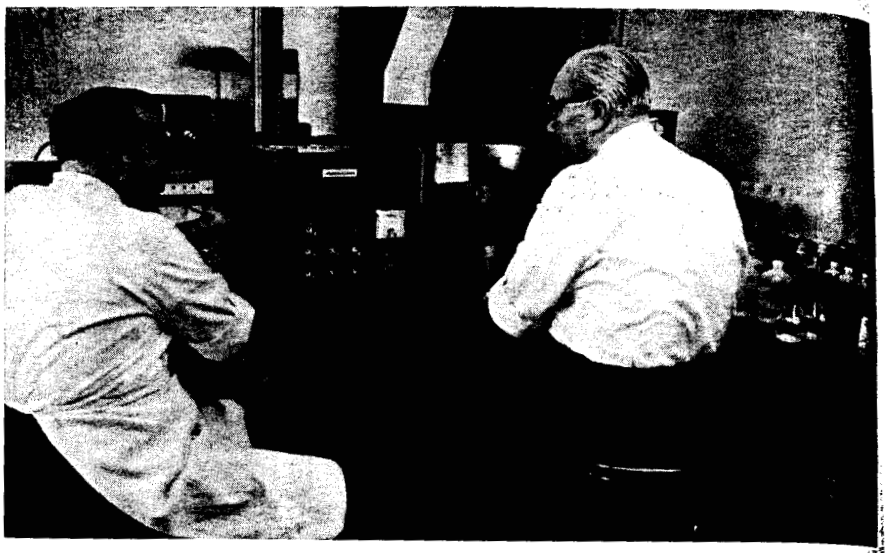
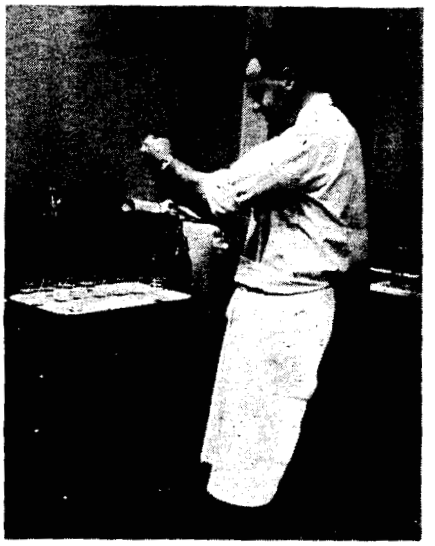
THE BUSINESS OF WATER MANAGEMENT



Philadelphia water quality monitor. Left side of panel contains conductivity and pH indicators at bottom and chart recorder at top. The dissolved oxygen and temperature recorder is at top right with the dissolved oxygen analyzer at bottom.

Field determination for dissolved oxygen to be checked against recorded values, using a specially designed field kit.



Preparing samples for determination of iron.

WE NEED MORE FACTS ON WATER RESOURCES TO FORM THE BASIS FOR PLANNING AND MANAGEMENT DECISIONS

by Luna B. Leopold

This instrument measures temperature, pH, specific conductance, tide stage, turbidity, and dissolved oxygen.

Installing a submersible pump to supply a continuous water sample to water quality monitor. At left is mobile laboratory used for special water quality investigations.

New needs for water data require new techniques for data collection. The U.S. Geological Survey has worked with industrial firms in the development of automatic continuous measurement of some water-quality factors including dissolved oxygen, specific conductance, pH, and turbidity, as well as temperature and water level.

There is no single solution to the water problems in the country today. Rather, water is like business. In industry, there are continuing problems and you meet them one by one. Every time that you have solved a problem immediately in front of you new problems arise, each one of which is affected by the last action that you took. And so it is a continual facing of individual problems, each of which must be met with foresight and with skill. There is not a single problem which you solve and then forget.

Water management is also like business in other ways. It involves, first, competition. It is affected both by changing needs and by technologic advance. There are costs as well as potential gains. Though clearly one wishes to keep costs down, there are times when investment now will make substantial savings in the long run. So let's look at the water matter in some hard-boiled business terms . . . as a business proposition.

