PROPOSED ZONES OF MIXING:
Honolulu Harbor and Kapalama Canal

by

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This statement pertains to the proposal to establish zones of mixing in Honolulu Harbor and Kapalama Canal, Oahu, in order to accommodate certain discharges of the Dole Company, Hawaiian Electric Company, and Libby McNeill & Libby, described in a notice of a public hearing (Docket R-40-70) published in the Honolulu Advertiser 18 May 1970. This proposal is made pursuant to provisions in the State Water Quality Standards (Department of Health, Public Health Regulations, Chapt. 37-A, 1968), under which also, the public hearing is to be held 9 June 1970.

INTEREST AND COMPETENCE OF THE WATER RESOURCES RESEARCH CENTER

The State Water Quality Standards were developed on the basis of public hearings held during 1966 and 1967, at which were presented such meager data as was available on water quality and waste discharges, and in which members of the staff of the Water Resources Research Center participated.

Honolulu Harbor, including its tributaries Kapalama Canal and Nuuanu Stream, was included in the state-wide part of a study of Estuarine Pollution in the State of Hawaii conducted by the Center in 1968-69 with the support of the Federal Water Pollution Control Administration. No new water quality analyses were made in that study, but all available information was summarized. An excerpt of the pertinent sectionof the report, "Estuaries and potential estuarine pollution on the major Hawaiian Islands" (Cox and Gordon, 1970, U.H. Water Resources Res. Ctr. Tech. Rpt. 31, vol. 1, pp. 74-77), is appended hereto.

It is our understanding that the proposed zones of mixing in Honolulu Harbor and Kapalama Canal are the first to be formally considered pursuant to the provisions of the Water Quality Standards. It is therefore of concern to all who have contributed to the development of the Standards and to subsequent investigations pertinent to their administration that sound precedents set in the consideration of and action on this proposal.

The preparation and review of this statement has involved most of those of the WRRC staff who have been involved in the activities above described. However, any conclusions and recommendations in it concerning the establishment of the proposed zones of mixing must be regarded as those of its authors alone. Neither the WRRC nor the University as institutions have any direct responsibility for administrative determinations under the Water Quality Standards.

INTENT AND ESTABLISHMENT OF ZONES OF MIXING

The State of Hawaii has chosen to exercise its control on water quality primarily through the establishment of standards pertinent to waters receiving waste discharges rather than pertinent to the waste discharges themselves.

Under its Water Pollution Control regulations (Department of Health, Public Health Regulations, Chapter 37, Sec. 3, as amended in 1968), it is unlawful "To discharge any wastes into any waters of the State so as to reduce the quality of the water below the standards of water quality adopted for such waters by Chapter 37-A" without a permit. The Water Quality Standards provide, however (*op. cit.*, Chapt. 37-A, Sec. 4), for "zones of mixing for the assimilation of municipal, agricultural and industrial discharges which have received the best practicable treatment or control or such lesser degree of treatment or control as will provide for a water quality commensurate with the classified use of the waters outside the zone of mixing", with the objective "to provide for a current realistic means of control over such discharges and at the same time achieve the highest attainable level of water quality". There are thus two mechanisms for allowance of the discharge into receiving waters classified under the Water Quality Standards of wastes that result in local degradation of the receiving waters below the tolerances set in the Standards; 1) by permit pertinent to the discharge (Chapt. 37, Sec. 3), and 2) by establishment of a zone of mixture in the receiving water (Chapt. 37-A, Sec. 4).

The Regulations are not explicit as to how a choice is to be made between these two methods. Permits may be issued for periods not to exceed 5 years (Chapt. 37, Secs. 4 & 5), whereas no terms are set in establishing zones of mixing (Chapt. 37-A, Sec. 7), and a public hearing is required in the establishment of a zone of mixture but not in the issuance of a discharge permit. Hence it may be assumed that permits should be granted in the case of discharges considered to be more or less temporary and zones of mixing established only in the case of discharges expected to be long term. Both permits and zones of mixing may be revoked under certain conditions (Chapt. 37, Sec. 6, Chapt. 37-A, Sec. 8).

Applications for discharge permits must be accompanied by statements as to the discharge activity and plans of the discharge works, (Chapt. 37, Sec. 4) and they are to be reviewed to ascertain effects upon water quality, they may not be issued unless the information clearly shows that issuance is in the public interest, and they may be issued subject to conditions such as a requirement of effluent sampling (Sec. 5). Explicitly the establishment of a zone of mixing seems to be less rigorous. Chapt. 37-A (Sec. 7) specifies that the application shall be made of forms furnished by the Director [of Health] and shall contain the information required therein, but does not in

itself specify this information. However, the Director must take "into account protected uses of the body of water, existing natural conditions of the receiving water (*i.e.*, depth, currents, location, etc.), character of the effluent, and the adequacy of the design of the outfall and diffuser system to achieve a maximum dispersion and assimilation of the treated or controlled waste with a minimum of undesirable effect on the receiving water". Hence it may be assumed that the information supporting a request for the establishment of a zone of mixing must be submitted at least in the degree of detail required for an application for a permit, and that the establishment and continuance of a zone of mixing may be contingent upon the initiation and continuance of an appropriate monitoring program.

