MODIFICATION OF SECONDARY TREATMENT REQUIREMENTS FOR DISCHARGES INTO MARINE WATERS

(95-54)

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the Committee on Environmental Issues, for the California Legislature. Dr. Brooks also served on the Environmental Research Assessment Committee, National Academy of Sciences.

Dr. Brooks has extensive experience in designing ocean outfall structures for the Orange County Sanitation District, California, and the Suffolk County Sanitation District, Long Island and has served as a consultant to several of these areas.

Please proceed.

TESTIMONY OF DR. NORMAN BROOKS, DIRECTOR, ENVIRONMENTAL QUALITY LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY

Dr. Brooks. Thank you, Congressman Roberts.

I have prepared a brief statement which I would like to have put in the record. I will paraphrase it, though, in order to proceed quickly.

Mr. Roberts. Without objection, the statement will appear in full in the record at this point.

[Statement referred to follows:]

STATEMENT OF NORMAN H. BROOKS, JAMES IRVINE, PROFESSOR OF ENVIRONMENTAL AND CIVIL ENGINEERING; AND DIRECTOR, ENVIRONMENTAL QUALITY LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CALIF.

SECONDARY TREATMENT WAIVERS AND OCEAN OUTFALLS

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 full consideration to the dilution obtained by the outfall system. In a high performance outfall diffuser, such as those used by major discharges in California and Hawaii, initial dilutions are typically 100:1, and may range up to 1,000:1 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 varies in time and space; hence, for setting criteria or regulations, the frequency distribution of dilution must be considered.

TABLE 1.—SUMMARY OF CHARACTERISTICS OF MAJOR PACIFIC OCEAN OUTFALLS (UNITED STATES)

	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) [b] (ft)	Velocity of discharge (nominal) for average flow (fps)	$OL/_d$ (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	.082	.44
San Diego	1963	108	11,500	2,688	200–210	363	[c]8.0 -9.0	48	15	.135	.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	.077	.51
Metropoliation Seattle (West Point)	1965	96	3,050	600	210–240	194	4.5 -5.75	3	6	.323	.60
Sanitation Districts of Orange County, Calif	1971	120	21,400	6,000	175–195	450	2.96–4.13	12	13	.075	.45
Honolulu (Sand Island)	1975	84	9,120	3,384	220–235	164	3.00–3.53	12	10	.048	.44

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

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

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 would 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 that BOD [1] 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 Revise Ocean Plan (Reference 4) for toxic material ("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.

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.

Dr. BROOKS. The first point that I make in this statement is that my experience and interest in outfalls is related to the engineering design of outfalls and the laboratory research that we have been doing at Caltech for a number of years.

I have, in addition to being a professor at Caltech, served as a special consultant on the functional design of outfalls for a number of agencies on the west coast and in Hawaii. Typically, I work as a special consultant to a consulting engineering firm, which does all of the detailed design work with my advice and guidance on design procedures.

One of the most important features of an outfall design is the dilution that it achieves. The capability to predict outfall dilution is well established, and therefore outfalls can be designed to achieve prescribed dilutions and water quality.

And we have found by experience that these design predictions are confirmed.

In my prepared statement, I describe some of the factors that affect the dilution of an outfall. An outfall is carefully designed to fit in with the characteristics of the environment and the characteristics of the wastewater, and the performance depends on such things as the overall length of the diffuser, the number of ports and their diameter,

[1] Biochemical oxygen demand.

the depth of the water, the ocean currents, the temperatures and salinities in the ocean, and of course, the flow rate.

In the table in my prepared statement, I have given some of the characteristics of the major west coast outfalls. They happen to all be projects with which I have had some association.

It is also interesting to note that outfalls are designed for a particular purpose, or a particular set of requirements, such as the California ocean plan.

In other words, as I am currently doing with the city and county of San Francisco, one can make a back calculation, starting with the requirements, and decide what configuration is needed for an outfall.

I want also to make it clear that I do not think that "dilution is the solution to pollution," but rather, that we have to be very selective about strategies for various types of contaminants. Substances like organic carbon, nitrogen, phosphorus, which are natural elements of the ecosystem can very well be dispersed back into the environment, from where they came, but——

Mr. CLAUSEN. Would you say that again?

Dr. BROOKS. Natural organic wastes like organic carbon, and the nutrients, like nitrogen and phosphorus—these substances are produced by man from many places—can very well be dispersed back into the global supply of these basic elements. There is nothing toxic about these materials. The troubles we have had in the past are often due to poor dilution. If there is high dilution, the concentrations of these substances are low enough to be favorable additions to the ocean's supply of nutrients, and are not deleterious—at least when you have a situation like the west coast.

On the other hand, for heavy metals or persistent organic chemicals, the best strategy is to control them at the source; that is pretreatment. If they are allowed to enter the sewage system and the sewage receives secondary treatment much of these toxic materials will become part of the sludges. In southern California there is a major governmental study in progress now to evaluate alternative strategies for sewage sludge disposal, which will be a very large problem if full secondary is implemented. The presence of toxic materials in the sludge is probably one of the key obstacles to developing easy options for disposal of that material.

So I am in favor of keeping the toxic materials out of the system entirely. The agencies in California are making vigorous efforts in that direction.

I would be happey to respond to your questions.

Mr. ROBERTS. I am real pleased, Dr. Brooks, at your statement with reference to predictability, that if you build the proper models and do the proper engineering, that you can predict what is going to happen pretty well.

Could you expand just a little bit on that?

Dr. BROOKS. Yes.

Mr. ROBERTS. And the reason we are concerned is that we have been told you cannot predict these things, regardless of all the know-how you have.

Dr. BROOKS. No. You absolutely can predict how an outfall will perform. In fact, I would like to refer to a brief paper which I wrote last year, entitled, "An Overview of the Functional Design of Ocean Outfalls for Waste-Water Discharge."

Mr. ROBERTS. Could we have a copy of that for the record?

Dr. BROOKS. Yes.

