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PHOSPHATES IN DETERGENTS AND THE EUTROPHICATION OF AMERICA'S WATERS

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HEARINGS

BEFORE A

SUBCOMMITTEE OF THE COMMITTEE ON GOVERNMENT OPERATIONS HOUSE OF REPRESENTATIVES

NINETY-FIRST CONGRESS

FIRST SESSION

DECEMBER 15 AND 16, 1969

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PHOSPHATES IN DETERGENTS AND THE EUTROPHICATION OF AMERICA'S WATERS

MONDAY, DECEMBER 15, 1969

House of Representatives,
Conservation and Natural Resources Subcommittee
of the Committee on Government Operations,
Washington, D.C.

The subcommittee met pursuant to notice at 10 a.m. in room 2247, Rayburn House Office Building, Hon. Henry S. Reuss (chairman of the subcommittee) presiding.

Present: Representatives Henry S. Reuss, Jim Wright, Floyd V. Hicks, Guy Vander Jagt, Gilbert Gude, and Paul N. McCloskey, Jr.

Staff members present: Phineas Indritz, subcommittee chief counsel; Laurence Davis, assistant counsel, and F. Clement Dinsmore, legal assistant. Also, J. P. Carlson, minority counsel, and Tom Saunders, minority staff, Committee on Government Operations.

Mr. Wright (presiding). The subcommittee will be in order.

Our chairman, Mr. Reuss, is unavoidably detained. He will be here a bit later. He has asked if we would go ahead and begin the hearing.

At the outset I should like to read the statement which Mr. Reuss had prepared for his delivery this morning:

"America's waters are beset by myraid forms of pollution. Some are gross and visible, like raw sewage. Others are subtle and insidious, like phosphates.

"Phosphates fertilize the growth of vegetation in water, and lead to accelerated eutrophication and destruction of a body of water by excessive vegetation, particularly algae. Oxygen deficiency occurs as the plantlife dies and decays. Lakes become uninhabitable by valuable sport and commercial fishes. Great mats of decaying weeds and slime wash up on beaches, create stench, foul fresh water intakes, and depress lakeshore property values. Eventually the lakes turn into swamps and bogs.

"Phosphates come from many sources, including detergents, fertilizers, chemical wastes, human and other wastes. Treatment plants and septic tanks now remove only a small part of the phosphates in domestic sewage. Detergents are certainly a major source of phosphate pollution. Almost 5 billion pounds of detergents were sold in the United States last year. Most of these, except some light-duty products, contain substantial quantities of phosphates. Hence, without in any way minimizing the amount of phosphates contributed from other sources, our hearings today and tomorrow will focus on how the detergent industry can help to reduce the phosphate pollution.

"The extent of the problem of phosphate-based detergents is indicated by the report to the International Joint Commission entitled, 'Report on Pollution of Lake Erie, Lake Ontario, and the International Section of the St. Lawrence River' issued this year by the International Lake Erie Water Pollution Board and the International Lake Ontario-St. Lawrence River Water Pollution Board. That report shows an increase in phosphorus concentrations in the Western Basin of Lake Erie from 14 micrograms per liter in 1942 to 40 micrograms per liter in 1967–68. That Basin is now clearly eutrophic. The report states, 'Similar dramatic increases in phosphorus have been observed in other lakes in various parts of the world and correspond well with the widely increasing use of phosphate-rich detergents since the 1940's.' The boards estimate that 35 to 50 percent of the total input of phosphorus to Lake Erie comes from detergents.

"The International Water Pollution Boards recommended at least 80-percent reduction of phosphorus from municipal and industrial waste discharges by 1975. However, their report urged 'immediate reduction to minimum practical levels of the phosphorus content of detergents and the amounts of phosphate-based detergents used' and 'complete replacement of phosphorus compounds in detergents with environmentally less harmful substitutes as soon as possible, but not later than 1972.' The water pollution boards stated that 'eutrophication can be controlled by the reduction of phosphorus,' and that 'phosphorus removal is the only economically feasible solution at the present time.'

"There are several reasons for removing phosphates from detergents as well as at the sewage treatment plants.

"First, the international boards pointed out that: 'partial replacement of phosphates in detergents is now possible with no reduction in cleansing power. Also, if urgency is attached to finding an environmentally harmless substitute for full replacement of phosphates, it might be possible to find an answer within a few years,' and thus achieve a substantial reduction in phosphorus loadings into our waters during the next several years while sewage treatment plants are being constructed.

"Second, the requirement of phosphorus removal would in many cases impose undue financial burdens on small municipalities, individual homes using septic tanks and small industries. In such cases the phosphorus cannot be economically removed, except by reducing the phosphate content of detergents.

"Third, it is estimated that removing phosphates from detergents would reduce treatment costs for phosphate removal at sewage treatment plants by a half to two-thirds. According to the report of the International Boards (p. 79), 70 percent of the phosphorus in municipal sewage in the United States, and 50 percent in Canada, now comes from phosphate-based detergents. The average content of phosphorus in sewage is now about 10 milligrams per liter, of which 7 milligrams per liter originate from detergents. If phosphates were replaced in detergents, removal of 80 percent of the remaining phosphorus at the sewage treatment plant would then reduce the concentration to 0.6 milligrams per liter. To achieve the same effluent concentration without replacement of phosphates in detergents would require more than

95 percent removal at the sewage plant, with two to three times the overall cost, largely due to the additional chemicals needed and solid wastes produced.

"In view of the large share of phosphate pollution contributed by detergents, it is not fair to require the taxpayers alone to bear the cost of phosphate removal. If the industry does not reduce phosphates at the source, some way must eventually be found to require it to share the cost of building advanced waste-water treatment plants.

"The Interior Department and the detergent industry are certainly aware of the need to eliminate phosphates from detergents. In August 1967, over 2 years ago, former Secretary of the Interior Udall announced the establishment of a Joint Industry-Government Task Force on Eutrophication 'to recommend a cooperative research program on controlling eutrophication * * * of lakes, including the role of phosphates and their possible replacement.' In January 1968, Secretary Udall congratulated the detergent manufacturers and their suppliers on their continued efforts to find substitutes for phosphates in detergents.

"Yet in a letter to this subcommittee dated November 24, 1969, less than a month ago, Assistant Secretary of the Interior Carl L. Klein, stated that reduction or elimination of phosphorus from detergents is desirable in concept but not feasible for implementation at this time, because the Interior Department does not yet have adequate evaluation materials for determining 'eutrophicationability' of substitute materials.

"The principal result of the joint industry-Government task force seems to be an agreement to develop a 'Provisional Algal Assay Procedure' for field testing about 2 years hence. The mountain has labored and brought forth a mouse. Studies can sometimes be a substitute rather than a prelude to action, and so it may be here. We don't need to assay algae nearly so much as we need to eliminate them.

"In 1965, the soap and detergent industry helped the Nation's fight for clean waters when it substituted biodegradable LAS surfactant for the previous nonbiodegradable ABS which had caused excessive foaming and suds on America's rivers and lakes.

"I am sure that the detergent industry could reduce or eliminate the phosphorus content of detergents without plunging the American standard of cleanliness back into the dark ages."

This is the statement of the chairman of the subcommittee, Mr. Reuss.

I should like to add that this subject interests me keenly, as a member of both the Public Works Committee, which has been concerned with the basic problem of water pollution, and as a member of the Government Operations Committee, whose subcommittee under the direction of Congressman Robert Jones of Alabama in 1965 looked into the question of the biodegradable substances, excessive foaming. At that time the industry did respond very promptly and we believe efficaciously, and we look forward with great hope and anticipation that it can do so now with respect to the matter of phosphates.

Our first witness will be the Honorable Carl Klein, our Assistant Secretary of Interior for Water Quality and Research.

Prior to Secretary Klein's statement are there comments the members of the committee desire to make?

(No response.)

Mr. WRIGHT. Secretary Klein, it is a pleasure for the subcommittee to have you with us this morning. We appreciate your being here and you may proceed in any fashion you desire.

STATEMENT OF CARL L. KLEIN, ASSISTANT SECRETARY OF THE INTERIOR FOR WATER QUALITY AND RESEARCH; ACCOMPANIED BY DR. A. F. BARTSCH, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, CORVALLIS, OREG.; REINHOLD W. THIEME, DEPUTY ASSISTANT SECRETARY, WATER QUALITY AND RESEARCH; DAVID D. DOMINICK, COMMISSIONER, FWPCA; AND DR. DAVID G. STEPHAN, ASSISTANT COMMISSIONER FOR RESEARCH AND DEVELOPMENT, FWPCA

Mr. KLEIN. Thank you very much, Mr. Wright.

Mr. Chairman and members of the subcommittee, it is a pleasure for Commissioner Dominick and myself to appear with our staffs today before this subcommittee on behalf of the Department of the Interior to give its views of the matter of phosphates in detergents as a source of pollution.

I would like to introduce briefly some of the effects of phosphorus in the environment and to explain our present position on the subject of phosphorus in detergents. The Commissioner will amplify the reasoning behind our present policy—and I substituted words there to let you know we will change as the state of the art changes—and discuss the programs of the Federal Water Pollution Control Administration which bear on the problem and its potential solution.

Let me first describe eutrophication. It is the nutrient enrichment of water, combined with oxygen depletion, which frequently results in an array of symptomatic changes. Among these are increased production of algae and other aquatic plants, deterioration of fisheries, and other impairments of water uses that are found to be objectionable. Eutrophication can be, and often is, the result of natural processes and it is well known that many lakes "age and die" naturally as the result of fertilization from decaying organic matter entirely apart from human activity. However, in an increasing number of cases, this natural eutrophication has been accelerated by pollution from men's activities—his cities, his farms, and his industry.

This, then, defines the context of our concerns about phosphorus in the aqueous environment.

Algae and other aquatic plants, like plants on the land, require a variety of chemical elements to sustain their growth. Among them is phosphorus, and it has been singled out for special consideration for several reasons:

1. It is indispensable to growth; without it there would be no plant growth.

2. In many lakes, phosphorus is a critical and controlling nutrient. This means that the frequency and magnitude of nuisance algal blooms are strongly influenced by the amount of phosphorus available.

3. Necessary quantities of phosphorus that contribute to such conditions are very small—as little as 0.01 milligrams per liter at the beginning of the growing season in some lakes or an annual inflow of 0.2 to 0.5 grams per square meter of lake surface in others. At such phosphorus levels, the amount of plant material produced is related to the amount of phosphorus available; thus the most aggravating characteristics of eutrophication are directly related to phosphorus.

4. Phosphorus is a persistent element in the aquatic environment. It does not, like nitrogen, enter into those biochemical reactions that permit it to escape from water as a gas nor is it readily removed from the system by organisms or sediments.

With present technology, and I emphasize that, with present technology, the preferred procedure to control eutrophication is to impede plant production by making phosphorus less available for growth. One important step toward this goal is to curtail phosphorus-bearing effluents.

What are the sources of phosphorus input to our waters? Phosphorus is a fairly abundant element in the earth's crust and so it is not surprising that it enters surface waters from many natural sources and as a result of human activities. Natural sources include: (1) surface water runoff, (2) soil erosion, (3) waste from animals and decay of plants, and (4) dissolved and suspended materials in rain and snow. In the course of time, over hundreds and thousands of years, these small but continuing inputs can by themselves bring lakes to an end through eutrophication and sedimentation. The Green River oil shales of Colorado, Wyoming, and Utah are a good example of lake deposits formed by natural eutrophication and sedimentation during the course of geologic time.

As for man-related sources, municipal sewage contains significant concentrations of phosphorus. It comes principally from such human wastes as feces, urine, and food waste disposal as well as from phosphorus-bearing detergents. On the average, adult humans contribute about 1.4 pounds of phosphorus per year. Detergent use adds an additional 1½ to 2 pounds per capita per year. Some of the phosphorus is removed by conventional waste treatment processes, but substantial amounts are still discharged routinely.

In other words, primary and secondary treatment does not remove any appreciable amount of phosphorus.

Urban runoff, industrial wastes, and animal feedlot and other agricultural runoff are other sources. Up to a saturation value, phosphorus is accumulative in its impact on the eutrophication process. It is reasonable to attack first those major sources that are controllable, but for a control campaign to be fully effective, it must ultimately control or curtail the bulk of phosphorus derivative from man's activities. Otherwise, at least 680 million pounds of phosphorus per year would continue to enter our surface waters from sources other than detergents. If this amount of phosphorus were distributed equally in the total annual streamflow of the United States, it would produce an average concentration more than 10 times the amount required to support excessive algal growth.

Control of the phosphorus input from these other sources will not be easy. Furthermore, some inland waters may already contain so much

phosphorus that control of future inputs would not retard eutrophication.

The Federal Water Pollution Control Administration is presently investigating the utilization of phosphorus already in water in its water quality control technology program. Crustacea and diatoms are desirable organisms for removing phosphorus; furthermore, they are superior high energy foods for the more desirable fishes and for other higher food chain organisms. In this way, phosphorus would be assimilated by aquatic species that provide a desirable water quality addition. This scheme represents a means of using nature's wide diversity of species and biological processes to manage phosphorus in the environment through new nonwaste treatment techniques.

We are well aware that the phosphorus used in detergent formulations makes up some 50 or 60 percent of the total amount of phosphorus in municipal sewage. The other 40 to 50 percent is mainly from human excrement. I noted that you quoted 70 percent, and I would like to arrive at how these figures were gotten at, so we can equalize our figures somewhere along the line.

Mr. WRIGHT. I believe the statement to that effect contained in the opening remarks of Chairman Reuss was quoted from a report by the International Water Pollution Board looking into the western basin of Lake Erie and parts of the St. Lawrence Seaway. Now, wherein these various estimates differ, perhaps they have been the result of studies at different locations. I think it is altogether conceivable that in large bodies of water, such as Lake Erie and that portion of the St. Lawrence Seaway which finds eutrophication from many sources in addition to the human waste sources, this difference might be understandable.

I think it is important that we do try, between us, to arrive at scientifically accurate estimates.

Mr. KLEIN. That may be so. It may take some time to do it. But I think we are all agreed that this is a major problem, and that is the impact of the committee's hearings today.

(Continuing with prepared statement:) Phosphate-based detergents constitute a major source of nutrient pollution which must be abated. Our primary thrust on controlling this problem has been the development and demonstration of phosphorus removal technology for application at municipal waste treatment plants. This approach has been given priority because it attacks all of the phosphorus in municipal wastes, regardless of its origin. Even if phosphates in detergents were to be completely eliminated from use, we would still have to apply phosphate removal technology to municipal waste waters.

We believe that the reduction or elimination of phosphorus from detergents is essential but inappropriate for implementation *at this time*. It is primarily a state of the art. Let me explain. The reduction or elimination of phosphorus in detergent formulations would undoubtedly require the replacement of phosphorus with some substitute material. These substitutes could possibly be equally stimulating to algal growth; it is even possible that these materials, or their degradation products, could cause other, more serious pollution than does phosphorus. We do not want to solve one problem by creating an even greater problem.

In 1965, when the detergent industry was faced with the problem of improving the biodegradability of detergents, it was faced with a structural rearrangement of some of the chemical components of detergents. The change from "hard" to "soft" detergents was accomplished by substitution of straight-chain linear alkylated sulfonate for the complexly branched alkyl benzene sulfonate.

It was the benzene ring that caused much of the problem. In that change, the basic chemical composition of detergents remained the same. The detergent industry must now seek an alternative to the basic phosphate building block of detergents. This involves a change in the basic chemical composition of detergents and may result in the introduction of different chemical elements into waste discharges and then into the environment.

Specific substitute materials must be identified and characterized. We must then make careful predictions as to whether or not conventional or proposed treatment systems would be capable of handling them. Moreover, we already have a reasonably sound knowledge of the effects of phosphorus on water quality and the threshold concentrations at which these effects begin and we have advanced waste treatment technology now available which is capable of removing phosphorus at high efficiency from municipal wastes. Taking these matters into account, we do not believe that the introduction of substitutes for phosphates should be forced by legislative edict at this time. And I emphasize "at this time." It may be necessary in the near future as we see how we go. We should not move in this direction until we can be assured that the step will lead to an improved and not a worsened water environment. Once this can be shown, and we are working with a real sense of urgency on developing the needed evaluative tests, we believe that reducing the amount of phosphorus in detergent formulations or even eliminating phosphorus altogether from washing products should be put on as tight a time schedule as possible. Industry must solve the phosphorous problem in the shortest possible time, showing the same sense of urgency and responsibility that it showed in the solution of the problem of biodegradability.

I would now like to introduce the Commissioner of the Federal Water Pollution Control Administration, Mr. David D. Dominick, who will amplify this position on detergent phosphates.

Mr. WRIGHT. Mr. Secretary, we are grateful for your testimony and anxious to hear the further elaboration by Mr. Dominick. Before he begins his prepared statement, I wonder if we might recapitulate briefly. If the Chair properly understands your position, it is that, first of all, the removal of phosphates from detergents, while desirable, is not feasible at present because the state of the art has not yet reached a point where some substitute material might not actually be more harmful in the eutrophication process than the phosphates themselves.

And second, even the removal of all phosphates from detergents still would not solve the problem, because phosphates result from many other and additional factors, including both human and animal wastes as well as runoff and sedimentation, and all of that sort of thing.

You have declared that we do already have available technology capable of efficiently removing phosphorus from municipal wastes. Do you disagree with the conclusions expressed by Chairman Reuss, how-

ever, as to the relative cost to the municipalities and local units of government of installing these tertiary treatment works beyond the first and second phases? Do you not feel that this in the long run will be an extremely costly procedure to all of the municipalities throughout the country?

Mr. KLEIN. I cannot see anything but that it has to be done for the larger cities. Let me go a little further along this line if I may. The Potomac coming into the Washington area from farmland mainly brings in three times as much phosphate as it should. And we have to do something about the upstream area as well. But the big problem is here from the human waste at Blue Plains, especially, as well as Piscataway. We know there are certain detergents that do not have phosphate in them. For instance, your wife and my wife use one in the dishwasher, which has no phosphate in it, but it has caustic in it and you cannot put your hands or shirts in it. So we have a problem that you cannot substitute that one.

We know there are sugar-based detergents, and that these are readily absorbed by the bacterial processes but they are not as effective in cleaning as are the sulfonates. Now we have a nitrilotriacetate. It is being tried in a number of laboratories and by detergent manufacturers, but it does not clean as effectively as do the phosphorus compounds.

I just point out at that point we get to the little woman at home and here is where we get into problems. Again I point out we moved from the hard detergents to the soft detergents. As a result of the soft detergents, we got phosphates that broke down very rapidly, and probably from 1965 on, when this was introduced, we stepped up the eutrophication process without realizing it.

Now we have to find an answer. Instead of saying that it is desirable, I say to you it is a must that we find an answer to it.

Mr. WRIGHT. Are you concluding that as a result of the biodegradeability changes that were brought about in the industry, largely at congressional urging in 1965, some more harmful ingredients were introduced into the detergent?

Mr. KLEIN. No, they were less harmful, but we did not realize the impact would be that by breaking up rapidly we would step up the eutrophication. It was a necessary step then, but it is an absolutely necessary step that we remove phosphate entirely from detergents.

But we should find out what the impact is of the substitute before we go ahead.

Mr. WRIGHT. Isn't part of the problem that to which you alluded when you spoke of the little woman at home?

Mr. KLEIN. That is right.

Mr. WRIGHT. I had the feeling that the industry had done a massive job in changing the public attitude, which not only desired, but demanded, great sudsiness.

I think earlier the advertising geniuses on Madison Avenue had made all of the ladies at home think that rich, billowly suds would cleanse the filthiest of things. And at first, perhaps, the ladies just did not want to accept something that did not give this tangible evidence of its cleanliness. But later, as Madison Avenue perfected the techniques of telling us how much more desirable it was, they began to accept the low-suds product.

Now, I have great faith in the ability of Madison Avenue, once we decide what is best, to convince these ladies that they just have to have it. I think most of us tend to believe what we see and hear on our mass media.

Mr. KLEIN. Let me say to you very clearly that as soon as we find the substitute is there, we will be asking this committee to impose the necessary dates to change the phosphates.

I think your statement was very good, that is why they were called soap operas during the daytime.

Mr. WRIGHT. And the brainwashing, then.

Mr. KLEIN. Yes.

Mr. WRIGHT. Actually, I did not mean to be facetious about that, because it is a serious part of the problem.

Let me ask you a question, Mr. Secretary. In our Federal Water Pollution Control Act, the Secretary of the Interior is, of course, the person primarily responsible for its administration.

We have provided this year some $800 million, which is almost four times as much as the $214 million the President had requested. Those of us in Congress regard $214 million as manifestly inadequate. I don't want to visit this on Mr. Nixon alone, because the request at first was in Mr. Johnson's budget, and was carried over into Mr. Nixon's budget. And yet, the Congress, in its earnest desire to act as speedily as possible on cleansing our streams and slowing eutrophication of our water resources, has provided some $800 million.

Part of that money is earmarked for research and development projects, though most of it, of course, is assigned to matching funds to assist the municipalities in more adequate treatment of wastes.

Do you see any hope, or do you and the Department have any plans, for getting the industry together and saying, "Look fellows, here is some money; now let us really get on with this thing"?

It took us about 14 years to get to the moon, and many billions of dollars, but we demonstrated that could be done by a massive and coordinated assault.

Do you have any plans, or have you had meetings with the people in the industry, to try to stimulate more rapid development, if possible, through research, of what we are seeking?

Mr. KLEIN. Yes, we have and we have a council that met just last month, and Dr. Bartsch and Dr. Stephan, and Dr. Singer, from my staff, met in Madison with the group at the University of Wisconsin, trying to find ways and means of doing this.

However, I will say this to you, it is our position that the maximum input of dollars here is the industry's business; it should not be the taxpayer's money. However, we will assist in every way we possibly can, and we will put in money when we see it is coming along the way it should.

We think they should find the answers, and they should find the answers very shortly.

Mr. WRIGHT. Do you find within the industry a sufficient sense of urgency?

Mr. KLEIN. Yes, I have had a number of conferences—so has Commissioner Dominick—directly with the industry in trying to find ways and means. This has been going on for the past 6 months with both of us.

Mr. WRIGHT. I don't want to delay the proceedings further, except there is one other question I would like to ask. It was suggested by your mentioning the use of crustaceans to remove some of this phosphate waste.

Exactly what did you have in mind there? Snails and oysters and clams, things of this sort, introduced at certain points?

Mr. KLEIN. I will let Dr. David Stephan answer that.

Dr. STEPHAN. The concept is to promote the growth of desirable organisms in the water through holding the conditions in the water in the proper range. In this way you can then harvest the organisms, whether they be fish or crabs or snails, as you suggest, in order to remove the nutrients with them.

It is an exploratory idea—not something ready for practice, but something we are working on at the present time as an alternative means of handling phosphorus already in water which you can't get out by treatment, or can't get out by preventing runoff from the land.

Mr. WRIGHT. What is a diatom? You mentioned crustacea and diatoms.

Dr. STEPHAN. A small algae-type organism, easy to harvest, as opposed to the blue-green algae, which are not easy to harvest and which are the troublesome ones.

Mr. WRIGHT. The Secretary mentioned that these then became foodstuff for fish.

What then happens to the fish if they get overloaded with phosphates? Is this harmful to them or to those who eat fish?

Dr. STEPHAN. Indeed not harmful.

The idea would be to promote the growth of large quantities of fish which are then much easier to harvest than algae.

In other words, you can harvest fish with nets. The idea behind it, sir, is to remove nutrients from water by getting them into harvestable form, putting them into the fishfood chain, and then harvesting them.

Mr. WRIGHT. My 10-year-old daughter has a little aquarium, and she puts snails in there to clean up the waste.

Is this generally the same idea?

Dr. STEPHAN. In concept, excellent. If you harvested the snails, you would be taking the nutrients out. You put nutrients into the aquarium as fishfood. You get them out by taking the snails out.

Mr. WRIGHT. I am mindful of something else—I do not want to drag a herring across the path——

Dr. STEPHAN. A herring would not work.

Mr. WRIGHT. Let's drag a perch or a catfish or whatever we may across it.

Should there be too much polluted matter that marine life eats, then is there not a concomitant danger to those who harvest the marine life for foodstuff?

Is this a danger?

Or, am I seeing witches under the water?

Dr. STEPHAN. You are getting a bit ahead of some of the material we are going to present. But with regard to phosphorus, no. Phosphorus is a building block in human physiology and it will not be harmful to us.

But with certain types of replacements being considered for phosphates, those which chelate or tie up heavy metals which are potentially harmful—lead for example, cobalt for example, zinc for example—these could be potentially harmful to humans who would eat aquatic life which had eaten these materials.

This is one of the things we need to be certain of in our judgment before we make a precipitous move to make a change of a rather massive type in adding new things to the water environment when we don't know what their effects will be.

Mr. WRIGHT. Mr. Gude is here, and he is vitally interested, of course, in some of the water waste in the State of Maryland—Chesapeake Bay, for example.

A few years back, there was an outbreak of a certain type of illness among the people, and it was at least thought to result from shellfish. And it did terrible things to the market for shellfish. In artificially altering this ecological balance, are we running any risk? What is it you get from eating shellfish?

Mr. KLEIN. Infectious hepatitis.

Mr. WRIGHT. Yes. Is this a problem in connection with the introduction of crustaceans?

Dr. STEPHAN. No, sir; not of that type of disease which would be caused by a virus or by microorganism. But the concept is the same, the concept being that we need to be very careful as to what we add to the water environment which may cause unknown and unpredictable effects.

This is why we believe we should not move precipitously to force that action until we can be certain that it would, in fact, create an improvement in the water environment and not degradation.

Mr. GUDE. Does hepatitis come essentially from the improper treatment of waste—of sewage?

Dr. STEPHAN. Hepatitis is a viral disease. And hence, if you have improper treatment of waste waters, or no treatment at all, and viruses are present and they escape, then they can be actually concentrated in shellfish. Of course, on ingestion by man the disease can occur.

Mr. GUDE. What you are talking about, in getting into the unknown, is the introduction of certain chemical elements which would change the cycles, but the bad effects would not be the creation of a disease.

It could be that a disease organism might be fostered, but essentially you are thinking the chemical cycles would be disturbed by changing the formulation of the detergents.

Dr. STEPHAN. Yes, sir.

We are thinking more of toxic effects, rather than disease effects. One is caused by an organism, bacterium or virus, the other by a poisonous chemical.

Mr. GUDE. One of the difficulties of using the upper estuary for the water supply for Washington is the fact that there is the possibility of hepatitis, because these waters are not completely treated; and this is because of improperly treated waste, not because of chemicals.

Dr. STEPHAN. That is right, sir.

Mr. KLEIN. Mr. Wright, you asked me one further question about cost to municipalities that I was not able to get into.

I point out to you that what I usually term as "exotic tertiary" from Lake Tahoe is a very expensive proposition. It calls for seven steps of tertiary treatment. This is expensive. If necessary, it should be done.

However, right now, under Dr. Stephan, we have a physical chemical plant operating on 100,000 gallons a day and the beginning of it, as shown from New York University up there, is that the cost should be substantially less and remove the phosphate quite well. And we are looking forward to this all over the country.

Lastly, I was out at Milwaukee several weeks ago on this Lake Michigan item, and I ran into something there and find that Dr. Stephan got there ahead of me at Detroit, and also in Rocky River outside of Cleveland.

But it appears if you take spent pickling liquid, which is a pollutant, and ferric sulfate, and you add it to the sewage of the primary-secondary treatment, you move the phosphate out of the liquid effluent into the activated sludge, and the cost for doing this is practically nil because right now you can get spent pickling liquid for nothing from the steel companies, and that is what they are doing there.

Today we will be announcing a grant of $40,000 for one year to remove 95 percent of the phosphate at the Milwaukee plant, 200 million gallons a day.

Mr. WRIGHT. And this by the introduction of the pickling liquors from the steel mills?

Mr. KLEIN. That is right, it moves it out from the liquid into the solid and they are already doing that in Lake Michigan.

Detroit will be on line to remove phosphate about January 1, I believe. Is that right? From primary.

And Rocky River outside of Cleveland will have this type of plant.

The costs on this are much, much less than the original one. In other words, we are beginning to find other ways and means of doing this which are very reasonable.