According to (Sec. 7), establishment of a zone of mixing depends on the determination, by the State Director of Health, that the use of such a zone for the mixing of a discharge "will not unreasonably interfere with any actual use of the water areas for which it is classified". It may be noted that this prescription has an anti-degradation effect, but does not encourage restoration of quality in those waters in which discharges have already for a long time restricted potential uses. Considering the greater gravity of the establishment of a zone of mixing than the issuance of a permit, the requirements for the former should be at least as stringent as those for the latter. Chapter 37 (Sec. 5) specifies that: "No permit shall be issued by the Director unless the application and the supporting information clearly show that the issuance thereof is in the public interest..." In this light, the use of the word "actual" in describing uses with which interference is not to be permitted in establishing a zone of mixture is misleading, suggesting as it does the exclusion of demonstrably practicable though non-current uses as well as impracticable and hypothetical uses.

The regulation (Chapt. 37-A, Sec. 7) indicates that "the boundaries of each zone of mixing shall be fixed by the Director" but does not explicitly recognize the need also to establish tolerance limits for the pertinent pollutants within the zone. There is no reason to suppose, however, that, just because the normal tolerance limits for the particular class of water involved are to be waived in establishing a zone of mixture, no substitute tolerance limits will be set. Indeed the requirement that the Director in fixing the boundaries must take into account "protected uses of the body of water existing natural conditions of the receiving water (*i.e.*, depth, currents, location, etc.), character of the effluent, and the adequacy of the design of the outfall and diffuser system to achieve a maximum dispersion and assimilation of the treated or controlled waste with a minimum of undesirable or noticeable effect on the receiving water" implies that he must take into account the limiting concentration field for each significant pollutant within the zone of mixture, and that he may for some pollutants set limits of concentration different from those normal for the water class and for others retain the limits normal for the class.

The same requirement that the Director take these factors into account, implies clearly that he must make or have access to an analysis of the socio-ecological system within which these factors operate adequate to a proper accounting.

In summary, we believe that there are five important considerations in establishing a zone of mixture that are of implied but not set forth explicitly in the regulations:

1) that, with an application for the establishment of a zone of mixing, information must be submitted whereby the pertinent economic, ecological, and esthetic effects may be analyzed.

2) that to determine the appropriateness of establishing a zone of mixture there must be such an analysis.

3) that in such an analysis, the overall public interest should be considered, including demonstrably practicable potential uses as well as current uses of the waters.

4) that in a zone of mixture tolerance limits may be set for some pollutants whose mixing is to be accommodated and whereas for other pollutants the normal limits for the water class in question will pertain.

5) that a suitable monitoring program may be required for the continuance of a zone of mixing.

Unless these considerations, now implicit, are recognized, plans should be made for their prompt explicit recognition by amendment of the regulations. It should be noted that zones of mixing established without such recognition may be liable to an early termination upon the remedy of these defects, and it might well be better to accommodate present discharges at variance with the Water Quality Standards by the use of permits as in Chapter 37 than by the establishments of Zoe zones of mixture as in Chapter 37-A.

BACKGROUND INFORMATION

Under the Water Quality Standards, the waters of Honolulu Harbor are classified Class B (protected for harbor, shipping and industrial, bait fishing, and esthetic enjoyment uses). However, the Kapalama Canal and Nuuanu Stream estuaries, which are classified as coastal waters by reason of their tidal response, must be classified as Class A (protected for esthetic enjoyment and recreational use including fishing, swimming, boating, and other water-contact sports) because they are not in the "limited area next to boat docking facilities" included in the Class B designation.

From the information in the WRRC report cited earlier (Cox and Gordon, 1970) it appears that, in certain respects, the waters of Honolulu Harbor and Kapalama Canal, or parts of these waters, fail

to meet the water quality standards applicable to the pertinent classifications. Although the waters of the southeastern part of Honolulu Harbor are relatively uncontaminated, the waters of the western part of the Harbor have high concentrations of both fecal and total coliforms. With respect to fecal coliform concentration the waters of the Sand Island Channel do not meet the tolerance set in the Standard for Class B waters, and the waters of Kapalama Canal fail to meet not only the tolerance for Class A but that for Class B as well. Data presented in relation to other water quality parameters is less satisfactory as to current applicability, adequacy of sampling, or geographic coverage, but it appears that with respect to pH and temperature the waters of Kapalama Canal have failed to meet either the Class A or Class B tolerance, at least in the past, that with respect to dissolved oxygen the Canal waters have failed to meet Class A tolerance, and that with respect to oil the waters of the Harbor itself have probably failed to meet the standards at times.

So far as the Kapalama Canal is concerned, it is not alone among estuarine drainage canals in failing to meet Class A water quality standards. Of four such canals discussed in the cited report, three do not meet the standards in at least one respect, and the remaining one probably does not meet the standards (Cox and Gordon, *op. cit.*, table 17, p. 129). The report concludes (p.130):

"The evidence that the water quality in none of the estuarine drainage canals meets the standards for Class A waters in which they are not included, raises the question whether these estuaries as a group should perhaps more appropriately be included with the harbors in Class B. The answer to the question depends upon more knowledge concerning the sources of their pollution, possible methods of reduction of the pollution, the costs of such reduction, and the benefits to be derived from meeting the higher standard than is now found".

