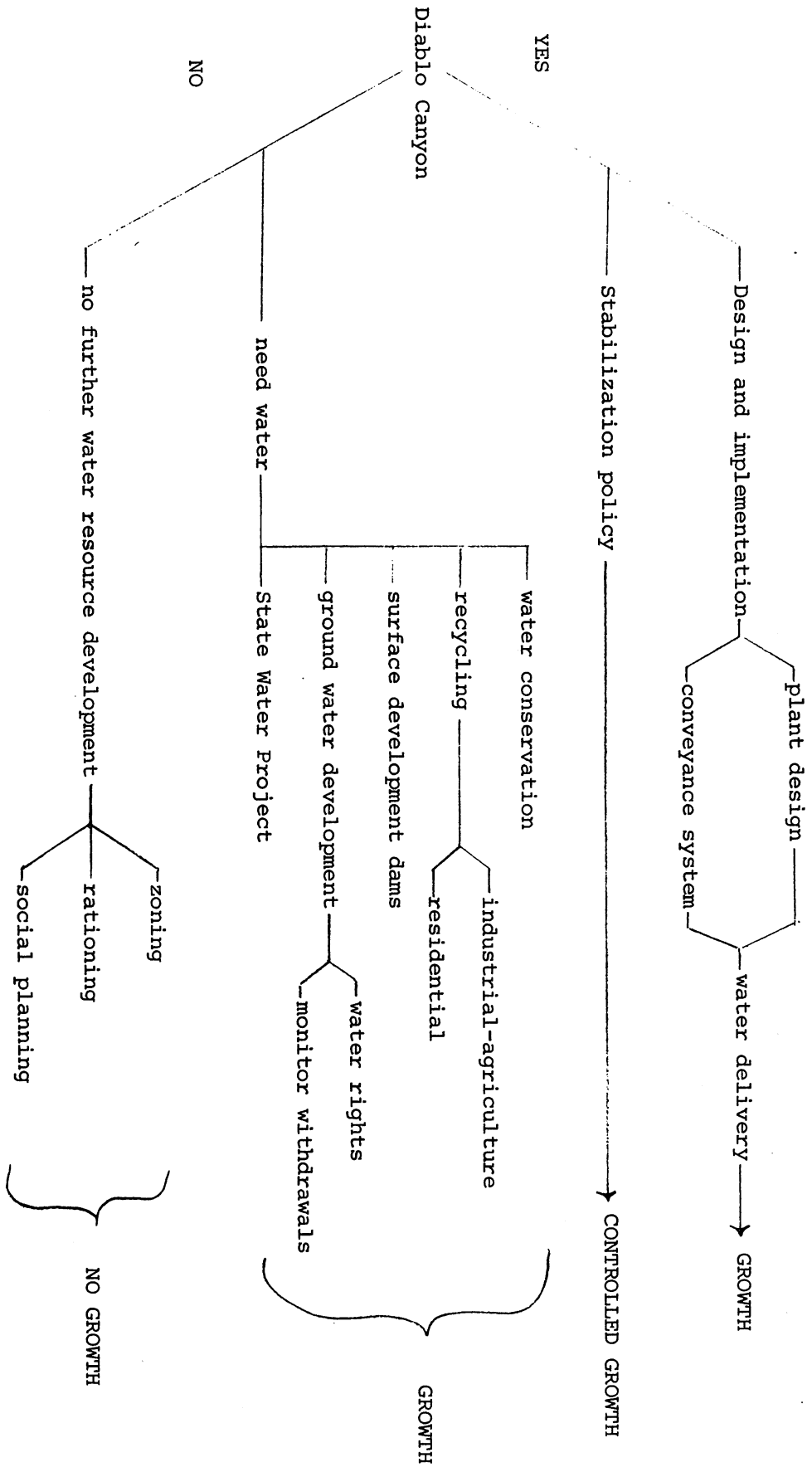
	<u>Constraints</u>	
	conceptual	institutional
technical capacity	value = economic value	impact presumed to be benign
implementation	economy = economy of scale	count only costs of hardware