Mr. WRIGHT. What about the problem, then, of disposing of the sludge which contains this?

Mr. KLEIN. Milwaukee has a good way of doing it. They package it and sell it and they get 40 percent of their cost from doing it.

As a matter of fact, if Chicago did that, they would ruin the market in the whole country. There is just not a market for activated sludge.

Mr. WRIGHT. There is not enough of a market to justify it?

Mr. KLEIN. Yes.

In some cases it works well, in other cases we have to incinerate as we do with ordinary sludge.

The other proposition is, if we can get it over in here, we can use this in an ever-continuing cycle, and we don't have to always get new phosphates into the cycle. We can cut it down that way.

Mr. WRIGHT. Now, Mr. Dominick, you may proceed.

STATEMENT OF DAVID D. DOMINICK, COMMISSIONER OF THE FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, DEPARTMENT OF THE INTERIOR

Mr. DOMINICK. Thank you very much, Mr. Wright.

You have already heard from Dr. David Stephan, our Assistant Commissioner for Research and Development.

Let me introduce also Dr. Fritz Bartsch, the Director of the Pacific Northwest Water Laboratory, who is principally responsible for the development of the PAAP tests, the evaluative tests we are going to discuss with you. And Mr. Bud Thieme, Deputy Assistant Secretary to Mr. Klein.

Let me now address in more detail the question of removing phosphate builders from detergents and the rationale behind our statement that we believe the reduction or elimination of phosphorus in detergents is essential but inappropriate for implementation at this time.

Current usage of detergents in this country amounts to 4 to 5 billion pounds per year. Of this amount, some 40 percent is sodium tripolyphosphate builder. This is the equivalent of 0.4 to 0.5 billion pounds per year of elemental phosphorus.

The change from alkyl benzene sulfonates (ABS) to the straight chain linear alky sulfonates (LAS) represented the change of an ingredient which constituted about 20 percent of the detergent formulation.

This change, although very significant, involved only modification of the surfactant molecule, not complete substitution. Nonetheless, extensive testing to assure that the new molecule was biodegradable under all circumstances which might occur in the environment was required before the product could be put on the market. The necessary test methods were either available from work on the ABS or were readily developed, as the biological phenomena involved were well known.

Only after exhaustive testing was it found acceptable to release into the environment a quantity of the highly biodegradable LAS which is roughly only half the amount of material involved in our current discussion.

The problem of finding a substitute builder involves the development of an entirely new material. As it is reasonable to expect that the substitute builder would be used to much the same extent as the present builder, we face the introduction of close to 2 billion pounds of a new, relatively unknown, material into the environment each year.

The problem is further complicated by the fact that the biological phenomena related to eutrophication are not as well understood as the biological degradation process. It is because of the magnitude of the possible adverse impact of a hastily chosen substitute for the present phosphorus builders that we feel it is critical that new builder materials be introduced only after thorough evaluation to avoid the creation of an even more undesirable situation.

Let me make the record absolutely clear on this question. We are firmly convinced that drastic reductions in the discharges of nutrient materials to many of the Nations waters are required at the earliest possible date. These nutrient materials come from multiple sources and their pollutional contributions are essentially additive.

Control of this type of pollution from all sources—municipal, industrial, and agricultural—must be achieved and all available control methods must be applied in optimum combination to reduce nutrient waste loads if we are to effectively attack the problem of man-induced eutrophication. A concerted effort by our advance waste treatment

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research program has already brought a variety of new treatment processes for removal of phosphorus from waste water to the point of practical applicability.

Waste treatment is, however, only one approach to the reduction or elimination of phosphorus in municipal waste effluents; elimination of pollutants at the source must also be considered. It is in this category, of course, that reduction or elimination of phosphorus from detergent compounds falls.

As pointed out above, we believe this "is essential in concept."

Furthermore, we believe this action should be taken where needed at the very earliest possible time at which we can determine that phosphate substitutes will improve and not degrade water quality in comparison with phosphates themselves. This leads to our disagreement with any recommendation that calls for banning or reducing phosphates without any recognition that substitute materials must be less harmful from a pollutional standpoint. If such a recommendation is couched in terms which would prevent substitution by materials more damaging than phosphates to the water environment, we would strongly endorse it.

Our present concern, however, is simply that substitute materials cannot yet be adequately evaluated with regard to their "eutrophicationability." Recognizing this, we have given first priority in FWPCA's national eutrophication research program to the development of a test procedure which could be used for this and other related purposes.

This effort, in which industry shares through the Joint Industry/Government Task Force on Eutrophication, is presently focused on the laboratory development of a Provisional Algal Assay Procedure. We are hopeful that this PAAP test will be ready for field testing during 1971 and that it will be available for practical use in 1972.

I might inject here that I have pressed my people very strongly on this point. I would like to have Dr. Bartsch discuss this matter in greater detail with you, and we can discuss the timing of this necessary testing technique and the amount of resources that we are devoting to it.

Mr. WRIGHT. Mr. Dominick, I just marked this place in your testimony to ask why such a test could not be ready for field testing during 1970, looking toward its availability for practical use some time in 1971?

Is this impractical, impossible, or what?

Mr. DOMINICK. I would like to have Dr. Bartsch, who is doing the actual work on the test, address himself to that question. This is a question which I have raised also, and I think we should explore this fully with the committee. Dr. Bartsch?

Dr. BARTSCH. Mr. Wright, gentlemen.

In order to answer that question adequately I would like to trace a little history relative to the development of the present effort in the PAAP test. If we go back in history, there are many people who have had an interest for many years in the problem of eutrophication. They have asked themselves how they could test to determine the capability of a given water to grow algae. Obviously the context of the interest was to be able to forecast whether a given water, manipulated in some

way or other, is likely to produce blooms of algae that people find objectionable—the crux of the eutrophication problem. So people have in the past developed some tests of their own, and if you look at this history, you will find that almost everyone who became involved in it developed his own pet test. And he had jealousies about it and every man thought his test was best.

There was no way in which the results of a test done in Denmark, for example, or Germany, had any compatibility or interpretability with respect to what people were doing in the United States.

With this as a threshold, about 1½ or perhaps 2 years ago it became obvious that there was need to have a test that everyone working in the field could agree is a reasonable test to use and that it would really in fact answer some of these crucial questions. As a result, then, this need was recognized within the Joint Industry/Government Task Force on Eutrophication. The urgency to move on with it was recognized, and we did proceed then with a test development program.

Let me say at this point that this program, which is now jointly sponsored by industry and Government, is on schedule. It consisted of some four principal elements. The first was to take a look at the experience of people throughout the world to see what was then known as a basis to develop a preliminary approach This was done through the leadership of the people in our laboratory. And the second step was to use this knowledge as a basis for consideration by experts assembled from various places in the United States and the world to determine what the next step would be.

I don't recall the exact date, but my recollection is that perhaps a year ago last April we met in Chicago, and spent 2½ days, in determining how we could proceed to develop a test that could become acceptable.

Out of this there grew a document which since that time has been distributed to practically all of the laboratories in the world that are interested in this subject, inviting them to participate in the developmental program. This effort also has gone through the Organization for Economic Cooperation and Development which is headquartered in Paris.

Through that mechanism the document has gotten to essentially all of the people in Europe involved in eutrophication study.

The third step is to carry out a laboratory program and this is the step we are in now. And it contemplates evaluating and developing and perfecting three kinds of test approaches.

The first is a bottle type of test which is fairly simple. And it would meet the criteria that we have set forth in one sense for an acceptable test including the desire that people without professional training could carry out the test.

The requirements in terms of laboratory space and facilities and equipment would be modest and so on.

Second, we also concurrently are evaluating a more complicated continuous flow, so-called chemostat test which may generate some more usable mathematical data in one sense.

The third test being considered is an in situ test that can be taken directly into the lake and to evaluate on the spot how they themselves respond to certain kinds of nutrient additions or removals or other manipulations.

In accordance with this schedule, we are right now projecting to the end of fiscal year 1971, to have answered many of the internal critical questions that come up in attempting to develop this kind of test. There are such detailed questions as: How do you treat the test organisms to be sure they are starved of phosphorus, for example, in preparation for testing for phosphorus, or the same for nitrogen?

How do you assure you have an adequate supply of carbon dioxide, which is also an essential nutrient? What about the pH? How many times a day do you agitate the cultures? At how many cycles per minute? What should the light intensity be, and so on?

I won't burden the committee with these details, but there are many complications involved in the tests which indicate to us that we will require essentially the time span specified in our time schedule to bring us hopefully to the point where this test can be accepted by most of the people, hopefully all of the people working in connection with the problem.

As a result, then, we could do work in California, the Northwest, the Middle West, any place in the United States or in the world, and have the information be compatible and logically interpretable.

Mr. WRIGHT. Doctor, may I interrupt at this point? How much is the funding on this project? What are we spending on this?

Dr. BARTSCH. I can express this perhaps best in terms of the numbers of people in our own laboratory who are devoted to it at the moment. The number is four. But then in addition, there is work supported at the University of California at Berkeley, and the number of people there is essentially three. It is also supported at the University of Wisconsin, with a similar number of people. At the University of North Carolina, with a similar number of people. And these projects, located in geographic settings, are designed to answer another critical question. This is, how does geography, if it does, have an effect on the performance of the test?

But then in addition, the Procter & Gamble Co. has a substantial effort in progress related to development of the test.

Mr. WRIGHT. Well, now, in the Government and in the universities you have mentioned, I believe you have enumerated some 13 people. This has been going on now for what—a couple of years?

Dr. BARTSCH. About a year and a half.

Mr. WRIGHT. About a year and a half. Well, the question which I think the committee really has is one of whether or not this is a crash program. A complement of 13 people does not sound like a crash program to me. I suppose it is natural that the public at large—nonlegislators principally—become quite impatient with the Congress in that we tolerate such conditions as exist for example in Lake Erie, where about one-third of the lake is so robbed of oxygen that it contains what might be called an underwater desert—an area of some 2,500 square miles where marine life cannot exist.

So the public is impatient with us. They want us to have a crash program to halt the rapid eutrophication of our water resources. They tell us to pass a law and stop it.

Now the members of the committee by and large are not chemists, and therefore it seems very simple to us to get with it—you know,

do it now, yesterday. We are most anxious. And I think you can understand our sense of impatience in that we are trying to be responsive to the public and its growing recognition of an environmental crisis that mounts daily. I wonder if it is not possible that by the assignment of additional personnel and a little extra sense of urgency we might speed up the desired conclusion of having a test—perhaps next year, rather than the year after next.

Mr. KLEIN. I may say to you that the Secretary of the Interior himself is very perturbed about this problem and wants it solved. One of the great things is that he is doing something at the west end of Lake Erie, because they are the major inputs into this area. I might say also that in going into this I found out from Dr. Stephan the other day—because both Secretary Hickel and I are concerned with this Washington area, the Potomac—I found out just to make the drawings for tertiary treatment for this 400 million gallon-a-day plant will take 1 year of drafting. Just to make out the sheets, one by one, where to put in all of these different valves and pipes, what have you, to get it ready.

I am just as impatient as the public is, as my staff has found out, in getting something done, and so is the Secretary.

We would like to get it done, and it is a must that it be done. The question is, How can you do it immediately? I don't find the answers immediately. And this is what Dr. Bartsch is saying. I have seen what they are doing at the laboratory, and what they are trying to do is get a fast test, instead of the old days where we would take 2 or 3 months to get a test. They are trying to get the data from all over in a couple of days, and put it together and come up with the answers. And we have seen the lakes in northern Wisconsin and northern Minnesota. I come from northern Wisconsin myself, and the lakes are going bad. We have to find answers and find them fast.

Mr. WRIGHT. The Finger Lakes in New York State, for example, are in dreadful shape.

Mr. KLEIN. Yes; we had a hearing in July at Ithaca. That is where this new physical chemical plant came out.

Mr. VANDER JAGT. Mr. Chairman, I wonder if we could just backtrack for a moment, Mr. Secretary.

What percentage of the phosphorus now entering our lakes and streams is a result of detergents? Do you have an estimate on that?

Mr. KLEIN. Well, Chairman Reuss had in his statement 70 percent and I had in mine 50 to 60. It is a kind of generalized figure, but we realize it is over the majority comes from detergents.

So it is the major problem.

Mr. VANDER JAGT. For example, you mention if we eliminated all phosphorus from detergents, there would still be 680 million pounds of phosphorus going in.

What is the source of that figure?

Mr. KLEIN. That would be if FWPCA worked on the subject.

Mr. VANDER JAGT. Any particular study in FWPCA?

Mr. KLEIN. Dr. Stephan, where do you get these figures? We furnish most of the input to the International Joint Commission on Erie and Ontario, for instance.

Dr. STEPHAN. I don't know specifically where the 680 million came from. Primarily out of published data on the use of phosphorus in known detergent applications.

Mr. VANDER JAGT. Would there be a particular study or series of studies?

Dr. STEPHAN. I can't answer that right now. We will get that for you. The specific source of that one figure.

Mr. VANDER JAGT. Your estimate was 30 to 50 percent.

Mr. KLEIN. Forty to fifty. It is 50 to 60 in the detergents in my figures. Over the majority of phosphate comes from detergents.

Mr. VANDER JAGT. What is the source of that figure, the 40 to 50 percent?

Dr. STEPHAN. That comes from data which we have collected through the analysis of sewage effluents across the country. Of course it does vary, as the Secretary points out; it may range from 40 to 70 percent. You have hit it on the head, Mr. Chairman, as far as the reason. But our numbers are based on actual analysis of sewage effluents taken at a number of locations over a period of time.

Mr. VANDER JAGT. One of the reasons I am interested is Dr. Ferguson, Dr. F. Alan Ferguson, did a study and his estimate was 680 million.

I wondered if that could be the source, since you mentioned there would still be 680 million.

(In response to Congressman Vander Jagt's question, the Interior Department subsequently informed the subcommittee that—)

The specific source of the figure of 680 million pounds of phophorus reaching surface waters from sources other than detergents was taken from the Ferguson article, "A Nonmyopic Approach to the Problem of Excess Algal Growths," Environmental Science and Technology, Vol. 2, No. 3, March 1968.

Mr. VANDER JAGT. Do you happen to know, and I don't, who financed the Ferguson study?

Dr. STEPHAN. No, sir; I don't.

Mr. VANDER JAGT. All right.

Now, you mentioned, I believe, that your primary emphasis would be on the removal of—the top priority would be the removal of phosphates through sewage treatment plants.

Mr. KLEIN. Yes. This will have to be done anyway in the larger cities.

Mr. VANDER JAGT. Do you have any estimate at all of what the cost would be?

Mr. KLEIN. We don't know. If they use the more expensive type, the Tahoe "exotic tertiary," it is one thing. If physical-chemical works—and we are in the process of proving it works on a larger scale, both here and elsewhere—that will reduce it.

If it comes out by the reverse osmosis process, that will reduce it further. And if it is ferric sulfate, and this is going ahead in Rocky River and in Toledo, this is a much cheaper way of doing it. As a matter of fact, the grant that they asked for, for demonstration in Milwaukee for 1 year, is only $40,000, because they are using pickling liquor, which is a waste to the steel company. They have been getting it free of charge.

Of course, if the steel companies find out it is valuable, they might start charging for it.

Mr. VANDER JAGT. Do you have a ball park estimate, if you use that less expensive method, as to what it will cost?

Mr. KLEIN. No; we have not. Until we are sure of where we stand on how it works and what it does.

Mr. WRIGHT. If the gentleman will yield, do you think these PAAP tests will help you to determine this, for example?

Mr. KLEIN. Oh, yes, yes.

Mr. WRIGHT. You would be able to take a sampling of the effluents and determine whether something else had been introduced into it which was more harmful than that which you eliminated?

Mr. KLEIN. If I may quote Dr. Bartsch on this, somewhere along the line, and it is really not fair to him, but if we can get the phosphates out at the sewage treatment plants at Detroit, Toledo, Cleveland, Sandusky, and these other places, the odds are we are going to put Lake Erie back into shape about 4 or 5 years after that. It will be a great improvement in the water quality.

Mr. VANDER JAGT. Getting back to the cost, we agreed that it would be astronomical, wouldn't it—in the billions and billions of dollars?

Mr. DOMINICK. I believe we can agree that the cost of advanced waste treatment is going to come very high. We think it is a necessary cost.

Mr. VANDER JAGT. All right.

Would you not significantly reduce that cost of phosphorus removal if you remove 50 percent of all of the phosphorus by banning it from detergents?

Mr. KLEIN. I don't think it will do the job.

Mr. VANDER JAGT. But would it have the effect of significantly reducing what we are agreed is a high cost?

Mr. KLEIN. It would help. But with the amounts that are already there in areas such as Lake Erie, and here in the Potomac, it will not do the job. You have also got to take it out—in the area of 95-percent removal—in a great other many cases, including human wastes, in order to do the job.

In other words, it has got to be done in those too. Somewhere along the line, we have got to do something with the phosphates that come in from the farmers and we don't know the answer to that yet. It is going to take a concerted attack, but this is the big item, we have to get to this one first.

Mr. VANDER JAGT. If you reduce 50 percent of the source of the phosphorus, by your figures, would that not significantly reduce the cost of doing the job? Maybe not a 50-percent reduction, but would it not be a significant reduction of what we are agreed is an astronomical cost?

Mr. KLEIN. If you have to put in tertiary treatment for a sewage treatment plant and treat all of the sewage, it doesn't matter whether the phosphate in there is from detergents, except you have got to use more lime under one or more ferric sulfate in the other.

Mr. VANDER JAGT. Just so I understand it, and so the record is clear, it is your position it would not significantly reduce the cost?

Mr. KLEIN. It would help, but we don't know exactly yet, but I don't think it would be—it would not reduce 50 percent of the costs, for instance.

Mr. VANDER JAGT. I would like to ask you about one other thing you mentioned, when you talked about the new treatment plant for the Potomac. You said that it would take 1 year just to draw up the papers, one after another. When we talk about removing phosphorus all across the country through the treatment of sewage at the plant, we are talking about a very long time off; aren't we?

Mr. KLEIN. The end of 1972 mainly, in places like Lake Erie, Lake Michigan, this area here. It may be 1972 before they are built here.

Mr. VANDER JAGT. You can do it all across the country by the end of 1972?

Mr. KLEIN. No; Lake Erie and Lake Michigan already have these dates set for them by the Lake Erie and Lake Michigan enforcement conference and this is set for 1973 here.

Mr. VANDER JAGT. How about the rest of them?

Mr. KLEIN. No; they haven't done this all over the country. As a matter of fact, there is some doubt as to whether it should be done—when you put the effluent into the oceans and gulf—because the chlorides immediately counteract them.

For instance, off Hawaii, they are short on phosphorus, where the sewage discharge is made. If they put this in, rich in phosphorus, it would help the water rather than hurt it. This is what Dr. Stephan was getting at in the shellfish area.

Mr. VANDER JAGT. That brings up a question.

As I understand it, one of the primary purposes of the use of phosphorus in detergents is softening water. Is that correct?

Dr. STEPHAN. That is correct.

Mr. VANDER JAGT. We have a study, which will later on be going into the record, which examines the water supplies of the 100 largest cities in the United States. And this study will show that many of the cities already have a very soft water.

Now, would they not require much less phosphorus in the detergents in a city that already had soft water than in a city, for example, that has very hard water?

Mr. KLEIN. Yes.

Mr. VANDER JAGT. And yet our detergents contain exactly the same amount of phosphorus right across the board for cities with soft and hard water. Wouldn't it be worth thinking about whether we can have different standards, depending on the hardness of the water?

Mr. KLEIN. Well, if I may, I would come back to you and say that the goal, very bluntly, is to remove the phosphates from detergents. And eleminate that problem. And at the same time attack the problem in the sewage treatment plant. It is just that at the present time we don't have the answer to the first one, and so the Commissioner and I want to keep some control on the phosphate detergents, so if it comes in, we can get to it.

Mr. VANDER JAGT. You said the goal is to remove the phosphorus from the detergents?

Mr. KLEIN. That is right.

Mr. VANDER JAGT. You also said, I believe, that it is primarily the job of industry to come up with a method of doing this.

Mr. KLEIN. I think they are the ones who should assume the major part of the cost on this. But we are doing the research as well. And we are cooperating with them. I mean there is good cooperation and coordination here, so we don't have duplication of effort.

Mr. VANDER JAGT. How many contracts have you let, in terms of research, to come up with a substitute such as NTA for phosphorus?

Dr. STEPHAN. We have let one contract on the specific question of finding a substitute for phosphorus.

Mr. VANDER JAGT. When was that contract let?

Mr. DOMINICK. This is the project which is listed as appendix to my statement and it was let roughly 6 months ago.

Mr. VANDER JAGT. Your statement, Secretary Klein, says that the detergent industry must now seek an alternative to the basic phosphate building nature of the detergents.

Is it your feeling they haven't been seeking that alternative up until now?

Mr. KLEIN. I believe, from discussions with them, that they have been working on it. What I am saying now is that we realize what the phosphates are doing to the waters. It is being pounded home to us day after day after day, that they must expand their work very rapidly and we must also. Commissioner Dominick and I have had discussions on this, and it will undoubtedly have to be in addition to the in-house work we have been doing. We have been doing mainly in-house work thus far, and we are probably going to have to go into expanded work on this.

But I think in the industry field, the industry itself should do it, and we should do it more with the professors and private researchers, universities and our own in-house programs, and coordinate and collaborate with them.

Mr. VANDER JAGT. Thank you, Mr. Chairman.

Mr. REUSS (presiding). Mr. Hicks?

Mr. HICKS. Just to put this in a little better prospective, for me anyway, how much of the pollution of Lake Erie, for example, is eutrophication caused by phosphorus and how much of the condition of it is due to something else?

Mr. DOMINICK. Mr. Hicks, we have a table here which came out of the Lake Erie enforcement conference report, which shows that the annual input to Lake Erie in 1967, of total phosphorus in pounds, was: from municipal sources, approximately 38 million pounds, from industrial sources 4 million pounds; total of municipal and industrial was 42 million, and all other sources was 17 million.

Now, we have projected that out to 1986, without control measures, showing an increase, for instance, in municipal loads up to 58 million pounds. But then we have asked what will occur if we, in 1986, take all phosphorus out of detergents—which is our goal—and 95 percent is removed from all municipal and industrial sources. And we get down to a total of 22 million for all municipal and industrial sources. We would be happy to make this a part of the record.

(NOTE.—The table to which Commissioner Dominick referred above follows:)

TABLE II.—LAKE ERIE, ANNUAL INPUT OF TOTAL PHOSPHORUS IN POUNDS

Source	1967	Projected for 1986 without control measures
Municipal	38,180,000	58,300,000
Industrial	4,060,000	9,620,000
Total municipal and industrial	42,240,000	[1] 67,920,000
All other sources	17,960,000	21,300,000
Total	60,200,000	89,220,000
Total if by 1986 all phosphorus is eliminated from detergents and 95 percent is removed from all municipal and industrial sources		[2] 22,320,000

[1] It is estimated that 70 percent of this amount will be from detergents.
[2] Corresponds to 0.39 g./m² yr.; eutrophication range 0.2 to 0.5 g./m² yr.

Mr. HICKS. My question, though, is what besides phosphorus adds to this type of pollution?

Mr. KLEIN. In a eutrophic condition, the main item is phosphorus, phosphate. There is some from nitrates, which seem to be a triggering agent, but we are not sure. Phosphorus is the big item, and this is why we have been heading for removal of it in the Lake Erie and Lake Michigan conference.

Mr. HICKS. If you could get rid of the phosphorus, the other industrial wastes would not be a major problem?

Mr. KLEIN. They constitute a different type of a problem, Mr. Hicks, and as far as we are concerned, they can't continue either.

Mr. HICKS. It was not clear to me just what the test to which you referred did. I wonder if you could clarify what you are looking for in this test. After you perfect it, what will it do for you?

Dr. BARTSCH. Let me comment first, as an introduction, to some basic facts related to eutrophication. I think it might, if I am permitted to do this, place this entire matter in perhaps a better context. Eutrophication is many different things, it has many symptoms. The symptom that aggravates people most is the superabundance of plant material that is produced in the lake.

Now the plants that are produced in water are essentially in their physiology not much different from crop plants that are produced on the land. Like them, they require the same kinds of chemical elements in the form of fertilizer, if you will; and there are some 10 major elements and some six or seven minor ones. If we look at the history related to lakes throughout the world, it appears that when the growth of aquatic plants progresses, eventually it comes to a stop because the plants have run out of some critical element. Most commonly this element turns out to be nitrogen or phosphorus. This also means if we had the capability of limiting or eliminating entirely any one of these 10 major elements or seven minor elements we could curtail and finally stop the production of plants.

When we look at the possibilities related to this, it turns out that our technology is strongest in the area of removing phosphorus. We

also find if we look at the experience throughout the world that more commonly than otherwise phosphorus is this critical nutrient.

Getting back to Lake Erie, in that lake obviously we have an abundance of all of the nutrients that are necessary to permit the production of plants—iron, calcium, magnesium, sulfur, potassium, and so on.

Again, if we could pick out potassium and eliminate it from the lake, we could accomplish our purpose. Again, in the light of what we know, phosphorus is the area in which we are best equipped to do this.

Second, in reference to the PAAP test, when it is perfected it should give the capability of using it in relation to any body of water, and getting some basis for judgment as to how far we would have to curtail phosphorus, for example, in order to give "x" percentage of relief to the people.

We could then do the same thing with respect to nitrogen, iron, sulfur and all of the other nutrients of interest.

Mr. HICKS. You are saying this test will show how much phosphorus you have to take out to keep the plants from growing?

Dr. BARTSCH. It is our intention to bring the test to that level of perfection, yes.

Mr. HICKS. The lake I am most familiar with is Lake Washington out by Seattle. They did demonstrate, by ringing the lake with sewer trunklines, instead of letting sewage into the lake, that you could eliminate enough phosphorus so the plants would go downhill. Is that correct?

Dr. BARTSCH. Right. In the case of Lake Washington, it was a diversion of treated sewage. Sewage contains many elements that contribute to the production of plants—carbon, for example, in the organic matter, nitrogen and phosphorus, and others. It appears, if I recall the information from Dr. Edmonson's studies correctly, that there also phosphorus seemed to have a very significant relationship to what happened in Lake Washington when it was eutrophic, and also what happened to it as the lake recovered. And this is a classical example of it.

Mr. HICKS. I have just one more question.

As I understood the testimony, you said that phosphorus is cumulative.

Mr. KLEIN. That is right.

Mr. HICKS. If it is cumulative, the fast elimination of any part of it will be greatly beneficial, won't it? I didn't understand that statement in relation to the statement that there is already so much in there that if we took out all of the detergents there would still be too much and eutrophication would continue. Those statements seem to be inconsistent.

Mr. KLEIN. No, you have to take the phosphorus out of more places than just the detergents. The detergents are the No. 1 problem by far; they are the major factor. Then you have to get to human sewage and take it out of there as well.

So we haven't had the answer to phosphorus from detergents, as in the Lake Erie and Lake Michigan situation, where we have come to the finding, between the States and the Federal Government, that we have to take it out entirely from the sewage treatment plants.

We are going to have to do that anyway on the human waste, so we

might as well take it out entirely. We also have to get to the fertilizer on the farms that contains phosphate and which leeches or runs into the waters with the sediment or siltation. But the big problem is to get to it.

Mr. HICKS. But it is all important, and you have to start some place.

Mr. KLEIN. Yes, you have to attack the larger problem each time and work your way down the scale and eliminate or cut it down so you get to a manageable point.

Mr. HICKS. You say the reason you didn't start with elimination of phosphates from detergents is that you are afraid you are liable to come up with something that is even worse?

Mr. KLEIN. We have not yet been able to determine what we can come up with that is better or as good or almost as good in cleaning and the impact of which on the waters will enhance the water quality rather than hurt it. As Dr. Stephan said, some of what they will put in will pick up toxic metals, and then through our drinking water we will get it in our bodies. Whereas now when we take in phosphate, it doesn't hurt us.

Mr. HICKS. Did you want to add something, Doctor?