APPLICATIONS AND SUPPORTING DATA FOR HONOLULU HARBOR AND KAPALAMA CANAL ZONES OF MIXING

According to the notice of the 9 June 1970 public hearing, the zones of mixing proposed for Honolulu Harbor and Kapalama Canal are intended to accommodate three discharges, one in Honolulu Harbor by Hawaiian Electric Company, and two in Kapalama Canal by Dole Company and by Libby, McNeill & Libby. In response to our request for information on the applications for the zones of mixing, we have received copies of: i) a Hawaiian Electric 1 June 1970 letter "Application for permit for waste discharge outlet, hearing for file no. G5-2521", attached statements by V. C. Cronkhite and Klaus Wyrtki, and an attached chart showing a proposed zone of mixing in Honolulu Harbor including Kapalama Basin; and ii) a 3 June 1970 statement by Dole Company with attached charts showing temperature and resistivity fields and a proposed zone of mixing in Kapalama Canal and Basin.

It seems unlikely that any of these materials constitute an adequate application for a zone of mixing "made on forms furnished by the Director and ... [containing] information required therein", as specified (Chapt. 37-A, Sec. 7). The information submitted is useful, however, especially in the light of the poverty of previous pertinent information, and it is, therefore, below both briefed and analyzed for seeming inadequacies.

The Cronkhite statement accompanying the Hawaiian Electric Company letter calls attention to the economic and social importance of electric energy, the necessary utilization of large amounts of cooling water in the generation of this power; and the fact that the heat rise associated with the discharge of this cooling water exceeds the tolerance set in the Water Quality Standards; claims that neither evaporative cooling towers nor cooling reservoirs are economically feasible; and suggests that a concentration of recreational fishermen near the cooling water discharge in Honolulu Harbor may indicate a benefit or at least the absence of a detrimental effect of this discharge on fishing.

The second accompanying statement by Wyrtki provides quantitative data on the discharge of cooling water, on the heat rise of this discharge, and on the temperature field in the harbor in the immediate vicinity of the discharge (apparently during trade-wind conditions); and in addition an analysis suggesting that most of the waste heat is discharged to the ocean during normal trade weather by way of the main channel, that some is discharged by way of the Kapalama Channel especially during easterly trades, that in Kona periods the lower natural water temperature compensates for the effects of southerly winds in opposing discharge from the harbor by surface currents, and that all of the Harbor between the main channel and the Sand Island channel must be considered a zone of mixing necessary to bring the temperature departure down to the tolerance set in the standards.

The Dole Company statement calls attention to the facts that, when new sewering has been provided, as planned both within and outside the Dole cannery, the discharges from the cannery to Kapalama Canal will violate the Standards only with respect to temperature, salinity, and dissolved oxygen; that adequate oxygenation will be provided by present or improved aerators; and that the discharges from the canneries greatly exceed the natural summer flow of the canal and tidal mixing is ineffective, so that with respect to heat and fresh water, adequate mixing does not occur until the discharge reaches Kapalama Basin. According to the statement a sampling program has been conducted in Kapalama Canal and Basin in various tide and weather conditions, involving several pollution parameters, and accompanying the statement are plots of the distribution of temperature and resistivity during a rising tide on one day and falling tides on two days, (one with rain mauka) all in May 1970. In these plots significant temperature and salinity departures from normal are shown to be confined to the Canal and the north part of Kapalama Basin, and

this part of the Basin is therefore outlined as a zone of mixing.

These statements do not provide the following seemingly pertinent information:

a) Quantitative economic information (even approximate) on costs of listed alternative waste head discharge mechanisms for the power plant.

b) Identification and at least approximate economic analysis of other alternative waste heat discharge mechanisms, such as non-evaporative cooling towers and discharge to the ocean rather than the harbor.

c) Discussion of atmospheric ecological consequences of alternative mechanisms for waste heat discharge.

d) Sampling of the actual thermal field in the harbor to substantiate the analysis for trade conditions.

e) Analysis of the frequency and consequences of kona wind occurrence dissociated from lower-than-normal ocean temperatures.

f) Sampling of the actual thermal field during kona conditions.

g) Identification of current and potential uses of the Harbor other than recreational fishing. (Is bait fishing still practiced, as was reported at one of the 1966 Water Quality Standards hearings by a representative of the Department of Land and Natural Resources (cited by Cox and Gordon, 1970, p.74)? Has testimony on fishing uses in the Harbor been sought from that Department for the 9 June 1970 hearing?)

h) Ecological, economic, and if pertinent esthetic analysis of the effects on all uses of anticipated thermal fields in the Harbor.

i) Sampling and analysis of thermal and salinity field in Kapalama Canal and Basin at other times of year than May.

j) Quantitative description of the flows, temperatures, and salinities of the cannery discharges, with diurnal and seasonal variations.

k) Identification and economic analysis of alternative means for dispersing heat and fresh water.

l) Description of the dissolved oxygen field in the vicinity of the aerators.

m) Identification of any uses of Kapalama Canal of a nature to be protected under Class A. Designation.

n) Ecological, economic, and esthetic analysis of the effects of the anticipated Kapalama Canal oxygen, thermal, and salinity fields, particularly in the absence of other pollutants now present.

SPECIAL PROBLEMS

In consideration of the application for the establishment of zones of mixing for Kapalama Canal and Honolulu Harbor there are a number of special problems, some arising primarily from lack of precision in the Water Quality Regulations, and some from inadequacy in the applications. It would seem from the materials submitted that their intent was to have established, not a single zone of mixing, but two or three partly overlapping zones of mixing, one for temperature involving Honolulu Harbor, including Kapalama Basin, and also Kapalama Canal, one for salinity involving the lower part of Kapalama Canal and the north part of Kapalama Basin, and perhaps one for dissolved oxygen involving part of Kapalama Canal.

