History and Description of the Oahu Water Plan

Edward J. Morgan


EVEN the most casual visitor to Oahu, the island on which Honolulu is located, is often perplexed about how such a comparatively small land mass can sustain the large population living there with a never failing supply of fresh water. Were he to pursue the question further, he would be still more astounded to discover that enormous quantities of water are also used in agriculture and industry. He would learn that an average of 475 mgd is developed from a land mass totaling only somewhat more than 600 sq mi, of which 150 mgd is required for industrial uses and more than 500,000 domestic consumers, and 325 mgd is used in agriculture. The board of water supply of the city and county of Honolulu predicts that by 1980 the combined industrial and domestic demand will be more than 200 mgd, and that agricultural use will also increase slightly.

Hence, it is readily appreciated that the matter of water supply on Oahu is highly complex and requires the most thorough long-range planning. The response of the island authorities was to develop the Oahu Water Plan, the most recently completed compendium of current facts and projections related to the development and distribution of water on Oahu.

Early Development

From earliest times the people of the Hawaiian Islands have been extraordinarily water conscious. Living on a string of islands surrounded by the sea and depending on agriculture for survival, the original Polynesians developed a keen awareness of the importance of fresh water and evolved a complex social structure in which water rights were of fundamental significance. Long before the arrival of Captain Cook, a rigid set of unwritten laws relating to matters of land and water had been enforced. Today many of these same laws have been recognized by the courts of the state of Hawaii as forming the basis of water rights litigation.

With the discovery of the archipelago by Captain Cook in 1778, the Western type of economic involvement began. The islands became the hub of the whaling industry in the Pacific and, later, an important coaling station. Business, population, and government grew, and, with them, demands for fresh water. Critical shortages arose early and continued throughout most of the nineteenth century. In a very real sense, the availability of fresh water became the limiting factor to economic growth.

By 1875 the search for new water sources had reached an impasse, and the islands seemed destined for a secondary role in the Pacific. In 1879, however, an enterprising landowner hired a California well driller who, with no more than his past successes
to support him, discovered artesian water beneath the arid plains of southwestern Oahu. The trickles of the small streams and springs that provided the only sources of water in the past became insignificant in comparison with the vast quantities that now flowed from these wells. Oahu boomed. Wells were randomly drilled at low elevations around the island. Large tracts of arid land were put to the plow and watered by the irrigation ditch. The water supply problems of the port of Honolulu appeared to be solved. Oahu became the economic and population center of the archipelago. An era of prosperity set in.

Twentieth Century

As has happened in most places where a seemingly inexhaustible source of fresh water is discovered, unconscionable exploitation took place. By the early part of the twentieth century it became obvious that the underground basin on Oahu was being overdrew. To appreciate the significance of this overdraft, some understanding of the manner of occurrence of the ground water is necessary.

As in most islands and along continental coasts, the ground water of southern Oahu occurs as a fresh water lens floating in hydrodynamic equilibrium with sea water in the aquifer. When more fresh water is withdrawn than percolates to the aquifer, sea water moves to the points of discharge and reduces the fresh water core to a brackish mixture unsuitable for use. Within the first decade of the new century, many coastal wells that originally produced palatable water had become salinized, and the deterioration was spreading inland at an alarming rate.

The prosperity of Oahu, hinging on an ample fresh water supply, was endangered. Government commissions were formed and private citizens’ groups were organized in efforts to curb wasteful exploitation. Fundamental investigations to explain ground water occurrence were initiated. This awareness had a retarding effect on the deterioration of the water supply, and, in addition, a fortuitous run of wet years brought the water levels higher than they had been at the turn of the century. Overdevelopment continued, however, although masked by a short-term surplus of rainfall, and when the wet cycle turned to one of drought, the water levels plummeted and salinization increased. By 1926, after several periods of severe drought, it became apparent that casual planning and sporadic, though intense, efforts to rationalize development were ineffective in solving the long-range problems of fresh water for the island of Oahu and its main city, Honolulu.