Dr. STEPHAN. Yes, I would like to provide a further answer to the question Dr. Bartsch answered, on the use of the PAAP test. One of the significant uses which we have overlooked in this testimony is that the PAAP test is aimed at assessing the pollution impact of any phosphate replacement material that would be used. So it not only will tell us the target goals to which we should strive with regard to the phosphorus levels, as Dr. Bartsch outlined; but, in addition, it will be the test, we hope, which will allow us to say, "if you put this material in water instead of phosphorus, it will cause more algae to grow, less algae to grow, or no algae to grow."

Mr. HICKS. Which is why it is important to have that before you start the removal or changing or structuring of phosphorus.

Dr. STEPHAN. Yes.

Mr. HICKS. Thank you very much.

Mr. REUSS. Mr. Gude?

Mr. GUDE. Yes. I don't know who this would be directed to, but this is somewhat in the line of Congressman Vander Jagt's question: What is the difference in the amount of detergent necessary to carry out the proper cleansing action in soft water, the varying degrees of hardness and softnes of water? You do require more detergent in a hard water than in a soft water; is that correct?

Mr. KLEIN. You have to make the water soft first before you can proceed with it. That is the gist of the many ads you hear on television and radio.

Mr. GUDE. Then you have to add more detergent to get the necessary effect.

Mr. KLEIN. That is right.

Mr. GUDE. Don't we have then an overkill from the housewife in certain areas, in that housewives are putting in more detergent than is necessary to accomplish the purpose?

Mr. KLEIN. She has to use more.

Mr. GUDE. Well, more than is necessary is going into the sewerage system of some areas. The housewife could accomplish the same job with less detergent.

Mr. KLEIN. If she softened the water first, if we got all the water at the same level to be soft water, we would need less detergent to do the job. The question is, how do you transform the water from hard water to soft water. It might be by detergents, a water softener—any commercial make—and there are other ways of doing it.

Mr. GUDE. But the housewife who's in an area where they have soft water is using more detergent than is necessary to accomplish the same job. She is using the same amount of detergent, but she doesn't need that much.

Mr. KLEIN. That could be. It depends on the directions on the box. It may be that that is true.

Mr. GUDE. Is there a variation in the directions on the box from one area to another?

Mr. KLEIN. No, sir.

Mr. GUDE. They have a universal language as to the amount necessary.

Mr. KLEIN. That is correct.

Mr. GUDE. And the manufacturer would naturally label for the hardest water in their experience, so that he would guarantee that the housewife would get results that would satisfy her?

Mr. KLEIN. I wouldn't know how they label them. I pass on that question. But I would say that the label is standard.

Mr. GUDE. It would seem to me we are using more detergent than is necessary—the housewife is using more in certain areas to get the results that she needs, and there is a lot of wasted detergent down the drain.

Mr. VANDER JAGT. Would the gentleman yield at that point?

Mr. GUDE. Yes.

Mr. VANDER JAGT. Are we not about the only country in the world that doesn't have categories for its detergents in terms of phosphorus content, so that the community that has soft water is not using as much phosphorus as the community that has hard water?

Dr. BARTSCH. I might comment on that. Again, I am not especially knowledgeable in that area, but it is my understanding that, among the array of detergent formulations that are available on the market, there is a range of phosphorus content. And I get the impression that the philosophy is that the housewife, through her own experience, will use the detergent with the particular formulation that works best for her particular needs.

Mr. VANDER JAGT. But our soap operas and commercials certainly don't tend to stress any difference between them—or are the boxes labeled in any way so the housewife could know the difference?

Dr. BARTSCH. I have to plead ignorant on the content of the soap operas.

Mr. VANDER JAGT. The commercials on the soap operas.

Mr. KLEIN. Those are nationwide, so they probably would be standardized. It is a trouble with our marketing proposition today. It may be we can look into it and ask the detergent industry to do the same.

Mr. GUDE. I have noticed, in regard to various baking preparations, that the directions on the label do vary according to the altitude and it is up to the housewife to figure out the altitude of her city. It seems to

me perhaps the detergents could be labeled for the particular river basin, but perhaps manufacturers can give us some answers on this.

I wonder if Mr. Dominick would be the one who could give us the answer to this. What is the difference in our Potomac estuary before and after the introduction of the biodegradable detergents? It would have been about 1965 that a tremendous influx of phosphorus came into our estuary.

Mr. DOMINICK. I have a table here, Congressman Gude, that shows the total phosphorus in sources before treatment at 7 million-plus pounds. The total phosphorus added to the Potomac River after treatment is 6 million-plus pounds. I do not have figures showing the percentage which may have come from detergents in the Potomac estuary. But I think we could probably extrapolate that out.

Is that your question?

Mr. GUDE. I was wondering about the amount of phosphorus going into the estuary and also whether eutrophication had been speeded up as a result of the biodegradable detergents going in since 1965?

Mr. DOMINICK. Since 1965 we have measured the water quality parameters in the Potomac, and this information is in our computer system. We will have that reported out and give it to the committee. As to the question of whether there is a direct increase or decrease attributable to the biodegradable detergent, I am not sure that we can give you that sort of an answer.

(The Interior Department subsequently advised the subcommittee:)

The introduction of the biodegradable detergents did not significantly change the amount of phosphates used in the detergent formulations and hence did not have a significant effect on the amount of phosphates discharged into the river. The average phosphorus loading from wastewater and land runoff discharges in 1966 was 94,130 lbs/day (as PO_4); over 87 percent on the average comes from wastewater discharges.

Using chlorophyll "a" as a measure of algal standing crop, water quality data indicates that there was a widespread bloom in the Potomac Estuary during the summer of 1968. For the month of August, chlorophyll levels of 150 mg/l and greater were observed. Measurements in the vicinity of Fort Washington reached a high of 115 mg/l in July of 1965.

Refer to pp. 43 through 47 of the attached Potomac River Water Quality report for more detailed information.[1]

Additional information and analysis will be furnished in early January by the Chesapeake Technical Support Laboratory.

Mr. GUDE. Would there be measurements of the algae and phosphorus in the waters of the estuary before and after 1965?

Mr. DOMINICK. We will certainly look into that and if we have that information we will make it available to the committee.

Mr. GUDE. That would be very helpful.

(In response to Congressman Gude's question, the Interior Department subsequently informed the subcommittee:)

The Potomac Estuary sampling network was established in 1965. Previous water quality data did not emphasize phosphorus and algae measurements. The enclosed CTSL Technical Report No. 9 gives a detailed presentation of the sources, temporal and spatial distribution of the nutrients in the Potomac River Basin.[1]

A complete series of technical reports from the Chesapeake Technical Support Laboratory will be forwarded in early January. The laboratory has undertaken an extensive water quality management study of the Potomac River Basin and has published a series of reports on nutrients in the Potomac.

[1] The report referred to is in the subcommittee files.

Mr. KLEIN. Mr. Gude, if I may go a little further, what I said before would apply here. If the percentage, and I don't know what the percentage of phosphorus was in the hard detergents, but I take it for granted it is something close to what it was before, the amount of phosphorus going in would be the same.

What I was getting at is we had to go forward to the soft, biodegradable detergents. But then it broke up faster, and as a result we may have had an acceleration of eutrophication. It may be also that this is good, because it brought the problem home to us faster, where if it had been hard detergents, breaking down over a longer period of time, we would not have recognized that the phosphate had to be attacked and that we have to do something about it.

Mr. GUDE. Isn't some of the phosphorus in the hard detergents permanently unavailable because it precipitates out in a form that would never be utilized by plant life?

Dr. STEPHAN. Two of the components in a detergent formulation are the surfactants, the so-called builder. The surfactant is the material which was converted, in 1965, from a nonbiodegradable form to a degradable form.

To the best of our knowledge, the amount of builder which was associated with detergents before soft detergents has not changed because of the conversion from hard to soft detergents. We have some reason to believe that the amount of phosphate has gone up in detergent formulations since 1965, but it had been going up before that as well.

To the best of our knowledge, the conversion from hard to soft detergents did not trigger a discontinuity—in other words, a sudden increase in the amount of phosphate builder which was being used. Does that answer your question, sir?

Mr. GUDE. Yes. A third area—what is being done by the U.S. Department of Agriculture and also by the fertilizer manufacturers about the problem of phosphorus in fertilizers?

Mr. KLEIN. We have outstanding coordination with them on the work on the Potomac now, through the Interstate Conference on the Potomac, trying to find ways and means as to where this actually comes in. The problem in an agricultural State is that it is added in small increments and it is almost impossible to trace as it gets in from either rain overflows or from leeching. Usually it doesn't come too much from farmers, because they only use what they have to. But still and all, it does come in in infinitesimal amounts that slowly add up to a problem.

Mr. GUDE. Did you state that before the Potomac reaches Blue Plains in the area where it gets a tremendous influx of sewage, it has three times the amount of phosphorus?

Mr. KLEIN. About the time it hits below Little Falls into the estuary the testimony in April before the Potomac Conference was that there is three times as much phosphorus and nitrates at that point as there should be in order to hold algal blooms to a minimum.

Mr. GUDE. And this is considered as primary algal bloom, and comes from agriculture.

Mr. KLEIN. Yes. There is a little bit, very little, however, from cities upstream. There is not very much from that source. Most of it is agricultural and natural.

Mr. GUDE. Has there been any contact or research with the fertilizer

manufacturers in this area as to the question of whether the amount of phosphorus in fertilizer runoff or drainage could be reduced?

Mr. KLEIN. I talked to the Department of Agriculture and they are looking into what the contents are and were, and seeing whether they can get an answer back to me. I don't have it and I don't expect it for several months, Congressman.

Mr. GUDE. Thank you, Mr. Chairman.

Mr. REUSS. Secretary Klein, on page 5 of your statement you say, "We believe that the reduction or elimination of phosphorus from detergents is essential but inappropriate for implementation *at this time*." Is that the position of the Department of Interior?

Mr. KLEIN. Yes, it is our present policy.

Mr. REUSS. Now, phosphorus from detergents makes up around 60 percent of the total phosphorus that appears at municipal waste treatment plants. Is that correct?

Mr. KLEIN. Yes.

Mr. REUSS. The three major detergent manufacturers—Colgate-Palmolive, Lever Brothers, Procter & Gamble—between them make more than two-thirds of all of the detergents sold in this country; do they not?

Mr. KLEIN. Something like that.

Mr. REUSS. You say you are presently concentrating on eliminating phosphates at sewage disposal plants; is that correct?

Mr. KLEIN. Phosphate at sewage disposal plants; yes, sir.

Mr. REUSS. Is it not a fact that about 65 percent of the people of the United States are served by sewage disposal plants?

Mr. KLEIN. About two-thirds are.

Mr. REUSS. Is it not a fact that only about 15 percent are serviced by activated sludge sewage disposal plants that are capable of removing phosphorus?

Mr. KLEIN. We don't have too many that have the advanced waste treatment in now, but the larger cities on fresh water lakes—the Great Lakes and the like—are going forward and have, from the Lake Erie and Lake Michigan, mandates to put them in.

Mr. REUSS. Isn't it a fact that only 15 percent of the people of this country are now served by advanced waste treatment plants?

Mr. KLEIN. I don't think it is even that high yet.

Mr. REUSS. It is less than that, then?

Mr. KLEIN. Yes.

Mr. REUSS. And by and large the phosphate which shows up at sewage disposal plants comes from two main sources, does it not—household detergents and human waste?

Mr. KLEIN. Yes, sir.

Mr. REUSS. And household detergents are made by three major manufacturers?

Mr. KLEIN. That is correct.

Mr. REUSS. And human wastes are made by a couple hundred million manufacturers; is that correct?

Mr. KLEIN. Yes, sir.

Mr. REUSS. Well, doesn't it occur to you that it is easier to do something about three than about a couple hundred million?

Mr. KLEIN. Yes. As a matter of fact, I think you and I are on the same side, Mr. Chairman, in that the phosphate must be removed from detergents. The answer is, as we stated earlier, to find a substitute that

will enhance water quality instead of damaging water quality. And we must be sure when we go forward that we have that.

On the other side, I also said if we have to, even if we did this, Milwaukee and Detroit and Toledo and Cleveland, the rest of these cities, are going to have to put in advanced waste treatment anyway. While we don't have one answer, we can't stop and wait for that on removing phosphate from detergents, we must at the same time move forward on removing the phosphate from the sewage effluent to get the job done as soon as possible.

Mr. REUSS. I am all for that phase of your work. What I am not all for is the way I must regard, unless I am convinced to the contrary, the very considerable lag in getting phosphates removed where most of them come from, in detergents. Under the law you are authorized to make grants and contracts to persons for research and demonstration projects for prevention of pollution of waters by industry; are you not?

Mr. KLEIN. Yes.

Mr. REUSS. And your authorizations there are in the order of $40 million a year; is that right?

Mr. KLEIN. I think it was $46 million this last year.

Mr. REUSS. Now, is it not a fact that to date the Department of Interior has entered into only one project to investigate the possibility of removing or reducing phosphates from household detergents?

Mr. KLEIN. That is correct.

Mr. REUSS. That is the so-called Illinois Institute of Technology Research Institute project.

Mr. DOMINICK. That is correct.

Mr. REUSS. When was the grant made on that project?

Mr. DOMINICK. We testified earlier, Mr. Chairman, that that was made about 6 months ago.

Mr. REUSS. Exactly when was the date of the check?

Mr. DOMINICK. I do not have the exact date. But will supply it to the committee.

Mr. REUSS. The exact date actually was something like June 28; was it not?

Mr. DOMINICK. I am not able to testify to that point. We will have to investigate our records.

Mr. REUSS. You will supply that for the record.

Mr. DOMINICK. Yes, sir.

(The Interior Department subsequently informed the subcommittee that the contract was awarded to IIT Research Institute on June 30, 1969.)

Mr. REUSS. What is the amount of the research project and what is the Federal contribution thereto?

Mr. DOMINICK. As I understand it, it is approximately $100,000.

Mr. REUSS. That is the Federal contribution.

Mr. DOMINICK. That is correct.

Mr. REUSS. Can anybody give us a more accurate idea of the amount?

Mr. DOMINICK. $99,896.

Mr. REUSS. The detergent industry is a $4½ billion annual industry; is it not?

Mr. KLEIN. We will accept your figures, sir. I am sure they are correct.

Mr. REUSS. Is it not a fact that the detergent industry spends close to a billion dollars every year on advertising?

Mr. KLEIN. I wouldn't be a bit surprised if you are right, sir.

Mr. REUSS. Doesn't it seem that in terms of national priorities, we are a little on the light side in having spent a total of $99,000 on research into how to make the detergent industry other than the Nation's number one polluter, which they now are, and yet around a billion dollars a year seems to be spent on advertising the stuff? Would you say that is a good set of national priorities?

Mr. KLEIN. Sir, we testified before that we have in-house at the Corvallis lab and we are working on this in-house as well. I also stated, and I think I want to make this pretty clear, that where industry is polluting, they are the ones who should spend their own money to find the answers to it, and it is our job to push them to find the answers.

Mr. REUSS. This PAAP test at Corvallis doesn't have anything to do with removing phosphates from detergents; does it?

Mr. KLEIN. No; it does not. That has to do with saving our lakes, sir.

Mr. REUSS. Can you furnish me now with a list of the members of the Department of Interior task force on phosphates and eutrophication?

Mr. KLEIN. If we may, we will furnish that later.

Mr. REUSS. Why don't you give me the best list you have and if it is incomplete, you can add to it.

Dr. BARTSCH. I don't have a list with me, sir, but I believe I can identify the members.

They are——

Mr. REUSS. I guess I am in a fortunate position, here, since I have the minutes of your meetings which contain such a list.

Mr. DOMINICK. We can identify those members, Mr. Chairman.

Mr. REUSS. Let me read them off. I will read first from a letterhead of the Joint Industry/Government Task Force on Eutrophication. That is the official name of the task force; is it not?

Dr. BARTSCH. Yes.

Mr. REUSS. The Chairman is C. G. Bueltman of the Soap & Detergent Association; then are listed D. M. Whitt, Vice Chairman, Soil Conservation Service, USDA; T. J. Army, International Minerals & Chemical Corp.; A. F. Bartsch, Federal Water Pollution Control Administration, USDI; G. E. Best, Manufacturing Chemists' Association; J. H. Brown, Hooker Chemical Corp.; J. A. Bruck, the Procter & Gamble Co.; C. Callis, Monsanto Co.; M. A. Churchill, Tennessee Valley Authority; P. F. Derr, FMC Corp.; W. H. Garman, National Plant Food Institute; M. A. Goldberg, Lever Bros. Co.; J. Lunin, Agricultural Research Service, USDA; F. M. Middleton, Federal Water Pollution Control Administration, USDI; L. B. Nelson, Tennessee Valley Authority; R. W. Ockershausen, Allied Chemical Corp.; W. M. Podas, Economics Laboratory, Inc.; S. F. Singer, U.S. Department of the Interior; D. G. Stephan, Federal Water Pollution Control Administration, USDI; R. B. Wearn, Colgate-Palmolive Co.; T. E. Brenner, Executive Director.

Mr. Brenner is from the Soap and Detergent Association, too; is he not?

Dr. BARTSCH. That is right.

Mr. REUSS. Is that an accurate list of members, as far as you know?

Mr. DOMINICK. It is, Mr. Chairman.

Mr. REUSS. Thank you. I see on this list very frankly an overwhelming preponderance of people who are either making the detergents now or are supplying the phosphates that are in the detergents; or representatives of the Department of the Interior, which takes the position you have just outlined—that you do not believe that the reduction of phosphorus from detergents is appropriate for implementation at this time. Do you not think this is a rather lopsided committee in which to lodge the saving of our lakes from untimely death?

Mr. KLEIN. I might point out this is only a joint committee, and that, in addition to that, we have our own philosophy, and that is that this must be done. The question is the state of the art does not permit it to be done at this time. As soon as we have the state of the art, as soon as we find something that will do the job, without hurting the water quality as a substitute, we will be in here asking you for a date on stopping the phosphates in the detergents; because we think they must be stopped also. It is a question of scientific answers to the problem.

Mr. REUSS. You do agree then that this joint industry-Government task force is a lopsided committee?

Mr. KLEIN. Well, in the amount of members, but as far as that goes, our members have their instructions as to what to find and so I do not think that it is lopsided on that point. They are not going to bend just because they are outnumbered by industry. They are not going to do what industry tells them to do.

Mr. REUSS. The committee as I see it consists entirely, or practically entirely, of makers of phosphates, makers of phosphate detergents, and your Department. Is that not correct?

Mr. KLEIN. And the Department of Agriculture.

Mr. REUSS. And the Department of Agriculture. And the sole voice, other than the makers of phosphates and the makers of phosphate detergents, to represent the public interest is the voice of the Department of Interior, which says that the reduction or elimination of phosphorus is inapropriate for implementation at this time.

Mr. KLEIN. At this time; yes, sir.

Mr. REUSS. Do you think things would move any faster if you put Ralph Nader on your committee?

Mr. KLEIN. If Mr. Ralph Nader could operate the test tube and come up with the answer to replacing phosphate in detergent, I would be glad to do it. But at the present time we do not have the answer to replacing the phosphate in detergent. I wish we did.

Mr. REUSS. Do you not think he might operate a needle in you to spend more than $99,000 trying to find a substitute for phosphate?

Mr. KLEIN. Again, sir, I do not believe that that is a question for use of the taxpayers' money. It is a question that the manufacturers have to come up with this one themselves.

Mr. REUSS. You reject, then, the wisdom of the Congress when we said in section 6(b) of the Federal Water Pollution Control Act:

> The Secretary is authorized to make grants to persons for research and demonstration projects for prevention of pollution of waters by industry including, but not limited to, treatment of industrial waste.

Do you think Congress was wrong in passing that law?

Mr. KLEIN. No, sir; it is a question of our having so many different aspects of pollution from so many different sources they must be apportioned out to find out the answers from a great many sources.

Mr. REUSS. Can you find an area of pollution, Mr. Secretary, in which the deviltry is caused by fewer sources than in phosphate detergents, 70 percent of the manufacture of which is concentrated in three major companies?

Mr. KLEIN. Sir, in addition to this, may I point out to you that we are spending millions of dollars all of the time in building advanced waste treatment works and research and development in this area to remove all of the phosphates at a sewage treatment plant—or the majority of it—from all of the sources of phosphate, including detergents.

Mr. REUSS. We have stipulated that that is great, you and I. But there are going to be a lot of dead lakes before you get all of the people of the United States served by advanced treatment sewage treatment plants. Less than 15 percent are now so served. Therefore, you would agree, would you not, that a much more favorable avenue is presented by trying to get something less destructive than phosphates into our household detergents?

Mr. KLEIN. Yes. I will agree with you on that, sir. But it is a question, again, of how you are going to put the money to work. Very frankly, we have been watching all of these and, as I said before, we know about the sugar-based detergents. We know they will replace the phosphates, and we know about nitrilotriacetate and we know that is in a laboratory stage and they do not at the present time clean as effectively and efficiently as phosphorus compounds. So the work is going ahead; we are keeping an eye on every one of these; we are coordinating these.

In addition to the fact that they are meeting there with industry, our men are meeting by themselves as well in order to find the other answers.

Mr. REUSS. Mr. Secretary, you have just said that basically the reason for the negligible Federal participation and leadership in removing phosphates from detergents is that this should be done by industry. Is that correct?

Mr. KLEIN. I believe they should do it—that they should use their own money for solving their own problems.

Mr. REUSS. You say on page 7 of your testimony:

> Industry must solve the phosphorus problem in the shortest possible time, showing the same sense of urgency and responsibility that it showed in the solution of the problem of biodegradability.

By biodegradability do you mean the foaming?

Mr. KLEIN. Yes.

Mr. REUSS. Because I was involved in that. Let me give you a bit of the history. Back in 1962, I was upset that the detergent industry in the United States was discharging its foam-producing detergents all over the country and denying there was any way of improving matters when I had heard that over in Europe they were developing methods. So I went to Germany and spent a good deal of time with the scientists of the Wasser, Boden, und Luft Purification Agency in Bonn and in Berlin and found out there was a method of producing foam-free detergents that did not have any untoward byproduct effects and that cleaned just as well.

So I came back and in 1963 put in a bill saying in 2 years the detergent industry has to produce a nonfoaming detergent. Instead of applauding this approach, the detergent industry sent its paid operatives throughout the country, into every newspaper office they could think of. And there suddenly appeared in all sorts of papers, which should have known better, little editorials talking about this marvelous foam which was called a sudsy detective; and the theme was we ought to be grateful to the detergent industry for having a foaming detergent, because while the foam was a little unesthetic, it nevertheless told you that something was amiss, which you otherwise might not know. Well, fortunately this did not wash, and the public kept up its insistence. So within the 2-year timetable the detergent industry did produce a foam-free detergent.

Now, if all the detergent industry shows with respect to phosphates in their detergents is the same sense—and I am quoting you—of urgency and responsibility that it showed in the case of foaming detergents, every lake and stream in America will be dead before they ever get around to using up their last supply of phosphates and getting on with the job. Therefore, I have to say that, much as I admire you and your work in so many other fields, in this field of phosphate detergents, I really find the Department fiddling while our lakes eutrophy and putrefy. I hope that you will change your attitude, and get some real Federal leadership, so that in 2 years time we can clear up this, because it is the leading source of death of our waters. Mr. McCloskey.

Mr. McCloskey. Thank you, Mr. Chairman.

I confess, Mr. Klein, that if your statement is correct, that phosphorus has been singled out for special consideration for several reasons, that $100,000 out of $46 million seems a fairly minor amount of dollars, despite the figures you mentioned for waste disposal research. I wonder if at this point in the record I might ask a question which you could answer for us with a written table submitted to the committee? This would be to take the $46 million of research budget and give us some idea of where you allocate those research funds and why you do make that type of allocation. It would be helpful to us if we knew the problems, in order of magnitude as you see them, that cause the putrification or eutrophication of our waters and the other problems. Could I ask for that, Mr. Chairman?

Mr. Reuss. Without objection, it is so ordered.

Mr. Klein. I may say to the chairman and Mr. McCloskey, we will be glad to furnish that information. There are a great many problems that we have to—as we go along and discover and find out more and more—shift to meet. Some of them are research grants, some of them are demonstration grants. As we go along, we keep changing them as we find these and we find orders of priority. It is a question of meeting the challenges as they appear today.

(Subsequently, FWPCA transmitted the following information in response to Congressman McCloskey's request:)

Establishment of Priorities in FWPCA's Research, Development, and Demonstration Program

Research priorities are not established independently within FWPCA. Through the planning, programing, and budgeting system, *problem priorities* are established, and research priorities then emerge based upon identified *needs* for new

technology or new scientific information required in order to solve various water pollution problems.

Fundamentally, research objectives and research priorities are not determined by the researchers themselves; rather, through a system of soliciting "research needs" from the nonresearch arms of the agency and from water pollution control authorities outside the agency in both State and local governments (see attached Statement of Need form), specific objectives are identified and regional priorities are established by each of the agency's nine regional directors. These regional priorities are then averaged into national priorities such that individual research needs on various pollution problems are listed in descending order of priority. Appropriated funds are then allocated down the priority list as far as they will go, thus assuring that the highest priority needs will be met first.

FWPCA RESEARCH, DEVELOPMENT, AND DEMONSTRATION BUDGET BREAKDOWN—FISCAL YEAR—1970 PLAN

[All figures in 3 million]

Research subprograms and problem categories	Allocations	Effort on eutrophication
Municipal pollution	$11.9	$2.6
Waste treatment	4.3	2.2
Storm and combined sewers	7.6	.4
Industrial pollution	7.1	.7
Organics	5.1	.6
Inorganics	2.0	.1
Agricultural pollution	2.9	1.2
Feedlots	1.4	.4
Runoff and irrigation returns	1.5	.8
Mining pollution	3.0	.2
Acid mine drainage	2.3	0
Phosphate mining	.2	.2
Other mining	.5	0
Other pollution	4.1	.4
Oil pollution	2.7	0
Salt pollution	.2	0
Construction projects	.2	0
Watercraft nd recreation	.6	.2
Dredging	.2	.1
Impoundments	.2	.1
Water quality control technology	9.0	3.4
Eutrophication causes and lake restoration	2.1	2.1
Analytical methods	.8	.2
Source, fate and persistence	2.2	.5
Nontreatment control	.7	.2
Water resources planning	1.4	.3
Arctic climate pollution	.6	0
Thermal pollution	1.5	.1
Advanced waste treatment	7.1	2.3
BOD and solids	1.4	.3
Refractory organics	.5	0
Nutrients	.9	.9
Inorganics	.8	.2
Disinfection	.5	0
Ultimate disposal	1.7	.9
Water reuse	1.3	0
Water quality requirements	5.0	.4
Municipal, industrial, and agricultural uses	.4	0
Recreational uses	.1	0
Propagation of fish and aquatic life	4.5	.4
Total	[1] 50.4	[2] 11.2

[1] Total planned effort on water pollution research ($39,000,000 fiscal year 1970 appropriation, plus $11,300,000 carryover).
[2] Total planned effort on eutrophication equals 22 percent of total.

STATEMENT OF NEED

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
TO BE ENTERED BY HEADQUARTERS

REQUESTING ORGANIZATION	ORGANIZATION CODE	PPB NUMBER	IDENT. NUMBER

REGIONAL PRIORITY RATING	TARGET DATE FOR COMPLETION MO/YR	NATIONAL PRIORITY RATING	TARGET DATE FOR COMPLETION MO/YR

IDENTIFYING TITLE OF NEED

PROGRAM TITLE RESEARCH, DEVELOPMENT AND DEMONSTRATION PROGRAM

SUBPROGRAM TITLE

SUBPROGRAM ELEMENT TITLE

SUBELEMENT TITLE

1. DESCRIBE SPECIFIC ANSWER BEING SOUGHT.

2. DESCRIBE WHY THE ANSWER IS IMPORTANT.

3. DESCRIBE SPECIFICALLY HOW THE RESULTS WILL BE USED.

NAME OF REQUESTOR	DATE

Mr. DOMINICK. Did you have other questions?

Mr. MCCLOSKEY. I have several other questions. But if you want to comment on this one, please do.