With respect to temperature, the regulations specify (Chapt. 37-A, Sec. 6.B.6) that in both class A and class B waters "Temperature of receiving water shall not change more than 1.5° F from natural conditions." It is not clear whether this means that the temperature should not at any time depart by more than 1.5° from the temperature that would have occurred naturally at that time, or that the temperatures should not drop more than 1.5° below or rise more than 1.5° above the naturally occurring temperature range. The ecological effects in some waters may well be different depending on which interpretation is accepted. Since in Honolulu Harbor and Kapalama Canal the natural conditions cannot now be monitored, the natural temperatures must be estimated by analysis.

With respect to salinity the regulations specify (Sec. 6.B.5) "no changes...in freshwater influx shall be made which would cause permanent changes in isohaline patterns of more than 10% of naturally occurring variation or which would otherwise affect biological and sedimentological situation. Total dissolved solids shall not be below 28,000 mg/l from other than natural causes". Much of the same uncertainty exists with this specification as with that for temperature, but neither the specification nor the uncertainty have any pertinence to the case of Honolulu Harbor and Kapalama Canal because the regulation is restricted in its applicability to Class AA waters. Wisely or unwisely there is no specification of tolerance limits for any salinity parameter pertinent to the Class A water of Kapalama Canal or the Class B water of Honolulu Harbor, so no salinity zone of mixing is required in these waters.

With respect to dissolved oxygen, the regulations specify (Sec. 6.B.4) definite lower limits of 5.0 mg/l for Class A and 4.5 mg/l for Class B waters.

CONCLUSIONS

The provision in the Water Quality Standards for the establishment of zones of mixing is in principle sound. If properly administered this provision will allow for optimum utilization of the natural processes of dissemination and degradation in the estuarine and marine environment for the necessary disposal of wastes, without undue detrimental ecological effects. However, the information and analysis explicitly prescribed for the establishment of zones of mixing seems inadequate, as may be seen by its comparison with the information and analysis prescribed for the issuance of less significant permits for discharges which would result similarly in local but presumably shorter term departures from tolerances set for various pollution parameters.

As required by the Water Quality Standards, a formal application must be made for the establishment of a zone of mixing, and the application must be considered through a formal process involving a public hearing. We believe that: 1) the application should be accompanied by information sufficient to permit a sound analysis of the economic, ecological, and esthetic effects of the proposed establishment; 2) the zone of mixture should be established if and only if it is in the overall public interest; 3) in the evaluation of public interest, demonstrably practical potential uses as well as current uses of the waters should be considered; 4) the departures from normal tolerances should be permitted only for specified pollution parameters in any zone of mixing, and that for these parameters special tolerances should be set; and 5) a suitable monitoring program should be required, if warranted, for continuance of a zone of mixing.

We believe that unless these considerations are recognized as implicit, if not explicit, in the regulations, plans should be made for their prompt explicit recognition by amendment of the regulations. It should be noted that zones of mixture established without such recognition may be liable to an early termination upon the remedy of the defects, and it might well be better to accommodate present discharges at variance with the Water Quality Standards by the use of permits as in Chapter 37 rather than by the establishments of zones of mixture as in Chapter 37-A.

The primary purpose of the 9 June 1970 hearing if prescribed more closely than is done by the public notice or the applications and supporting information, should be to consider the advisability of establishing all of Honolulu Harbor, including Kapalama Basin, and also the lower part of Kapalama Canal, as a zone of mixing for temperature alone. A possible secondary purpose may be to consider the advisability of establishing a zone of mixing in a part of Kapalama Canal for dissolved oxygen.

We are, in general, of the belief that the establishment of these proposed zones of mixing might be shown to be appropriate. However, considering the importance of the establishment of zones of mixing under the Water Quality Standards and the special importance of the precedents that will be set by the establishment of the first of such zones, the information that, to the best of our knowledge, has been supplied pertinent to the establishment of these proposed zones of mixing seems gravely inadequate.

We recommend that:

1) Amendment of the application or applications for establishment of the zones of mixing in Honolulu Harbor and Kapalama Canal be requested:

a) to formalize and clarify their intent,

b) to indicate a restriction to zones with respect to temperature alone or temperature and dissolved oxygen, as appropriate, and

c) to provide either in themselves or by attachments, information adequate to permit a sound analysis of the overall public interest in establishing the proposed zones of mixture;

2) If adequate information cannot be provided within a reasonable time, discharges in violation of the Standards be accommodated temporarily by permits;

3) If and when warranted by thorough analysis based on applications, zones of mixture be established within which special tolerances are set for those pollution parameters permitted to vary from the normal tolerances for waters of the pertinent classes.

4) Consideration be given to establishment of a suitable monitoring system within the zones so established.

APPENDIX

Excerpt from

ESTUARIES AND ESTUARINE POLLUTION ON THE MAJOR HAWAIIAN ISLANDS

By Doak C. Cox and Lawrence C. Gordon, Jr.