At the present time we are spending approximately 10 billion dollars a year on water development in this country. The total expenditure for the collection of facts on our water resources amounts to less than one-tenth of one percent of this amount. We need to examine the myth that we are actually using what facts we have intelligently and that we have enough facts to make the kinds of decisions which managers must make.

Planning and Perspective

A few years ago I went to India as a consultant to that government on an important flood control project in the state of Bihar. In looking over some of their problems of rivers in Northern India I saw again and again staff gages which the Indians were using to measure water levels. Discharge of the river requires for its computation measurements of water level at these gages. These were large rivers. The staff gages were standing out in the middle of an open place on a flat bar. Some of the gage rods were twisted over sideways, some of them leaning over another way. And the graduations on them were in hundredths of a foot.

After seeing this, I came back and talked to the man principally engaged in their program of collection of water data. I said it is very peculiar that we in the Geological Survey who publish the data on water flow in the United States, only publish the data to three significant figures usually, because we don't think it is more precise than that. But in India, they publish discharge to six significant figures. I said their staff gages are in a poor state of repair for many are not even standing up straight. How could they make computations with such precision? And this gentleman said, "You know, I just fixed it . . . I wrote a memorandum yesterday."

This is fixing the problem by what I should call a declaration of concern. And it is not quite enough.

To effectively run the business of water management, first you need data. No business is run without knowing something about the materials, the costs, the matters of supply, demand, personnel, equipment needed . . . to name a few. You need facts to run a business.

Second, you can't run a business without advanced planning; and by advanced planning in the water field I do not mean merely a plan for water development. Advanced planning means the intelligent use of foresight.

And third, to run this business there must be realism about costs. Water is a raw material and it no longer comes free. In the coming years we must begin to spend water like money instead of vice versa.

A Dearth of Data

Surprisingly, the people who are most concerned about water do not know how much data we have, where it comes from, what it is based on, or even more subtly what kind of data we need which we do not have. If you were to manage the stockpiles of raw materials in your business without records of where they were and how much the increments and decrements were, you could hardly call that management. It would be more like fortune telling.

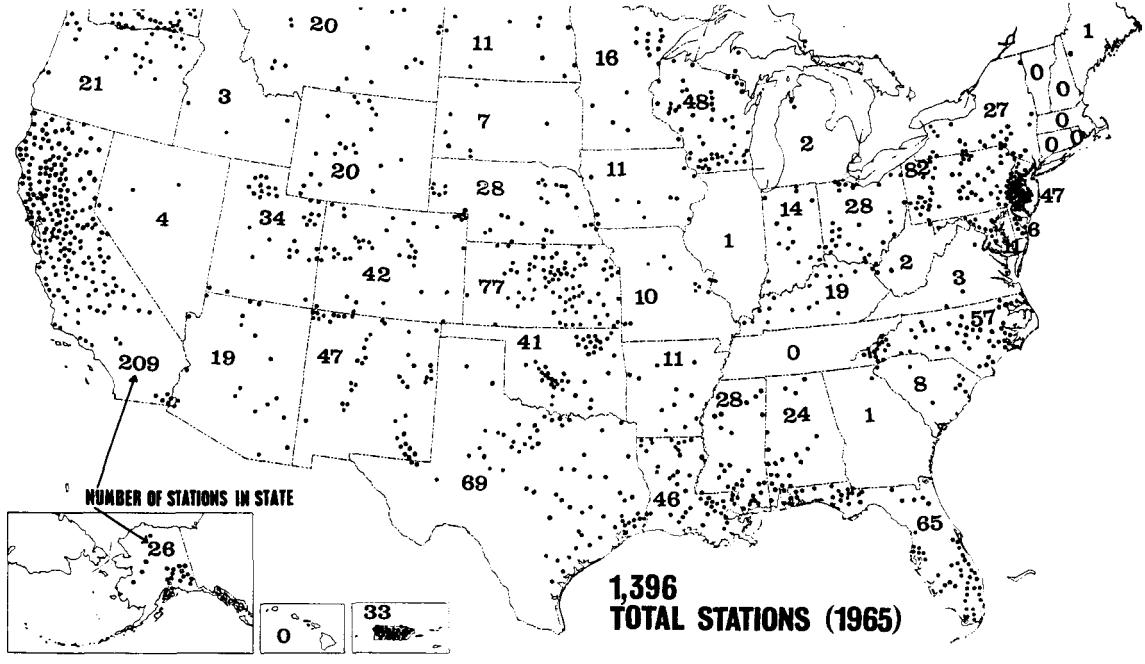
In the United States alone, we have three million miles of stream channel of large and small size. To measure the flow in three million miles of stream channel we have 8000 continuous measuring points, all run by the U. S. Geological Survey. The assessment of water quality also requires gaging stations for measuring water quantity. But in three million miles of stream channel, we have only 1800 quality measuring points run by the Geological Survey and a small additional number by other organizations.