Mr. CLAUSEN. Mr. Chairman, I would ask unanimous consent that Dr. Brook's statement that he just presented be added as an addendum to his testimony.

Mr. ROBERTS. Without objection. [See page 99.]

Dr. BROOKS. I think it is useful for me to describe what I would call the systems aspect of waste-water disposal. You cannot design an outfall without considering the three parts of the system.

The first is the source control or the pretreatment of industrial sources. The second is the main municipal waste treatment plants. And the third is the ocean outfall that goes with it.

Now, with regard to different pollutants. You can use different strategies—I am not talking from a legal point of view, but rather from a technical point of view.

For example, if you do a good job on source control, then you have more options on what you can do with the waste-water and sludge, because the toxic material is reduced as a problem; then, the use of dilution is a good technique. For instance, if you have only primary treatment combined with a very long outfall, such as those designed on the west coast giving a very high dilution, then you can achieve the same results as if you had full secondary treatment but a poor outfall.

I have always maintained that the initial 1972 act made a mistake in not considering the outfall as part of the overall system, because sewage treatment is not the end of the system. You have to dilute it and dispose of it.

And it turns out that use of long, deep outfalls, when you have good receiving waters, are much cheaper than treatment.

All right. Once you recognize the systems aspect, then you can study various alternative combinations of the degrees of treatment and the characteristics of the outfall.

Now, an outfall is designed to achieve a particular dilution. We do various kinds of research at Cal-Tech, and these are some of our reports, on the fluid dynamics of mixing in the ocean, with the density stratification. From these results, developed from actual laboratory experiments, computer simulations have built up gradually into an engineering practice or an engineering design procedure. To design an outfall you also need measured ocean data at the site including the temperature profiles and the ocean currents at all different times of the year. This information is used in the computer simulations to develop a functional design which will have a certain predicted performance.

It is just like any other engineered project—a spacecraft or a bridge is designed for a particular purpose and the engineers who are responsible for it have procedures for developing an economical, effective design. Outfalls too are designed for particular objectives. Particularly I can say that is true for these west coast outfalls mentioned in the table because I did that kind of work, in association with the engineering groups, for all of those projects.

The design of an outfall includes, of course, the consideration of costs and the size of the pipe and whether it will be pumped and so on, but these are all engineering details which are, of course, important, but do not bear especially on the issue you raise.

In summary, you can predict the dilution, and from the dilution, then you can predict the chemical concentrations of the elements that you will get after dilution, and following the initial dilution, you can predict, then, the subsequent dilution and how the material is carried away by the currents.

We are just learning pretty well how to predict the deposition on the bottom and are working more and more with biologists and chemists to get comprehensive prediction capability.

We are doing some of this kind of work now for sludge discharge in the ocean, even though that is not very popular, but it is a subject which is also subject to a rational, physical, chemical, biological study of what happens for different systems of discharge.

The State of California has recognized the predictability of dilution in its new ocean plan and has a system for relating the effluent limits for toxic materials to the ambient levels which are considered to be safe and prudent, and with a back calculation, then, using the dilution obtained for each particular outfall system to establish effluent limits.

If you would like a set of the California ocean requirements introduced into the record, I would be happy to do so.

Mr. ROBERTS. Without objection, they will be introduced into the record. [See page 102.]

Mr. ROBERTS. Could I ask one question, just out of personal interest. Did you have anything to do with the design of the sand flat Honolulu outfall, which is the most fantastic I have seen?

Dr. BROOKS. Yes, sir, I did.

Mr. ROBERTS. Well, it is a fantastic operation.

Dr. BROOKS. A colleague of mine, Dr. Robert Koh, and I were special consultants to the company which did the design for the city and county of Honolulu. I was instrumental in determining the general layout and the length and size of that outfall.

Mr. ROBERTS. The reason I thought you might be was because you talked about the tides and the currents, and certainly, they have an unusual situation there. But it has been eminently successful.

Mr. Clausen?

Mr. CLAUSEN. I have a few questions.

Would health officials in the State of California—or, for that matter, whoever you come in contact with—would they agree with your assessment and the recomendations that you have made that you have presented to this committee? Would they agree with you?

Dr. BROOKS. I am not familiar with what the people in the Department of Public Health would say, but I think the people in the Water Resources Control Board would generally agreee with what I said, and I think it is reflected in the requirements which they have adopted. In other words, secondary treatment is not part of the required treatment in the California ocean plan.

They do recognize the predictability of the ocean in the way they have prepared the requirements.

Mr. CLAUSEN. Well, would there be any reason for the Public Health people to challenge the thrust of your recommended designs?

Dr. BROOKS. Well, it is hard for me to speculate what somebody else would do for a challenge, but personally, I do not see any basis for a Public Health challenge, provided that a system of monitoring is in effect. After you build an outfall and put it in operation, it is desirable to monitor public health parameters, like bacterial concentrations, to confirm its satisfactory operation.

Let me add one further thing. I believe that the ocean provides an unusually large public health protection for the disposal of waste water, because the public health interface with the ocean is much less than with freshwater systems; in other words, the potential for contamination of drinking water just is not there, because it just is not a drinking water source.

Mr. CLAUSEN. Now, when you refer to monitoring, do we have adequate equipment to do the kind of monitoring job that you think is necessary, or should we be addressing this in some form?

Dr. BROOKS. I think I would like to have you ask that question of Dr. Bascom, who will be coming up later. He is more in the business of measurement and monitoring in the ocean.

But I think in a general way, the answer is yes. I think perhaps I might say in the general area of biological systems is perhaps the greatest latitude of uncertainty.

Mr. CLAUSEN. You talk about effluent limits. Could you give us an indication of what you would describe as the effluent limits on pulp and paper; we have on the west coast some discharges from pulp and paper plants.

I guess what I am really thinking about is what would be required to control it in terms of eliminating any possible adverse impact on fish and marine life, or is there any reason to be concerned about the effluent?