state decision-makers, the value of government investment is reduced to economic terms whenever possible. Reliance upon a discount rate, indeed, is one manifestation of this conceptual constraint. When the technology

is implemented, as a consequence, one seeks first to guarantee its *economic* viability; most commonly this means looking for economies of scale, on the argument that larger investments yield more than proportional benefits. This is far from obvious once we take noneconomic costs into account, as the controversy over Diablo Canyon itself shows: had the plant provided, say, 1 million gallons per day, no one would have objected on the grounds which are now being used, since no further growth would then have been encouraged by the supplemental water source. Thus, to count only the costs associated with hardware and operation--to pay only for the things in the dotted box in our flow of interactions--is seriously to underestimate the costs, and sometimes the benefits, of public projects. In fact, the qualitative nature of the benefits is far from clearly specified; the technical capacity of the project--fresh water in the case of Diablo Canyon--is presumed to be beneficial to the local community, and it is assumed to be at least benign to the nation at large if only it is cheap enough. The complications of how much water is beneficial, who benefits from the supplemental water, and how it will affect development patterns in the service areas are not included in this framework. These incidental features are shaped indirectly through the contractual negotiations of the boards of supervisors, citizen lawsuits, and the like. The state and Federal agencies charged directly with responsibility for the desalting plant, by contrast, have no reason to be mindful of the broader welfare of their service areas: they care simply that enough water will be purchased. Because governments are always understaffed, activities which are not required for the agency to survive are mostly neglected, and thus local voices are lost in the press of business.

### *Summary*

What we have seen, up to now, is that the Diablo Canyon desalting facility is an idea which is linked to a number of socially and politically significant issues in the local community. The decision for or against the plant now "stands for" decisions about a host of other issues, most prominently growth. As the following chart shows, there is no clean logical connection between the decision and the issues, although there would undoubtedly be considerable political momentum generated by a decision to build or to refuse the plant. The interesting point is that, whether or not Diablo Canyon is built, one can imagine a stabilization in the population. If the desalting plant is built, it might be used as a cushion, to provide flexibility for local governments so that they can plan to level off the population over a 30-year period. The difficulty, as far as opponents of the plant are concerned, is that there is now no way to tie the plant to a stabilization policy; they fear that once the plant is built local governments will feel no pressure to formulate long-range stabilization plans. If the desalting plant is not built, growth will be at least temporarily halted. But it is by no means certain that nongrowth, if it were achieved, would be socially desirable; certainly the problems of public policy and public regulation seem at this point to be much deeper than ordinary, pragmatic American government can easily handle. So it is possible that the desalting plant would be rejected, and yet the growing need for water will force the development of other large sources such as the State Water Project--leading perhaps to more growth than Diablo Canyon would have prompted.



CONSEQUENCES OF DECISION ON DIABLO CANYON

The point is that the desalting plant, as one of a number alternative sources of supplemental water, does not by itself determine the issue of growth. While the connection between growth and water is widely discussed in the counties, *neither the policy problems of limiting growth nor the range of choice on water supplies is yet part of the political dialogue.* Therefore Diablo Canyon serves as a *means for focusing debate*, rather than as an occasion to resolve the controversy once and for all.

That is, the desalting plant serves a teaching function, raising into public consciousness a series of issues related to the environmental, technological, and social meaning of the facility and of water and growth. Our analysis of these issues may be rapidly summarized in a series of charts.

#### OPPORTUNITY AND ACTION IN DESALTING

	technical capacity	implementation
perception	learning	supplemental water
response	MSF, dual-purpose concept	feasibility study

perspective: public decision-makers

In the first of these, we see the kind of opportunity which desalting technology posed for public decision-makers: a prototype plant would provide technical learning, and it would also supply water to an area now running short. Following out the ideas to see if it made sense, a feasibility study was made, using as a basic plan multistage flash technology in a plant hooked to a large electric power plant.