Thus, for the increasingly complicated job of assessing water quality there are only about 2000 measuring points and not all of them are taking data to serve all purposes. It is a small sample to run the stockpile. Furthermore, I suspect that there are many people in industry who are not actually even acquainted with how these data are obtained, by whom, under what circumstances, or even how they are financed. The principal water data collection activity in the United States is financed jointly by states and municipalities with an equal contribution by the federal government, and the work is done by the U. S. Geological Survey.

Unbiased Appraisal

To manage the stockpile of this business, it is important to know that the data are unbiased—that is, are not collected to prove some preconceived view. The United States Geological Survey, which collects most of the data on which you have to depend, is a fact-finding organization which does not carry responsibility for construction or development, for water use, or making enforcement rules. It is important that there continue to be a separation between fact-finding for the sake of getting unbiased facts, and the responsibility for regulation and construction.

One would suppose that the businessmen themselves would be asking whether there are enough facts actually to make the management decisions needed. The answer is often reiterated in the many conferences and meetings and committees which have been held about water in the last two years. Everyone seems to agree that more unbiased facts are needed in



On the map dots indicate water-quality station sites; figures indicate number of sites in each state. (Not included on the map are 239 stations where temperature only is measured.) This map shows the location of about 1400 (1,396) water-quality stations in operation during 1965 throughout the United States, including Puerto Rico. This total represents an increase of 11% compared with 1964. Depending upon the need for information, chemical variables measured at individual water-quality stations may be few (3 or 4) or as many as 15 to 20, or more. Sediment measurements usually consist of the determination of concentration and particle size. Frequency of measurement is variable and may range from one every three months to continuous, around-the-clock monitoring, as represented by the recording-type station.

order to face the increasingly complicated water problems. But it looks as if we are again making only declarations of concern.

Field data themselves are not the things you need for management. Those data have to be interpreted in terms that make them usable to the industrialist, the municipality, and the consulting engineer in a practical way. We do not have enough facts about water to manage the stockpile intelligently, especially because the available knowledge is not usually in the form necessary to evaluate the results of alternative actions. This leads to the second point.

Advanced Planning

Advanced planning requires adequate information organized in such a way that allows us to estimate what will happen if we take some particular action. Water is an environmental resource. Anything that you do to it affects all other aspects of the resource in one form or another. The water system on a continent can be considered as a vast plumbing system in which all parts are interconnected. There is no separation physically between ground water and surface water. If you take water out of a stream you affect the local ground water. If you take the water out of the ground you affect the local stream flow.

In the development of water and its management, what we mean by advanced planning is this: You as a manager must know whether if you drill a well, or build a reservoir, or discharge a certain waste product, the action will have an effect that you can't live with. Therefore, what you need is not merely facts but sufficient understanding that sophisticated forecasts can be made of the results of alternative actions.

Take, for example, the question of drawing water out of the stream or out of the ground, or putting something into the stream—a pollutant or the sediment from urbanization. These are going to have important relationships to other parts of the environment. Whoever takes such actions upstream from you is going to affect you; everything that you do is going to affect somebody else. We should be able to forecast such effects. But actually water development plans now being made are not put in such terms. Possible alternative actions with assessment of their respective results are often not weighed at all and are seldom made public.

Hidden Decisions

How do water development plans actually look by the time they reach a public stage? A so-called "best plan" is given to a legislature or to a congress; either accept it or reject it; either appropriate the money or don't appropriate the money. And unless you happen to be on the inside, you never know what the hidden decisions were.