Dr. BROOKS. Well, I have not worked with pulp and paper discharges, so I am not immediately acquainted with the exact waste water parameters or the requirements. But I think in general, I would say, though, that given any particular waste water stream and given a set of water quality requirements, there is an optimal system which combines treatment and dispersal, taking account again of the kinds of pollutants you have, whether they are just organic carbon, or whether you have toxic materials which need to be controlled. I have every confidence that if I were hired as a consultant, and I was informed that "These are the waste water characteristics, and these are the environmental characteristics; what shall we do," that it would be perfectly feasible to make a system design.

Mr. CLAUSEN. Well, would you design it so that it would be self-contained, and contain some recycling arrangement, or would you design it on the basis of potential outfall—or both?

Dr. BROOKS. Often mixed strategies turn out to be optimal. But it is very difficult to design any system without some discharge of residuals and waste water.

I would certainly not discharge paper waste without treatment. But I am not able to say exactly what level of treatment, without considering a specific situation.

Mr. CLAUSEN. You made reference to mixing zones.

Dr. BROOKS. Yes.

Mr. CLAUSEN. Could you give us an indication of what the overall parameters or the boundaries of the mixing zones would be for these outfalls?

Dr. BROOKS. Yes; the initial mixing zone is often identified because it is the place where the initial buoyancy and the momentum of the discharge produce a lot of turbulence, agitation, and stirring resulting in large initial dilution. The process occurs within the first few minutes after discharge.

And it usually occurs within a relatively short distance of the diffusion pipe. For example, I was just looking at some data from METRO Seattle. The end of the mixing zone is within 100 meters of the West Point outfall. Of course the mixing zone will bend over in the down current direction, or it will reverse when the current reverses, but all within a few hundred feet or 1,000 feet at the most.

These discharge diffuser pipes are often quite long, too. They may be several thousands of feet long. But the mixing zone occupies only a local, small area around the diffuser. When you look at a map of the coastline, and you draw the initial mixing zone around an outfall, it is really relatively quite a small region.

Mr. CLAUSEN. Right. Well, following this somewhat, yesterday we heard testimony regarding upwelling of nutrient-rich waters in the lower levels of the sea.

Now, what would be the magnitude of the discharge from a city like Los Angeles as compared to the volume of the natural upwelling?

Dr. BROOKS. Well, would I be correct if I inferred that the discussion was referring to the nutrient input?

Mr. CLAUSEN. Yes.

Dr BROOKS. I believe that the input of nutrients from the outfalls in southern California is of the same general amount as the nutrient input by upwelling in the vicinity of the outfalls, but is significantly less than natural upwelling for the whole southern California bight.

Mr. CLAUSEN. You say it is comparable to that which is coming naturally?

Dr. BROOKS. That is right, for the local areas around a major outfall.

Mr. CLAUSEN. Now how far from the diffuser are reasonably measurable quantities of pollutants detectable?

Dr. BROOKS. It depends a lot on which pollutant. If you are talking about something very persistent, like PCB's or, in earlier times, DDT, it might be picked up a number of miles away. But if you are talking about ammonia, which decays relatively rapidly within a matter of one-half hour, then you would not pick it up more than a mile away.

I think the nutrients, as another example, would be probably spread around over tens of miles, but they would be at such a low level compared to background that you could not tell whether they came from the outfall or whether they came from another source.

It is hard to try to put a cutoff point for detection. If you put fertilizer in the garden, how much can you detect that you put there. Well, you are not quite sure after a while whether you put it there or——

Mr. CLAUSEN. What percentage of the outfall would actually be diluted and picked up by the natural ecosystems, as contrasted with the amount that would actually settle and go to the bottom of the ocean?

Dr. BROOKS. As I recall, the studies that have been made around the Los Angeles County Sanitary District's outfall system show that even though there is some deposition of particles on the bottom, that most of the fine particulates are dispersed far away from the outfall, probably out into the deep ocean. So that a small part of the material does reach the ocean bottom.

Mr. CLAUSEN. All right. Now, the final question, and then I will ask some others in writing for you to respond to, so that I may yield to the other members.

I am sure you are familiar with that which took place in Italy, with the mussels, where there were some health problems with this outfall in that area.

Now, based upon the recommendations that you have made for design, and the control over the quality of the water and so forth, based on fish life, do you have any concern about health problems and eating fish that would be in that general area, knowing what you know?

Dr. BROOKS. No, provided an outfall is properly designed and operated; but this is not the case for many Italian outfalls.

Mr. CLAUSEN. Thank you.

Mr. ROBERTS. The gentleman from Washington?

Mr. MCCORMACK. Thank you, Mr. Chairman.

Dr. Brooks, I have three or four sort of relatively unrelated questions. Yesterday's suggestion that we allow ocean dumping or ocean diffusion of sewage after primary treatment, provided that we have monitoring for potentially harmful organisms, heavy metals, organic poisons, such as certain insecticides—I take it this is what you are suggesting; is that correct?

Dr. BROOKS. Well, yes; let me se if I understand you correctly. In my opinion, secondary treatment does not provide a useful function for discharge into deep waters such as off the States of California or Hawaii. It is not a kind of treatment which is specific to the problem in the ocean.

The main thing that secondary treatment does is to provide an in-plant biochemical oxidation which can be done perfectly well in the ocean, because when you have a high dilution, there is plenty of oxygen capacity in the ocean to carry out in a perfectly natural way the reduction of these organic elements back to their basic nutrients.

Particulates, which can make turbidity problems in the ocean, are removed by primary treatment or advanced primary treatment, with chemical additions (such as polymers). The Los Angeles County Sanitation Districts has been successfully experimenting with advanced primary treatment in order to be specific to that particular ocean problem—in other words, to get more of the particles along with the toxic substances out of the sewage without trying to make a whole onshore oxygenation system; that is, secondary treatment.

Does that answer your question?

Mr. MCCORMACK. Yes, it does. This requires monitoring for various categories of potential hazardous materials.

But once we build a system, and once it is in operation, then if we find that we are exceeding the concentrations, isn't it too late to modify the system to handle the particular contaminants? Isn't it really saying that we have made a miscalculation?

