Statement to
Water Resources Subcommittee of
House Committee on Public Works and Transportation

for a

Hearing, May 24 and 25, 1978, Washington, D.C.

regarding

SECONDARY TREATMENT WAIVERS AND OCEAN OUTFALLS

by

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1. This statement relates to the subject of waivers for secondary treatment for certain ocean discharges according to Section 44 of the Clean Water Act of 1977. In past years I have participated in the design of most of the major outfalls along the California coast and at Honolulu as a special hydraulics consultant and am presently so engaged for the City and County of San Francisco (as a special consultant to the consulting firm of PBQ&D, Inc., San Francisco).

At Caltech I have been involved in research on dispersion and mixing of wastewater discharges, and am presently Director of the Environmental Quality Laboratory, an interdisciplinary policy study center for environmental problems.

However, my comments are given here as an individual and not as representing either Caltech or any of the sewerage agencies.

2. The principal technical reason for having a waiver provision for secondary treatment for municipal discharges is that for some outfall systems the dilution is so high that very good ambient water quality can be achieved with less than secondary treatment. Therefore, the criteria for a waiver of the secondary treatment requirement must give

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full consideration to the dilution obtained by the outfall system. In a high performance outfall diffuser, such as those used by major dischargers in California and Hawaii, initial dilutions are typically 100:1, and may range up to 1000:1 in very favorable circumstances.

3. The dilution for an outfall system is achieved in stages which can be designated as initial dilution and subsequent field dilution. The initial dilution is that which occurs immediately in the vicinity of the outfall diffusion structure as the result of the buoyancy and momentum of the discharge fluid during the first few minutes after discharge. The mixing process in this phase is determined by the kinetic and potential energy of the discharge itself. The subsequent field dilution, however, occurs as a result of natural oceanic turbulence as the sewage plume drifts away from the discharge site. For engineering and regulatory purposes, it is better to consider just the initial dilution as has been done by the State of California because: a) it is much larger than the subsequent dilutions for a well designed outfall diffuser; b) it is more predictable; c) it is more easily measured; d) it is under the control of the design engineer.

The initial dilution is determined by: a) the characteristics of the diffuser (overall length, number of ports, diameter of ports and orientation of ports and overall diffuser structure); b) depth of water; c) the ocean currents; d) the water-column density stratification (by temperature or salinity gradients); and e) the effluent flow rate.

Typical diffuser geometry and depths for major west coast outfalls have been tabulated by Koh and Brooks (see Reference 1 and Table 1). The effect of all of the parameters above (diffuser geometry, depth, currents, stratification and flow rate) are explained in that same paper. Additional information on modeling is given in References 2 and 3. The state-of-the-art is now such that it is possible to predict dilutions by computer simulations as has been done for the design of major California and Hawaii outfalls. After outfalls are built and are operating, the dilutions can also of course be measured in the field. Like other water quality measures, the dilution is a quantity which

Table 1 Summary of characteristics of major Pacific Ocean outfalls (USA)

	Year Operation Began	Pipe Diameter (inside) (inches)	Length of Main Outfall (excl. diff.) (ft)	Length of Diffuser L_d (ft)	Depth of Discharge (ft) (nominal)	Design Average Flow Q (ft^3/sec)	Port Diameters[a] (inches)	Port Spacing (average)[c] (ft)	Velocity of Disch. (nominal) for ave. flow (fps)	Q/L_d (ft^2/sec)	Area Factor (Total Port Area/Pipe Area)
Sanitation Districts of Los Angeles County Whites Point No. 3	1956	90	7,900	2,400	200–210	232	6.5–7.5	24	8	0.097	0.63
City of Los Angeles at Hyperion	1960	144	27,525	7,920	195	651	6.75–8.13	48	13	0.082	0.44
San Diego	1963	108	11,500	2,688	200–210	363	8.0–9.0[b]	48	15	0.135	0.39
Sanitation Districts of Los Angeles County Whites Point No. 4	1965	120	7,440	4,440	165–190	341	2.0–3.6	6	9	0.077	0.51
Metrop. Seattle (West Point)	1965	96	3,050	600	210–240	194	4.5–5.75	3	6	0.323	0.60
Sanitation Districts of Orange County, Calif.	1971	120	21,400	6,000	175–195	450	2.96–4.13	12	13	0.075	0.45
Honolulu (Sand Island)	1975	84	9,120	3,384	220–235	164	3.00–3.53	12	10	0.048	0.44

[a] Exclusive of end ports, which are usually somewhat larger.
[b] Blocked by orifice plates with openings of 6.5–7 inches for early years' low flow.
[c] Length of diffuser divided by number of ports; real spacings on each side of the pipe are twice the values indicated.

Source: Koh and Brooks, "Fluid Mechanics of Waste-Water Disposal in the Ocean", Annual Review of Fluid Mechanics, Vol. 7, 1975, p. 192.

varies in time and space; hence, for setting criteria or regulations, the frequency distribution of dilution must be considered.

4. One question raised by the new law (Sec. 301(h)(1)) is what to use as "an applicable water quality standard specific to the pollutant to which the modification is requested..." Since the key technical idea behind the waiver provision is high dilution in ocean waters, the appropriate effluent limits should be derived from ambient water quality standards by a back calculation based on dilution. If ambient dissolved oxygen is used as an ambient water quality parameter, then it may be inferred what BOD* increment is allowable after dilution, and then, by multiplying by the dilution, the effluent BOD limit is obtained. For example, if the BOD of the mixture after initial dilution is to be kept less than 1 mg/ℓ and the dilution is 150, then the effluent could have up to 150 mg/ℓ of BOD.

This approach of deriving effluent limits by a back calculation from ambient limits has recently been adopted in California's Revised Ocean Plan (Reference 4) for toxic materials ("Table B") after extensive study. This same approach can logically be applied to all pollutants.

5. These remarks should not be construed to imply that the statement "Dilution is the solution to pollution" applies to all pollutants. For certain pollutants which are natural ecosystem products (such as carbon, nitrogen, phosphorus) the statement is true, i.e. the best strategy is to disperse them back into the marine ecosystem. These elements are widely dispersed in nature, and the main difficulties man has encountered are due to excessive local concentrations.

On the other hand, wide dispersal is not an appropriate strategy for toxic substances, which can most effectively be contained at their sources rather than be released to public sewers, to become part of either sludges or effluents.

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*Biochemical oxygen demand

REFERENCES

1. Koh, R. C. Y., and N. H. Brooks, "Fluid Mechanics of Wastewater Disposal in the Ocean," Annual Review of Fluid Mechanics, Vol. 7, 1975, pp. 187-211.

2. Brooks, N. H., "Dispersion in Hydrologic and Coastal Environments," W. M. Keck Lab. Report KH-R-29, California Institute of Technology, December 1972, 136 pp. (Also Environmental Protection Agency, Ecological Research Series, EPA-660/3-73-010, August, 1973.)

3. Baumgartner, D. J., D. S. Trent, and K. V. Byram, "User's Guide and Documentation for Outfall Plume Model" (Working Paper #80, EPA Pacific Northwest Water Laboratory), 1971.

4. California State Water Resources Control Board, Water Quality Control Plan for Ocean Waters of California, January 1978 revision.