Best plan for whom, one may ask? Cannot the facts be put out in such a way that the public or the consumer may actually see what the alternatives were and why the recommended alternative happened to be chosen? Much needs to be done in water planning philosophy. The public deserves to be better informed as to what the real alternatives were, what they cost, not only fiscally, but socially. They deserve to be told the rationale by which choice was made among the various alternatives.

What do I mean by forecasting the results of alternative actions? Visualize that the natural world is a complicated environment; any change made in it is going to have an effect both spacially and in time. The effect of a pollutant alters from winter to summer. The effect might be quite acceptable in winter conditions but the situation may be entirely changed in another season. With three million miles of stream channel, even if we had a much larger and more adequate measuring system for obtaining basic data, we are always going to have to make extrapolations.

Like all stockpile problems, you cannot go out and shovel the whole stockpile every time you want to measure it. You measure it by a sampling system. But by sampling we meet interpolations and extrapolations, and these are not straight-line extrapolations. The present basic data program is not adequate for such extrapolations. There is simply not enough financial support for the analytical tools necessary to make the kinds of extrapolations and forecasts that are needed.

Financial Alternatives

The third item — in this business we need a realistic view of costs. Water is no longer free. Costs are not something that we are going to be able merely to throw into the lap of the community and say, "This is not our problem." In trying to figure out the question of who should bear the cost and to what extent, again it is necessary to know the results of our actions. This depends upon an adequate knowledge of exactly how the environment is operating.

In the pollution problem one might suppose that each disposer of waste should be charged in accordance with how much he puts in the stream. But the effect of a given pollutant is not directly proportional to its amount. To differentiate the effect of individual pollutants and in various degrees, one has to know a lot about how the environment operates. What can the environment accept? We should, in fact, be interested in the effect of the pollutant on the stream under the conditions there prevailing.

Stream quality standards or criteria really are going to depend importantly on an increased understanding of the environment itself. Otherwise we might simply make rules which disregard how the biological and physical parts of the environment interact. And so even the question of costs comes back to the first two points. We need information analyzed so that we can forecast the results of alternative actions. This is the essence of planning and it involves costs.

Projecting Water Use

Another type of information that is needed is on the question of water use. The public statements that are again and again made about water needs for the future tend to be too much a linear extrapolation of what has happened in the past. We need a more sophisticated knowledge of the human environment as well as the physical environment in order to find out really what is going to be the call on the water resource in the next two decades.

Even such simple facts as the general picture of how water is used is not very well understood. When the public thinks about a water crisis, they are thinking about a crisis in the city; they are usually not thinking about a crisis in an industry. Yet it is not generally realized that only 8% of the total water used in the United States at the present time is used in municipalities. And of the 8% which is used to serve municipalities, an important part is actually purchased from municipalities to be used by industry.

The other two principal uses are approximately equal in amount—irrigation and by industry. Irrigation uses water consumptively by dissipating water-vapor back into the atmosphere. It is the largest consumptive use. Together industry and irrigation, about equally divided, make up approximately 92% of the total water used in the United States.

In my view one of the most important facts about water in the United States is this: Nearly half of the water used in the United States at the present time is used by industry, and practically all of that is used for cooling.

Some Big Questions

Costs which will be faced by industry or municipality depend on the alternatives open to satisfy a particular need. Costs of construction depend upon what kind of water development or what kind of water treatment is required. That again should be determined by an information content and analysis sufficient to forecast what is likely to happen under alternative schemes.