Dr. BROOKS. No, I don't think so, because you have to understand that experience is gathered over many years. The various sewage agencies have been in operation a long time. Their plans are constantly being evolved. They respond to new information.

The Los Angeles County Sanitation Districts, for example, has for a number of years now careful records on trace elements concentrations. It is a big system, and they have an ongoing source control program. In fact, I have some data here from the districts which show the general trend of the trace contaminants.

In other words, there is not an opportunity for surprises, and rather, what you can do is if, as a result of your for example when ongoing monitoring indicated that there was a patch of the bottom which was found to be anoxic around the L.A. County outfalls due to too many solids, the agency upgraded the system for removing solids and advanced the primary system, and the spot is shrinking.

What I am saying is that many of these effects in the ocean, with the exception of highly toxic trace organics, are quite reversible.

If you stop an outfall, a study in Orange County showed that in a few years, the ocean recovers. It recovers much faster than——

Mr. MCCORMACK. Here we are on a day-to-day process, where we are handling millions of gallons of sewage and effluent, and all of a sudden, we spot this problem; we are exceeding limits of something or other. How do we handle that situation? We cannot just turn it off. We have to handle the problem.

Dr. BROOKS. Usually, if something really goes bad, and you find a big jump in something, there is a reason for it. And I am sure that in any agency, the industrial waste inspectors would be going out into the sewer network and taking samples at different places.

It is just like detective work. You can chase right up the trunk sewer system to where this particular illegal discharge is coming from, and cause it to be stopped in a matter of a few days. The system is not perfect. That is right, you have a few risks. But I think that is the problem you have with all environmental systems: How are you going to keep people from spilling things illegally?

Mr. MCCORMACK. I see. Well, Dr. Brooks, I am playing the devil's advocate with this question, and I think you can appreciate that, but the fact is, this is the sort of atmosphere in which we are living, particularly in Congress, with a lot of emotional groups with which we are dealing, and they are saying to us, "Prove to us that it is perfect," which of course is not possible.

Dr. BROOKS. May I make another comment?

Mr. MCCORMACK. Certainly.

Dr. BROOKS. You know, if somebody dumped in a large slug of heavy metals, you could throw the secondary treatment plant all out of kilter, too. It would be upset—it could be upset for several days, and the secondary treatment would have a poor performance. The sludge digesters could be thrown out of whack.

In other words, there is not any system that is immune from some kind of an upset that is unscheduled or irresponsible.

Mr. MCCORMACK. Thank you. Now, on a different subject, the gentleman from California asked about how far away one could detect various contaminants. Isn't it true now that when detection systems are operating, we can detect 1 part in 10^{12}, or something of that sort, in many of these contaminants, so that we are dealing——

Dr. BROOKS. No; I do not think that is generally true. I think you have to be pollutant specific. If I release some special tracer material like sulfur hexafluoride, SF_6, that is true, you can detect them at that level. But I think ordinary heavy metals, for example, you could not detect at that low dilution, because the background level is far higher on that.

Mr. MCCORMACK. All right. So you can detect them, but you are below background. You can detect the presence of those substances with neutron radiation, for instance.

Dr. BROOKS. Yes; but again, you have to go through it element by element and talk about which concentration. You could not get dilutions—I do not think you could measure dilutions of 1 in 10^{12}.

Mr. MCCORMACK. The thrust of my question is that it is possible, with our present detection systems, to go down to such low concentrations for virtually everything that we would be below background in most cases.

Dr. BROOKS. Right, I understand what you are saying. Let me put it in perspective. You know, I have worked on this area for 25 years, and I have seen a tremendous growth in the analytical capabilities of chemical detection.

What you find is that many of the problems seem to be recently measured——

Mr. MCCORMACK. With new analytical technologies——

Dr. BROOKS [continuing]. With the new analytical technology, that is right, so that sometimes, I think people get the mistaken impression that suddenly, our environmental problem has taken a very sharp turn for the worse, which is not the case, but rather, that a lot of things are being measured which could not be measured before.

Mr. MCCORMACK. Mr. Chairman, may I ask one more question?

Mr. ROBERTS. Go ahead.

Mr. MCCORMACK. All of our discussion has to deal with bypassing secondary treatment, designing treatment possibilities of other approaches, such as using raw sewage as process water in certain chemical technologies, such as, for instance, coal gasification, where everything is incinerated and you are working with very high temperatures.

Has there been any study on this sort of thing, that you know of?

Dr. BROOKS. Well, let me speak a little more generally. There are many opportunities for reuse of water. The key to the reuse of water, though, is the quality that is necessary for the process for which you are using it.

Mr. MCCORMACK. That is why I said coal gasification, because there are virtually no limits except salt concentrations.

Dr. BROOKS. I am not so sure, though, because the water has to be run through various kinds of equipment and processes, and it may be more optimal just for an in-plant optimization to treat the water so you will have less maintenance of the parts of the coal gasification equipment,

So I think that is more of an in-plant optimization question. But in the general sense, you can use many kinds of waste water for many kinds of industrial purposes, everything from cooling towers to makeup water, and that, I would certainly agree with.

Mr. McCormack. Can sludge be incinerated, Dr. Brooks?

Dr. Brooks. Yes; if you want to. That is one of about 17 different alternatives being studied in southern California. But, I do not think you would want to do that in southern California, because you would add to our serious pollution problem and you would release toxic materials—or at least, the heavy metals would be released as very fine particulates into the atmosphere——

Mr. McCormack. Wouldn't you be able to scrub the metal oxides out?

Dr. Brooks. Well——

Mr. McCormack. You would be getting the phosphorus back anyway.

Dr. Brooks. Yes; but these techniques are never completely efficient, and then you still have the problem of what to do with the residuals then. That is, you have not closed the residuals loop. If you want to take what you get out of the scrubber and take it to a landfill, then one can say, "Well, maybe it will get in the drinking water"——

Mr. McCormack. Phosphorus would go back in the food chain, deliberately, as fertilizer.