Mr. DOMINICK. Well, I just might say, Mr. Chairman, that I broke off in my statement to discuss the PAAP test and to ask Dr. Bartsch to discuss in some detail the PAAP test. Without going back to the statement, I would like to reply to your comments—which I think are good comments—in this way: We are as concerned as you and the committee about the total effect of phosphorus in our waters. And we welcome—Assistant Secretary Klein and I welcome—the attention of this committee to this problem.

I think we should make it abundantly clear that the industry is on

notice that the removal of phosphorus from detergents will be required. The sticking point that I have been able to understand has to do with the development of adequate evaluative techniques to evaluate and predict effects of substitute materials.

I would like to say to the chairman that since the national attention has been focused on this problem—and appropriately so—I have directed within our agency that we move forward as rapidly as is humanly possible to develop the appropriate evaluative techniques. We are going to keep an extremely tight time schedule on that process. And we would be happy to keep the committee informed of this time schedule.

Mr. McCloskey. May I ask you this question at this point: You are apparently devoting 1/460 of your research budget to phosphates. Do you contemplate any change in that fractional proportion of the resources?

Mr. Dominick. In direct answer to that, Mr. McCloskey, we have one research and development grant on the specific problem of seeking to find a substitute for phosphorus in detergent compounds. We are devoting several millions of dollars to the eutrophication problem, of which phosphorus is only a small part, and several millions of dollars to the development of treatment technology in the advanced waste treatment field. Now I think we should keep these separate areas of effort clearly distinguished.

Mr. McCloskey. Fine. The table you are going to submit will answer this question on allocation of resources. Let me go on because of the time problem, if I might. In your testimony, Mr. Secretary, you indicated that each person, each human being, without reference to detergents, causes about 1.4 pounds per year to pass into the waste treatment system. That is just from eating and the ordinary human wastes, I take it. And that for each person there is 1½ to 2 pounds per year, if detergents are used on behalf of that person for washing and so forth. That means that roughly 3 pounds per year per person using detergents pass into the waste system and into the waterways.

I would like to draw a distinction, if I may, between the types of water into which these wastes go. We have salt water lakes and estuaries, we have high mountain lakes such as Lake Tahoe, we have relatively low elevation lakes such as Lake Erie, Mich., and the like. Now, if your figures are correct, one person per year living on the edge of a waterway can be responsible for eutrophving about 7,500 square meters of lake. I take it from your testimony that an annual inflow of 0.2 grams per square meter of lake surface can eutrophy that lake. Is that correct?

Mr. Klein. That is right.

Mr. McCloskey. That indicates, if I understand it correctly, that in a high mountain lake—say one of our recreational lakes, the Trinities, the Rocky Mountains, the lakes we go to for fishing and recreational resources—it does not take very many people to eutrophy that lake. If I have this again correctly—and I ask you to check my arithmetic—one person can eutrophy 7,500 square meters of lake per year or a family of five vacationing for 2 weeks in the summer could cause eutrophication of about 750 square meters in a 2-week period, if this continues.

Now I would like to ask you, Mr. Secretary: Your Department of the

Interior has the geographical jurisdiction over many of these recreational lakes, does it not?

Mr. KLEIN. Only on interstate waterways, sir.

Mr. MCCLOSKEY. Let us take Lake Tahoe.

Mr. KLEIN. We have that.

Mr. MCCLOSKEY. Do you have it within your power, in a lake like Tahoe, which is in a crisis situation, to ban the use of detergents entirely within that basin?

Mr. KLEIN. No, sir. It would be up to the Congress of the United States to do so unless, in a conference, the conferees—and that would include the State of California and the State of Nevada—would agree to it. I do not even know whether we would have that, then, in the Federal Water Pollution Control Act.

Mr. MCCLOSKEY. You have the power to approve State criteria for water quality, do you not?

Mr. KLEIN. That is right. Not on the effluent going into them, though, sir.

Mr. MCCLOSKEY. You cannot control that?

Mr. KLEIN. No, sir. I have no jurisdiction whatsoever. The States may do so, but I cannot.

Mr. MCCLOSKEY. Could you prohibit, for example, visitors to national parks from taking in detergents with them?

Mr. KLEIN. It could be done by, I believe, the Director of the national parks doing so. I am not sure. I would have to look into that and get an opinion of the Solicitor.

(Subsequently the subcommitte received the following statement and Solicitor's Office opinion from the Interior Department:)

It would appear that the Secretary of the Interior would have the authority to prohibit the use of detergents in national park areas under the acts of August 25, 1916 (16 U.S.C. 1, 2–4), and August 21, 1935 (16 U.S.C. 461), as amended and supplemented, which establish the National Park Service and provide for the promulgation of regulations governing the management of the national park system. We have requested the Solicitor of the Department of the Interior to render a legal opinion on this matter which should be forthcoming.

It is the opinion of the Solicitor's office that such a regulation could be made part of the general regulations, if the need arises. As a matter of fact, present Park Service regulations do restrict the location of laundering and washing in some parks where a problem might arise.

Mr. MCCLOSKEY. Take some of the lakes, such as in Mount Lassen National Park in California. A very few campers camping alongside those lakes using detergents could tremendously increase the eutrophication; could they not?

Mr. KLEIN. Yes. It is a question of whether they would do it even. At a certain level it causes eutrophication, below that level it would not. The question is, are they adding to it below the level, or are they adding to it above the level, of the input of phosphorus?

Mr. MCCLOSKEY. The question I have, Mr. Secretary, is whether or not the Department of Interior, as the guardian of the Nation's water quality, has made any study whatsoever to determine what limitation of population use of our recreational lakes is permissible to prevent eutrophication, and whether or not the people using those lakes for recreational purposes should not be allowed to take in detergents in

view of the impact you have discussed. Is there any study being made on this?

Mr. KLEIN. This is the study that is now going on which Dr. Bartsch mentioned as to the critical point in every lake—where you can add some and it does not matter. The second is, I would have to know for each and every park whether or not it went into the water waste. For instance, at Tahoe you and I know that this discharge from South Tahoe does not go into there. It goes 8 miles and over a ridge, and away from it, in order to keep any of the phosphate out of there.

Mr. MCCLOSKEY. This is not my point. When we are discussing an allocation of Federal resources to protect a lake like Tahoe from eutrophication we have to balance the cost of the tertiary sewage treatments, or the removal of the water into another watershed, against the impact of new population growth which uses detergents. And merely living around the lake can destroy the same purpose we are trying to accomplish. What I am interested in knowing is what you, the Department of Interior, are doing with your jurisdiction over water quality, to balance the cost of the tertiary sewage treatment against new population and against use of the detergents, and whether or not you are making an inventory of what happens in individual basins.

I think we have lost Lake Erie, and your testimony to us indicates that it may be 1972 before you would require the industry to ban the phosphates in the detergents. But with respect to some of these high mountain lakes that we have not yet lost: Are there not other remedies that the Department of Interior should be taking on a crash basis to prevent detergents from infringing on those lakes?

Mr. KLEIN. On Lake Tahoe—it is a very critical lake, but, as far as I can gather, it is not going to be the detergents or the human wastes that are going to make the difference there. Because thus far, they are being diverted away and are being treated. This is what the people around Lake Tahoe are doing themselves.

It seems to me that from what I gather now—and Commissioner Dominick and I have both taken a look at this lake ourselves—the disruption of natural phosphates and nitrates by building—everyone wants to be on the lake shore—is pouring additional phosphates and nitrates into the lake. It is not human sewage or detergents, believe it or not

Mr. MCCLOSKEY. Isn't this correct: You have described five sources of phosphates—human wastes, detergents, industrial wastes, agricultural runoff, and natural runoff, from the soil and the earth itself. Now you have added a sixth, by the intrusion or interference with the land through building construction you can accelerate the flow of phosphates into the waters?

Mr. KLEIN. That's right.

Mr. MCCLOSKEY. So in any given waterway, lake, stream, or river, you have a balance between those six factors to consider in the intrusion of phosphates into the lake?

Mr. KLEIN. That's right.

Mr. MCCLOSKEY. Now, what department in the Government is doing the research to inventory each presently existing recreational watershed or basin in our country to determine what priorities to attach to those six causes in that given basin?

Mr. KLEIN. I would say we probably are doing most of it and this is being done under Dr. Bartsch. And we are working with lakes, streams, and rivers all over the country. We know what the problem is from the conference at Lake Michigan—what has to be done. We know what has to be done thus far on Lake Erie. We are not positive what has to be done, but we are going to do something there, in order to alleviate it in the meantime, and try to find better scientific methods and better results.

We don't have all the answers. Everybody started too late on this matter. Even we are too late on the phosphorus matter, and we are first getting into it. All of us are, not just one of us.

Mr. MCCLOSKY. Mr. Klein, let's look at it, as I think the chairman stated a week or so ago, from the perspective that the decade of the 1970's should put the same priority in the attack on pollution that we did in the 1960's in putting a man on the moon. If we are to attack this water pollution question with a sense of urgency, aren't you going to require additional appropriations, additional personnel, to make this national inventory and determine these priorities?

Mr. KLEIN. If we are going to do it; yes, sir.

Mr. MCCLOSKEY. Is any thought being given in your department to requesting the Bureau of the Budget and the White House to increase the authorizations so you can carry out this type of priority effort?

Mr. KLEIN. The thought has been given to it, sir.

Mr. MCCLOSKEY. Let me go back to the question of tertiary sewage treatment. I have sort of rough figures that primary treatment costs about 2 cents per 1,000 gallons in a large treatment plant and secondary treatment costs 4 cents.

I would like to know the cost for tertiary treatment that removes 95 percent of the phosphorus.

Mr. KLEIN. Dr. Stephan?

Dr. STEPHAN. On a national average, you will find the cost for primary treatment is—and this includes amortization of the capital which is probably not included in your figures—perhaps 5 cents per 1,000 gallons for an average sized plant. You spoke of a large plant, and there, of course, the unit cost would be smaller.

Mr. MCCLOSKEY. An average plant—what would that be?

Dr. STEPHAN. 10 or 15 million gallons a day, a city of 100,000 or 150,000 people—if that is average.

Mr. MCCLOSKEY. What would the cost of secondary be?

Dr. STEPHAN. The total primary and secondary cost runs around 11 cents per 1,000 gallons. So that is an additional 5 or 6 cents per 1,000 gallons. It roughly doubles it.

Mr. MCCLOSKEY. All right, sir. Can you stop there a minute?

What does secondary treatment do as far as phosphate removal is concerned?

Dr. STEPHAN. It is extremely variable. Sometimes zero, sometimes as high as 80 percent. But a good average figure is 30 percent.

Mr. MCCLOSKEY. All right. What is the incremental cost, then, of tertiary treatment?

Dr. STEPHAN. We anticipate tertiary treatment specifically for phosphorus removal, which I believe is what you are after, would cost less than 5 cents per 1,000 gallons in addition to primary-secondary treatment costs; so roughly, this is a 40-percent increase.

I would like to point out, however, that that is less than 1 penny per person per day.

Mr. McCloskey. That 5 cent incremental cost per 1,000 gallons for tertiary treatment—what percentage of the phosphates does that remove?

Dr. Stephan. That would allow us to remove at least 90, and in many cases, over 95 percent.

Mr. McCloskey. That would be satisfactory from your computations?

Dr. Stephan. In most cases, yes. Such as Lake Erie, the Potomac—yes, sir. Currently.

I would point out the needs for phosphorus removal will increase with time, because there are going to be more of us, and, therefore, the amount of phosphorus we can allow to go into the waters has to be held at some tolerable level. So percentage removals are sometimes misleading.

Mr. McCloskey. It is my understanding in the Lake Tahoe basin that because of Federal water standards that have been established, you are requiring the new vacation cottages built in the upper watershed areas to hook up to sewage treatment plants; is that correct?

Dr. Stephan. That is correct.

Mr. McCloskey. In these vacation areas, what level of sewage treatment are you requiring on the high mountain lakes? Is it primary, secondary, or tertiary?

Mr. Klein. Advanced waste treatment is what they have in both north and south Lake Tahoe. That is 95 percent removal of phosphate. They don't even put it back into the lake.

Mr. McCloskey. That standard is required by the Federal Government, not the State or local; is that right?

Mr. Klein. No, this was a result of conferences in which the States of Nevada and California and the Federal Government agreed on this.

Mr. McCloskey. But you had it within your power to refuse to approve their criteria, if you wished; did you not?

Mr. Klein. Yes.

Mr. McCloskey. So if the local government should come to you and say, "We want only primary treatment for new houses being built on the watershed of these recreational areas," you could say, "No, we won't approve those criteria, we won't give you any money?"

Mr. Klein. We can't say that, sir. All we can say is what goes in finally. I mean we have nothing to say about who can build there. The State of Nevada and the State of California have the doctrine of the Federal Water Pollution Control Act—the doctrine of States' rights with Federal cooperation and coordination.

Mr. McCloskey. Do you need a change in the law, then, to require that in the high mountain lakes within States they are going to have tertiary sewage treatment contributed to by the Federal Government? Do you need a change in the law to impose that?

Mr. Klein. Commissioner Dominick and I, through our meetings with State administrators—those we have talked to thus far—feel we need local effluent controls to bolster water quality standards, and they should be a part of the water quality standards so we can get at this problem directly.

Mr. McCloskey. The problem we find in local controls all around the country is, given the choice between pollution and a new industrial or chemical plant, like the Viscose plants over here on the Shenandoah, the local government is not going to require standards which would meet your criteria to grow fish in that river. Isn't that correct?

Mr. Klein. That is correct, sir.

Mr. McCloskey. How are we going to change that?

Mr. Klein. But I'm talking about their adopting local effluent controls, to supplement and augment the water quality standards for each portion of each stream. The States would do that, and they would be accepted and promulgated by the Secretary, if they met the proper standards.

Mr. McCloskey. Let's take that Viscose plant over here on the Shenandoah as a particular example. That is industrial waste going into the Shenandoah River.

What power does the Department of the Interior have to require that that industrial waste receive tertiary treatment to remove the phosphates?

Mr. Klein. Sir, that just came to a head on the setting of the standards for the State of Virginia, and it was one of them that was considered. In this case, because the Shenandoah is part of the Potomac and runs down to a boundary State, it is interstate waters, and therefore we have jurisdiction on them. And I believe that the State of Virginia is now going to establish proper water quality standards, from our last discussions with the State people. So we have, therefore, postponed indefinitely our setting of those standards in order to meet that particular problem as well as others.

Mr. McCloskey. Under those standards that the State is imposing, what percentage of phosphates are removed from the Viscose plant waste?

Mr. Dominick. If the water quality standards which we are attempting to establish with the State of Virginia call for secondary treatment or the equivalent, they would require a level of treatment which we would specify. If it is secondary, it would be in the vicinity of 50-percent removal of phosphorus. If it is higher than that, of course that would be in the water quality standards.

I don't have the specific answer to your question on the Viscose plant.

Mr. McCloskey. One thing was left out of your testimony: When you gave us the figure of 680 million pounds of phosphorus per year, other than from detergents, there is no breakdown between industrial and agricultural runoff, or natural runoff. Could we get those figures from you by a supplemental letter?

Mr. Klein. Yes, sir.

(In response to Congressman McCloskey's question, the subcommittee was informed by the Interior Department:)

In estimating the 680 million pound figure, the source article, "A Nonmyopic Approach to the Problem of Excess Algal Growths," by Mr. F. Alan Ferguson, did not include industrial sources of phosphorus. Table 2 of the attached article breaks down the specific sources used to develop the figure "at least 680 million." The actual value is 681 million pounds, using the low values of the ranges given.[1]

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[1] The article by Mr. Ferguson referred to above and elsewhere in this hearing record is reprinted in appendix 2 of this hearing record.

Mr. McCloskey. No further questions. Thank you.

Mr. Reuss. Commissioner Dominick, you said that it will be more than 2 years—not until 1972—before you would be willing to consider replacing phosphate in detergents as—and I'm using your words—"a viable candidate method for pollution control along with waste treatment."

Is that right?

Mr. Dominick. I did not read that portion of the testimony. I don't think we should be weasel-worded about this at all. I have changed the testimony to read: "As a necessary method for pollution control, along with waste treatment."

Mr. Reuss. What it all boils down to is that you are going to wait until you develop this PAAP test to test how much algae a given substance causes and how quickly—you are going to wait until that is developed and viable for practical use in 1972—before you turn your mind to the question of getting phosphates out of detergents. Is that right?

Mr. Dominick. Not at all.

Mr. Reuss. But that's what you said. Let's clean up the record here.

Mr. Dominick. We expect that phosphate substitutes will have to be found and will be susceptible to testing the moment we have the proper testing techniques in hand.

Mr. Reuss. What makes you think they will have been found, if you leave their finding to the phosphate and detergent industry, which makes its money out of phosphates?

Mr. Dominick. I think the very fact of this discussion should put the industry on notice that we expect to commence testing at an early date.

Mr. Reuss. 1972.

Mr. Dominick. That's correct.

Mr. Reuss. That's 2 years from now.

Mr. Dominick. That is correct.

Mr. Reuss. I , for the life of me, cannot understand this Department of the Interior concentration on developing the PAAP test before it does anything else. After all, we've been sitting here for 20 years now, allowing people to pour whatever they wished into municipal wastes without any PAAP test.

Why is this now dragged forth as a reason for a 2-year postponement, while you are just whispering to the detergent industry that they ought to do something about their phosphates?

Mr. Dominick. The principal purpose in developing the PAAP test is to give us the necessary assurance that any given substitute will not be deleterious to the environment.

Mr. Reuss. Why all this concern, though? For 20 years we have gotten by without a PAAP test, and people have been pouring what they will into lakes and streams. We know for a fact that phosphates are what is ruining our lakes and streams, and that Procter & Gamble and Lever Brothers and Colgate-Palmolive make most of the detergents which are the biggest source of those phosphates. Why do we blind ourselves to reality and say nothing is going to happen for 2 years? Isn't this a little bit as if you heard that the headmistress of a

school was feeding her kids arsenic, but you didn't want to ask her to stop, because she might feed them something worse if she laid off the arsenic?

It seems to me that's a reasonable analogy. I would like your comment.

Mr. DOMINICK. Let me attempt to clarify the record here with you, Mr. Chairman.

Secretary Hickel and Assistant Secretary Klein and I are firmly committed to the proposition that phosphorus must be removed from detergents, just as soon as we are sure that a substitute material will be less damaging to the environment.

This assurance is going to receive the highest priority in FWPCA. If we can beat the 1972 date, I am sure all of us will bend every effort to do so.

Mr. REUSS. I think you are dead wrong. I think the Department of the Interior is dead wrong. I think the highest priority ought to be to disband this industry-controlled committee and appoint a knowledgeable, energetic fellow to coordinate all public and private activities toward the developing of a phosphate-free detergent.

We know that is what causes the problem, and you don't need any PAAP test to know that phosphates ruin our lakes. So why not undo the stop order on trying to find a substitute for phosphates, and, instead, try to find one; meanwhile, going along with your PAAP tests and other methods of making sure that that which comes in the place of phosphates is not a worse thing—though I will bet there are pre-PAAP methods right now that can give us a pretty good idea.

Mr. DOMINICK. Mr. Chairman, I think substitutes for phosphorus must be sought, and sought right now.

Mr. REUSS. But you are leaving it to the industry, which uses phosphorus, and the makers of phosphates, to seek them. And obviously, our lakes will all be dead before they do it.

They have built-in conflict of interest; and as long as they can report to you once a year, "Sorry, boss, we haven't found any substitute for phosphate yet," and as long as your attitude is "let's wait until we find a method of making sure that a worse thing doesn't come in its place," there is going to be no progress.

How can this be? You leave it to the industry; they enjoy things as they are. That's why they haven't found a substitute.

Mr. KLEIN. If I may, I already pointed out that there are no phosphates in your dishwasher, but there is a caustic in there.

I also pointed out earlier, Mr. Chairman, that we have sugar-based detergents and these are no problem to our waters, because the bacteria eat them up very easily. But they don't clean well.

I pointed out we have nitrilotriacetate, and it doesn't clean as well. And we have other substitutes that are being tried at the present time.

It may be that one of those will be the breakthrough that gives us the difference. But if we issued an edict at this time that nobody can sell a detergent with phosphate in it, I think we would have some real difficulty in the homes of America.

Mr. REUSS. Nobody has suggested that. What some of us have suggested is that there is nothing that would concentrate the attention

of the detergent industry so finely on the business of finding a good, harmless, substitute for phosphate than the knowledge that they had to do it in 2 years. I hope that you or members of your establishment will be here throughout the hearings, because we are going to have witnesses from Sweden and Canada and various other places who tell us that there are perfectly good substitutes; and the only reason the detergent and phosphate industry doesn't use them is that they make their living off of selling phosphates, or they have stockpiles of phosphate.

So I don't see how you are ever going to make any progress with your present wait-until-the-industry-finds-the-answer philosophy, and hold back on everything for 2 years until we get a PAAP test.

It seems to me the PAAP test is fine, but that ought to go along with intensive efforts to find a substitute for phosphates that will clean without degrading our waterways.

Mr. KLEIN. As I understand it, sir, the hearings before this committee did a good deal to expedite this in 1963, 1964, and 1965, and that is why it was done. And I think it takes more than just the Department of the Interior—I think it takes your committee and what you are doing now to do that as well.

We are very grateful that you are doing it. I wanted to tell you, in case you didn't think there was an active program in the Department of Interior, you are mistaken. There is an activist program going on now and this is part of it.

Mr. REUSS. On the discovery of substitutes for phosphates?

Mr. KLEIN. No, but on making sure industry goes out and finds the substitute for phosphate in detergents.

Mr. REUSS. Mr. Indritz?

Mr. INDRITZ. Mr. Secretary, has the Federal Water Pollution Control Administration made any grants to the Soap and Detergent Association for work on removing phosphates from detergents?

Dr. STEPHAN. Yes, we have one phosphate removal grant. This is a waste treatment grant, for a project at State College, Pa., for the use of chemicals to remove phosphates from effluents.

Mr. INDRITZ. Could you send to us for the record a memorandum summarizing the scope of that grant—the amount, the dates, and the results thereof?

Dr. STEPHAN. Yes, sir. I will send you a copy.

(The following data were subsequently received by the subcommittee:)

This grant was awarded as a 2-year project and was funded on a yearly basis. Attached are copies of the information sheets that show the date of award, project dates, the amounts awarded each year, and brief description of the project objectives and plan of operation.

The plan for the study includes three phases. Phase I is for plant modifications. Phase II is for initial experiments to determine form, amount, and location for addition of aluminum. Phase III is for a year's operation to gather long term operation and cost data.

Work on phase I began on April 1, 1968. Separate sludge return facilities were constructed to permit parallel operation of two aeration tank and settling tank combinations, one combination to serve as a control. Sludge wasting facilities were installed for each parallel system. Chemical storage and feeding equipment was constructed with sufficient flexibility that aluminum salts could be added at a number of points in the plant. This phase of the work, including acquisition of operating personnel was completed on January 27, 1969.

Phase II began immediately with testing of the effectiveness of aluminum sul-

fate (alum). Best removal of phosphorus and best effluent clarity were obtained when the alum was added in the channel carrying mixed liquor to the settler. Adequate mixing was obtained in this way. Using a weight ratio of aluminum to phosphorus of 2:1 it was possible to obtain a total soluble phosphorus concentration in the effluent of about 0.3 mg/l. In addition to phosphorus removal, an increase in organic removal was observed. On May 28, sodium aluminate was substituted for alum. It was found necessary to add the sodium aluminate near the end of the aerator rather than in the mixed liquor channel to get proper mixing. Phosphorus removal was not as effective as with alum at equivalent aluminum doses. At a 2:1 aluminum to phosphate ratio, an average soluble phosphorus concentration of about 0.4 mg/l. was obtained. Considering the higher cost of aluminum in the form of sodium aluminate, alum appeared more appropriate for further studies. In addition, a white haze was observed in the effluent using sodium aluminate which was not present using alum. This phase of the work was completed on August 12, 1969.

Phase III is now underway and will continue until August 1970. The effects of alum on phosphorus removal and general plant operation are being compared with operation in the absence of chemical addition. Data necessary for a good overall evaluation of chemical-biological phosphorus removal will be obtained. Dependable cost estimates for the treatment method will be made.

Research and Development Grant

This sheet describes briefly a research and development grant awarded under section 5, Federal Water Pollution Control Act (Clean Water Restoration Act).

Grantee.—Soap and Detergent Association.

Title of project.—Phosphorous removal in the activated sludge process.

Project site.—New York, N.Y.

Federal grant.—First year, $108,116.

Project number. WPD-220-01.

Date awarded.—April 1, 1968.

Total estimated project cost.—None.

Estimated duration.—2 years.

PPBS No.—1701/N.

Description of project.—The overall objective of this project is to determine the feasibility of removing phosphorus in an activated sludge plant treating domestic wastewater through chemical precipitation with aluminum and utilizing only the existing aeration and settling units of the plant.

Inquiries.—Contact the Office of Research and Development, Federal Water Pollution Control Administration, U.S. Department of the Interior, Washington, D.C. 20242.

Demonstration Project Grant

II. SUMMARY DESCRIPTION OF DEMONSTRATION PROJECT

Title of project.—Soluble Phosphate Removal in the Activated Sludge Process.

Agency or institution.—The Soap and Detergent Association.

Project director.—Theodore E. Brenner.

Senior investigators.—John B. Nesbitt and Rupert Kountz (Pennsylvania State University).

Summarize the proposed project on this page, following titles given below.

A. PROJECT OBJECTIVES

The overall objective of this project is to determine the feasibility of removing phosphorus in an activated sludge plant treating domestic wastewater through chemical precipitation with aluminum and utilizing only the existing aeration, settling, and sludge digestion units of the treatment plant.

B. PLAN OF OPERATION*

The project is being conducted in the final aeration and settling units of that part of the university treatment plant treating university sewage and in the

*The project will be carried out under the administrative and technical direction of The Soap and Detergent Association, New York, N.Y. The research itself will be conducted by the Department of Civil Engineering, Pennsylvania State University under the immediate supervision of Professors Rupert Kountz and John B. Nesbitt.

digestion units serving the entire plant. After initial experiments to determine form, amount, and location of the aluminum addition, the experiment will be continued for 1 year to gather long-term operation and cost data. During this latter period, one aeration and settling basin will receive no chemical and will thus serve as a control.

C. NEED FOR PROJECT

Excessive eutrophication of our Nation's lakes and streams has only recently received nationwide attention. One factor is the overfertilization of receiving waters with the element phosphorus which occurs in domestic wastewater and is not removed appreciably by present treatment methods. It is expected that this project will develop and demonstrate a minimum cost method for phosphorus removal that will be applicable to both existing and new installations.

D. FACILITIES AVAILABLE

The treatment plant described previously and owned and operated by The Pennsylvania State University is available for use during this project. In addition the university is able to provide two well-equipped sanitary engineering laboratories, a machine shop, libraries, and digital and analog computers. The sanitary engineering staff also has personal and professional liaison with many of the university academic areas that through consultation can be useful to this project.

Soluble Phosphate Removal in the Activated Sludge Process Report, April 1, 1968, to March 31, 1969

Work on this project was begun on April 1, 1968. Phase I involved the preparation of plans and specifications for the necessary modifications to the University Sewage Treatment Plant, the construction work involved in the plant modifications, and the hiring of laboratory analysts and graduate assistants. It was expected that this work could be completed in 3 months. The expectations were overly optimistic and it took neary 10 months to complete phase I. The delays were caused by delays in the delivery of equipment, construction bids which exceeded the job estimate and required modifications in both construction and financing, design modifications which were to accommodate unforseen operating problems and changes in the treatment plant operation and the difficulty in locating a full-time laboratory analyst. However, phase I was completed on January 27, 1969 and provided the project with both a physical facility and an operational staff capable of carrying the project to a successful conclusion. During the last several months of phase I considerable analytical data were gathered. These data included background data on nearly all of the parameters to be examined during the project and phosphorus and flow profiles required in the determination of chemical feed flows. Data from this period which have been analyzed are shown in table I.