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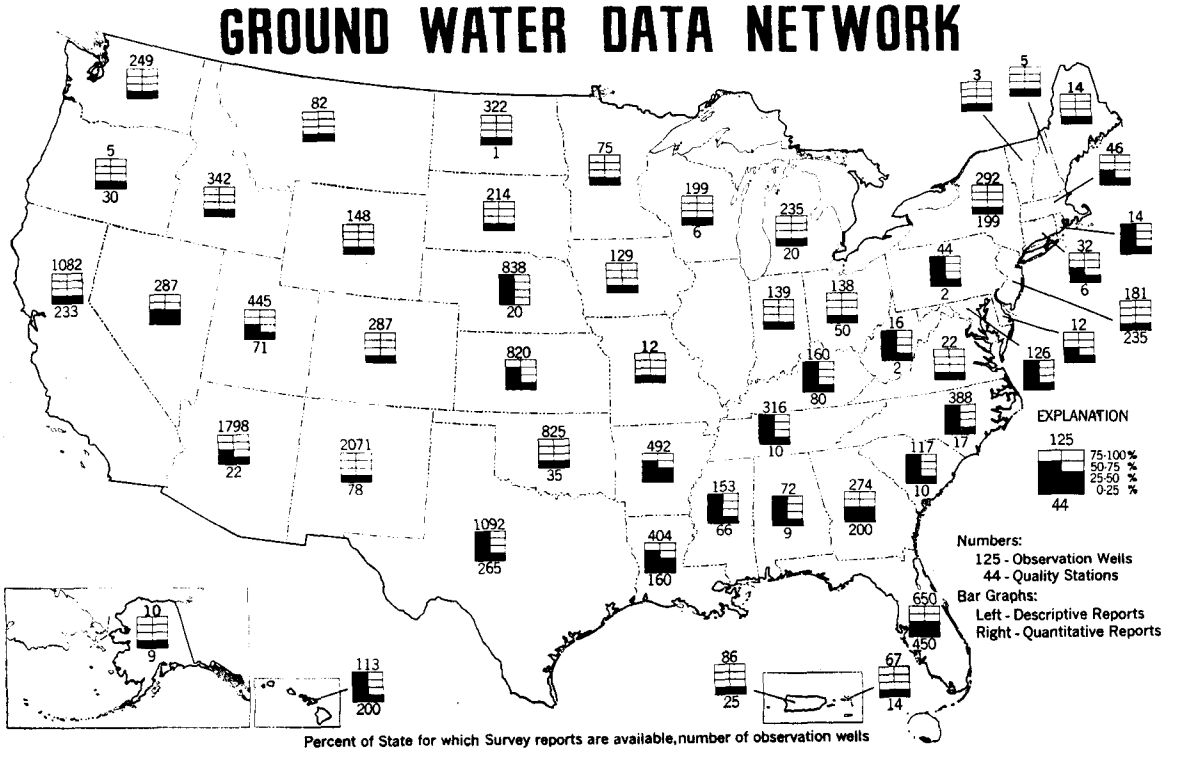
The Geological Survey, within its ground-water data network, has about 15,900 observation wells and about 2500 quality stations to assist in appraising the nation's water resources. Additional data concerning the occurrence and movement of ground water are included in published reports. In the exhibit the upper figure indicates the number of observation wells in each state, and the lower figure indicates the number of quality stations maintained. The left side of the graph reflects the percent of the state covered by descriptive reports, and the right side of the graph reflects the percent of the state covered by quantitative reports.



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The water user is increasingly going to want to know when a capital development is necessary, whether his supply is stable, and for how long. What are the actions of other people going to do? How are they going to affect his costs? All of these cost factors come back basically to the same thing. We need more knowledge which will allow forecasts to be made.

Now we cannot wait for water development until we research all of these things to death. But research also has a place in it because research is that aspect of water information which allows new techniques to be developed, which allows an increasingly sophisticated understanding of the environment. I am not suggesting that decisions are going to be put off, awaiting either facts or research. But the lack of knowledge and facts is costing people in the United States good, hard money.

Fact or Fancy: An Assessment

Today, many of the public pronouncements about water remind me of my Indian friend's response to his water gage problem . . . they sound a great deal like "declarations of concern." Water problems are described in crisis proportions. But to say that we have a water crisis and we must fix it connotes the idea of a solution . . . a panacea. The "crisis" then usually subsides by being forgotten or quietly slipped into the laps of research people.

But if we are realistic about confronting our water problems, we must begin to deal with them much as we do our business problems. This involves getting and utilizing the facts needed to make decisions. Water planning programs are too important to be based on fortune telling rather than on meaningful projections based on fact. ■