The initial technical design raised a number of questions about the kinds of constraints which the feasibility study took for granted. Let us begin with the institutional constraints. The need to make the plant economically viable dictated lowering the risk that the plant would need major

#### DIABLO CANYON: EMERGING PROBLEMS

	technical capacity	implementation
conceptual <u>constraints</u>	useful methods: VTE and others	local social impact
institutional	minimal risk	safe design

perspective: design engineers

modifications after it was built. For this reason, Kaiser Engineers chose the relatively safe MSF design in the feasibility study. Their conservative assumption--which does not commit the Office of Saline Water to multi-stage flash in the final design--drew fire from Gordon Rausser in his estimate of how much of value would be learned at Diablo Canyon. More generally, the question of using other methods, such as vertical tube evaporation, has been prominent in the technical discussion over whether the plant as now designed is a good idea. Finally, and most important from our point of view, the initial design of the plant took no account of the local social and political impact of a major new source of water.

As these technical doubts were voiced, public debate started to heat up. The issue of growth, part of the wider concern for the environment and a problem which gained prominence in the El Capitan controversy, became the central concern of debate. The problems of implementing a policy on growth took a back seat to the initial enthusiasm of those who wanted to limit population and development. Both state officials backing Diablo Canyon and local activists seeking to stop it began making public statements which set the stage for debate during the elections. The elections, in turn, drew their substance from the choice between continued growth and controls, and

#### THE PROCESS OF DEBATE

##### constraints

	conceptual	institutional
perception	growth issue	water district coordination
response	lobbying	electoral process

perspective: political actors and observers

from the problem of "responsive" local government. The latter issue, made popular by the recent upsurge of a so-called "new populism," also sounds the theme of local governments made creakingly inefficient by the proliferation of special district administration. In this case, the election, by providing an opportunity to have debate, illuminated the perception that water-district coordination is difficult, if not impossible.

Most of the issues raised in debate thus far may be conveniently classed using all three of our dimensions of analysis together. The effective management of a national research program in desalination, the concern of federal and state authorities and private industry, is focused on Diablo Canyon as a technical capacity. These outside interests care about the plant as a prototype of something which may someday become a major investment on a much larger scale; Diablo Canyon, in other words, is of interest as a member of an evolving family of desalting facilities. The local controversy, by sharp contrast, is concerned primarily with implementation, with Diablo Canyon as a single, important feature of the political landscape.

constraints

	conceptual	institutional	
technical capacity	perception	technical capacity	Federal & State
	response	increased Federal research and development	
implementation	perception	future needs; growth policy	Local
	response	rationing, zoning policy	
		support for innovation in desalting	
		discount rates	
		alternative supplies--SWP	
		regional government?	

The technical uncertainty about a feasible desalting design, and the national and international interest in developing such a design, define the basic situation of the Office of Saline Water and the Department of Water Resources. The many approaches described in Chapter II represent a capital investment of many millions of dollars in engineering research aimed at producing a viable desalting technology. From the standpoint of this overall picture, Diablo Canyon is one small step in reaching the goal of water from the sea. Because it will be supported by public funds, however, the project acquires a political dimension: successful completion of Diablo Canyon, it is argued, will enhance future support for desalting research. But only if the finished plant delivers adequate benefits locally and to the technological community. The measurement of those benefits via the discount rate is itself a political matter, as we mentioned above, since it contains an implicit judgment on the worth of publicly funded alterations of the natural environment. A rise in the discount rate used in federal cost-benefit analyses, as we noted, could change the ground rules of the search for an economic desalting technology.

Meanwhile at the local level, the prospect of a large new water source is sharpening a number of long-range dilemmas which will face San Luis Obispo and Santa Barbara for a number of years. In making decisions on the desalting plant and the State Water Project, the persons who hold office in the county government will commit their communities to certain distributions of flexibility for several decades. Deciding against more water--the option most often discussed now--will halt growth, but also raise in painful ways the problems of shaping a political consensus of what nongrowth means. Because we live in a finite world, the problems of a responsible nongrowth policy will be upon us all eventually--but eventually may be a long time coming.