Phase II studies to determine whether the aluminum precipitant should be added in the form of liquid alum or liquid sodium aluminate, where this precipitant should be added to the flow, and how much of it should be added were begun on January 27, 1969 with the addition of liquid alum to one aeration tank (tank No. 2) at a point ⅔ of the way down the tank from the influent end and at a rate expected to produce an Al : P molar ratio of 1.5 : 1. After an initial decrease in settling tank effluent suspended solids in the treated tank, these solids increased considerably over the untreated (control) tank (tank No. 1) so the point of chemical addition was moved to the influent end of the channel carrying mixed liquor from the aeration to the settling basin. After this change effluent suspended solids in the treated tank decreased and remained approximately the same as those in the control tank. Data collected during this period and which we have had time to analyze are included in table I.

On February 21, 1969 liquid alum was added to tank No. 1 at the influent end of the channel carrying mixed liquor from aeration tank to the settling basin. The molar ratio of Al : P was expected to be 1.25 : 1. Data again are included in table 1.

The data in table I show that to date phosphorus removals have been good in the unfiltered samples and excellent in the filtered ones and BOD removals have been increased over that experienced without chemical treatment. Visual obser-

vation of the settling tank indicates a considerable increase in supernatant (and thus effluent) clarity and a reduction in color compared to an untreated tank. Plant operators comment continuously on how far down in the tank they can see. As the plant is hydraulically over loaded, flocculated solids are washed from the tank during peak daytime flows; however, at other times the effluent is quite clear. Sludge volume indicies at all times are lower in the treated tank than in the control.

Unfortunately the molar ratios of 1.5 : 1 and 1.25 : 1 Al : P were not achieved as expected. After at least 4 years of receiving raw sewage having a BOD of 300 to 500 mg/l and a total unfiltered phosphorus concentration (binary acid method) of above 40 mg PO_4/l the raw sewage began to get weaker about the first of the year.

By March 1, the BOD of the raw sewage was down to 200 mg./l and the phosphorus readings were about 20 mg. PO_4/l. Adjustments in chemical feed have now been made but these adjustments are not reflected in the data in table I. Actual Al : P molar ratios are approximately 3 : 1 in tank No. 2 and 2.5 : 1 in tank No. 1. No reason for this reduction in sewage strength has yet been found.

Study plans for the project for the coming year include the completion of phase II. The addition point and feed rate for liquid alum should be determined by May 1. Similar studies for liquid sodium aluminate should be concluded by July 15. It is entirely possible that the feasibility of adding chemicals at other locations can be determined very quickly. If this is true, phase II could be shortened considerably and every effort will be made to do so.

Phase III which is the year's study to gather long term operational and cost data should begin no later than July 15. During this phase chemical will be added to one tank with the other tank serving as a control. For half this period excess biochemical activated sludge will be added directly to the sludge digester. During the other 6 months it will be added to the digester through the primary clarifier to see what effect it has on the primary treatment processes.

During the completion of phase II and during phase III the sludge digestion studies which were begun in phase I will be continued. These studies involve the analyses of sludge entering and leaving the digester to determine how the biochemical sludge affects the digestion process and how the digestion process affects the biochemical sludge. Present data on this study have not yet been analyzed but so far there does not appear to be any effect either way.

So far the project has fostered two satellite studies which are not a part of the proposal but which will provide valuable to the project. Dr. Richard F. Unz, assistant professor of sanitary microbiology, has received funds from the university's water resources research institute to study the flora and fauna in the biochemical and the straight biological activated sludge. The bulk of this study must be done during phase III of this project but it is already well underway although no results are available at present.

One of our candidates for the M.S. degree, as a thesis study, has constructed a one square foot, san-anathracite coal, pilot filter and installed it in the chemical feed building at the treatment plant. He plans to filter the settling tank effluent and to study the effects of filtration rate, filter media, and backwashing techniques on phosphorus, BOD, and COD removal by the filter. This study should be conducted during phase III so that control filter runs can be established.

It appears at this time that the project may run beyond the March 31, 1970 termination date. Although the length of overrun cannot be determined until the phase II studies are complete it should not be more than 3½ months of data collection and at least 1 month for report writing and returning the plant to normal operation. If the phosphorus concentration continues at its present level we should be able to continue for this length of time without a request for additional funds.

INFORMATION SHEET—RESEARCH, DEVELOPMENT, OR DEMONSTRATION PROJECT

This project is a demonstration grant, under section 5; Federal Water Pollution Control Act (Clean Water Restoration Act).

Grantee or contractor.—The Soap & Detergent Association, 485 Madison Avenue, New York, N.Y.

Project director.—Theodore E. Brenner, the Soap & Detergent Association, 485 Madison Avenue, New York, N.Y.

Title of project.—"Soluble Phosphate Removal in the Activated Sludge Process."

Project site.—New York, N.Y.
Program (project) number.—17010 EIP.
Date offered.—June 10, 1969.
Date accepted (awarded).—June 19, 1969.

2d Year—grant or contract period, from July 1, 1969, through August 30, 1970

Eligible grant period costs	$80,286
FWPCA grant or contract amount	48,494

Description of project.—The objective of this project is to determine the feasibility of removing phosphorus in an activated sludge plant treating domestic waste water through chemical precipitation with aluminum and utilizing only the existing aeration, settling, and sludge digestion units of the treatment plant.

FWPCA project officer.—Robert L. Bunch, Advanced Waste Treatment Research Laboratory.

Inquiries.—Contract Project Coordination, Office of Research and Development, Federal Water Pollution Control Administration, U.S. Department of the Interior, Washingteon, D.C.

Mr. INDRITZ. Has FWPCA made any grants for phosphate removal to Food Machinery Corp. (FMC)?

Dr. STEPHAN. No, sir, not for grants, but for contracts; yes, sir.

Mr. INDRITZ. How many of them and in what amount?

Dr. STEPHAN. Again, I can supply that to you.

(The following information was subsequently submitted to the subcommittee:)

Attached is an information sheet on a contract with the Food Machinery Corp. for phosphate removal:

DEPARTMENT OF THE INTERIOR, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, OFFICE OF RESEARCH AND DEVELOPMENT

INFORMATION SHEET ON RESEARCH AND DEVELOPMENT CONTRACT

This sheet describes briefly a research and development contract awarded under section 5, Federal Water Pollution Control Act (Clean Water Restoration Act).

Contractor.—FMC, 1185 Coleman Avenue, Santa Clara, Calif.

Title of project.—"Process To Remove Carbonaceous, Nitrogenous, and Phosphorous Materials From Anaerobic Digester Supernatant and Related Process Streams."

Project site.—Santa Clara, Calif.
Federal contract.—$119,346.
Contract number.—14-12-414.
Date awarded.—June 28, 1968.
PPBS number.—1701.
Project duration.—18 months.

Description of project.—A process will be developed to remove plant nutrients and COD materials from digester supernatant liquors. The sequence of operations to be studied involve (*a*) heating to romove CO_2, (*b*) addition of lime to precipitate phosphates and to coagulate organic matter, (*c*) stripping the alkaline slurry with air to remove ammonia, (*d*) settling the sludge to separate phosphates and COD material, and (*e*) recovery of the ammonia stripped from the alkaline slurry by scribbing the air-ammonia mixture with sulfuric acid. From this work, a portable and proven pilot plant will result and estimates of plant costs developed for treating up to three MGD of supernatant liquors.

Inquires.—Contact the Office of Research and Development, Federal Water Pollution Control Administration U.S. Department of the Interior, Washington, D.C.

Mr. INDRITZ. Have any grants or contracts been made to Monsanto Corp. for removal of phosphates?

Dr. STEPHAN. Again I will be happy to supply whatever details you want on such projects.

Mr. INDRITZ. Have there been any?

Dr. STEPHAN. I don't recall a specific one to Monsanto.

Mr. INDRITZ. Will you provide to us information concerning all grants and contracts for phosphate removal that the Federal Water Pollution Control Administration has made to any corporation or agency which either manufactures detergents or supplies phosphates to detergent manufacturers?

Mr. DOMINICK. Yes, sir.

(The following information was subsequently supplied to the subcommittee:)

Attached are the information sheets on all grants and contracts for phosphate removal with corporations or agencies that either manufacture detergents or supplies phosphates to detergent manufacturers.

INFORMATION SHEET—RESEARCH, DEVELOPMENT, OR DEMONSTRATION PROJECT

This project is a research contract, under section five, Federal Water Pollution Control Act (Clean Water Restoration Act).

Grantee or contractor.—General Mills, Inc., Chemical Division, 4620 W. 77th Street, Minneapolis, Minn.

Project Director.—Mr. Ronald Swanson.

Title of project.—A Study on the Feasibility of Liquid Ion Exchange for Extracting Phosphates From Secondary Effluents.

Project site.—Minneapolis, Minn.

Program (project) number.—17010 EAP 14-12-590.

Grant or contract period—18 months

Eligible grant period costs	$50,000
FWPCA grant or contract amount	50,000

Date accepted.—June 30, 1969.

Description of project.—To develop a selective liquid ion exchange reagent for removing phosphates from secondary effluent. The phosphate loaded exchanger would be stripped using either NaOH or NH_4OH and recycled in the process. Separatory funnel experiments would provide data on selectivity and capacity. A novel contacting system in which droplets of the ion exchanger would be passed up through the effluent and collected as a separate phase will be evaluated.

This is a modification of an earlier proposal No. 68-P326 "Proposal for Removing Phosphate Nitrite, and Nitrate from Municipal Sewage Effluents."

FWCPA project officer.—Dobbs, AWT Res. Lab.

Inquiries.—Contact Project Coordination, Office of Research and Development, Federal Water Pollution Control Administration, U.S. Department of the Interior, Washington, D.C.

DEPARTMENT OF THE INTERIOR, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, OFFICE OF RESEARCH AND DEVELOPMENT

INFORMATION SHEET ON RESEARCH AND DEVELOPMENT CONTRACT

This sheet describes briefly an R. & D. contract awarded under section 5, Federal Water Pollution Control Act (Clean Water Restoration Act).

Contractor.—W. R. Grace and Co., Dearborn Chemical Division, 320 Genesse Street, Lake Geneva, Ill.

Title of project.—Ultimate Disposal of Phosphate from Wastewater by Recovery as Fertilizer.

Project site.—Lake Zurich, Ill.

Federal contract.—$125,138.

Contract number.—14-12-171.

Date awarded.—June 18, 1968.

PPBS number.—1707.

Project duration.—15 months.

Description of project.—A method will be developed for removing nutrients, i.e., phosphates and ammonia nitrogen, from wastewaters and converting them into a fertilizer material. The phosphates, which are concentrated in the aerobic step of the activated sludge process, will react with the ammonia present in the waste stream and added magnesia to form magnesium-ammonium-phosphate.

This compound is of low solubility in water and can be separated by the use of flotation or other separation techniques. The separated magnesium-ammonium-phosphate sludge will be converted by further processing into a fertilizer material.

Inquiries.—Contact the Office of Research and Development, Federal Water Pollution Control Administration, U.S. Department of the Interior, Washington, D.C.

DEPARTMENT OF THE INTERIOR, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, OFFICE OF RESEARCH AND DEVELOPMENT

INFORMATION SHEET ON RESEARCH AND DEVELOPMENT CONTRACT

This sheet describes briefly an R. & D. contract awarded under section 5, Federal Water Pollution Control Act (Clean Water Restoration Act).

Contractor.—W. R. Grace & Co., Washington Research Center, Clarksville, Md.

Title of project.—"Chemically Exfoliated Vermiculites for Removal of Phosphate from Wastewaters.

Project site.—Clarksville, Md.

Federal contract.—$48,920.

Contract number.—14-12-485.

Date awarded.—January 17, 1969.

PPBS number.—1701.

Description of project.—The objective of this contract is to determine the practicability of using chemically modified and regenerable vermiculites for the removal of phosphate from wastewater.

The treatment method proposed is an ion exchange process which makes use of relatively inexpensive vermiculite and which should be highly selective for phosphate. The contractor will chemically treat the vermiculite to increase its phosphate-sorbing capacity and determine the maximum phosphate removal and cost for the chemical treatment. The study also includes a determination of the feasibility of regenerating the phosphate-loaded vermiculite so it may be reused to treat more wastewater.

Inquiries.—Contact the Office of Research and Development, Federal Water Pollution Control Administration, U.S. Department of the Interior, Washington, D.C.

Mr. INDRITZ. Secretary Klein, you have mentioned the role of the Department in moving toward promoting tertiary treatment and advanced waste treatment at municipal sewage treatment plants to assist in the removal of phosphates.

Approximately how many people in this country are not served by municipal sewage treatment plants or are served by septic tanks?

Mr. KLEIN. About 70 million, I believe.

Mr. INDRITZ. Would the advanced waste treatment process that you are now working on effectively remove phosphates in the septic tank area?

Mr. KLEIN. No. There has to be a collection system thus far in order for it to work.

Mr. INDRITZ. Is there any method, other than removal of phosphates from detergents, which would aid in reducing the amount of phosphates contributed to the environment by septic tank populations?

Mr. KLEIN. Not at all. The septic tank manufactures its own phosphates by its own biological action, as well as what goes into it from detergents. It is a very bad situation in septic tanks, on the east coast particularly.

Mr. INDRITZ. Would the removal of phosphates from detergents used by those who have septic tank facilities substantially reduce the amount of phosphates contributed to the environment?

Mr. KLEIN. Yes, it would.

Mr. INDRITZ. During the course of your testimony you mentioned a figure of 680 million pounds of phosphorus contributed to the waters from other sources. And I believe Congressman Vander Jagt in col-

loquy with you brought out that those figures may have come from an article by F. Alan Ferguson, entitled "A Nonmyopic Approach to the Problem of Excess Algal Growths."

Could I ask whether that article, which was published in the Environmental Science and Technology, March 1968 issue, has been read by your assistants at FWPCA?

Mr. KLEIN. I'm sure they have read it.

Mr. INDRITZ. There are various discrepancies in the figures used in that article and those contained in your testimony. For example, you testified that 500 million pounds of phosphorus comes from detergents, whereas this article states that only 280 million pounds of phosphorus comes from detergents.

The article also concludes that the benefits of eliminating phosphates from household detergents are marginal at best and that the amount of phosphorus concentration in our waters would still be ten times the concentration necessary for excessive algal growth. The sum and substance of Mr. Ferguson's conclusion is that it is not necessary to eliminate phosphates from detergents, and he even casts doubt on whether there ought to be any further efforts to treat wastes in order to reduce the phosphate loading of our waters.

Do your people concur in the conclusions of this article?

Mr. KLEIN. I would not concur in them whatsoever, sir. Phosphate has to come out of detergents, and it has got to come out of sewage treatment plants, and it has to be reduced in runoff from farms and other areas.

Mr. INDRITZ. Could we have from your technical people a detailed analysis of this article indicating the extent to which your Department agrees with the figures used, and the conclusions reached, in that article?

Mr. KLEIN. I think it would take a little time, because when we get into the figures, it depends on where Mr. Ferguson got his figures from. He may have gotten them from one source or another, he may have decided to take figures which in our opinion would not be correct, and he may have only gotten three or four sources, when we have ten or 12 in our figures.

So it would take a little time, and if the chairman would give us that time, we will be glad to go into it.

Mr. REUSS. Yes, I appreciate this is detail. Take as much time as you want, because we will keep the record open.

(The following review of Mr. Ferguson's article was subsequently transmitted to the subcommittee:)

PACIFIC NORTHWEST WATER LABORATORY, FWPCA,
Corvallis, Oreg., January 26, 1970.

To: Acting Director, Water Quality Research, FWPCA
Through: Director, Pacific Northwest Water Laboratory [initialed by A. F. B.[1]]
From: Chief, Physiological Control Branch, NERP
Chief, Ecological Control Branch, NERP
Subject: Review of Paper by F. A. Ferguson, "A Nonmyopic Approach to the Problems of Excess Algal Growths"

The theme of the subject paper is to show that if all the phosphorus were removed from detergents there would still be sufficient phosphorus from other sources to support heavy growths of algae in all of our surface waters. Ferguson

[1] A.F.B. is A. F. Bartsch.

attempts to prove this point by making rather irrational assumptions and mathematical manipulations.

Table 2 contains most of the key data in the paper. The data in tables 4, 5 and 6 are derived from that in table 2. Much of the data in table 2 appear to have been taken from a report of task group 2610–P—nutrient associated problems in water quality and treatment. The data were published as a task group report entitled "Sources of Nitrogen and Phosphorus in Water Supplies." (JAWWA, vol. 59, No. 3, March 1967).

In order to compare the data used by Ferguson and that appearing in the task group report, we have prepared the table below which contains both sets of data. Generally the data that Ferguson has used for nitrogen and phosphorus are the same or lower than those appearing in the task group report. These data, however, are manipulated to prove his point. The most serious fault of the paper and the most irrational assumption appears on page 192. He estimates that at least 680×10^6 pounds of phosphorus per year would still enter our surface waters if all phosphates were removed from detergents. Based on a national total annual stream flow of 450×10^{12} gallons, the resulting phosphorus concentration would be 0.18 p.p.m. in all U.S. surface waters. In doing this he makes the erroneous assumption that the same quantities of phosphorus enter into the same volumes of surface waters in all areas of the country. In "Phosphorus and Flowing Waters," Keup (Water Research, Pergamon Press, vol. 2, pp. 373–386, 1968) has shown that the phosphorus in various drainage areas varies from 4 lb/annum/mile^2 in a forested drainage area to 6,540 lb/annum/mile^2 in an urban drainage area. Thus the average hypothetical phosphorus concentrations in table 7 of Ferguson's paper are meaningless. It should also be pointed out that the surface waters listed in table 3 are in areas with heavy agricultural activities and, also, while the amount of phosphorus entering the surface waters is given the stream flows are not.

While the author may not be suffering from myopia in his approach to algal growth problems, it does appear that he is afflicted with "Tunnel Vision."

THOMAS E. MALONEY,
Chief, Physiological Control Branch, NERP.
CHARLES F. POWERS,
Chief, Ecological Control Branch, NERP.

APPROXIMATE QUANTITIES OF ALGAL GROWTH MATERIALS (FROM SOURCES EITHER IN OR ENTERING U.S. SURFACE WATERS), A COMPARISON OF DATA IN FERGUSON'S TABLE 2 WITH TASK GROUP DATA

Source	Quantities available (million lbs. per year)			
	Nitrogen		Phosphorus	
	Ferguson	Task group	Ferguson	Task group
Rainfall	30–590	30–590	2–71	3–9
Aquatic plants	0–1,070	----------	0–107	----------
Runoff from forests	990–2,250	----------	243–587	----------
Domestic wastes	1,330	1,100–1,600	----------	200–500
Human and food	----------	----------	137–166	----------
Washing (detergents)	----------	----------	250–280	----------
Runoff from—				
Urban land	200	110–1,100	19	11–170
Cultivated land (fertilizers)	2,040	[1] 1,500–15,000	110–380	[1] 120–1,200
Land on which animals are kept	420	----------	170	----------

[1] Task group designation for this category is agricultural land.

Mr. KLEIN. As far as I am concerned, we have got to get to the removal of nutrients. Nutrient pollution is one of our major problems.

If I may agree with the chairman, I am not going to wait for the PAAP test to remove phosphates. They will be removed.

Mr. INDRITZ. Commissioner Dominick, in your statement, on page 2, you say you assumed that a substitute builder will be used to the same extent as the present builders. I would like to ask you why you make that assumption in view of the fact that the single contract that has

been let by the Department for studying substitutes for phosphate in detergents indicates that the objective of the contract is to use biodegradable surfactants which are self-chelating or would not require chelating agents.

Why do you assume any substitute builder will be used to the same extent as the present builder?

Mr. DOMINICK. I am not a chemical engineer, Mr. Indritz. But we assume a significant quantity of material would be required as the builder for any detergent compound. That is as far as I would be willing to go on this point. Dr. Stephan may have additional information for you.

Dr. STEPHAN. Well, I would like to point out that the contract which we are supporting, the one with Illinois Institute of Technology Research Institute, is unique, to our knowledge, with regard to an approach toward solving this problem. That is the reason we chose to fund this one—it was a unique approach, one that hadn't been taken up by industry, one that deserved to be evaluated. Yet it is only one project, about a $100,000 project——

Mr. INDRITZ. I am not challenging the project. I am just asking, in view of that objective, why there is an assumption in the testimony that any substitute builder would be used to the same extent as the present builder.

Dr. STEPHAN. I am trying to respond. We are assuming the other projects which are underway within the chemical industry are predominantly along the line of replacing the phosphate builder with a substitute material or materials which would perform the same function as phosphates. It is a reasonable assumption to make from a technical standpoint that the amount of this substitute material would be of the same order of magnitude as the phosphate itself. That is why we make that assumption.

Mr. INDRITZ. Now I have a map here furnished by the Geological Survey, entitled "Chemical Quality of Public Water Supplies of the United States and Puerto Rico, 1962," printed in 1964 by the Geological Survey. And it shows—I am sorry it isn't large enough for you to see it, but take my word for it—that in the northeast area of the United States, in the Atlantic coastal region, and in various other States, including the Pacific Northwest, the hardness of finished public water supplies is less than 60 parts per million. In other words, these are soft-water areas.

In addition, a booklet put out by the Geological Survey, water supply paper No. 1812 entitled, "Public Water Supplies of 100 Largest Cities in the United States, 1962," indicates that there are millions of people, and many cities whose finished water supplies have hardness that is, in parts per million of calcium carbonate, in the order of zero to less than 60. These are all soft-water areas.

In view of the fact that in European countries the quantity of phosphate in the detergent is substantially less than in the detergent sold in the United States—in view of the fact that all of the U.S. products have phosphates in them—why shouldn't the FWPCA assume that the present builders can be replaced by something less than the same extent so that the housewives in soft-water areas may have a choice of using detergents which are either free of phosphates or have very

small quantities of phosphates, but which are suitable for cleaning clothes in soft-water areas?

My question is, Why shouldn't the Department of the Interior make an assumption somewhat contrary to what you stated in your testimony?

Dr. STEPHAN. Mr. Indritz, to our knowledge the range of phosphate content in heavy-duty laundering products will be from 15 percent to maybe 60 percent. The point I am trying to make is that a large range in phosphate concentration already exists in such products. I assume—although not being a housewife and not being a user of these products myself I can't be sure—that the housewives choose those products which are most suitable to their individual needs. Those in hard-water areas I presume will choose products which have better effectiveness in those types of areas. Those in soft-water areas will use those products with better effectiveness there.

That is an assumption on my part.

Mr. INDRITZ. Is your assumption based on the fact that the percentage of phosphate is stated on the detergent boxes?

Dr. STEPHAN. No, sir; I am basing it on performance. I assume they, like my wife, evaluate these products one against the other as they use them. On that basis, I am assuming that in order to perform these same function over the U.S. average, from the hard- to the soft-water areas, averaging it all out, the quantity used would be roughly the same as the quantity of polyphosphates now used.

Mr. INDRITZ. Commissioner Dominick, in your statement you indicated that the detergent manufacturing companies have assured the Interior Department that they are vigorously pursuing development and performance evaluation of phosphate substitutes and have been doing so for some time.

Would you please provide the subcommittee with copies of all reports, studies, and assurances that have been given by any of the detergent companies or their suppliers, as to just how they have vigorously pursued the development and performance evaluation of phosphate substitutes?

Mr. DOMINICK. We will be happy to do so.

Mr. INDRITZ. You also indicated that the Interior Department has repeatedly told the detergent industry to develop substitutes.

Would you please provide the subcommittee with copies of all statements, letters, and other communications, in which the Department has so stated to the industry?

Mr. DOMINICK. We would be happy to do so.

(The Interior Department subsequently submitted the following data to the subcommittee:)

Exchanges with industry on phosphate replacements:

1. Report of the Lake Erie Enforcement Conference technical committee June 1, 1967, recommending accelerated research on phosphate substitutes.

2. Letters by the Assistant Secretary to Colgate-Palmolive Co., Economics Laboratory, Inc., Lever Brothers Co., Procter & Gamble Co., Purex Corp., and the Soap & Detergent Association in June and July 1967 (copies attached).

3. Meeting by Secretary of the Interior with representatives of main firms involved on July 31, 1967, at which time he and the Assistant Secretary for Water Pollution Control strongly urged stepped up research on phosphate replacements (copy of remarks by the Assistant Secretary attached).

4. Meeting between the Secretary of the Interior and representatives of the soap and detergent industry at which the Secretary urged acceleration of industrial effort to find, test, and utilize phosphate replacements. (January 1968.)

5. Press release by the Soap and Detergent Association, January 11, 1968, in which the SDA stated: "Research on possible substitutes for phosphates in detergents is being vigorously pursued by detergent manufacturers and their suppliers." (Copy attached.)

6. Report by FWPCA, August 1968, recommending continued research on development of phosphate substitutes. (Copy attached.)

(Subcommittee Note.—The report referred to is "Lake Erie Report: A Plan for Water Pollution Control—August 1968." The pertinent statement in that report appears on page 71, under a summary of the recommendations of a technical committee established by the Lake Erie enforcement conferees "to delve into the nutrient problem in Lake Erie." The recommendations were agreed to by each of the States.

The recommendation follows:

"2. Promotion and encouragement of accelerated research and development of a suitable product solution to the detergent-phosphate problem.")

7. Visit by joint task force to industry facilities in New Jersey, April 1969. Work on testing procedures for new detergent builders was discussed and viewed at both Lever Brothers and Colgate-Palmolive. Oral remarks by Interior representatives urging accelerated effort and assurances of vigorous action by industry were exchanged.

8. Letter to president of the Soap & Detergent Association by FWPCA's Assistant Commissioner for Research and Development urging research on phosphate replacements, November 21, 1969. (Copy attached.)

9. Meeting of joint task force at University of Wisconsin, November 26, 1969, at which time FWPCA's Assistant Commissioner for Research and Development orally conveyed Interior's urging for faster effort on phosphate replacement to industry representatives.

10. Visit by joint task force to industry facilities in Cincinnati, Ohio, December 9, 1969. Work on development of phosphate replacements was viewed at Procter & Gamble and, once again, strong urging for acceleration of industry's effort was given. Procter & Gamble officials stated that "major effort" was being given to the problem.

U.S. Department of the Interior,
Office of the Secretary,
Washington, D.C., June 19, 1967.

Mr. Walter Hahn,
Vice President, Colgate-Palmolive Co.
New York, N.Y.

Dear Mr. Hahn: There have been a number of developments recently, such as the Lake Erie enforcement conference, which have indicated the need for accelerating research into the development of suitable substitutes for phosphates in detergents. I recognize that this is a subject of considerable concern to you, as it is to us. For this reason, I have asked the Soap and Detergent Association to assist me in setting up a meeting on this subject with their key members. At their suggestion, I will be sending you a formal invitation to attend this meeting some time during the month of July. I would particularly like to have you and your research director present. The importance we place on this meeting is evidenced by the fact that Secretary Udall will be an active participant.

I would like to assure you that the purpose of the meeting will not be one of "blaming anyone," but rather to discuss the need for such research and to attempt to arrive at a mutual agreement as to what each of us can do.

I will be in touch with you shortly by telephone to discuss this further. If you feel it is desirable, I would be happy to meet with you in person.

I hope that you will find it convenient to attend.

Sincerely yours,

Frank C. Di Luzio,
Assistant Secretary.

Identical letters sent to:
Economics Laboratory, Inc. (Bart Osborn).
Lever Brothers Co. (Milton Mufford).
Procter & Gamble Co. (Rowell Chase).

Purex Corp. (Lt. Bill Tincher).

Soap & Detergent Association (E. Scott Pattison).

Walter Hahn, vice president, Colgate-Palmolive Co., 300 Park Avenue, New York, N.Y. 10022.

Bart Osborne, president, Economics Laboratory, Inc., 250 Park Avenue, New York, N.Y. 10017.

Mr. Milton Mumford, chairman of the board, Lever Brothers Co., 390 Park Avenue., New York, N.Y. 10022.

Rowell Chase, vice president, Procter & Gamble Co., Post Office Box 599, Cincinnati, Ohio 45201.

William Tincher, president, Purex Corp., Ltd., 5101 Clark Avenue, Lakewood, Calif. 90712.

E. Scott Pattison, president, Soap and Detergent Association, 475 Madison Avenue, New York, N.Y. 10022.

U.S. DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D.C., June 8, 1967.

Memorandum to the Secretary.
From: Assistant Secretary for Water Pollution Control.
Subject: Substitutes for Phosphates in Detergents.