Estuarine Pollution in the State of Hawaii

Volume 1: Statewide Study

Water Resources Research Center Report No. 31

University of Hawaii

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Honolulu Harbor

Honolulu Harbor (Fig. 22) on southern Oahu is the principal commercial port of the Hawaiian Islands. It is also the fifth most important source of nehu (bait fish) according to David Butchart of the State Department of Land and Natural Resources (Department of Health, 1966b). The harbor was originally a natural channel in the reef resulting from the fresh-water discharge of Nuuanu Stream. In numerous successive stages of dredging beginning in the mid-1800's, the size and depth of the harbor have been increased. It is now connected by deep water with Kapalama Basin, from which it was formerly separated by a shallow reef. Sand Island, southwest of the harbor, was, at successive stages, created by dredged fill, greatly enlarged and connected with the mainland west of Kapalama Basin, and again separated from the mainland by the present Kalihi ship channel. Other reef and lowland areas around the harbor have been filled, notably east of the harbor entrance. The harbor receives the flow not only of Nuuanu Stream, including that of its major tributary Pauoa Stream, but also considerable drainage from the Kapalama Canal. Nuuanu Stream originates in forest reserve lands in the Koolau crest area. Its valley is filled to the crest line with sediments and post-erosional lavas, from which some perched springs emerge. The stream flow is stabilized by three reservoirs, one of 1,630 acre/ft capacity. Pauoa Stream arises in a shorter

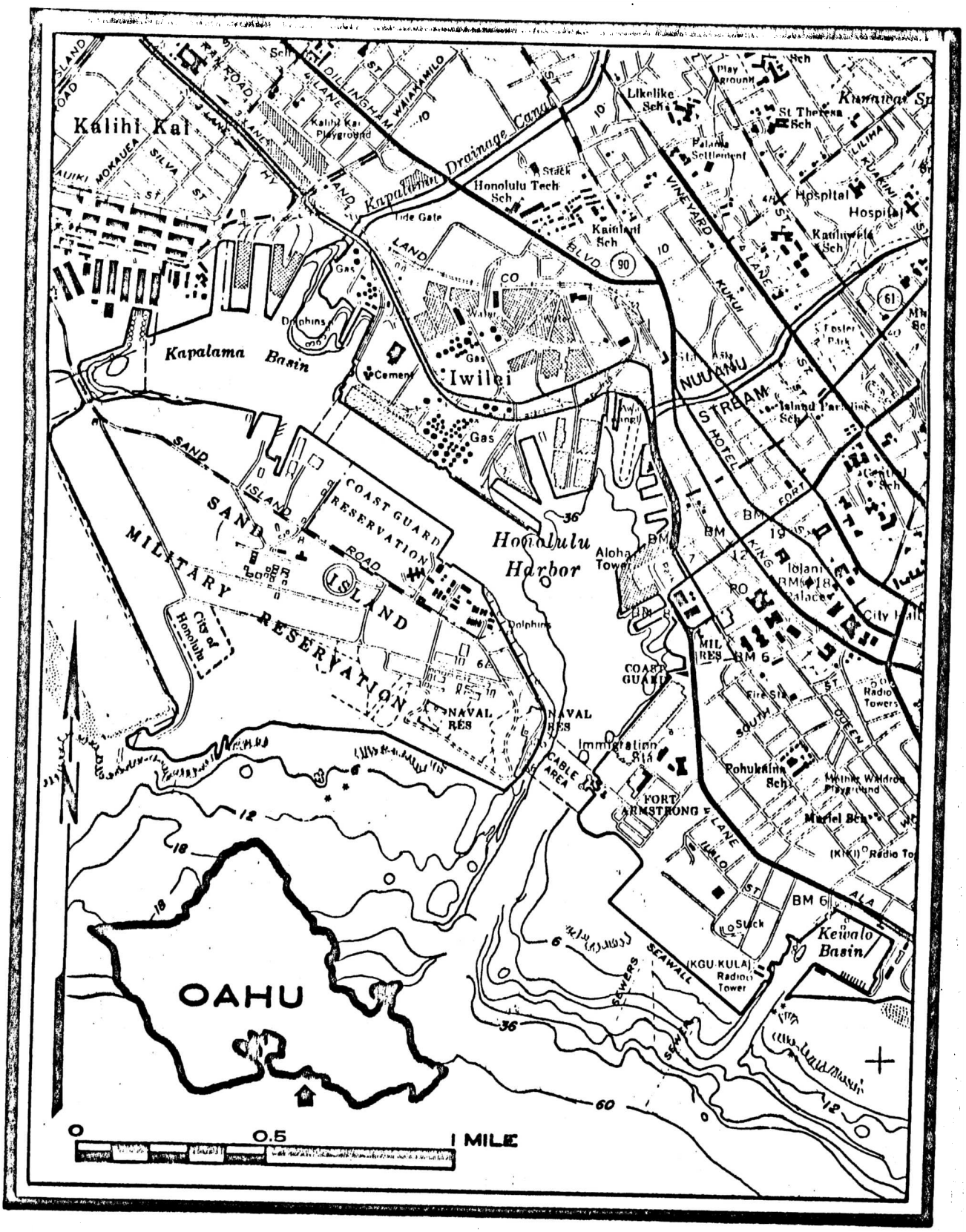

FIGURE 22. KAPALAMA BASIN, HONOLULU HARBOR, AND KEWALO BASIN.

valley, filled similarly to the Nuuanu Stream valley. Both streams flow through residential and business districts of Honolulu to the Nuuanu estuary which has been channelized. Part of their drainage areas is still served by cesspools but most is served by the Honolulu sewer system.

The mean flow of Nuuanu Stream, at the lowest gaging station at 631-foot altitude, is 5 mdg (U. S. Geological Survey, 1961). Fragmentary records suggest that the mean flow of Pauoa Stream is about 1 mgd. Flood flows and lowland spring flows and seepage probably add greatly to the mean discharge through the Nuuanu estuary. The minimum discharge is, however, quite small.