We come, therefore, to the end of a long trail. The story of Diablo Canyon is a tangled one primarily because it is still developing and changing. Not only in local politics, where the unpredictable chemistry of personality may bring opponents (or proponents) of growth to office, but also externally, as in the case of the new Hong Kong multistage flash plant, Diablo Canyon remains vulnerable to major shifts. Rather than hazard some unreliable predictions, then, it may be useful for us to step back to see what kinds of broader lessons the proposing of a desalting plant may offer.

## B. Evaluation

As we noted above, the desalting facility has so far served primarily as an occasion for focusing debate. In this process a number of dilemmas have been revealed. A number of the policy problems related to growth, technological experimentation, and the structure of government have arisen, and it is now clear that they are not problems at all in the usual sense of the word. If they were, we could set about solving them through the rational procedures which engineers and administrators have over the years honed to surgical precision. What we find instead is that there are issues which we do not know enough to resolve analytically--but which need to be acted upon. Sometimes dilemmas of this sort can be outflanked by ingenious solutions;



sometimes they can be turned back into ordinary problems. And sometimes they are resolved by power rather than reason. As the desalting proposal moves toward decision, we need examine the possibilities for both kinds of resolution.

### *Dilemmas*

The dilemmas we have found follow a pattern: they all concern cases in which some important public interest has been under-represented. The issue of environmental protection may be described as a case in which environmental interests--the birds and fishes--have only lately begun to receive powerful representation in human decision-making. Our dilemmas are thus similar in spirit, though they cover different substantive areas. But our concerns also reflect the analytical style of political science: these are problems of justice and equitable distribution of power and resources.

*Present vs. future.* One of the fundamental difficulties of social planning in democratic societies is that no one speaks for the people of the future. Yet with the growth of large, sophisticated technologies the need to plan becomes visible, then inescapable. To the social scientist, the dilemma can be described as the problem of predicting the social awareness of societies of the future. Whatever one calls it, however, there are ambiguities in policy formulation which result from the absence of a future constituency. If we knew something about the values which twenty-first century America will hold dear, it would be easier by far to assign a reliable discount rate to government projects, and easier to define the technical learning benefits of the Diablo Canyon plant. Thirty years ago, when the Cachuma Dam was built, it was possible to assume that the water to be provided would on balance be beneficial. But the accelerating changes of the past few years make projections into our own future a hazardous undertaking. In the meantime, the discount rate is assigned by political intuition, and the environmental activists are left to feel that their environment is being altered to benefit future generations who will have wanted the environment preserved, given a choice.

*Here vs. elsewhere.* The learning benefits of the plant are not only realized in the future, but they are to be redistributed geographically as well. What is learned at Diablo Canyon will be used to improve the designs of plants in Israel, Texas, or San Diego, but not in Santa Barbara. Indeed, this is the rationale for using public funds to subsidize the desalting plant, for it is unfair that the residents of coastal California pay for research and development which will benefit desalting technology all over the nation and the world. Thus, it is argued, we should all help to pay for the plant since at least indirectly we shall gain from its operation. As we have noted at a number of points in this report, however, it is far from obvious that the traditional justifications of federal intervention in research and development are valid any longer. As the case of Diablo Canyon itself illustrates, federally financed research can be done with little regard for the social communities in which the work takes place.

What has happened here is that economics has become unhooked from politics. Although the money to be spent on the desalting plant comes from taxes, the people of Santa Barbara and San Luis Obispo have no political control over what that public money will buy; a sort of reverse taxation without representation. The two counties command insufficient power in Sacramento and Washington to enforce their will, even were their sentiments more clearly defined. The influx of funds to pay for Diablo Canyon is thus effectively identical to private money: the only kind of control which can be exerted is negative, through expensive lawsuits or outright refusal. Note, moreover, that political control need not have involved politics in the electoral or ideological sense. As we have stressed above, the public perception of the plant would likely have been far different if area residents had only been consulted about features of the design such as the size of the plant.