The recent Lake Erie enforcement conference report recommended that the soap and detergent industry and the Federal Government should encourage research and development to find a suitable substitute for phosphates in detergents. This is a particularly urgent need because the major pollution problem in Lake Erie results from excess algae which are stimulated by nutrients and especially phosphorus. Municipal wastes going into the lake and responsible for 80 percent of the phosphorus content and about 66 percent of the phosphorus in these wastes comes from detergents.

This problem is not confined to Lake Erie but exists in varying degrees all over our country. It is true that there are other sources of phosphates besides detergents and that these must also be controlled. It is also true that we are working to develop a technique for removing phosphates from water. Nevertheless, one of the most effective methods of controlling pollution is to prevent the phosphates from getting into the wastes or water in the first place.

In this regard, there is some research underway at the present time by the soap and detergent manufacturers aimed at finding substitutes for phosphates. This research must be accelerated because we need the answer today, not 10 years from now. The time may soon come when it may become necessary to limit the amount of phosphates in soap and we should be ready to replace them. This can happen only if intensive research is underway right now.

As per our discussion of last evening. I am calling a meeting of the presidents and research directors of a number of the soap and detergent manufacturers to discuss this subject, and specifically what their industry and the Federal Government can do to rapidly expand research on phosphate substitutes. The meeting will be held at the Interior Department at your convenience, some time during the weeks of July 10 or July 17.

An address by you to this group will be extremely helpful in setting the tone of the meeting and in spurring them on to accelerate their efforts.

FRANK C. DI LUZIO.

U.S. DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D.C., July 13, 1967.

Mr. WALTER HAHN,
Vice President, Colgate-Palmolive Co.,
300 Park Avenue, New York, N.Y.

DEAR MR. HAHN: This letter is being written as a follow-up to my communication to you of June 19, 1967, concerning the meeting that will be held here on the subject of research into the development of suitable substitutes for phosphates in the detergents. I am happy to inform you that we have had an excellent response from the key members of your industry as well as from the Soap and Detergent Association. Informal conversations with the Soap and Detergent Association have led us to an agreement that this meeting will be held in Secretary Udall's conference room, room 5160, on July 31, 1967, 10:30 a.m.

The tentative schedule for the day is as follows:

10:30: Presentations by the Department of the Interior and detergent manufacturing companies.

12:00 to 1:30: Lunch break.

1:30 to 4:30: Informal discussion and summary.

The response from the people we have contacted has been very encouraging. We are looking forward to your participation in this meeting.

Sincerely yours.

FRANK C. DI LUZIO,
Assistant Secretary.

Identical letter sent to:

Bart Osborne, president, Economics Laboratory, Inc., 250 Park Avenue, New York, N.Y.

Mr. Milton Mumford, chairman of the board, Lever Brothers Co., 390 Park Avenue, New York, N.Y.

Rowell Chase, vice president, Procter & Gamble Co., Post Office Box 599, Cincinnati, Ohio

William Tincher, president, Purex Corp., Ltd., 5101 Clark Avenue, Lakewood, Calif.

E. Scott Pattison, president, Soap and Detergent Association, 475 Madison Avenue, New York, N.Y.

REMARKS BY FRANK C. DI LUZIO, ASSISTANT SECRETARY OF THE INTERIOR FOR WATER POLLUTION CONTROL, BEFORE REPRESENTATIVES OF THE SOAP AND DETERGENT INDUSTRIES, JULY 31, 1967

I want to add my thanks for your cooperation in meeting with us today. We hope this conference will prove to be the constructive beginning of a coordinated industry-government effort to abate nutrient pollution of our waters.

If we work together to find suitable substitutes for phosphates in detergents, our joint progress will be considerably greater than the sum of separate, piecemeal efforts.

Each of us has pieces of the phosphate pollution puzzle. We both have information and will continue to develop answers on phosphates as they affect the quality of our waters. So today, we would like to prepare to put those pieces of work and interest together, and accelerate both, to solve much of the puzzle of nutrient pollution.

We want to make it clear from the beginning that we do not think that finding substitutes for the phosphates in detergents is the total answer to nutrient pollution.

It will not even be the total answer to phosphate pollution. There are serious effects from phosphates from other sources—municipal sewage, industrial wastes, agriculture run-offs, atmospheric sources, and subusrface drainage. But your products are a significant part of the phosphate problem.

There are serious water pollution effects, too, from other nutrients—principally nitrogen compounds.

The complete answer to nutrient pollution of lakes, rivers, and estuaries, we recognize, must include solutions to all these segments.

All these answers are not now available, which, I might add, becomes increasingly clear to those residents along the banks of Lake Erie, Lake Sebasticook, or the Potomac estuary, for instance.

The Department of the Interior is vigorously working to develop answers to other segments of the total solution. We are stepping up our liaison with other industries to develop answers to their particular segments of the problem. For example, later this week, Jack Bregman, one of my Deputy Assistant Secretaries, and Leon Weinberger, Assistant Commissioner for Research and Development of the Federal Water Pollution Control Administration, will be meeting with representatives of the Department of Agriculture, the U.S. Chamber of Commerce, and the American Farm Bureau to set up a conference to attack the problem of eutrophication of lakes by agricultural products.

Our research and development programs have filled some of the information gaps on the complex problem of pollution and eutrophication. Our research will continue. We want to share this information with you to augment your research and development efforts and continue to fill the information gaps.

We do, however, have sufficient knowledge *now* of the pollution and eutrophication problem to know that action must *begin immediately* to limit phosphates

added to our waters. Whenever possible, we are emphasizing tertiary treatment plants. We know, too, research is necessary to further limit phosphates in detergents.

To give you a clearer idea of the nature and extent of our studies, relating to nutrient pollution either in-house, contract or through grants, I would like to list our areas of inquiry for you:

A. Effects of pollution discharges on water quality

1. Environmental requirements of algae or stimulation of algae growths by pollutants.
2. Nitrogen and phosphorous and other growth elements including trace elements.
3. Critical elements from stimulation or control point of view.
4. Ecological effects—interrelationship among various organisms and their environments—disturbance of proper balance.
5. Natural and man-induced eutrophication.

B. Source of pollutants

1. Natural:
   - (*a*) Runoff.
   - (*b*) Birds.
2. Manmade:
   - (*a*) Agriculture-runoff, including irrigation return flows.
   - (*b*) Industry.
   - (*c*) Municipalities.
     - (1) Detergent.
     - (2) Foods.
     - (3) Runoff.
     - (4) Fertilizer.
   - (*d*) Mining.
   - (*e*) Dredgings.
   - (*f*) Vessels.
   - (*g*) Individual homes treatment units.
   - (*h*) Animal wastes.

C. Fate of pollutants

1. Dynamics:
   - (*a*) Lake dynamics.
   - (*b*) River dynamics.
   - (*c*) Coastal water dynamics.
   - (*d*) Ground water.
2. Chemical, physical and biological aspects.

D. Treatment

1. Improvements of existing treatment processes.
2. Additions to existing treatment plants.
3. New treatment methods.
4. Biological and chemical methods.
5. Algae ponds.
6. Soil treatment.
7. Industrial waste treatment.

E. Other control methods

1. Elimination at source through process or product modification.
2. In-stream, in-lake treatment.
3. Lake modification:
   - (*a*) Mixing.
   - (*b*) Dredging.
   - (*c*) Harvesting.

F. Institutional problems

1. Sociological
2. Economic
3. Political

This research is vital and will continue to give us a more complete answer to the nutrient pollution puzzle.

But nutrient pollution is complex. We may never develop the absolute answer.

And, we cannot postpone action until every fact is in. The problem is severe and will not wait for perfect knowledge. If we wait for perfect knowledge, our lakes may be dead, estuaries completely clogged, and fish and wildlife habitat destroyed.

The problem demands action today, using the knowledge we have. And, I want to reemphasize, I think *we do have sufficient knowledge to begin.* We know that phosphates are a serious pollutant, excessively fertilizing aquatic plants. We know the sources of these phosphates, in large part, and that they must be controlled.

Now we seek specific information—substitutes and controls for those phosphates. This we hope the soap and detergent industry—working with the Department of the Interior—will undertake.

We hope our cooperation and progress will encourage other industries that also contribute to nutrient pollution—phosphate companies, chemical and petroleum companies, fertilizer manufacturers and the agriculture industry—so they will also initiate and maintain a vigorous effort as well.

I would like to recommend specific ways in which I believe the Department of the Interior and its Federal Water Pollution Control Administration, can work with your industry for phosphate solutions. I point them out as guide-posts in the hope that we both can follow them to a mutually useful goal.

(1) A Federal-industry technical committee can be established to exchange information secured from past and future research and development programs. Also, to exchange information on the direction of those efforts so that duplication of work is avoided.

(2) Cooperative research between industry and Government.

(3) Joint research in Government or industry labs, or joint supported contract and grant research.

(4) Federal grants and contract directly to the soap and detergent industry or to contractors on subjects deemed mutually beneficial.

(5) Industry support research that is planned and coordinated with Federal efforts.

We welcome your specific recommendations on each of these means to a cooperative, coordinated forward move to better detergent products and cleaner waters.

WASHINGTON, D.C., January 11.—Following a meeting today between Secretary of the Interior Stewart L. Udall and industry representatives, the Soap & Detergent Association issued the following statement:

"Research on possible substitutes for phosphates in detergents is being vigorously pursued by detergent manufacturers and their suppliers. Because of the possible effect of phosphates in detergents on eutrophication the Department of Interior has urged that this effort be intensified.

"Concurrent with its work on possible replacements for phosphates, the industry is supporting, jointly with the Government, programs dealing with the removal or control of nutrients through sewage treatment and other means. Since this will remove most nutrients, including phosphates, these programs will be a major contribution to combating eutrophication. The search for a phosphate substitute is being undertaken in the context of this broader effort. It should be emphasized, however, that an extensive amount of work to date has failed to uncover a phosphate substitute which will yield detergents to satisfy the health, cleanliness, and sanitation requirements of housewives and industrial users. Therefore, it is the industry's considered judgment that removal or control of nutrients through sewage treatment and other means is the most important approach and will likely be the most fruitful in the overall effort to control eutrophication.

"In addition to the formulation difficulties, there is no assurance that phosphate replacement, even if made possible by a satisfactory substitute, would be useful in solving the eutrophication problem. Key to this question is the development of a test method to determine the algal growth potential of various chemicals in our natural waters. Moreover, the industry must guard against actually worsening eutrophication by using a substitute which might have deleterious effects.

"The Joint Task Force composed of Department of the Interior and detergent industry representatives recently announced that a procedure for measuring algal growth potential will be developed by scientists from the detergent manufacturers and their suppliers, and Federal Water Pollution Control laboratories, as well as university experts and independent research institutes. The detergent industry heartily endorses this move and will give it full support."

U.S. DEPARTMENT OF THE INTERIOR,
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION,
Washington, D.C., November 21, 1969.

Mr. E. SCOTT PATTISON,
President, Soap & Detergent Association,
485 Madison Avenue, New York, N.Y.

DEAR MR. PATTISON: Thank you for your letter of October 17, 1969, to Commissioner Dominick, in which you asked for his views concerning a recommendation by an advisory group to the International Joint Commission that calls for the immediate reduction of the phosphorus content of detergents and their complete replacement not later than 1972. Commissioner Dominick has asked that I provide you with the following discussion which covers the present thinking of the Federal Water Pollution Control Administration concerning the banning of phosphates in detergent formulations.

We believe that the reduction or elimination of phosphorus from detergents is desirable in concept but inappropriate for implementation *at this time.* The reason is primarily that the reduction or elimination of phosphorus in detergent formulations would undoubtedly require the replacement of phosphorus with some substitute material. The substitutes could conceivably be equally stimulating with regard to algal growth. It is even possible that these materials or their degradation products could cause other, more severe, pollutional effects than phosphorus in receiving waters. Specific substitute materials must be identified and characterized and we must then make careful predictions as to whether or not conventional or proposed treatment systems would be capable of removing their pollutional effects. Moreover, we already have a reasonably sound knowledge of the effects of phosphorus on water quality and the threshold concentrations at which these effects begin and we have waste treatment technology now available which is capable of removing phosphorus at high efficiency from municipal wastes. Taking these matters into account, we do not believe that the introduction of a new type of potential contaminant into municipal waste water (that is, phosphate substitutes) should be forced by legislative edict until we can be assured that the step will lead to an improved and not a worsened water environment. Once this can be shown, and we are working with a real sense of urgency on developing the needed evaluative tests, we believe that reducing the amount of phosphorus in detergent formulations or even eliminating phosphorus altogether from washing products would make a real contribution to pollution control in the United States. We hope and expect that industry is now working intensively on the development and characterization of phosphate substances.

We are convinced that drastic reductions in the discharges of nutrient materials to many of the Nation's waters are required at the earliest possible date. These nutrient materials come from multiple sources and their pollutional contributions are essentially additive. Control of this type of pollution from all sources—municipal, industrial, and agricultural—must be achieved, and all available control methods must be applied in optimum combination to reduce nutrient waste loads if we are to effectively attack the problem of man-induced eutrophication. As I am sure you are aware, a concerted effort by our advanced waste treatment research program has already brought a variety of new treatment processes for removal of phosphorus from waste water to the point of practical applicability. Waste treatment is, however, only one approach to the reduction or elimination of phosphorus in municipal waste effluents; elimination of pollutants at the source must also be considered. It is in this category, of course, that reduction or elimination of phosphorus from detergent compounds fails.

As pointed out above, we believe this "is desirable in concept." Furthermore, we believe this action should be taken where needed at the very earliest possible time at which we can determine that phosphate substitutes will improve and not degrade water quality in comparison with phosphates themselves.

Our disagreement with recommendation 2(a) of the Advisory Group to the IJC is only that it calls for banning phosphates without any recognition that substitute materials *must be less harmful* from a pollutional standpoint. If this recommendation were couched in terms which would prevent substitution by materials more damaging than phosphates to the water environment, we would endorse it and even recommend an earlier date for conversion. Our present concern, however, is simply that substitute materials cannot yet be adequately evaluated with regard to their "eutrophicationability." Recognizing this, we have given first priority in our National Eutrophication Research Program to the development of a test procedure which could be used for this and other related

purposes. This effort, in which industry shares through the Joint Industry/Government Task Force on Eutrophication, is presently focused on the laboratory development of a provisional Algal assay procedure. We are hopeful that this PAAP test will be ready for field testing during 1971 and that it will be available for practical use in 1972. Once available, we believe that this test, in conjunction with other assay procedures for biodegradability, toxicity, etc., will enable rational judgments to be made as to the potential benefits or detriments to water quality of proposed phosphorus replacements. As soon as this test becomes available, our modifying clause, "but inappropriate for implementation *at this time*," will be withdrawn and we shall consider "phosphate replacement" by less harmful substitutes as a viable candidate method for pollution control along with waste treatment.

We are aware from past assurances given to this Department by the Soap and Detergent Association that many of the individual firms within your industry have been vigorously pursuing the development and performance evaluation of phosphate substitutes. We firmly believe that the burden of developing satisfactory phosphate substitutes must lie primarily with your industry and we expect that such efforts by the soap and detergent industry will be continued and even accelerated. I hope you will convey this expectation to your member firms.

Sincerely yours,

DAVID G. STEPHAN,
Assistant Commissioner, Research and Development.

Mr. REUSS. Mr. Vander Jagt, do you have further questions?

Mr. VANDER JAGT. No.

Mr. REUSS. Mr. McCloskey?

Mr. MCCLOSKEY. I just have one.

In response to that last statement you made, that the phosphates in any given product may vary from 15 to 60 percent—I take it that is the choice of the company that manufactures it—do you have any knowledge as to whether the detergent manufacturers market these things regionally—for example, a 60-percent product going into a hard water area, a 15-percent product going into a soft water area?

Dr. STEPHAN. I don't have any first hand knowledge. I assume so.

Mr. MCCLOSKEY. You assume this is so. If it turned out in later testimony that we get from the industry representatives themselves that this marketing is not done regionally, would there be any way to limit, other than through Federal regulation, from your standpoint?

Do you see what I am getting at?

Dr. STEPHAN. Yes.

Mr. MCCLOSKEY. If they are sending 60-percent phosphate compounds into areas they only require 15, there would be no way to limit them to a 15-percent product, say in the Pacific Northwest or the New England States, except by Government regulation, would there?

Mr. DOMINICK. I know of no other way, no.

Mr. KLEIN. I think only the Congress can regulate interstate commerce and it would have to be an act, obviously starting from the studies of this subcommittee.

Mr. MCCLOSKEY. Mr. Klein, I get the impression sometimes that the Congress, reflecting the people's insistence, is sometimes ahead of the administrative agencies in moving to this type of regulation. And we could use some expert guidance from your Department as to which laws and which appropriations you might need to give this new priority that the people of the country and apparently the White House are demanding.

Let me ask you finally: You have $46 million for research on this subject this year. What did you request from the Government in your budget request?

Mr. DOMINICK. For fiscal year 1970?

Mr. MCCLOSKEY. This year—the year you got the $46 million—what was your request for what you felt was adequate?

Mr. DOMINICK. I believe we went forward with about a $48 or $49 million request.

I would point out that the $46 million is for the total research, development, and demonstration program, not just on the problems of municipal wastes.

Mr. MCCLOSKEY. I appreciate that. But the Secretary stated that Congress would have to change the law. In order to change the law, to give you more money or to recognize a changing priority, you should be the expert to tell us what you need. Then if we don't give it to you, the burden is on Congress, rather than on your Department for failing to give this the priority we insist on.

Mr. KLEIN. Yes, sir; I think you will be hearing from us. And that is not because of the testimony this morning; it is well underway, sir.

Mr. MCCLOSKEY. Thank you.

Mr. REUSS. Just one question of Commissioner Dominick.

Commissioner, are you familiar with the bill I introduced last June which would require the detergent industry to produce a substitute for phosphate within 2 years of enactment?

Mr. DOMINICK. Yes, I am.

(Subcommittee Note.—Congressman Reuss' bill, H.R. 12435, is printed as appendix 1 of this hearing record.)

Mr. REUSS. On August 4, 1969, you issued a memorandum to all of the assistant commissioners and regional directors in the Federal Water Pollution Control Administration from which I would like to quote:

"Increasingly," your memorandum said, "questions are being raised concerning the desirability of banning phosphorus from detergent formulations as a means of reducing nutrients in municipal wastes. I am sure that a variety of individual views exist on this question within the agency. However, the following material is presented for your guidance in responding for the agency to questions on this subject." You then go into position, which is "The reduction or elimination of phosphorus from detergents is desirable in concept but undesirable for implementation *at this time*. For the above reasons," you conclude, "we do not believe that the imposition of a requirement for the reduction or limitation of phosphorus should be initiated at this time. I hope the above information will be of use to you * * *."

Now, my question is: Wouldn't it be just as well to let the officials in the Federal Water Pollution Control Administration hold the view that I do—which is that phosphates cause lakes to die, that the detergent industry is the biggest contributor of phosphates, and that therefore the detergent industry ought to be given some sort of a deadline for developing substitutes that don't kill lakes. Wouldn't it have been a good idea to allow those respected officials of the Federal Water Pollution Control Administration who happen to agree with me the right to say so?

Why silence them? They could be right.

Mr. DOMINICK. We agree, Mr. Chairman; if this is in any way construed as an attempt to silence the people in the agency, let's dispel

that right now. This was a guidance memorandum which was issued on the basis of the best scientific evidence we had at the time.

I would be happy to hear from anyone within the agency whose view differs from this view, and I will be looking for that sort of comment.

Mr. REUSS. I am very glad to hear that. And I am grateful to you, as I am to Secretary Klein and the other witnesses. While we obviously do disagree with the Department of the Interior on the priority which it is now according to the removal of phosphates from detergents—a leading source of lake eutrophication—I nonetheless am most pleased by the cooperative spirit that you all have shown; and if you don't mind this committee working with you, hopefully we can move a little faster.

Mr. KLEIN. Sir, knowing how this committee works, I think the job will get done a little faster; and that will please me, too.

Mr. REUSS. Thank you very much.

Mr. KLEIN. I think you will put the pressure on to get the job done.

(Mr. Dominick's prepared statement and the attachment thereto follow:)

PREPARED STATEMENT OF DAVID D. DOMINICK, COMMISSIONER OF THE FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, DEPARTMENT OF THE INTERIOR

Mr. Chairman and members of the subcommittee, let me now address in more detail the question of removing phosphate builders from detergents and the rationale behind our statement that we believe the reduction or elimination of phosphorus in detergents is essential but inappropriate for implementation at this time.

Current usage of detergents in this country amounts to approximately 10 pounds per capita or 4 to 5 billion pounds per year. Of this amount, some 40 percent is sodium tripolyphosphate builder. This is the equivalent of 0.4 to 0.5 billion pounds per year of elemental phosphorus.

The change from alkyl benzene sulfonates (ABS) to the straight change linear alkyl sulfonates (LAS) represented the change of an ingredient which constituted about 20 percent of the detergent formulation. This change, although very significant, involved only modification or the surfactant molecule, not complete substitution. Nonetheless, extensive testing to assure that the new molecule was biodegradable under all circumstances under which it might occur in the environment was required before the product could be put on the market. The necessary test methods were either available from work on the ABS or were readily developed as the biological phenomena involved were well known.

Only after exhaustive testing was it found acceptable to release into the environment a quantity of the highly biodegradable LAS which is roughly half the amount of material involved in our current discussion.

The problem of finding a substitute builder involves the development of an entirely new material. As it is reasonable to expect that the substitute builder would be used to the same extent as the present builder, we face the introduction of close to 2 billion pounds of a new, relatively unknown, material into the environment each year.

The problem is further complicated by the fact that the biological phenomena related to eutrophication are not as well understood as the biological degradation process. It is because of the magnitude of the possible adverse impact of a hastily chosen substitute for the present phosphorus builders that we feel it is critical that new builder materials be introduced only after thorough evaluation to avoid the creation of an even more undesirable situation.

Let me make the record absolutely clear on this question. We are firmly convinced that drastic reductions in the discharges of nutrient materials to many of the Nation's waters are required at the earliest possible date. These nutrient materials come from multiple sources and their pollutional contributions are essentially additive. Control of this type of pollution from all sources, municipal,

industrial, and agricultural, must be achieved and all available control methods must be applied in optimum combination to reduce nutrient waste loads if we are to effectively attack the problem of man-induced eutrophication. A concerted effort by our advanced waste treatment research program has already brought a variety of new treatment processes for removal of phosphorus from waste water to the point of practical applicability. Waste treatment is, however, only one approach to the reduction or elimination of phosphorus in municipal waste effluents; elimination of pollutants at the source must also be considered. It is in this category, of course, that reduction or elimination of phosphorus from detergent compounds falls.

As pointed out above, we believe this is essential in concept. Furthermore, we believe this action should be taken where needed at the very earliest possible time at which we can determine that phosphate substitutes will improve and not degrade water quality in comparison with phosphates themselves. This leads to our disagreement with any recommendation that calls for banning or reducing phosphates without any recognition that substitute materials must be less harmful from a pollutional standpoint. If such a recommendation were couched in terms which would prevent substitution by materials more damaging than phosphates to the water environment, we would strongly endorse it. Our present concern, however, is simply that substitute materials cannot yet be adequately evaluated with regard to their "eutrophicationability." Recognizing this, we have given first priority in FWPCA's national eutrophication research program to the development of a test procedure which could be used for this and other related purposes. This effort, in which industry shares through the Joint Industry/Government Task Force on Eutrophication, is presently focused on the laboratory development of a provisional algal assay procedure. We are hopeful that this PAAP test will be ready for field testing during 1971 and that it will be available for practical use in 1972. Once available, we believe that this test, in conjunction with other assay procedures for biodegradability, toxicity, etc., will enable rational judgments to be made as to the potential benefits or detriments to water quality of proposed phosphorus replacements. As soon as this test becomes available, our modifying clause, "but inappropriate for implementation *at this time*," will be withdrawn and we shall consider phosphate replacement by less harmful substitutes as a necessary candidate method for pollution control, along with waste treatment.

Because of the above situation, no schedules have yet been developed for the gradual reduction of the phosphate content of detergents. The Department of the Interior has, however, been assured by the Soap and Detergent Association that the individual companies of that industry have been vigorously pursuing the development and performance evaluation of phosphate substitutes for some time. We firmly believe that the burden of developing satisfactory phosphate substitutes must lie primarily with industry, and we have repeatedly conveyed our expectation to the Soap and Detergent Association that efforts to develop satisfactory phosphate substitutes will be continued and even accelerated.

The Federal Water Pollution Control Administration has attempted to stimulate industrial effort on this problem. The causative role of phosphorus in many pollution situations, for example, in Lake Erie or here in Washington in the Potomac estuary, has been emphasized by FWPCA witnesses at enforcement hearings, an Information Center on Eutrophication jointly supported with industry has been established, biodegradability tests for organic chelating agents which might be used to replace phosphates have been developed, and FWPCA is even supporting a research contract specifically for the development of phosphate replacement materials. An interim progress report on this effort is available at this time and is attached as an appendix to this statement.

Appendix.—Project Summary—Development of Phosphate-Free Home Laundry Detergents (IITRI Project No. C 6194, FWPCA Contract No. 14–12–575)

I. INTRODUCTION

Eutrophication of the Nation's lakes has become a great problem and while all ramifications of the origins of algae bloom have not been entirely established, it appears certain that the combination of phosphates and nitrogenous wastes in sewage help to fertilize this growth. Though it appears unlikely that the phosphate contribution has a single origin, it would seem logical that a large contribution of this pollutant comes from household detergents.

II. OBJECTIVE

Our work is directed toward the elimination of phosphates from household detergents. Our objective is to set up and evaluate several model systems of home laundry detergents from which condensed phosphates have been eliminated. We do not intend to create finished consumer products; the aim is to point the way to a different concept of formulation for household detergents which does not incorporate the use of phosphates or other potentially objectionable water pollutants.

We hope to achieve this goal primarily through the use of biodegradable surfactants which are expected to be either self-chelating or which do not require chelating agents and the incorporation of various inorganic and/or organic salts which will take over the functions of the excluded phosphates.

III. SCOPE OF THE PROGRAM

To compensate for the elimination of phosphates from detergent formulations part of the overall approach of this project involves the systematic investigation of the effects produced by replacing all, or part of, the currently used linear alkylbenzenesulfonate (LAS) surfactant with four different types of surfactants. Thus, phase I of our program consists of the synthesis of these candidate surfactants. A requisite for thorough evaluation of any of these surfactants is sufficient biodegradability. Phase II consists of the biodegradability evaluation of these materials by known, accepted techniques. Initially, the convenient presumptive (shake culture) test will be used. Where the result of this test is inconclusive, the confirming test will be applied to determine the biodegradability of the surfactant in question. The test result for a given surfactant is compared to that of a commercial LAS control sample.

In phase III, the surfactants are incorporated into phosphate-free detergent formulations. The first test formulation allows us to judge and compare the effectiveness of the candidate surfactants. They will then be incorporated into formulations which contain additional acceptable organic and/or inorganic salts for the purpose of improving the cleaning effectiveness. This phase is intimately related to phase IV, detergency evaluations. The cleaning ability of the formulations is evaluated by a method generally accepted by the detergent industry: standard, artificially soiled cloths are washed under controlled conditions using varying concentrations of the formulation; the whiteness of the washed cloths is then compared to that of the unwashed fabric by the use of a reflectometer which measures the reflectance of the cloth. Although the test values can be compared directly, a plot of percent soil removal (PSR) against surfactant concentration yields a graph from which one can better judge the overall cleaning effectiveness. The cleaning ability of the test formulations is compared to that of a reference standard phosphate containing formulation supplied by the Association of Home Appliance Manufacturers (AHAM) and to the results obtained when using LAS in the same test formulation.

IV. SUMMARY OF WORK TO DATE

Five of the eight candidate surfactants have been synthesized. These represent all members of types I and II as well as the first surfactant of type III. Chemical analyses have established the structural features and purity of these materials. Biodegradability evaluations, detergency formulation work and detergency testing were initiated simultaneously on four of these five products.