The Kapalama Drainage Canal carries, besides flood waters, the bland wastes of the following pineapple canneries, California Packing Corporation (3,000 gpm), Dole Pineapple Company (8,300 gpm), Libby, McNeil and Libby (2,000 gpm). Strong wastes from the canneries are discharged to the Honolulu sewer. Honolulu Gas Company discharges to the canal a combined stream of effluent and cooling water of 500 gpm. In dry weather the effluent discharge to the canal is approximately 14,000 gpm (about 20 mgd) (Department of Health, 1966b).

The Department of Health, State of Hawaii, samples show that in 1965 the temperature in the canal ranged from 78° to 95°F, dissolved oxygen ranged from 0 to 8.4 mg/l, biochemical oxygen demand ranged from 11 to 1,012 mg/l and pH ranged from 4.4 to 9.2 (Department of Health, 1966b). More recent sampling by the pineapple companies indicates that dissolved oxygen increases from 3,000 in the pineapple waste discharge area to the Harbor to 5.5 ppm at the Harbor and that biochemical oxygen demand is 300 ppm about 1,500 feet from the mouth of the canal.

Additional potential sources of pollution to the harbor itself are an oil refinery, a thermal power plant, storm drainage from the business and industrial zones around it, and the ships in the harbor.

Pollution in the harbor has long been noted.

> Keller, Tay, and Collins in 1920 described stagnant and polluted conditions that indicated inadequate tidal and stream flushing. The isocol maps of Metcalf and Eddy in 1944 indicated high bacterial concentration in Honolulu Harbor and also in some parts of Keehi Lagoon. The opening of the Kalihi ship channel from Honolulu Harbor west through Keehi Lagoon to the sea, however, has restored an original but long closed route for circulation. (Laevastu, Avery, and Cox, 1964).

The harbor waters are generally oily, as might be expected from its intensive commercial use. Significant oil contamination has been noted on occasion but rarely traced to sources, which are probably ships. Three specific spills of oils or other dark liquids were noted in the second quarter of 1968 (FWPCA, 1968).

The Hawaiian Electric Company power plant on the north shore of the Harbor uses salt water from the Harbor for cooling and discharges the warm water back to the surface in the Harbor.

The median coliform content from six years of samples taken by the Department of Health at the Harbor entrance (Station 1, Table 11) is only 6 MPN/100 ml and the upper decile value only 700 MPN/100 ml. A recent 10-day intensive survey by the Department (Fig. 21 and Table 12) showed low concentrations of both total and fecal coliforms throughout the Harbor (median count less than 500/100 ml) except in the Sand Island channel and Kapalama Canal. In the Sand Island channel the medians of both total and fecal coliforms were greater than 125,000/100 ml, and the maxima were 8.7×10^6 for total and 6.9×10^6 for fecal coliforms/100 ml. In Kapalama Canal the total coliforms showed a median of over 20×10^6 and a maximum of 22×10^6/100 ml, and fecal coliforms a median of 14×10^6 and a maximum of 227×10^6/100 ml.

The Harbor has been designated as a Class B coastal water, but even for this class the fecal coliform content in the Kapalama Canal and Sand Island channel very greatly exceed the standards.

Three moderate to heavy fish-kills have occurred in the Kapalama Canal. The first, occurring in May 1963, and third, in September 1966, which involved main y forage species, were attributed to "food and kindred products." For the second which occurred in July 1965 and involved in estimated 100,000 fish, the cause was undetermined (FWPCA, 1964, 1966, 1967).

TABLE 11. COLIFORM ANALYSES FOR OAHU ESTUARIES ANALYSES BY DEPARTMENT OF HEALTH.

STATION NO.	PLACE	PERIOD (YRS.)	MPN/100 ML N	MINIMUM	MEDIAN	UPPER DECILE	MAXIMUM
C-1	KEEHI LAGOON PARK	1962-68	96	0	240	7,000	70,000
D	MOANALUA STREAM MOUTH	1962-68	96	6	2,400	70,000	700,000
E	KALIHI STREAM MOUTH	1962-68	96	240	24,000	240,000	700,000
X	KEEHI PARK AND SEA-PLANE RUNWAY	1962-68	96	0	240	7,000	70,000
Y	KEEHI LAGOON PARK AND SEA-PLANE RUNWAY	1962-68	96	0	240	24,000	240,000
1	HONOLULU HARBOR ENTRANCE	1962-68	99	0	6	700	7,000
2	KEEHI LAGOON, SEAWARD SEA-PLANE RUNWAY	1962-68	100	0	240	7,000	700,000
3	KEEHI LAGOON, SEAWARD SEA-PLANE RUNWAY	1962-68	99	0	62	7,000	24,000
4	SAND ISLAND BRIDGE	1962-68	99	24	7,000	240,000	240,000
5	KEEHI LAGOON SMALL-BOAT HARBOR	1962-68	99	6	700	24,000	240,000
	KEWALO BASIN	1959-68	220	0	2,400	7,000	700,000
	ALA WAI CANAL AT ALA MOANA BLVD. BRIDGE	1959-68	218	6	2,400	7,000	240,000
	ALA WAI CANAL AT McCULLY ST. BRIDGE	1961-69	76	6	2,400	70,000	700,000
	ALA WAI YACHT HARBOR	1959-68	224	0	240	7,000	240,000
	KAELEPULU STREAM AT KEOLU BRIDGE	1957-69	130	0	700	24,000	240,000
	KAHANA BEACH PARK	1965-69	36	0	240	24,000	240,000

TABLE 12. TOTAL AND FECAL COLIFORM COUNTS - FROM DEPARTMENT OF HEALTH 10-DAY SURVEY, 1968, FOR ESTUARY STATIONS. DATA ANALYZED BY TETRATECH, INC. (PARSONS, 1968).