*Us vs. them.* Beyond problems of representation in time and in space, Diablo Canyon also presents dilemmas for various interest groups in the political arena. The issue of growth is the obvious example here. Taken literally, the notion of limiting growth requires us to revise our concepts of legal and social freedom, which historically have included the right to move from place to place. One might expect that, if San Luis Obispo and Santa Barbara remain desirable places to live, a government committed to limiting growth would have to make a distinction between a "permanent" resident of the area and a "visitor." The counties, in short, might need to operate immigration bureaus, issue visas, and the like.

It is far more likely, of course, that regulation of growth would be implemented by decreasing desirability, using land-use policy and restrictions on natural resources such as water to limit the number of jobs available. These indirect methods, however, pose dilemmas of their own. The current enthusiasm for "controlled growth," for example, pins its hopes on tactics such as zoning for low-density housing, a move which usually has the effect of raising property values; indeed, well-to-do suburbs in our major metropolitan areas have long used these methods to exclude the poor. "Nongrowth", therefore, can readily become a code word for elitist enclaves of the privileged--a suspicion already harbored by middle-class union members fearful for their industrial jobs, and by minorities fearful of continued discrimination.

*Predispositions.* These dilemmas point to the erosion of shared American values and assumptions, a sharing which analysts since Alexis de Tocqueville have identified as the unique ingredient of our special American brand of liberal democracy. Even the *status quo*, which everyone seems to think needs changing, is internally unstable. For if we look at the directions in which our various dilemmas are going, we see some significant inconsistencies. The future and the national and worldwide beneficiaries of desalting research are firmly entrenched at the Office of Saline Water and the California Department of Water Resources, at least in the sense that these organizations continue to define the choices available; all that local nongrowth advocates can do is say no. That is, those who are presently powerful are the technologically sophisticated, and they set the parameters of discussion in terms suited to the technology.

But there is also a shift in the works, whose thrust is directed at bringing together political resources at the regional level, to place major emphasis

on environmental protection. The emergence of growth as a campaign issue is the clearest sign, of course. But the spreading enthusiasm for regional government is important as well. For if regional government can emerge from the present tangle of special districts, it would likely become the organizational framework for regional environmental policy and politics. What remains to be seen is which of the political meanings of ecology will dominate: whether environmental control will mean technologically based management of the environment, or preservation and restoration of wilderness, perhaps with a technological assist.

### *Ingenious solutions?*

These changes in the works provide opportunities as well as dilemmas, and it is possible for Diablo Canyon to become the spark for some innovative experiments in the use of technology for social development. For, while there is as yet no consensus in San Luis Obispo and Santa Barbara Counties opposed to growth, the interest stirring suggests that such a consensus might emerge. If it did, that would be important to people and governments throughout the industrialized world. For it would mean that someone is attempting to grapple with the day-to-day difficulties of controlling growth. That is, Santa Barbara and San Luis Obispo may be marshalling the political will to conduct social experiments on a stabilized--or, as it is called, "steady state"--society. It is evident that stabilization, at least in the next fifty to one hundred years, must be on the agenda of the industrialized world: we simply have not the resources to maintain historical rates of growth for another century. What is less obvious is that a desalting plant might be used to facilitate such an experiment.

Although the notion of being an innovative community may be exciting to some, it should be made clear that experiments involve risk as well as payoff. As we noted above, the concept of a stable society involves questions of the equitable distribution of wealth, power and even privacy, whose answers are not yet known. In addition, it is worth remembering that the whole history of this nation has been a history of continual growth; it is not certain that the democratic values and institutions which we have created are even possible in a steady-state setting. It is consequently necessary to have public ratification before one embarks on such an adventurous policy.