Dr. Brooks. Yes; if sludge is used as fertilizer.

Mr. McCormack. Thank you.

Thank you, Mr. Chairman.

Mr. Roberts. Counsel has some questions.

Ms. Kovalic. Dr. Brooks, can you describe for us the importance of temperature and salinity stratification in the ocean and also the concept of a submerged sewage field?

Dr. Brooks. Yes; one of the most interesting things that we have learned in the last 20 years, and many of the things that are described in the laboratory work we have been doing, has got to do with what we call density-stratified flow.

For example, off southern California, typically, the water at the bottom is 50° Fahrenheit, and at the top it may be 65, just by gradation of temperature. And when you introduce an outflow of discharge into the bottom water and it mixes with that cold bottom water, the density of the mixure is such that it stops rising maybe only halfway up. And therefore, this mixture of the ocean and the sewage water may be completely out of sight from the surface—this is what is called a submerged sewage field. It may be anywhere from 50 to 100 feet submerged below the ocean surface.

In fact, our present outfall technology allows us to predict the amount of submergence, and it is measured in the different outfall sites.

For example, at Orange County before construction, we predicted that the sewage flow would be submerged 11 out of 12 months of the year; in other words, you would never even see it during that time. When submerged you cannot even see anything at the surface right over the discharge point. And that has been confirmed; the slime has very rarely been seen reaching the surface, and only in winter. The same protection occurs at Honolulu, and at Seattle.

The reason this is a very important and interesting development is because most of the life zone in the ocean, the very rich life zone—the kelp areas—are all in shallower waters, say, up to 60 feet. Those are the zones where the light penetrates the most. So if you put this wastewater cloud down at a lower level, it has less interference with the use of the upper waters, and it also provides an additional public *health barrier* against transmission of viruses and bacteria, and that it is prevented from approaching the shore. That is the reason, Mr. Roberts, why in Honolulu, the Sand Island outfall is doing so well: there is also stratification there, and the outfall is designed to take the advantage of it. It is a phenomenon that is peculiar to these outfalls in deep water, because you have the ability to get down under that stratification which is usually not possible to do on the east coast, which is typically shallower.

Ms. KOVALIC. Can you elaborate a bit on the comparison between the characteristics of the east and west coasts, with regard to temperature, salinity, currents, depth, and amount of dilution?

Dr. BROOKS. Yes. You know, I sometimes summarize it for my students this way. I say, on the west coast we have a poorly ventilated atmosphere but we have an ocean that really flushes well; and on the east coast we have an ocean which is much more stagnant but we have a generally pretty well ventilated atmosphere, because you have a lot more wind here. So, coming out of Washington, we tend to get too little for air pollution control for us Californians, and too much water pollution control, because you have the inverse situation as far as what is what.

More specifically, anyway, the east coast has a broad continental shelf that runs out for over 100 miles, and the water is shallower, the flushing if the shelf water in exchange with the deep ocean is a great deal less.

For example, off Palos Verdes (Southern California), we have water that is 2,000 feet deep within about 5 miles of shore, and yet off the east coast, you would have to go 100 to 200 miles to find such deep water.

Generally speaking, because of this, the ocean currents are greater off California, because the water is deeper, and the major ocean currents come closer to shore.

Ms. KOVALIC. Is it possible to design an outfall pipe on the east coast that will compensate for the conditions that you are describing, such that the net cost might still be less than that associated with secondary treatment?

Dr. BROOKS. It depends on the site, but generally, no. You have a matter of economics here. To get a high dilution, you may find that the length of outfall you need to build on the east coast to get to that deep water is prohibitively expensive. You might find that it is much cheaper to go to secondary treatment and have a lesser outfall system.

In California, if you can build an outfall like Orange County, for $9 million, or the last one that Los Angeles County built, which was 15 years ago, for $5 million—but they would probably cost three times as much now. Those are still relatively modest sums compared to a secondary treatment plant now, which may run to something like $60 million per 100 million gallons per day capacity.

These are large outfalls, which benefit from an economy of scale.

If the system is only medium size, you may find that secondary treatment is cheaper than getting an outfall which will go way, way out.

On the other hand, if you have a good coastal situation, it may be just much cheaper to use a good outfall system, and less treatment.

As an engineer, I really like to see an optimum arrangement of facilities. If you have an opportunity to do something at a much reduced cost and get the same result, I would like to see the law and the regulations fixed so that that is possible.

Ms. KOVALIC. You have made several comments this morning about predictions, the ability to predict. Do I understand you to be saying that it is possible to make an accurate predictive judgment as to whether an unconstructed but proposed pipe would meet specific water quality, physical, chemical, and biological criteria?

Dr. BROOKS. Yes, it is, and I do that for my professional work.

Ms. KOVALIC. Could you give me your assessment of EPA's proposed regulations implementing section 301(h) of the Federal Water Pollution Control Act? In particular, I am curious about your thoughts on the proposed definition of the term, "existing discharge".

Dr. BROOKS. Yes. As I understand, their interpretation is that as of the December 1977 date, the evaluation for waivers is to be based only on what is actually in place and in use at that time. That seems to me to be unduly restrictive; it squelches the initiative of agencies and engineers—prevents them from carrying out planning, design improvements of facilities which they may determine to be most cost effective. It prevents the engineering of new developments, of new innovations, which I think could be reasonably proven to be of such quality as to provide a technical basis for a waiver, even though they may not have been in place at that particular cutoff date.

For any branch of technology, you would not want to say, "Let us freeze the technology at what was actually in place last year," if you had another good idea just coming along that you are already developing, and it has been shown to be much cheaper and cost effective and would have the same result as previous works already in use. Then it would seem to me it would be very uneconomical to prevent such further developments of the same kind and character.

Ms. KOVALIC. Thank you, Dr. Brooks.

Mr. ROBERTS. Doctor, there seems to be one main assumption in your statement—that you cannot have one set of plans or one idea that suffices for every operation, is that right?