At this time, the data has been evaluated for only one of these materials. At the lowest concentration tested, Test formulation I–II (T.F. I–II), containing surfactant II (methyl 3-dodecylbenzoyl-3-(sodium sulfonate) propionate ($C_{12}H_{25}$-C_6H_4-COCH-(SO_3Na)$CH_2CO_2CH_3$) is almost as effective as the phosphate containing reference standard (AHAM–2A). Its cleaning ability at this concentration exceeds that of the same test formulation which incorporates LAS (T.F. I–LAS). However, the detergency of T.F. I–II levels very rapidly so that this value soon falls slightly below that of AHAM–2A and T.F. I–LAS. Comparison of T.F. I–LAS to AHAM–2A shows that the former is less effective than AHAM–2A at all concentrations. These detergency studies were performed using Chicago wash water which has a hardness of 130 ppm.

The biodegradability of surfactant II is disappointing. The presumptive test shows a value of only 79.7 percent. A material is deemed biodegradable if its

degradation is greater than 90 percent and is considered insufficiently biodegradable if this value is less than 80 percent. Since an 80- to 90-percent loss of surfactant in this test is termed an inconclusive result, surfactant II is only three-tenths of a percentage point away from being eligible for the confirming test. If a repeat of the presumptive test supplies a value between 80 and 90 percent the confirming test will probably be performed in order to evaluate this property conclusively. In the meantime we will not use this product for further indepth formulation and detergency studies.

We are currently analyzing the biodegradability and detergency data for three of the four remaining candidate surfactants which we have prepared.

Mr. REUSS. The committee will now stand in recess until 2 o'clock.

(Whereupon, at 12:50 p.m., the subcommittee was recessed, to reconvene at 2 p.m., this same day.)

AFTERNOON SESSION

Mr. REUSS. Good afternoon. The Subcommittee on Conservation and Natural Resources will be in order for a further inquiry into phosphate-based detergents.

We are very happy to have with us this afternoon Mr. Charles G. Bueltman, vice president and technical director of the Soap & Detergent Association; accompanied by Miss Anne Lyng, director of home economics for the Procter & Gamble Co.; Dr. Richard B. Wearn, technical director, Colgate-Palmolive Co.; Dr. Frank H. Healey, vice president, research and development, Lever Bros. Co.; Mr. John A. Bruck, associate director, product development division, the Procter & Gamble Co.; Dr. Clayton F. Callis, director of research and development, Inorganic Chemicals Division, Monsanto Co.

Is that an accurate identification of your associates?

Mr. BUELTMAN. Yes, sir.

Mr. REUSS. Miss Lyng and gentlemen, we are most grateful to have you here. We would now like to ask you to proceed, Mr. Bueltman. Please call on any of your associates as you wish. I should say that there are bells ringing for our attendance on the House floor, and one or the other of us may have to absent himself briefly from the hearings. But don't be disturbed by it; we shall return.

STATEMENT OF CHARLES G. BUELTMAN, VICE PRESIDENT AND TECHNICAL DIRECTOR OF THE SOAP & DETERGENT ASSOCIATION; ACCOMPANIED BY ANNE LYNG, DIRECTOR OF HOME ECONOMICS, PROCTER & GAMBLE CO.; RICHARD B. WEARN, TECHNICAL DIRECTOR, COLGATE-PALMOLIVE CO.; FRANK H. HEALEY, VICE PRESIDENT, RESEARCH AND DEVELOPMENT, LEVER BROS. CO.; JOHN A. BRUCK, ASSOCIATE DIRECTOR, PRODUCT DEVELOPMENT DIVISION, PROCTER & GAMBLE CO.; CLAYTON F. CALLIS, DIRECTOR OF RESEARCH AND DEVELOPMENT, INORGANIC CHEMICALS DIVISION, MONSANTO CO.

Mr. BUELTMAN. If I may, I would like to ask your indulgence. I appreciate that my statement is rather lengthy. However, rather than having six individual statements, it was felt best to incorporate it into one comprehensive statement and then the individuals can respond to particular parts.

Mr. REUSS. Your entire comprehensive statement will be, without objection, incorporated in the record. And you may proceed in any way you wish, sir.

Mr. BUELTMAN. Thank you.

Mr. Chairman and members of the subcommittee, I am Charles G. Bueltman, vice president and technical director of the Soap & Detergent Association, on whose behalf I appear today. The association was founded in 1926, and has more than 120 member companies. Their names are attached to my statement. Our membership represents well over 90 percent of the soap and detergent production in the United States. Aside from our overall concern about matters affecting the environment, this industry has a selfish interest in clean water. Its products require clean water to do an effective cleaning job.

Mr. Chairman, I believe it is fair for our industry to say that it has made substantial contributions to the cause of clean water during the past two decades. I need hardly recount to this subcommittee the unique step taken by the detergent manufacturers and their raw materials suppliers in eliminating the portion of stream foaming problems attributed to our products.

As you know, in mid-1965, the industry completed a 10-year, $150 million conversion program, replacing alkyl benzene sulfonate (ABS), the old "hard" surface active agent, with the new "soft" linear alkylate sulfonate (LAS) material. The success of this voluntary changeover to biodegradable detergents has been amply documented in the monitoring data accumulated by Government agencies, and in the published works of academic researchers and others who have attested to the dramatic reductions in detergent residue levels on a nationwide basis. Former Secretary of the Interior Udall said, in commenting on this action:

> The soap and detergent industry merited the thanks of each American by conducting an accelerated program over the past few years to convert from "hard" to "soft" degradable ones.

Our interest in clean water has been manifested in other ways as well. In addition to the support of basic research in specialized areas of waste treatment, we have embarked on a national public education program to help develop public understanding and awareness of the need for adequate waste treatment facilities in every community. A key element in this effort has been the award-winning motion picture, "It's Your Decision—Clean Water," which was cosponsored by the Soap & Detergent Association and the League of Women Voters of the United States.

During the past 3½ years, this film has had 325 television plays and 10,500 other showings before a wide variety of community groups, with a total audience of 15 million viewers. In addition, Federal and State agencies have purchased prints for their film libraries. This motion picture emphasizes that citizens must take an unmistakable stand for the conservation of our clean water resources through control of pollution by supporting the construction of modern sewage treatment facilities.

Further evidence of the interest of the industry in clean water is the retention on the staff of the Soap & Detergent Association of three full-time employees whose training and experience are in this professional

field. I am a sanitary engineer with 21 years of experience in both industrial and domestic waste treatment as well as the general field of water pollution control. My active memberships include the Water Pollution Control Federation, American Water Works Association, American Institute of Chemical Engineers, American Association for the Advancement of Science, and the Long Island Water Conference.

I have also been a member of several State study groups in Maryland, Wisconsin, and New York concerned with water pollution abatement. Additionally, I currently serve as chairman of the Joint Industry-Government Task Force on Eutrophication.

Inasmuch as the Chair did introduce the people with me, I will skip that part of the testimony.

The soap and detergent industry is pleased to respond to your request to furnish facts as well as our views and comments on phosphate-containing detergents and their role in relation to water quality.

As we will demonstrate, phosphates are essential ingredients of today's detergents, which form the basis for the high standards of cleanliness, sanitation and health achieved by homemakers, hospitals, restaurants, and industry.

Although, as I shall discuss in greater detail, the industry is intensively searching for replacement materials, should they be needed, *there is at this time no suitable phosphate replacement available for detergents.*

THE DEVELOPMENT OF DETERGENTS

A brief historical note may be helpful in understanding this point. The first synthetic detergent for household use was marketed in the United States in 1933, and did not contain phosphate, which, however, was an important ingredient in soaps of that day. Because of its cleaning limitations, this brand and others which were subsequently marketed were rejected by the housewife. It was not until after World War II, when phosphates were incorporated into detergents, that the housewife, who is always the final judge of what will and will not clean properly, began to move in the direction of detergents as the product for her washing tasks.

What has happened since is a well-known fact of American life: Today, detergents represent over 90 percent of all cleaning products used in the home. Moreover, this trend toward detergents coincided with a tremendous postwar increase in the use of automatic washers, in the home and in coin-op laundries. Each takes full advantage of the other's attributes.

THE ESSENTIAL ROLE OF PHOSPHATES IN DETERGENTS

Phosphates are important components of detergent products because in combination with other detergent ingredients, phosphates contribute not one but multiple benefits which are vital in detergent performance:

A. The function of phosphates in detergents:

(1) They increase the efficiency of the surface active agent; that is, the biodegradable LAS.

(2) They reduce redeposition of dirt by keeping the dirt particles in suspension.

(3) They furnish necessary alkalinity to insure proper cleaning.

(4) They provide resistance against changes in alkalinity due to water supply or wash load which impair cleaning performance.

(5) They emulsify oily and greasy soils.

(6) They soften water by sequestering; that is, tying up objectionable minerals (iron, calcium, magnesium).

(7) They materially contribute to the reduction of the level of germs on clothes, thereby reducing cross-infection.

To give the housewife equivalent cleaning results, any substitute material or materials must have characteristics which permit it to be readily formulated with other detergent ingredients into a total product which lends itself to convenient and effective use.

B. From a product safety point of view, phosphate is:

(1) nontoxic;

(2) safe for colors;

(3) safe for all fibers and fabrics—particularly important today with so many new synthetic fibers available;

(4) safe for use in washing machines, for example, noncorrosive and nonflammable.

Once again, a substitute material must be just as safe and meet these criteria.

C. From a water quality standpoint, phosphate:

(1) breaks down satisfactorily through hydrolysis in sewage treatment plants and surface waters and thus loses its chelating ability.

(2) does not interfere with other aspects of waste treatment operations.

(3) can be effectively removed in waste treatment plants.

(4) is a material which is part of the natural environment and with which there are years of experience.

If phosphates were removed from detergents, housewives would no longer have available even one of the many heavy-duty detergent products which they have become accustomed to using. This step would be equivalent to setting back health, cleanliness, and sanitation standards many years. They would find it virtually impossible to continue to enjoy the cleaning benefits of the modern automatic clothes washing machines they now own. In addition, the automatic dishwasher would become useless, since highly specialized phosphate-containing detergents are essential in this application. All of the washing appliances used in the home and restaurants are programed for these products.

IMPORTANCE OF PHOSPHATES IN NONHOUSEHOLD APPLICATIONS

In uses outside the home, the removal of phosphates from detergents would adversely affect commercial establishments, hotels, public institutions, and industries. It would wipe out the bulk of the special detergents which now allow food processors, such as dairies and canners, and food vendors to comply with governmental health standards. The high cleanliness and sanitation of public health facilities such as hospitals and nursing homes would be seriously affected.

On the industrial side, phosphate cleaners are widely used, for example, in all phases of metal finishing.

Of course, the principal use of phosphates is in farm fertilizers. Most—about 70 percent—of the phosphate production of this country is used in agricultural fertilizers, approximately 13 percent is used in detergents, and the remaining 17 percent is found in other applications, such as food products, animal feeds, water treatment, et cetera.

Phosphates in surface waters come from many sources, such as fertilizers, runoff from uncultivated lands and forests, human excrement, detergents, and industrial wastes. While efficient processes are known for removing phosphorus from municipal and industrial wastes, a growing body of scientific information leads to the conclusion that the elimination of these phosphorus sources would not be sufficient to reduce the rate of cultural eutrophication.

Furthermore, it clearly follows that the elimination of detergent phosphate alone could not possibly mitigate or diminish excessive algae growth. (See "A Nonmyopic Approach to the Problem of Excess Algal Growths," F. Alan Ferguson, Environmental Science and Technology, March 1968, pp. 188–193.)

(Note: The text of Mr. Ferguson's article is included in app. 2 of this hearing record, pp. 234–240.)

The opinion, therefore, that removal of phosphates solely from detergents would help alleviate the algae problem is not supportable from a technical point of view. The situation is not at all analogous to the foam problem and "hard" surfactants, and I shall comment further on this point later in my statement.

PHOSPHATE AS A NUTRIENT

Scientists know that phosphate is a nutrient and is an essential element in the growth of all plant and animal life both in soil and in water. They also know that there are many other essential nutrients such as nitrogen, carbon, iron, calcium, and so forth, present in the Nation's water resources which similarly are required for the growth of aquatic plants.

In fact, it is well known that in many cases some element other than phosphorus is the controlling factor in algae growth. Famous Lake Tahoe is an example of an oligotrophic lake in which it is now well recognized that algal growth is limited by available nitrogen, not phosphorus. Also, in recent work by Lange (See "Effect of Carbohydrates on the Symbiotic Growth of Planktonic Blue-Green Algae With Bacteria," W. Lange, Nature, Sept. 14, 1967, pp. 1277–1278), the addition of CO_2 produced significant increase in algal growth. In other work, Dr. Lange has demonstrated that the addition of phosphorus did not always increase algal growth. Similarly, it has recently been shown by Kuentzel (See "Bacteria, Carbon Dioxide and Algal Blooms," L. E. Kuentzel, Journal of the Water Pollution Control Federation, October 1969, pp. 1737–1747) that CO_2 is required for algal growth and that without the presence of healthy bacteria living in close association with the algae, they cannot acquire the needed CO_2.

Further work should certainly be done to show whether interruption of this biological cycle, through bacterial control, may not be the most effective way of controlling eutrophication.

(Note: The articles by Dr. Lange and Dr. Kuentzel referred to above are reprinted in app. 2, pp. 241–256, of this hearing record.)

DETERGENT PHOSPHATES IN WASTE WATER

There is no question that detergent phosphates enter surface waters through effluents from sewage treatment plants. However, the amount of phosphate contributed by detergents is only a portion of the amount contributed by other sources, such as human excrement and industrial wastes. As previously noted, there are no definitive data establishing the impact of *detergent* phosphates on algal growth.

The fact is that hunderds of scientists are working at this very moment to define the nature and extent of the overall eutrophication problem, and attempting to come up with solutions. The development and testing of the Provisional Algal Assay Procedure, to which the detergent industry has made a major contribution through its participation in the Joint Industry/Government Task Force on Eutrophication, has the highest priority. It is only when such a standardized procedure becomes available that scientists will be able to evaluate fully the actual effect of any material, including potential detergent phosphate replacements, on eutrophication.

Despite the growing technical belief that total removal of phosphates from detergents would have no effect in reducing cultural eutrophication, the suggestion has been made that the phosphate content of detergents be reduced as an emergency measure to limit eutrophication. The levels of phosphate used are those which manufacturers have found necessary to satisfy the American housewife's demand for acceptable cleaning performance. Phosphates are expensive chemicals. Detergents with reduced levels of phosphates would be less expensive to make, if the housewife would buy them. If she were forced to buy products with lower prosphate levels, she very likely will use larger quantities per washload to obtain the degree of cleanliness she expects. This would completely negate any expected reduction in phosphate going into waste waters.

We submit that concentration on one nutrient alone—phosphorus—is highly unlikely to achieve a meaningful reduction in cultural eutrophication. Rather, we believe in, and we are fully supporting, scientific efforts to define the basic causes of eutrophication. Work already has led to approaches to the problem primarily through treatment other than phosphorus control. Maintenance of phosphorus levels sufficiently low to control algal growth may not be possible, due to the contributions from land runoff and bottom muds.

We further submit that efforts to maximize total nutrient removal through advanced waste treatment programs and other programs to minimize total nutrient contributions from other sources, such as agricultural runoff, offer the best opportunity to bring significant relief to the perplexing problem of eutrophication.

THE SEARCH FOR A REPLACEMENT

Notwithstanding the foregoing, the detergent industry has agreed to the Department of the Interior's request to intensify the research effort to seek a phosphate replacement, should one be needed. A great many candidate replacement materials for phosphate have already been investigated to determine their suitability for inclusion in detergent formulations. Several hundred potential nonphosphate builders of various chemical characteristics have been intensively examined to see if they meet essential criteria—cleanability, compatibility with other ingredients, effect on water quality, safety, stability, and so forth. To evaluate each of these factors in depth requires an extensive research and developmental effort, utilizing scientific and technical personnel in company laboratories.

All indications are that the necessary research and developmental effort will continue to be long, costly and complex. Not only must the candidate materials be safe, effective and readily available in large quantities if and when used, they must also have no adverse effect on water quality. Evaluating this last factor is, in itself, a monumental task. The basic knowledge does not exist to develop new procedures, tests and programs to measure the direct and indirect effects on eutrophication, not only of original materials themselves, but of their degradation products as well.

The industry has conscientiously pursued every lead to find chemicals which appear to have all the consumer-required performance of modern-day detergents. So far, the industry has not found a satisfactory substitute which meets the two principal requirements of adequate cleaning performance and demonstrated safety for the environment at the very high usage which would be required. Some materials have shown promise and deserve mention here.

NTA

One widely discussed new builder is nitrilotriacetate (NTA). There is considerable interest in NTA at this time, but primarily in its value as a material which can be used in conjunction with phosphate in detergents. Limited amounts of NTA have been incorporated in certain formulations to enhance product performance. This use is based solely on its value as a subsidiary detergent builder. From a water quality standpoint, studies have shown that NTA, at the current low levels of use, degrades biologically in waste treatment processes and in surface waters, and that it raises no aquatic toxicity problems. However, it has not yet been tested sufficiently in the new physical-chemical waste treatment processes recently suggested by the FWPCA. Furthermore, there are still questions about the effect of large quantities of NTA on such environmental factors as algal growth. In this regard, the industry shares a common concern with the FWPCA that it would be irresponsible to introduce large quantities of NTA or any other new material without full knowledge of its environmental effects.

Let me reemphasize that the rationale for NTA's use at this time is on the basis of its contribution to improved product performance in formulations which are still based primarily on phosphate builders.

POLYCARBOXYLATES

Another class of materials showing promise are the polyelectrolytes, specifically the polycarboxylates. Work has not progressed far enough at this point to estimate the value of these compounds as possible phosphate replacements. But early indications are that, in addition to performance weaknesses, these materials will not meet the necessary biodegradability standards.

STARCH

An example of the difficulties that illustrate the complexity of the search for a phosphate replacement is the failure of a material derived from starch. Candidate materials were developed from starch to function as a detergent builder, but it has now been found that when starch is so modified, it becomes nonbiodegradable. This nonbiodegradability factor raised the possibility of adding a chelating agent to our waters which could not be removed. Thus, it might accumulate and increase in concentration, thereby upsetting the solubility limits of heavy metals and other balances in surface waters. It could even affect drinking water quality. Further work may eliminate this difficulty, but at the moment starch has lost most of its luster.

In another approach, studies have been limited to those materials containing only carbon, hydrogen, and oxygen in an attempt to minimize any effect of product residues on water quality. Even this approach could be questioned on the grounds that carbon inputs, as noted earlier, also contribute to the growth of bacteria and algae. This fact is mentioned merely to underline the complexity of the problem.

THE COMPLEXITY OF DEVELOPING NEW COMPOUNDS

Should any new materials show promise in the laboratory, the road to broadscale use in detergents is an involved and extremely complex one. The potential effects on water quality of any new ingredient to be used in very large quantities must be studied in long-term experiments in actual lake or stream conditions in order to guarantee that it will have no adverse effects. But before such a test can be undertaken, the material must be examined in extensive laboratory studies to establish safety for human beings, safety for washing machines, fabrics, finishes and surfaces, the stability of the ingredient on the shelf and during use by the consumer, and extensive market tests would have to be conducted to confirm predicted consumer acceptability. Repeating for emphasis, if and when the tremendously complicated problem of finding an adequate substitute for phosphate is solved, a long and complex program will have to take place in order to bring the new material through testing to market.

It has been suggested that even if total replacement of phosphates in detergents is not feasible, partial replacement should be undertaken, and that the existence of products on the market containing a low level of NTA is evidence that this can be done. Adoption of partial replacement on a large scale poses many of the problems of safety in use which I have just mentioned in regard to total replacement. As stated earlier, and this would apply to a partial replacement with a material

such as NTA, there is no evidence that any beneficial effect on algal growth levels would result.

ABS/LAS CONVERSION NOT COMPARABLE SITUATION

It has been stated that the phosphate situation is similar to the LAS conversion which the industry completed in 1965. This is not the case. It should be noted that the industry possessed considerable knowledge and know-how concerning the composition of alternate surfactants, when it began its search in 1951 for an answer to the "detergent foam problem." Nevertheless, it still required more than a decade to find a satisfactory replacement for ABS and to develop the technology to permit commercial production of the massive quantities of LAS required to satisfy the large volume requirements. This was true, despite the fact that LAS is a member of the same chemical family as ABS. To find a nonphosphate substitute for today's detergent phosphate is a much more difficult task.

There is another major difference between phosphate residues and surfactant residues which must be considered. The "hard" surfactant was identifiable as a specific cause of foam. In contrast, a causal relationship between detergent phosphate and the level of algal growth has been postulated, but has not been established.

SUMMARY

1. There is no conclusive proof at this time that detergent phosphates are the key element in accelerated cultural eutrophication. Indeed, there is a growing body of facts in scientific circles that nutrients other than phosphates or combinations of nutrients may be much more critical and perhaps more easily controlled in triggering this water problem.

2. Nutrients found in lakes and other surface waters come from many sources, including natural and agricultural run-off, human excrement, industrial wastes, and the atmosphere, as well as detergents. To single out only one nutrient, such as phosphate, is unrealistic in attempting to control the accelerated growth of algae and other symptoms of eutrophication. Rather, attention can and should be focused on total nutrient control or removal. We strongly endorse the FWPCA's advanced waste treatment program for the removal of total nutrients as a significant step forward in controlling cultural eutrophication.

3. The algae problem, in all of its ramifications, is currently under vigorous study by the Joint Industry-Government Task Force on Eutrophication, by Federal and State agencies, by academic institutions, and by the detergent industry. An important activity now underway is the development of a provisional algal assay procedure which will help identify the algal growth potential of various chemicals, including phosphates.

4. Phosphates are absolutely essential to the cleaning power of household laundry and automatic dishwashing detergents and many industrial detergents.

5. Housewives will be deprived of their familiar cleaning products if phosphates are removed from detergents. They would find it vir-

tually impossible to enjoy the cleaning benefits of their automatic clotheswashing and dishwashing appliances.

6. Dairies, hospitals, food producers, meatpackers, public institutions, restaurants, and large and small industries would find it difficult, if not impossible, to meet today's cleanliness and sanitation standards without modern phosphate-based detergents.

7. Finally, the individual detergent manufacturers and their raw materials suppliers have undertaken an extensive program to find possible replacement materials in the event they are proved to be needed. At this point the search, by hundreds of scientists, has not uncovered a single material or combination of materials that have been found to satisfactorily perform the vital functions of phosphates in detergents and which will have no adverse effect on water quality.

(The list of member companies of the Soap & Detergent Association, appended to Mr. Bueltman's statement, follows:)

Acme-Hardesty Co., Inc.
Adco, Inc.
Alcolac Chemical Corp.
Allied Chemical Corp.
Amerace-Esna Corp.
Amway Corp.
Arco Chemical Co., Division of Atlantic Richfield Co.
Armour-Dial, Inc.
Armour Industrial Chemical Co.
Ashland Chemical Co.
Astor Products, Inc., Blue Arrow Division.
Atlas Chemical Industries, Inc.
Babbitt Products, Inc.
The Baker Castor Oil Co.
Calgon Corp.
Capital City Products Co., Division of Stokely-Van Camp, Inc.
Campwood Associates, Inc.
Chatham Laboratories, Inc.
Chemagro Corp., Bon Ami Division.
Chevron Chemical Co.
ClearWater Products, Inc.
Colgate-Palmolive Co.
Continental Chemical Co.
Continental Oil Co.
Crosby Chemicals, Inc.
Culver Chemical Co.
Darling & Co.
Darrill Industries, Inc.
DeSoto, Inc.
Diamond Shamrock Chemical Co., Nopco Chemical Division.
C. B. Dolge Co.
Dow Chemical Co.
Drew Chemical Corp.
DuBois Chemicals, Inc., Division of W. R. Grace & Co.
E. I. Du Pont de Nemours & Co.
Duveen Soap Corp.
Economics Laboratory, Inc.
Electric Reduction Co. of Canada, Ltd.
Emery Industries, Inc.
Enjay Chemical Co.
Ethyl Corp.
Alex C. Fergusson Co.
FMC Corp.
GAF Corp.
Imoco-Gateway Corp., Chemical Service Division.
Geigy Chemical Corp.

General Mills, Inc.
SCM Corp., Glidden Durkee Division.
Glyco Chemicals, Inc.
Gojer, Inc.
Grace-Lee Products, Inc.
W. R. Grace & Co., Hampshire Chemical Division.
A. Gross & Co.
Harley Chemicals, Inc., Division of Concord Chemical Co.
Harshaw Chemical Co.
Hercules, Inc.
Hershey Estates, Inc.
Hewitt Soap Co., Inc.
Hooker Chemical Corp.
HumKo Products Division, Kraftco Corp.
Huntington Laboratories, Inc.
Hunt-Wesson Foods, Inc.
Hysan Products Co.
Jefferson Chemical Co., Inc.
Andrew Jergens Co.
Lanman & Kemp-Barclay Co.
Lan-O-Sheen, Inc.
Lehn & Fink Industrial Products Division, Sterling Drug, Inc.
Lever Brothers Co.
Lightfoot Co., Division of Philip Morris, Inc.
Los Angeles Soap Co.
Marco Chemical Co.
Millmaster Onyx Corp.
Miranol Chemical Co., Inc.
Mobil Chemical Co.
Monsanto Co.
Mt. Hood Chemical Corp.
Murro Chemical Co., Inc.
National Chemsearch Corp.
National Milling & Chemical Co.
National Purity Soap & Chemical Co.
New South Manufacturing Co., Inc.
Northern Petrochemical Co., Varney Division.
Novo Enzyme Corp.
Olin Corp.
Original Bradford Soap Works, Inc.
Pennwalt Corp., Harchem Division.
Chas Pfizer & Co., Inc.
Philadelphia Quartz Co.
Pilot Chemical Co. of Calfornia.
Pioneer Soap Co., Inc.
Procter & Gamble Co.
Purex Corp., Ltd.
Retzloff Chemical Co.
Richardson Co.
Rohm & Haas Co.
Scholler Bros., Inc.
Scientific Packaging Corp.
John Sexton & Co.
Shell Chemical Co.
Stahl Soap
Standard Chemical Products, Inc.
Standard Household Products Corp.
Standard T Chemical Co.
Stauffer Chemical Co.
Stauffer Chemical Co.—Cowles Chemical Division.
Stepan Chemical Co.
R. R. Street & Co., Inc.
Sugar Beet Products Co.
Swift Chemical Co.
Terex Corp.

Texize Chemicals, Inc.
Theobald Industries.
Tidy House Products Co.
Union Camp Corp.
Union Carbide Corp.
U.S. Borax & Chemical Corp.
Utility Co., Inc.
Wallerstein Co., Division of Travenol Laboratories, Inc.
Vestal Laboratories, Division of W. R. Grace & Co.
West Chemical Products, Inc.
Westvaco Corp.
Foster-Milburn Co., Division of Westwood Pharmaceuticals.
Wilson Harrell & Co., Inc.
Wilson-Martin Division, Wilson Pharmaceutical & Chemical Corp.
Witco Chemical Corp.
Woburn Chemical Corp.
Wandotte Chemicals Corp.

Mr. BUELTMAN. Mr. Chairman, through the text I referred to three or four specific technical references which I would like to include as exhibits with my testimony.

Mr. REUSS. Without objection, they will be made a part of the record.

(The three articles referred to by Mr. Bueltman are reprinted as app. 2, pp. 234–256. of this hearing record.)

Mr. BUELTMAN. If I may, sir, there were some previous witnesses this morning who might have given some erroneous impressions relative to specific products and their use and what might be the possible situation at this time relative to them.

I would like to emphasize at this point some of these points. One seemed to be an assumption that automatic dishwashing compounds, as used in the household, did not contain phosphates. Household automatic dishwashing compounds are very high phosphate content products. The reference to caustic would be for industrial automatic dishwashing. We could not permit a caustic product to be used in the household. The other technical point was a discussion about the conversion from ABS to LAS, all of which I was not privileged to hear, which left the impression that there was some change in the phosphate content of the products.

The change from ABS to LAS had no influence on the phosphate contents of our products. This was a change in the surfactant, not in the builder.

Without getting into the intricacies of the details, there seemed to be some confusion about Ferguson's work as to the report of the pounds of phosphate per year as reported by Secretary Klein and as reported in the Ferguson work.