Whether the citizenry will form a consensus on growth will be more apparent after this fall's elections and next winter's revision of zoning policy. The latter event is important to the emergence of a consensus because it will be an occasion for people interested in growth to participate in shaping county policy. A recent California statute requires that by January, 1973, the General Plan of each county must conform to its existing pattern of zoning. General Plans, which are meant to specify long term land use patterns, have been taken casually in the past; in Goleta, for example, half the growth since 1965 has been on land which was scheduled to remain undeveloped according to the Santa Barbara General Plan. Reconciling the General Plan and the zoning map is thus not a trivial undertaking either practically or politically. In Santa Barbara County, citizen committees

have been appointed to recommend ways to bring about consistent land use plans. Their suggestions will provide an important measure of citizen interest.

That interest, if it is demonstrated, would be significant to both the California Department of Water Resources and the Office of Saline Water. A desalting plant at Diablo Canyon, somewhat different in design from the present proposal, could be an integral part of a plan to stabilize the population of the two counties in its service area. And if it were, the present political unease about the plant would be defused.

The idea runs roughly like this. Each of the 20 million gallon per day desalting trains now planned would provide virtually all the learning benefits provided by the full 40 mgd plant. The size of the plant was originally set, remember, to provide economic feasibility rather than additional learning. Twenty mgd, on the other hand, would alleviate the shortages likely to develop between now and 1980, and it would provide a cushion for moderate growth. The central political idea, then, is to use resources saved by building only one of two trains to encourage population stabilization plans on the part of county government--in exchange for which the two-county area would provide a stable political environment for this and further desalting experiments. Some of the money saved could be used to pay for design work aimed at increasing the ability of the technical system to respond to evolving social needs. For example, the single desalting train ought to be designed so that further trains may be added with minimal expense, should growth again become a clear-cut community goal; the conveyance system might be rerouted to discourage future links to the State Water Project by making them more expensive--but not impossibly so; the desalting plant might even be re-sited closer to the Santa Barbara South Coast, where the high demand is located, trading the efficiency of a dual-purpose plant at Diablo Canyon for lowered expense in the conveyance system. The possibilities are manifold, for what is plausibly in reach is a rethinking of the style of cooperation: the counties can try to maximize the learning opportunities for desalting, in exchange for increased social and political flexibility, especially flexibility connected with growth policy.

Note that our self-styled ingenious solution would cost more, proportionately, than the present plant; although it would provide only half the water, the 20 mgd plant would likely cost more than half the \$136 million of the present proposal. Alternatively, the cost could be held down by lowering the state subsidy, making desalted water more expensive than State Project Water. Such a policy would evidently discourage our more innovative proposal. Still, our "solution" would require less money to be paid out of the public treasury, and the price of water, in any case, may not be a good measure of the benefits of a smaller plant. The smaller plant, together with a carefully thought out and rigorously negotiated service contract between county water agencies, and state and federal agencies would constitute a strong incentive to control growth--partly because of the very costliness of the desalting plant, since further supplemental water would be expensive indeed. It can be argued that stabilizing water needs would bring *indirect* savings, as a smaller population would require reduced expenditures for welfare, garbage collection, fire and police

protection, and other social services. This is the argument made familiar by opponents of central-city high-rise developments, only in reverse; they have argued that, although business development does raise the tax base, the increased municipal revenues are more than eaten up by the need to provide governmental services. Turning this logic around, the higher *direct* cost of water would not accurately reflect the benefits of a simpler, less urbanized life.

We stress again that we are not recommending the 20 mgd plant. It is far from obvious that a workable consensus opposing growth exists, and the economics--not to mention the engineering and the political negotiation--of our "solution" have not been closely studied. Our object in bringing it up is to point out that, in the rhetoric about growth and Diablo Canyon, opponents and proponents alike have assumed that the choice is between using water to constrain growth and using some other means, such as zoning. A combined approach, in which water resource commitments to Diablo Canyon are used to create positive incentives to control growth, might prove to be more fruitful.