Dr. BROOKS. Absolutely right. Everything is custom designed to a particular situation.

Mr. ROBERTS. Mr. Clausen had one more question.

Mr. CLAUSEN. To place on the record what we have heard here today in the form of a summary, would this come fairly close? The engineering profession has the capability to determine mixing, dispersion, or dilution rates for discharges from outfalls.

Dr. BROOKS. Yes, sir.

Mr. CLAUSEN. Now, your actual experience confirms your predictions; there is no mystery. Is this correct?

Dr. BROOKS. That is correct. If you like, I will introduce the titles of some of these reports into the record.

Mr. ROBERTS. Would you have copies of those that we could not put in the record, but as part of the file on this case; do you have copies of those?

Dr. BROOKS. Yes; I would be happy to leave this with you.

Mr. ROBERTS. We appreciate it very much, sir.

Dr. BROOKS. One of these is an EPA report that was written by me.

Mr. ROBERTS. OK.

Mr. CLAUSEN. Thank you very much.

Mr. ROBERTS. Dr. Brooks, we appreciate it very much.

Dr. BROOKS. Thank you for the opportunity to testify. I have been interested in the subject a long time, and I really welcomed the opportunity to speak to you.

Mr. ROBERTS. Thank you.

[Dr. Brooks' submission for the record follow :]

AN OVERVIEW OF THE FUNCTIONAL DESIGN OF OCEAN OUTFALLS FOR WASTEWATER DISCHARGE

(By Norman H. Brooks)

1. SYSTEMS ASPECTS

The design of ocean outfalls for wastewater discharge must be considered as an overall system with many interacting factors. First, for producing a given ambient water quality in the ocean there is always a trade-off between increased degree of treatment and increased outfall performance (increased length and depth of an outfall diffuser, and distance of the diffuser from shore). The ocean itself provides a high assimilative capacity ("treatment") for oxidizing wastewater if the effluent is properly dispersed.

Another systems aspect involves the choice of diameter of an outfall pipe. When larger it is more difficult to provide necessary physical stability of the line for withstanding earthquakes, scour by currents and wave attack in the breaking wave zone. On the other hand, smaller pipe sizes, although cheaper, require more pumping head, or installing a pump station when one otherwise might not be required. The balance of all these factors is very much site dependent both with respect to the environmental characteristics of the ocean, the discharge requirements, and the economics of construction.

As in any system there are constraints, such that not all factors are variable. For example, in accordance with present federal law, secondary treatment is a requirement for all municipal discharges, although the recent report of the National Commission on Water Quality recommends that some deferrals and waiver of this requirement be provided in an amendment to the legislation.[1] In some cases, an outfall may be designed, built, and put into operation for primary or screened effluent, before secondary treatment facilities are provided. The design must take this into consideration as well as the slight possibility that secondary facilities may never be built if the outfall performance with primary effluent is outstanding and meets all State requirements, and if the federal law should be relaxed. The design requirements for outfalls for primary vs. secondary effluent are not very different because the water quality improvements resulting from secondary treatment are not the ones that are critical for ocean discharges. If high dilution of the order of 100 :1 is not required for maintaining dissolved oxygen, then it would be required for control of the impact of nutrients which may not be significantly reduced by secondary treatment. Furthermore, for protection of public health both primary and secondary effluent should be far enough from shore so that there is adequate mortality of bacteria and viruses without the necessity for effluent disinfection which is a costly operating expense.

Finally, the physical factors of the outfall design, such as soil conditions, earthquake faults, waves, and local submarine topography near the outfall terminus may dominate the local considerations for outfall alignment; in other words, water quality predictions may not be sensitive to minor shifts in location (1000 feet or so) and so the detailed location is often governed by these other factors.

2. OBJECTIVES

The objectives of an outfall system are clearly to disperse the effluent sufficiently into the ocean current so that the ecosystem products of the effluent (the organic carbon, nutrients, etc.) can be kept within allowable limits. Toxic materials in significant quantities should of course be controlled at their sources in the sewer system.

[1] Report to the Congress by the National Commission on Water Quality, Mar. 18, 1976.

The California Ocean Plan regulations presently require initial dilutions of 100:1 (median) and 80:1 (90-percentile). Individual permits may be more stringent, or even less stringent in a few cases. Furthermore outfalls should be far enough from shore so that the bacterial requirements can be met without the use of disinfection (if feasible).

Federal regulattions do not deal explicitly with outfalls because they do not encompass the systems point of view described above in Section 1. Requirements are set in terms of effluent limitations corresponding to secondary treatment regardless of the method of discharge into the receiving waters and the location. (There are, however, general requirements relating to permits and ocean discharge (PL 72–500, Secs. 402 and 403).)

3. REGIONAL VIEW

The functional design of an outfall starts from the large-scale and works back to the small. In the planning stages the general characteristics of the collection system and the general location of the outfall and the receiving body of water are selected. However, as part of the final design effort the ocean circulation and stratification data must be analyzed to confirm that the general location and distance from shore are optimized, taking account of shoreline constraints on siting of facilities. The depth and length of the diffuser at this stage in the consideration are still kept as open variables depending on the dilution analysis described below.

In general it is found from experience that the marginal cost of additional outfall length is really rather small compared to the whole cost of the outfall, along with the cost of collection and treatment systems. Design experience on the west coast of the United States has confirmed that choice of long outfalls has been a wise investment and has enabled some systems to absorb an upgrading in requirements without modification of the outfall system. However, in some instances where outfalls have been built to minimum distances to meet current requirements, costly future modifications have been necessitated.