Formation of Board

In 1926 the Honolulu sewer and water commission was formed and assigned the task of constructing a mod-
ern sewer system and developing and distributing water within the city of Honolulu. Three years later this agency was dissolved and its members concerned with water supply organized as the Honolulu board of water supply, a recognition of the critical importance of water to the community. The newly formed board was made as nearly autonomous as is possible for a public utility and charged with the immense task of not only providing water for the city but also safeguarding the water resources. Its authority was extended to the entire island of Oahu in 1959.

With the establishment of the board in 1929, long-range water supply planning for Honolulu became possible. A staggering job faced the new board. The city supply had to be metered, the distribution system brought up to date, defective wells either repaired or sealed, and increasing demands met. The current sources of supply were being exploited at a dangerous rate to meet these demands, and, hence, it was obvious that new sources were required and would continue to be required to meet projected demand. Planning became a firm part of the board's policies.

**Start of Plan**

A program to evaluate Honolulu's water resources was immediately undertaken. In the initial phase, water supply data filed with various agencies throughout the city were collected, and stations for the continuous recording of hydrologic parameters such as rainfall, streamflow, well discharge, water table elevations, and salinities were installed. Comprehensive geologic and hydrologic studies were undertaken. By the mid 1930’s, order had been brought to the water supply system of Honolulu. As a result, even in the severe drought of 1933 the board was able to meet demand.

The value of planning well into the future was dramatically illustrated during World War II, when Oahu became the logistics bastion of the Pacific theater of war. A tremendous influx of civilian workers and military personnel streamed into Oahu, most of them to the Honolulu region. Within a few years, the demand for water nearly doubled. Simultaneously, the worst cycle of drought on record struck the islands. By accelerating the implementation of plans drafted 10 years earlier, the board was able to accommodate the new demands, although under crisis conditions in some instances.

Following the war, major readjustments in supply and demand occurred. With the exodus of much of the war-induced increase in population, demand fell by one-third, necessitating a new analysis of the distribution system for maximum efficiency. In effect, an opportunity was presented to initiate a new stage of planning, based once again on anticipated normal growth.

Economic development progressed slowly until the Korean War, which provided a new stimulus to growth. Development was accelerated again when Hawaii became the fiftieth state of the Union in 1959. In this year, also, the entire island of Oahu became the responsibility of the board of water supply.

A population explosion was occurring not only in Honolulu but in communities outside the city. In 1950 the board’s responsibilities were limited to supplying 250,000 people in 80 sq mi; 10 years later the board had to meet the demands of nearly 500,000 people in 600 sq mi. Thirty years of plan-
ning and administrative experience on the part of the board and a history of a half century of public concern enabled the board to undertake its new responsibilities with a minimum of disruption and to meet the challenge successfully.

**Oahu Water Plan**

Until World War II, a paternalistic system of plantation agriculture based on sugar cane and pineapple dominated the economy and social structure of the Hawaiian Islands. On each of the main islands—Hawaii, Maui, Oahu, Kauai, Molokai, and Lanai—this system flourished, although Oahu was affected, in addition, by the presence of the Pearl Harbor naval base and the port of Honolulu.

The creation of new economic opportunities during and following the war helped to erode the paternalism of the old order, liberating latent demands for housing and the conveniences of modern living. Most such opportunities were generated on Oahu, and, as a consequence, steady migration from the “outside” islands to Oahu took place. New towns formed, and housing developments surrounded Honolulu. The momentum of growth was so great that in its early stages the efforts of town and city planners of necessity were devoted to meeting short-range needs. To effectively accommodate the fundamental social and economic changes that had occurred, however, it was evident that long-term needs would have to be projected and steps taken to meet them. The Oahu Water Plan was prepared to accomplish this.