### *Technology as legislation*

Our study of the Diablo Canyon desalting plant has struck a number of themes, but none more forcefully than that the conventional wisdom about technology and social life is woefully inadequate. To say, as most analysts have, that technologies are ethically neutral, to be bent to whatever purposes suit their users, is rather to miss the point. For it is to say that technical capacity, rather than implementation, is what matters. For the purposes of understanding and controlling technology as a social phenomenon, that is the wrong way round. Note, for example, that our attempt at a policy solution which could benefit both sides of the conflict sought to rearrange the implementation; the problem is not whether to provide water or not, but how much water to provide and where. Deciding on these matters of distribution is much more complicated, to be sure. One needs data on existing patterns of use, and a theory to inform one of the probable consequences of supplying more water in particular places. The first is usually in short supply; the second, nonexistent. So one muddles through, basing decisions on such tenuous principles as subsidizing water to meet the price of the cheapest available alternative. Muddling through turns out to be incredibly effective, even surprisingly efficient. But it is a process shot through with value presumptions: the harried administrator chooses, half-consciously, what he can safely slough, what kinds of judgments he will not be called on to defend, and each time he is presuming, on little or no evidence, that some set of values does not matter. In such circumstances the conceptual neutrality of a technical capacity is irrelevant; the implementation distributes the capacity in ways which matter to people's lives.

We have, however, few conceptual processes by which to evaluate implementations in the abstract. That, in a way, is the source of the dilemmas which we outlined above. Implementations often appear to be routine and ordinary, the scruffy details to be handled by engineering firms for pay, not by politicians for glory. So no one pays much attention--and the

dilemmas are resolved by default, a *by-product* of muddling through. Once the capacity is in place, the technology is ready for use, but only in limited ways: a conveyance system is built to carry water from the desalting plant, but it also favors later commitment to the State Water Project; water to relieve a critical shortage is delivered, but at a price which drives out agricultural use. The technology has become legislation, channeling the activities of its so-called users.

The importance of Diablo Canyon and the issue of growth, therefore, is that it reminds us that we need not delegate the design of implementing systems. For the dilemmas we have pointed to--and they are but a few of the many lurking in this and other large technical systems--need not be resolved by default. They can be tackled as well by the more chaotic, but more obviously legitimate, processes called politics. The choice of effective alternatives is the choice among different political strategies; it is not a choice between politics and something else. But having urged here and in several other places the value of political scrutiny of public projects, we should also note that the sheer size of our complex society threatens always to thwart the efforts of good citizenship. No single person, and perhaps no single organization, can monitor all the activities which alter the natural or social environment. Indeed, the term "environment" already announces a principle of selection, a way to identify what is important. In the past few years the development of environmental consciousness has focused primarily on man's relationship to the natural biological world. Man's relationship to other men, the social consequences of human technical activity, is now enriching our sense of environmental protection, and beginning to refine our sense of what in public life is worth investigating. Diablo Canyon can be part of that beginning.

## Chapter V. Footnotes

- <sup>1</sup>A. E. Keir Nash, Dean E. Mann, and Phil G. Olsen, *Oil Pollution and the Public Interest* (Berkeley: Institute of Governmental Studies, 1972), p. 113.
- <sup>2</sup>*Compare Technology: Processes of Assessment and Choice*, report of the National Academy of Science to the House Committee on Science and Astronautics (Washington: U. S. Government Printing Office, 1969), pp. 15-19.
- <sup>3</sup>This chart was originally proposed by Todd R. LaPorte in his analysis of the short take-off and landing aircraft, a study done for the National Aeronautics and Space Administration and reported in Todd R. LaPorte, Bayard Catron, John Forester, Neil Mayer, and Daniel Metlay, "A Perspective in the Assessment of Large-Scale Technology: the Case of the STOL Aircraft Transport System," Institute of Governmental Studies, University of California, Berkeley, 1971.
- <sup>4</sup>Robert L. Heilbroner, *The Limits of American Capitalism* (New York: Harper Torchbooks, 1967), p. 97.
- <sup>5</sup>*Ibid.*, p. 119.

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