4. DIFFUSER LOCATION, DEPTH, AND DISTANCE FROM SHORE

With the general regional location settled, the next step is to strike a balance between diffuser length, depth and distance from shore. The outcome of the balance depends on costs and the slope of the ocean bottom as well as hydrodynamic calculations of dilution. One of the simplest ways to grasp the tradeoff is expressed by the line plume formula for buoyant discharge into a quiescent unstratified ocean, as follows:[2]

where:

$$S_c = 0.38 \left(\frac{\Delta\rho}{\rho} g\right)^{1/3} y L^{2/3} Q^{-2/3}$$

Q=the total effluent discharge

L=length of the diffusion structure

y=depth

$\frac{\Delta\rho}{\rho}$=relative density difference between effluent and sea water

g=acceleration of gravity

S_c=dilution on the centerline of the plume at the surface

$$\log y = -0.328,\ \log x = -0.905$$

y=the water quality objective to apply when chlorine is being discharged;
x=the duration of uninterrupted chlorine discharge in minutes.

(No allowance for surface effects is included in this simplified formula.)

Although this formula is too simplified for design purposes, it does show that under the most simplified conditions for equal Q and S_c, the factor $yL^{2/3}$ equals a constant; therefore, for the same initial dilution the required length is inversely proportional to the 3/2 power of the depth. Since the diffuser cost is practically the same as for the outfall pipe itself, the economics of this trade-off is easy to work out for a rough first approximation.

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[2] N. H. Brooks, "Dispersion in Hydrologic and Coastal Environments," W. M. Keck Laboratory Rept. No. KH-R-29. California Institute of Technology. December 1972.
R. C. Y. Koh and N. H. Brooks, "Fluid Mechanics of Waste-Water Disposal in the Ocean," Annual Review of Fluid Mechanics, Vol. 7, 1975, pp. 187–211.

In addition to the tradeoffs based on initial dilution, there is also an analysis which considers the mortality of microorganisms between the outfall location and the shore based on the overall distance and the current patterns and travel times. For example, the optimum tradeoff for initial dilution may result in a solution which is too close to the shore to get adequate die-off, and in such a case the location should be pushed further offshore.

The final tradeoff of all these factors depends on a detailed hydrodynamic analysis for outfall performance assuming various trial configurations. With the approximations based on experience, the design proceeds successively to narrow down the options with a complex computer analysis which takes account of the effects of ocean surrents, the thermal and salinity stratification, natural ocean diffusion, and die-off or decay of non-conservative pollutants. For this analysis typical port spacings and jet velocities are assumed, although the solution at this stage is not highly sensitive to those variables (i.e. these are details which are settled later). The state of the art of modeling of outfall discharges is not yet completely satisfactory and there are a number of judgmental factors involved. There is no omnibus program that just requires a list of inputs; rather, models are usually built on a site-specific basis because of the varying importance of different characteristics. For example, in the San Francisco case the depth is relatively shallower than in some cases and a different method of handling the effect of the current on the initial dilution is required. (See for example a publication by P. Roberts.[3] The models for initial dilution and subsequent spreading and advection of the sewage field also have to be coupled in an empirical way as we do not understand all of the hydrodynamic factors of relating the end of the jet mixing phase with the ambient advection phase in the ocean. This is especially true when we have stratified ocean current—a problem for which laboratory research is still going on at the W. M. Keck Hydraulics Laboratory at Caltech.[4]

When the model is developed and the various conditions are run corresponding to the different times of the year (different stratification), and at different tidal and current conditions, a whole range of predicted dilutions and plume behaviors is generated. The comparison of what these results are for different outfall configurations may not give a clear-cut comparison as to which configuration is better, as some may look better at some conditions and some better at other conditions. Thus judgmental decisions must be made regarding the final design, including full consideration of physical factors, construction, and costs.

5. DIFFUSER HYDRAULICS

After the oceanographic analysis has been made, the detailed diffuser hydraulics is worked out, i.e. the selection of port sizes and spacing and the steps in pipe diameters along the outfall diffuser. It is important to realize that this is a final part of the hydraulic design and is not the determining one. Many of the dilution calculations are not very sensitive to the actual port spacing and jet velocities because the diffuser is primarily creating a line source.

To work the manifold hydraulics problem a computer program is used which takes account of the discharge characteristics of the individual ports and does a numerical integration of the hydraulic conditions port by port with a trial and error optimization of pipe and port sizes considering the various discharges and constraints.

Experience indicates that the range of discharges to be handled has an important relationship to the allowable change in depth along the diffuser. It is sometimes necessary to run the diffuser essentially along an ocean bottom contour in order to get a good distribution of flow among the various ports over a wide range of flow. If the bottom has a substantial slope to it (greater than 1 percent) the hydraulic necessities to the manifold flow may be the dictating requirement for the alignment of the outfall diffuser.

6. DIAMETER OF OUTFALLS AND POSSIBLE PUMPING STATION

A discharge agency always likes to avoid the necessity of an outfall pumping station and hopes that outfalls can be made to flow by gravity. The key question

[3] P. J. W. Roberts, "Dispersion of Buoyant Waste Water Discharge from Outfall Diffusers of Finite Length", W. M. Keck Laboratory of Hydraulics and Water Resources, Report No. KH–R–35, California Institute of Technology, 183 pp., March 1977.

[4] Steven J. Wright, "Effects of Ambient Cross Flows and Density Stratification on the Characteristic Behavior of Round, Turbulent Buoyant Jets", W. M. Keck Laboratory of Hydraulics and Water Resources, Rept. No. KH–R–36, California Institute of Technology, 254 pp., May 1977.

is whether it is cheaper to use smaller outfall pipes and to install and operate a pumping station, or to use larger diameter pipes and to withstand increased wave and earthquake forces, and face possible maintenance problems due to deposition because of low velocity.

Because the head loss is a quadratic function of the discharge, an economical arrangement is often one in which the flow is by gravity for a large part of the time and the pump station is only used for a relatively small fraction of the time to handle the larger flows. In this way the actual energy consumption is not large and the uncertainties in factors such as outfall friction do not have to be decided on a very conservative basis in order to be absolutely sure that gravity flow can take care of the situation. Put another way, the uncertainty of the outfall friction and the future real flow rates can be absorbed into the number of hours that the pump station is required to operate.