Prior water supply plans had been prepared essentially for use by board members only. The Oahu Water Plan, on the other hand, was designed for use by the widest possible leadership—city planners, developers, government officials, bond houses, consultants, and so forth—without sacrificing its basic purpose as a vehicle for staff decisions. Although interested

---

Fig. 2. Average Daily Domestic Use on the Island of Oahu

*The solid bars are for actual and the hollow for projected use.*
laymen could readily understand the plan, it was not written for them. A 20-year period, 1961-80, was selected as the optimum planning interval.

The plan was largely concerned with the management of the sources of water. The board of water supply currently operates 50 separate water producing stations on the island and will have many more in operation by 1980. This high number of primary stations reflects not only the size of the region but also the uniqueness of the supply problems. Although many large cities are able to rely upon a single source, such as a river, withdrawals on Oahu must be evenly distributed over wide areas to prevent destruction of the sources by salinization or depletion.

Included with the discussion of the management of water resources are descriptions of the current and projected developmental and distribution systems. The plan includes 31 maps, 62 photographs, 24 graphs, and about 40,000 words of text.

**Structure of Plan**

In the plan, Oahu is divided into eight regions called "service areas." In general, each region is characterized by a similarity in natural environment and in the development and distribution of water. Discussion of the island as a whole and each service area is carried out under three distinct categories.

Under the first category, "Hydrology," the natural phenomena responsible for the water resources are evaluated and their occurrence described. A page-size map shows the basic hydrologic parameters of rainfall, water table elevation, and salinity, and pertinent geologic information. Cross sections are included with the map. Emphasis is on the occurrence and the quality of the ground water. The text also discusses in some detail the climate, geography, and geology of the region.

In the second category, entitled "Water Sources and Areas Served, 1962," population and consumption statistics are given, and the currently used water producing stations are described. A large map shows the location of the producing stations and the skeleton of the main distribution system.Outlined on the map, also, are the areas served by the board.

The third category—"Water Sources and Area Served, 1980"—contains the projections of the board's staff. Discussed are the anticipated population increases over the next 20 years and the increase in demand that will accompany them. The means of satisfying the greatly increased requirements are also discussed. Graphs of population and water consumption, past, current, and expected, are included. Figures 1 and 2 are two of these. On a large map that illustrates the current supply and distribution network, the additional construction projected for 1980 is superimposed. Present areas of service are differentiated from anticipated new ones by a difference in color.

**Other Features**

In order to relate the discussions under the three categories, the plan begins with a summary history of water development on Oahu and a review of the island's geologic history and geography. The concluding format contains a verbal and statistical summary and a comprehensive bibliography of references to the literature on water resources and their development.
Each map is drawn to the same scale and faces the text, graphs, and photographs referring to it. The totality of the island's water resources is analyzed and then related to the sources developed and proposed by the board. Actually, more water is developed by the large sugar plantations on the island than by the board, and, thus, any water planning must be closely coordinated with all users.

The critical concept of "sustainable capacity" is introduced. By sustainable capacity is meant the ability of the individual stations to provide water indefinitely without exhausting the water resources or endangering them by sea water contamination. Actual capacity at any station is always greater than sustainable capacity in order to provide for emergency conditions and for extraordinary water use during dry periods; however, the average annual draft from a station must be equal to or less than its sustainable capacity if the station is to survive as a water producer. The plan conclusively shows that with skillful development techniques and withdrawal patterns guided by the concept of sustainable capacity, the vast fresh water resources of Oahu will be sufficient to meet growth requirements well beyond the foreseeable future.

Perhaps one of the most important features of the plan is that it brings together for the first time in a coherent form data on widely scattered hydrologic and water resource developments on Oahu. In this function it has already proved its worth. It can be used for educational purposes in addition to its primary function of serving planners and developers. Of course, it also is the basic document for decision making within the board of water supply.

The Oahu Water Plan was conceived, designed, and prepared by the staff of the board of water supply. Outside aid was required only for the cover artwork and for advice on the layout. Printing, of course, was commercially done.