STA. NO.	NO. OF OBS.	TOTAL COLIFORM (NO./100 ML) AVERAGE	MEDIAN	MAXIMUM	MINIMUM	FECAL COLIFORM (NO./100 ML) AVERAGE	MEDIAN	MAXIMUM	MINIMUM
1	9	13	3	81	0	39	0	260	0
18	5	12	10	30	0	2	0	10	0
19	5	4	0	20	0	0	0	0	0
20	4	32	30	60	10	15	10	40	0
21	9	6,780	0	56,000	0	3,339	0	30,000	0
22	9	12,120	170	107,000	0	11,294	50	100,000	0
23	5	66	60	118	0	1,740	1,480	4,000	0
24	5	194	110	692	0	3,468	1,135	11,000	0
25	5	644	100	3,000	0	632	10	3,000	0
26A	9	1,683,044	125,000	8,700,000	19,600	960,000	125,000	6,900,000	9,000
26B	6	4,678	5,000	9,000	0	3,168	2,500	9,000	0
27	5	164,634	370	816,000	0	160,920	400	800,000	0

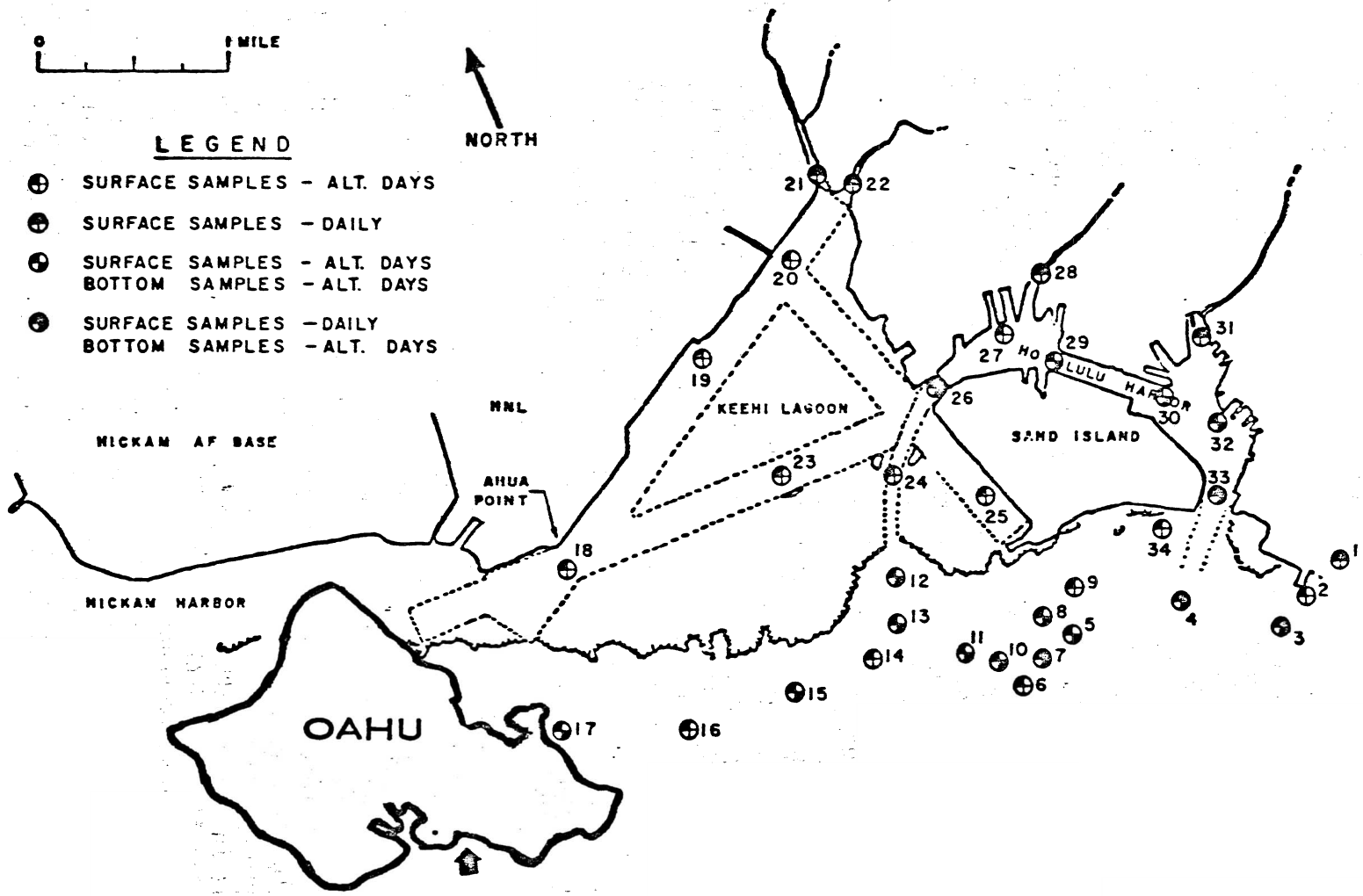

FIGURE 21. SAMPLE STATIONS OF DEPARTMENT OF HEALTH 10-DAY SURVEY, KEWALO BASIN TO KEEHI LAGOON, 1968 (AFTER PARSONS, 1968).