If the system does flow by gravity then the excess head must be dissipated before the flow enters the outfall system. Chutes with hydraulic jumps or vortex structures are possibilities. For all but the very largest flows the head to be dissipated is quite significant, and represents a waste of energy if the water is pumped up to the required forebay level from some pump stations elsewhere in the sewerage system.

7. PHYSICAL FACTORS

Thorough analysis of wave attack on the outfall is important,, and requires the selection of sizes of ballast stone to hold the pipe in place under maximum breaking waves. Since most California outfalls go out to depths of at least 80 feet (frequently 200+ ft.) the largest waves at the site will break in depths through which the outfall must run. (The breaking wave height is about 79 percent of the depth.) The wave defense may involve burial of the pipe with riprap to protect it further in case of local scour or sand profile change. It will probably be found that the wave defense is an important component in the relationship of outfall cost to diameter. The same is true probably also for earthquate resistance.

In analyzing the stability of the pipe it is important to realize that the submerged weight of the outfall under water is much less than it would be on land. In fact the entire volume of effluent inside the pipe actually provides a slight buoyancy rather than a net weight. This is especially important to realize in the earthquake analysis that when the ground accelerates laterally the entire mass of the pipe and its contents along with the ballast stone must also be accelerated. (There is also an apparent mass affect in the ocean water.) But on the other hand the mass of water inside the pipe does not contribute anything to friction on the sea bed. Obviously this problem get more severe as the diameter of the pipe increases and the mass of water inside the pipe increases as the square of the diameter.

(An analysis of wave resistance and earthquake stability along these lines has been conducted for the Orange County outfalls and Honolulu outfalls by Drs. F. Raichlen and R. F. Scott.)

8. CONCLUSION

From the foregoing discussion it is clear that there are many interconnections in the design process so it is truly a system which is being developed. Experience in previous outfall designs is important in expeditiously sorting out promising from unpromising approaches and in helping to make all the design factors converge on an optimum design. Furthermore, if critical oceanographic data on water characteristics and currents are missing, they must be identified and obtained as part of any final design effort.

State of California, the Resources Agency

STATE WATER RESOURCES CONTROL BOARD RESOLUTION NO. 78–2—WATER QUALITY CONTROL PLAN FOR OCEAN WATERS OF CALIFORNIA

(The 1978 Amendments to the "Water Quality Control Plan for Ocean Waters of California" were adopted by the State Board at its January 19, 1978 meeting and will become effective upon approval of the Environmental Protection Agency.)

Whereas:

1. The Board adopted the "Water Quality Control Plan for Ocean Waters of California" on July 6, 1972;

2. In the period between July 1972 and December 1977, the Board has received additional information regarding ocean water quality and wastewater management needs

3. The Board conducted an extensive review of the 1972 Plan, prepared a draft set of amendments, prepared and circulated a draft initial study and negative declaration in accordance with the provisions of the California Environmental Quality Act, and on October 19, 1977, held a public hearing regarding the draft amendments.

Therefore be it resolved that:

1. The Board adopts the "Water Quality Control Plan for Ocean Waters of California 1978" and the Negative Declaration and Initial Study pertaining thereto.

2. The Board hereby declares its intent to determine from time to time the need for revising the Plan to assure that it reflects current knowledge of water quality objectives necessary to protect beneficial uses of ocean waters and that it is based on latest technological improvements.

3. The Board hereby declares its intent to require continual monitoring of the marine environment to assure that the Plan reflects the latest available data and that the water quality objectives fully protect the marine environment.

CERTIFICATION

The undersigned, Executive Director of the State Water Resources Control Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on January 19, 1978.

LARRY F. WALKER,
Executive Director Water Quality.

California State Water Resources Control Board

WATER QUALITY CONTROL PLAN FOR OCEAN WATERS OF CALIFORNIA (AS AMENDED, 1978)

INTRODUCTION

In furtherance of legislative policy set forth in Section 13000 of Division 7 of the California Water Code (Stats. 1969, Chap. 482) and pursuant to the authority contained in Section 13170 (Stats. 1971, Chap. 1288) the State Water Resources Control Board hereby finds and declares that protection of the quality of the ocean waters for use and enjoyment by the people of the State requires control of the discharge of waste [1] to ocean water [2] in accordance with the provisions contained herein.

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[1] This Plan is applicable, in its entirety, to point source discharges to the ocean. Nonpoint sources of waste discharges to the ocean are subject to Chapter I—Beneficial Uses, Chapter II—Water Quality Objectives, Chapter III—General Requirements, Chapter IV—Table B (wherein compliance with water quality objectives shall, in all cases, be determined by direct measurements in the receiving waters), and Chapter V—Discharge Prohibitions.

This Plan is not applicable to discharges to enclosed bays and estuaries or inland waters nor is it applicable to vessel wastes, and the control of dredging spoil.

Provisions regulating the thermal aspects of waste discharged to the ocean are set forth in the Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California dated May 18, 1972.

[2] Ocean waters are waters of the Pacific Ocean adjacent to the California coast outside of enclosed bays, estuaries, and coastal lagoons.

Enclosed bays are indentations along the coast which enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. This definition includes but is not limited to: Humboldt Bay, Bodega Harbor, Tomales Bay, Drakes Estero, San Francisco Bay, Morro Bay, Los Angeles Harbor, Upper and Lower Newport Bay, Mission Bay, and San Diego Bay.

Estuaries and coastal lagoons are waters at the mouths of streams which serve as mixing zones for fresh and ocean waters during a major portion of the year. Mouths of streams which are temporarily separated from the ocean by sandbars shall be considered as estuaries. Estuarine waters will generally be considered to extend from a bay or the open ocean to the upstream limit of tidal action but may be considered to extend seaward if significant mixing of fresh and salt water occurs in the open coastal waters. The waters described by this definition include but are not limited to the Sacramento-San Joaquin Delta as defined by Section 12220 of the California Water Code, Suisun Bay, Carquinez Strait downstream to Carquinez Bridge, and appropriate areas of the Smith, Klamath, Mad, Eel, Noyo, and Russian Rivers.