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Water Resources Research Center

Office of the Director

9 June 1970

Statement of Doak C. Cox at
Public Hearing to Consider
Establishment of Zones of Mixing
in Honolulu Harbor and Kapalama Canal

My name is Doak Cox. I am Director of the Water Resources Research Center of the University of Hawaii. I am joined in this statement by L. S. Lau and Reginald H. F. Young, both engineers associated with the Center. The statement which we are presenting orally is only a summary of a written statement prepared in the form of a memorandum report of the Water Resources Research Center, of which we submit copies herewith. I should state that the conclusions in neither statement represent institutional positions of the Water Resources Research Center or of the University.

The gist of our testimony is that:

1) zones of mixture are in principal appropriate and useful;
2) the establishment of a zone of mixture for temperature in Honolulu Harbor and Kapalama Canal, and perhaps a zone of mixture for dissolved oxygen in a part of Kapalama Canal, might well be shown to be appropriate; but

3) the applications and supporting information at hand do not adequately demonstrate the appropriateness of such establishment.

4) if necessary to give time for the development of adequate information, the discharges which the proposed zones of mixture were intended to accommodate should be accommodated temporarily by permit.

The provision in the Water Quality Standards for the establishment of zones of mixing is in principle sound. If properly administered this provision will allow for optimum utilization of the natural processes of dissemination and degradation in the estuarine and marine environment for the necessary disposal of wastes, without undue detrimental ecological effects. However, the information and analysis explicitly prescribed for the establishment of zones of mixing seems inadequate, as may be seen by its comparison with the information and analysis prescribed for the issuance of less significant permits for discharges which would result similarly in local but presumably shorter term departures from tolerances set for various pollution parameters.

As required by the Water Quality Standards, a formal application must be made for the establishment of a zone of mixing, and the application must be considered through a formal process involving such a public

hearing as this. We believe that: 1) the application should be accompanied by information sufficient to permit a sound analysis of the economic, ecological, and esthetic effects of the proposed establishment; 2) the zone of mixture should be established if and only if it is in the overall public interest; 3) in the evaluation of public interest, demonstrably practical potential uses as well as current uses of the waters should be considered; 4) the departures from normal tolerances should be permitted only for specified pollution parameters in any zone of mixing, and that for these parameters special tolerances should be set; and 5) a suitable monitoring program should be required, if warranted, for continuance of a zone of mixing.

We believe that unless these considerations are recognized as implicit, if not explicit, in the regulations, plans should be made for their prompt explicit recognition by amendment of the regulations. It should be noted that zones of mixing established without such recognition may be liable to an early termination upon the remedy of the defects, and it might well be better to accommodate present discharges at variance with the Water Quality Standards by the use of permits as in Chapter 37 rather than by the establishments of zones of mixture as in Chapter 37-A.

The primary purpose of this hearing we take to be the consideration

of the advisability of establishing all of Honolulu Harbor, including Kapalama Basin, and also the lower part of Kapalama Canal, as a zone of mixing for temperature alone. A possible secondary purpose may be to consider the advisability of establishing a zone of mixing in a part of Kapalama Canal for dissolved oxygen.

We are, in general, of the belief that the establishment of these zones of mixing might well be shown to be appropriate. However, considering the importance of the establishment of zones of mixing under the Water Quality Standards and the special importance of the precedents that will be set by the establishment of the first of such zones, the information that, to the best of our knowledge, has been supplied pertinent to the establishment of the zones of mixing in Honolulu Harbor and Kapalama Canal seems gravely inadequate.

Some examples of inadequacies follow:

a) Quantitative, if approximate, economic information on stated and unstated alternative mechanisms for waste heat disposal.

b) Sampling of the thermal field in the harbor to substantiate conclusions based on analysis for trade and kona conditions.

c) Determination of the frequency and consequences of kona wind occurrence dissociated from lower-than-normal ocean temperatures.

c) Identification of current and potential uses of the harbor other than recreational fishing, and evaluation of effects of

the thermal field on them.

e) Description of thermal field in Kapalama Canal and Basin at other times than May.

f) Quantitative description of the flows and temperatures of cannery discharges.

g) Identification and evaluation of alternative means of disposal of warm fresh-water wastes.

h) Description of dissolved oxygen field in Kapalama Canal in vicinity of aerators.

i) Identification and evaluation of uses and potential uses of Kapalama Canal and effects of thermal field.

Other examples and some special problems are discussed in our more comprehensive statement.

We recommend that:

1) Amendment of the application or applications for establishment of the zones of mixing in Honolulu Harbor and Kapalama Canal be requested:

a) to formalize and clarify their intent,

b) to indicate a restriction to zones with respect to temperature alone or temperature and dissolved oxygen, as appropriate, and

c) to provide either in themselves or by attachments, information

adequate to permit a sound analysis of the overall public interest in establishing the proposed zones of mixture;

2) If adequate information cannot be provided within a reasonable time, discharges in violation of the Standards be accommodated temporarily by permits;

3) If and when warranted by thorough analysis based on amended applications, zones of mixture be established within which special tolerances are set for those pollution parameters permitted to vary from the normal tolerances for waters of the pertinent classes.

4) Consideration be given to establishment of a suitable monitoring system within the zones so established.