It so happens that we sponsored that work. We went to Ferguson, at the Stanford Research Institute, in order to obtain their analysis of the situation. And I feel there might be some indication of differences in numbers, where actually the numbers were very consistent, in that the numbers in Ferguson's work were the pounds of phosphates that went into the surface waters of the country from the detergent products. I believe that the Secretary was talking about total tonnage of phosphates used, so that the numbers are consistent in that regard.

Mr. REUSS. How much did the Soap & Detergent Association pay Mr. Ferguson for the study?

Mr. BUELTMAN. I believe that that amount was $5,000.

Mr. REUSS. Did you have additional points with regard to this morning's testimony?

Mr. BUELTMAN. I have one specific point. I would like to emphasize very strongly, I have worked for this industry for some 7 years now, I am a professional sanitary engineer; they obtained my services to assist in this whole program of the involvement of their products in the waters of this country. And I feel that this industry is a very responsible industry. It has moved forward with a concern about the effect of its products on the environment, but this concern has to be balanced with a concern for the consumer and how the products are performing for the consumer, the housewives, the various industries, and others that are dependent on these products to meet standards of cleanliness.

I would like to emphasize that we do share a dual responsibility: one, to maintain the standards of cleanliness that can be achieved through the use of the products that the industry produces today; and two, through our efforts and work on the environmental problems we have a responsibility to try to do something about the involvement of our products in the environment.

I believe there were some other points that might have come up, but if the members of the committee wish clarification, we can respond to them in answer to questions.

Mr. REUSS. Is this Mr. Ferguson a biologist, a chemist, or what are his scientific qualifications?

Dr. BUELTMAN. I believe his specific qualifications are in the area of biology. But I would have to verify that point; I am not sure.

Mr. REUSS. In the little blurb on his article it says F. Alan Ferguson is an industrial economist.

Mr. BUELTMAN. The point I was just going to make was he was the project leader. We gave the grants to Stanford Research Institute and he had a team of people who worked with him on this.

Mr. REUSS. On page 3 of your statement, Mr. Bueltman, you said this, and I quote: "* * * The industry is intensively searching for replacement materials, should they be needed * * *."

I gather that the industry has not concluded that they are needed. Is that correct?

Mr. BUELTMAN. We feel, as I would paraphrase from my testimony, that the unilateral attack upon the phosphate content of the detergents is not going to be a meaningful result in the reduction of eutrophication in the major bodies of water in this country. For instance, one of the specifics I referred to is Lake Tahoe. The technical information available on Lake Tahoe is its nitrogen dependence. But coming back to the phosphate content—phosphate as opposed to the surfactant situation—we are not the unilateral producers of phosphate in this country and there is enough phosphate coming from other sources to continue to promote the degree of algal growth we now have. The single step of taking phosphates from our products is not going to bring levels far enough down on the scale of total phosphate available to make any impression on algal growth.

Mr. REUSS. I don't think anyone is suggesting a unilateral attack on phosphate-containing detergents. I think everyone would agree that agricultural fertilizer runoff control and better waste treatment procedures are also very necessary.

But is it the position of your industry that the industry believes that replacement materials for phosphate in detergents may not be needed?

Dr. HEALEY. If I may, I am Frank Healey of Lever Brothers. I think our position, to state it briefly, is that we don't think the evidence is yet available to arrive at a conclusive decision one way or the other. But recognizing our responsibility, and that a replacement may be needed, I think it is true of our company and true of every company—not only detergent manufacturers in the United States, but the suppliers—and the suppliers not only of phosphates, but the suppliers of other chemicals that might possibly serve as a replacement, and even further, the effort that is being made is not just in this country, but the same situation exists in many countries in the world. I know personally of efforts being made in a number of these countries and companies to seek out replacements.

All we are saying is, at this point in time there is no conclusive evidence.

Mr. REUSS. Thank you. Mr. Bueltman, in your last point on page 15 you say: "The individual detergent manufacturers and their raw materials suppliers have undertaken an extensive program to find possible replacement materials in the event they are proved to be needed."

Can you give us the amounts spent in those programs during the current year, 1969?

Mr. BUELTMAN. Specifically, I cannot give you the amounts. I think the best way to arrive at an answer on this is for the individual men who are the research directors of the companies who are here to so indicate, because this is on-going research in a new product development area.

We can talk about historical fact from the association's position; but to say what is going on currently, each individual company will have to speak for itself.

Mr. REUSS. Well, we have the three principal manufacturers here. Dr. Healey, of Lever Brothers. What has Lever Brothers spent in 1969 on research and development toward new replacements for phosphates in detergents?

Dr. HEALEY. If I may, I would like to express it not in terms of dollars, which I don't think is a very useful measure, but in terms of the proportion of our efforts.

The search for a replacement for phosphates is the largest single project in our laboratory. It is being supplemented by work in a number of other laboratories in the world under Unilever's guidance. But in our own laboratory it is taking up the major efforts of the basic scientists, because this is a basic problem. We are seeking a new material, not just how to adopt or adapt a material.

We are also taking the materials that have been mentioned by Mr. Bueltman and others as possible substitutes and testing those to see how they stack up against the criteria. So it is the major project that we have, and it is certainly taking up the bulk of our basic scientist's time.

Mr. REUSS. But you are unable to assign a dollar value on it?

Dr. HEALEY. I would appreciate not to in an open hearing, if I may.

Mr. REUSS. How many people do you have working on the question of a phosphate replacement?

Dr. HEALEY. I don't offhand have those figures. I think we could supply them to the committee.

Mr. REUSS. If you will, please. Dr. Wearn of Colgate?

Dr. WEARN. Yes. I would like to explain that this is not a company problem; it is a world problem, because we in this business, all of the people represented here are also engaged in the manufacture of detergents in many countries in the world. And in this endeavor we are dealing with all of the major chemical companies throughout the world. I can't think of a single major chemical company that is not deeply engrossed in this search, because to them it represents an opportunity, a major market for a new material, which is very exciting in this type of economy of ours. And we diligently pursue these things. I think the ideas to a large extent come from raw material manufacturers, those people who benefit under raw materials, throughout the world. I personally have made many trips to Europe, to other places, in the interests of our company, to find out what these materials are, and whereas we do our own laboratory synthetic work to see what we can do, we also eagerly seek any material of this nature we can possibly find. We bring it back to the laboratory and go to work on it.

But as I say, the ideas are the real source of the materials with which we can work; and having those, we can then go to work with great vigor. I would like to emphasize that there must be, I am sure there must be 50 companies of major size which are working on this problem and which communicate as they succeed to what they consider their potential customers of the future. And I think whereas the companies which make phosphates are engaging in their searches to find replacements—because to them it means replacing that business with other materials that will also be useful in their picture—are outnumbered considerably by other companies who see this as an opportunity to get new materials and new markets for their own company. And we play the whole field.

I think we did an estimate here recently. There are about 1,300 reported testified compounds in the industry. There is some duplication in that, because we can't exchange the prior information on all of the research we do.

But from that large number reported, there are hundreds, literally hundreds, I am sure. In my own experience, I notice that is true.

So I can assure you that this is a very important drive on our part to get a better product and also one which sells as well.

Mr. REUSS. How many dollars did Colgate-Palmolive devote to finding a substitute for phosphates in 1969?

Dr. WEARN. I cannot be specific, because we are doing this in laboratories throughout the world. We have numerous laboratories, not just in the United States. We have major laboratories in Europe, as well as in this country. But it is in very large numbers, and I am sorry I do not have that. I can submit that privately if called upon to do so.

Mr. REUSS. Thank you. We would appreciate that.

The third major company: Proctor & Gamble, Mr. Bruck.

Mr. BRUCK. I am John Bruck, Mr. Chairman. On behalf of our company I would like to explain that our research efforts are devoted to two major areas. First in our basic research area, where we have a substantial number of research chemists who are investigating the basic

organic chemical structure that might provide potential replacements for detergent phosphates. And in this regard I can assure you that we have as much effort in this area as is reasonable from the point of view of productive or potential leads to useful materials. The remainder of our efforts are in our product development area, where not only the materials which are synthesized and produced in small quantities by our research division, but materials from suppliers and combinations of these materials are evaluated in the complicated processes of formulating detergents and in bringing them finally to the market. And in this effort we have not yet found one which is totally satisfactory from the standpoint of providing the consumer with the standards of sanitation, cleanliness, and health which we provide today, and additionally providing safety for the environment.

Mr. REUSS. And how much is Proctor & Gamble spending in 1969 to find a substitute for phosphates?

Mr. BRUCK. I do not have that number available. It can be made available if you wish, sir.

Mr. REUSS. We would like it and would appreciate your supplying it. Dr. Callis?

Dr. CALLIS. I am Clayton Callis of Monsanto Co., and perhaps unique at this table, in that I am the only one representing a supplier of materials. You may ask whether a supplier of phosphates is working on this problem. I can say unequivocably, "Yes, we are." We have spent hundreds of man-years of effort on this problem. We perhaps have more incentive than anybody else, because we feel if somebody finds that replacement, we must find it. And our competition feels the same way. Because of the potential opportunities and the competitive nature of the industry, other companies who are not supplying are putting a large amount of effort into this also. So we have invested a tremendous amount of effort in it. It is the major project in the inorganic division; it is one of the major projects in the entire company.

Mr. REUSS. So despite the detergent industry telling us here that they do not know whether a substitute for phosphate is needed, Monsanto is working very hard just in case they are wrong and one turns out to be needed?

Dr. CALLIS. You see, we have had this incentive ever since this product, polyphosphate, became important. Because you work from the beginning to find out what the competition is and what it is going to do to you if someone else comes up with it. So it is a criterion you work with from the very beginning.

Mr. REUSS. If I may just ask, Dr. Callis: You have a pretty good hunch, do you not, that if a substitute can be found for phosphates, which cleans clothes and dishes satisfactorily, and does not ruin America's lakes and streams, this would be a pretty good thing for Monsanto to be in on from the ground floor?

Dr. CALLIS. We would like to supply that material, if there is such. You put a lot of "ifs" into the question, though.

Mr. REUSS. My confidence in Monsanto is not misplaced.

Mr. Bueltman, how much did the detergent industry spend in 1969 on advertising?

Mr. BUELTMAN. I have never collected that statistic sir. I deal specifically in the technical area. I know it is a very large number.

Mr. REUSS. Its business is around $4.5 billion a year in detergents; is it not?

Mr. BUELTMAN. I think the detergent business, the cleaning products business, is about $1.2 billion. I think the number of 4.5 billion is the total pounds of product we are discussing.

Mr. REUSS. Does the detergent industry list on the containers of its household washing detergents the phosphate content?

Mr. BUELTMAN. No. Not that I am aware of.

Mr. REUSS. So that a housewife who does want to do something about stopping the destruction of our lakes by using a detergent which has a smaller rather than a larger phosphate content is helpless to do that patriotic act; is she not?

Mr. BUELTMAN. We gave some very serious thought to this because in other areas of the world there has been some concern about requesting the industry to label phosphate content on their packages. From some surveys that we have done, and some other information we have been able to obtain, it is our complete conviction that the average housewife seeing a higher percent content will automatically equate this to better cleaning. Therefore, you might just do the reverse, by advertising the phosphate content on the package, of what was originally intended.

Mr. REUSS. Did you happen to see that story in the New York Times this morning about detergents and phosphates?

Mr. BUELTMAN. I did not have time, sir.

Mr. REUSS. Included in it is a table that I had prepared by Limnetics, Inc., a Milwaukee scientific consulting firm, which indicated that in Milwaukee, Wis., supermarkets detergents were sold containing phosphate content that ranged from 43.7 percent down to 1.4 percent. I gather that these phosphate contents are not on the label and that a housewife who wanted to use the detergent containing light phosphate would not know whether she was doing that or was using a detergent containing 50 or 60 percent. Is that correct?

Mr. BUELTMAN. That is correct. I have just had a copy of this put in front of me. I would like to clarify that these are not all the same product categories, from a functional point of view. There is quite a mix, if I may say, of apples and oranges. I think you will find in the analysis that heavy duty laundry powder products will be within a small range. And light duty products and liquid cleaners and hard surface cleaners will also fall into ranges, because the phosphate content is essentially determined by the function the product is to serve. Heavy duty laundry powders, because of the nature of the job they are designed to do, have generally the highest phosphate content.

Mr. REUSS. But whether a housewife is buying a product in a given category at the high of the phosphate range or the low of the phosphate range is something she now has no way of determining. Is that not so?

Mr. BUELTMAN. That is right.

Mr. REUSS. Mr. Vander Jagt.

Mr. VANDER JAGT. Thank you, Mr. Chairman.

I gather from the testimony that you would all disagree with the international board, which pointed out that, "Partial replacement of phosphates in detergents is now possible with no reduction in cleansing power." Do you disagree with that statement?

Mr. BUELTMAN. Yes, In fact, we would like to know the source on which they based that. We invite anyone and everyone who has an idea to bring it to us.

Mr. VANDER JAGT. While we are on the subject of sources, on page 6 of your statement at the bottom of the page you say, "* * * a growing body of scientific information leads to the conclusion that the elimination of these phosphorus sources would *not* be sufficient to reduce the rate of cultural eutrophication." I wonder if you could identify for the committee the growing body of scientific information.

Mr. BUELTMAN. I can. If I may, I will accumulate that and submit it, with proper documentation, rather than rely on mental recall.

Mr. REUSS. Without objection, that will be received.

(The materials submitted by the Soap and Detergent Association are in the subcommittee files.)

Mr. VANDER JAGT. Then you go on: "Furthermore, it clearly follows that the elimination of detergent phosphate *alone* could not possibly mitigate or even diminish excessive algae growth," and you give a footnote in support of that statement, that as I understand it the total elimination of phosphorus from detergents would not even diminish eutrophication. The footnote is the Ferguson study. Is there any other support for that statement?

Mr. BUELTMAN. Not for the purposes of challenging anything, but strictly from the point of view of taking documented information and listing it, we put together for our own analysis some information on a chart. It might help in this regard if we were to use that chart to show you what we are discussing.

Dr. HEALEY. This is taken from the board's report to the IJC, the International Joint Commission.

Dr. WEARN. I am technical director of the Colgate-Palmolive Co., but my skill and knowledge is scientific data—studying it, evaluating it and reaching conclusions on the basis of the data. We have studied the IJC report because we look to sources like this to give us this information on need that we have been talking about here. And that report is a rather large document containing much survey information, estimates of situations in various places. But there is very little actual experimental data on which we can base a conclusion. So this leads us to look further into that situation to see what we can learn from it. As observers of other scientific people who have presumably reached these conclusions, we are happy to know there is going to be a hearing, because we do not believe there is enough known for the IJC to accept that report. In the hearings more will be brought out, because there are supplementary reports which they refer to, which we have not seen. They do make a very definite statement in the report that it is the most difficult problem to determine whether the reduction of phosphate alone can control eutrophication.

They also go on to say that trace elements—organic materials, trace elements, other things—are not adequately understood. These are some of the nutrients that are abundant in Lake Erie, for instance, that were referred to this morning. And just to put the thing in the perspective that we se it now, we would like to show you this chart, using data from the report. It is a very simple presentation. The program which is proposed, of course, consists of our taking all of the phosphate out of our

detergent products. Having done that, we would then have this situation in Lake Erie (indicating on chart). Now the residue of municipal wastes from other sources, human and so on, would of course still be there, having removed the detergent part. These are the numbers the report actually uses from their estimates. The industrial contribution would still be there. That phosphates incoming from Lake Huron will of course still be there——

Mr. REUSS. Although with the detergent phosphate removed, so the blue will shrink a bit.

Dr. WEARN. We have done that. We are assuming what they say will be done and this will lead to that ultimate situation.

Of course the land drainage phosphate sources will still be there. They go on, they say we must have the detergent out of the packages by 1972. Of course this advanced treatment program talked about this morning would further reduce the municipal and industrial wastes. That would take us to—note that is 70 micrograms per liter—(indicating on chart).

Now then, at the point where 80 percent of the remaining phosphate in the municipal sewage and industrial would have been taken out in these treatment plants between 1972 and 1975, as has been explained—the report makes this point, this recommendation—you would then have still remaining 50 micrograms per liter of phosphorus. And if in the ultimate program this is all eliminated by technology not yet undestood, but presumably which will be developed in time, we would have a picture in which 40 micrograms per liter of phosphorus would still be in Lake Erie, the regular incoming amount, to say nothing of the sediment, the amount of phosphorus which is in the depths in the bottom of the lake and which is also not too well understood.

Now the report on page 66 refers to the level for nuisance algae conditions, meaning the blooms of algae. It is generally recognized that 10 micrograms per liter is enough phosphorus to cause nuisance algae conditions. This was published about 20 years ago at MIT by Sawyer. It has been measured and referred to by others, and the IJC report refers to this nuisance level as a level having some significance.

And you will note that, after all is done in this very expensive and elaborate program, there will still be at least three to four times the amount of phosphorus coming into Lake Erie which would produce nuisance algae conditions.

As I say, I am not an expert, but I think this raises scientific questions which need to be answered before we can be sure there is proof. There is no experimental proof, to our knowledge, in the IJC report. We do believe that with PAAP tests, and with modern approaches in our research, we will get the evidence in the next few years.

But we don't have it today.

Mr. VANDER JAGT. You are moving on that chart to a level number 10. When you reach that level there is the assumption you are operating under, I assume, that when you have that much concentration of phosphate, you have eutrophication problems.

Dr. WEARN. That is the Lake Erie situation.

Mr. VANDER JAGT. Right. You have been using Lake Erie as an example, because the report was based on Lake Erie.

Can you imagine lakes in the country today, right now, where the total removal of phosphates from detergent would in fact bring the phosphate content below that critical line?

Dr. WEARN. There may be some. As you know, there are some which are already below that line.

Mr. VANDER JAGT. So some of our lakes would be saved by the removal of phosphates from the detergents.

Dr. WEARN. You can certainly find an example of anything one might imagine.

Mr. VANDER JAGT. Then I ask you this question as a scientist: Wouldn't this statement be a little more correct scientifically if instead of saying the elimination of detergent phosphate alone could not possibly mitigate or diminish excessive algal growth, you said that it would contribute to the solution of the problem in the country today? It wouldn't work for Lake Erie, but there are some lakes where it would work.

Dr. WEARN. I would like to see the evidence. I am sure we will have it, but I don't think we have it today. The American Chemical Society had a committee of scientists that made a report—the Subcommittee on Environmental Improvements—and they caution against these specific programs of phosphate and nutrient removal. And the director of the Water Pollution Laboratory of Great Britain, in his last annual report, also cautioned that this rush to eliminate the phosphate nutrient in United States might not produce desired results.

As I say, we look at this information; we are not the experts, we ask the questions. At the same time we are working hard to get a replacement.

Mr. VANDER JAGT. I was reassured, in the explanation, that we are talking about the same thing: We are talking about the total accumulated phosphorus in the water and we are trying to reduce that level. Is that correct?

Dr. WEARN. Yes.

Mr. VANDER JAGT. Do I understand your position correctly, that even though FWPCA said, in their written statement, that the source of phosphorus in the water was between 40 and 50 percent, and before the testimony was over, it went up to 60 percent—even though we remove 60 percent of the phosphorus that is getting into our rivers and waters, it wouldn't solve the problem, because you have to do something about that other 40 percent, too.

So, therefore, we shouldn't worry too much about removing 60 percent of it.

Dr. HEALEY. There may have been a misunderstanding in the figures this morning. The 40 to 60—I think it finally became 60—refers only of the percentage of municipal waste. I think the point of this graph, for example, is to show that just tackling that end of the problem doesn't really solve the problem.

So we concentrate all of our resources and time and effort on one part of it, and don't solve the entire problem. That is our fear, that we overemphasize the one.

Mr. VANDER JAGT. Let me not quarrel with the percentages. Let me put it this way: Is it your position, then, that even though a substantial

portion of the source of phosphorus in our lakes and streams can be traced to phosphorus in detergents, that because the elimination of that source would not completely solve the problem, because the other fellows are also partly responsible, then we shouldn't be concerned about taking the phosphorus out of detergents?

Dr. HEALEY. No, I don't think that is our position. We recognize it is a total country problem in that everybody in the country should be contributing. We think we are trying to contribute. And all we are saying is we haven't yet been proven guilty, at least give us the benefit of the doubt at this point. But we will do our best to find a replacement.

Mr. VANDER JAGT. Everybody has contributed to the level of phosphorus, not just you?

Dr. HEALEY. Yes, we hate to be singled out as the only culprit, that is all.

Mr. VANDER JAGT. But you are a portion of the problem.

Dr. HEALEY. Yes.

Mr. VANDER JAGT. You have a statement on the first page of your testimony that the industry has made substantial contributions to the cause of clean water during the past two decades. I think you have, and I congratulate you for it.

We could also say you made substantial contributions to the cause of dirty water and pollution during the past two decades, could we?

Mr. BUELTMAN. Must I answer?

Mr. VANDER JAGT. You have been a part of the problem, haven't you?

Mr. MCCLOSKEY. You can take the fifth amendment.

Mr. VANDER JAGT. I do get tangled up in statistics and percentages.

On page 6—I just want to make sure I understand this—you point out that 70 percent of the phosphate production goes into agricultural fertilizers and only 13 percent of the phosphate production goes into detergents. You don't mean to imply by that that the 70 percent of it that reaches the lakes and streams is from agriculture and only 13 percent from detergents?

Mr. BUELTMAN. No.

Mr. VANDER JAGT. Isn't it true that all of the phosphorus in detergents gets back into the water supply and only a relatively small portion of the agricultural fertilizers get back?

Mr. BUELTMAN. Not necessarily.

Dr. HEALEY. That figure of 280 million that came up this morning versus the 500 million I think indicates someone's estimate of the ratio that gets into surface waters, versus the total amount going into detergents. The material that goes into septic tanks is absorbed by the tile field, that phosphate is in the ground just like fertilizer. That part that runs in the ocean I don't think is in issue here.

So both are a fraction of the fertilizer and a fraction of the detergents.

I know your next question—more detergents go into the water than fertilizers, probably.

Mr. VANDER JAGT. Wouldn't it be a substantially higher fraction?

Dr. HEALEY. I guess, although you heard the testimony about the Potomac already having too much phosphorus before it ever gets to Washington, and that is all fertilizer.

Mr. BUELTMAN. I think one of the points we found in our whole study of this is you almost have to make a lake-by-lake study and a

drainage basin-by-drainage basin study—because of the industrial and population mix—to know what is the controlling factor and what is the situation pertaining to that drainage basin.

Mr. VANDER JAGT. In your efforts to find a substitute for phosphorus in detergent—and you are going to supply for the record the amount that you are spending or have spent in 1969 to find that substitute—can you give us a little better idea whether there is any sense of urgency attached to that research?

Do you have any kind of timetable? Do you have a goal you are shooting for?

Mr. BUELTMAN. As soon as possible.

Mr. BRUCK. Mr. Vander Jagt, I would like to comment on that.

We certainly do have a timetable, as Mr. Bueltman says, to do this just as quickly as we can. But I must respectfully point out that it is impossible to schedule an invention and that is exactly what we are talking about here. We simply do not have a satisfactory replacement for phosphorus. We have indeed, as I explained a moment ago, investigated each and every organic structure possibility that we know of. We welcome suggestions from elsewhere, but we think we have covered most of them already.

We shall continue that effort. It certainly has been renewed. But it is not possible to put a date on a material that hasn't been invented yet.

Mr. VANDER JAGT. I realize that it is impossible to schedule inventions. But in getting from this planet earth up to the moon in 8 years, there were a number of technological and scientific inventions that had to be made along the way. One of the reasons that we made them as rapidly as we did was there was a national commitment and a sense of urgency.

What I am driving at is, where is the sense of urgency, and how great is it? For example, would you feel a greater sense of urgency if we passed legislation that said the phosphorus had to be out of all detergents in 2 years?

Mr. BRUCK. I don't think so, sir. I think we perhaps have not yet reflected to you properly the sense of urgency that we as an industry and we as a company have. It isn't just Procter & Gamble's effort, or Lever's, or Colgate's; it is our total effort, plus the efforts of a great many suppliers, thousands of scientists, who are working vigorously today to find an answer to this problem. Each of us is looking into these areas individually, each of us is looking at suppliers' suggestions, each of us is looking, not only here in the United States but in Europe, Sweden, and elsewhere. It is an unending, almost immeasurable, very vigorous effort.

Mr. VANDER JAGT. It is the position of all of you that nothing the Federal Government could do would in any way enhance your sense of urgency?

Mr. BRUCK. There would be two concerns if we were to have such stimulation. One is that, as of today, we would not know how to provide the levels of cleanliness and health and sanitation which our products now provide; and secondly, we would be most reluctant to use any other material than phosphate because of its unknown effect on the environment.

And this immediately relates to the problem of eutrophication itself. It is indeed an extremely complex process that is not well under-

stood, and the role of phosphorus in eutrophication is not well understood. But it is the study of this problem, through the joint task force and through our individual laboratories, that we think will lead us finally to the identification of the kind of material that will both achieve cleanliness standards and safety for the environment.

Mr. VANDER JAGT. I am a little curious. You have testified, I think, that all of you really have an overwhelming sense of urgency in discovering this substitute, but that there is nothing really that can be done to accelerate it. And yet it is your position, as I undersand it, that there is no proof that detergent phosphates are a key element in eutrophication.

Why, then, do you have this sense of urgency?

Mr. BUELTMAN. If I may, for several reasons:

Once an ingredient is incorporated into a product, research immediately begins to find a replacement for it. So that there is no loyalty to phosphorus as such. If an ingredient can be found tomorrow that will perform all of the functions, all things being equal, the industry would probably move to that; because it might make a better product—it cleans better, it might cost less, all kinds of factors.

Mr. VANDER JAGT. And the fact that it might pollute less.

Mr. BUELTMAN. Very well so. Each of these factors would have to be taken into consideration.

I would like to speak to the simile to the space program that was used this morning—that within a decade from the pronouncement we would put a man on the moon, and we did. In that instance it was the application of known technology. It was a matter of fine tuning to escalate up to larger sizes, and so forth. In this instance, we don't know what the technology might be for the ingredient that we might find.

Mr. VANDER JAGT. Dr. Bueltman, this discussion is reminiscent of the early days of the space program. For 5 years they were talking in terms of "the state of the art is not that far yet, we have to have a technological scientific breakthrough for this problem or that problem," and so forth. Later they developed the sense of urgency that enabled them also to advance the state of the art.

Mr. HICKS. Would the gentleman yield?

Mr. VANDER JAGT. Be glad to.

Mr. HICKS. Was the space program fragmented like we discussed here—they are urgent, but they are all urgent, trying to keep it to themselves and see if they can't beat somebody to the product first—or was this a concentrated effort, where everybody knew what was going on as in the space effort—or do you know?

Mr. VANDER JAGT. It was concentrated and centralized.

Mr. HICKS. Thank you.

Mr. VANDER JAGT. Before I have to run and vote, could you tell me: I understand that there is no labeling, and I understand your concern that it could have the opposite effect. But is any effort made to market a lower level of phosphorus in detergents in those areas that have a soft water supply and don't need as much phosphorus to make the water soft? Is any effort at all being made along those lines?

Mr. BUELTMAN. This is an individual company problem. I am not a marketing man.

Dr. HEALEY. We are marketing all of our products in hard water areas and soft water areas.

Mr. VANDER JAGT. With no attempt to distinguish between the water supply in any area?

Dr. HEALEY. No; not in our advertising, at least. In our directions we do point out that in hard water areas you should use more. We tend to give directions for the average hardness, but we suggest "in hard water areas, use more."

The implication is that in soft water areas the housewife may be able to use less. However, there is a point that wasn't brought up this morning: Hardness comes not only from the water in the locale, but also in the soil and cloth she is washing.

So even though she has soft water, her soiled clothes contribute hardness to that water.

Mr. HICKS. Miss Lyng is trying to help you out here.

Dr. HEALEY. Oh, fine. I yield.

Mr. VANDER JAGT. We would like to hear from the distaff side. Maybe when you answer you can also wander into the subject of what the housewife would say if we did take the phosphate out of detergents right now.

Miss LYNG. I think she would be extremely unhappy. I think it would be a great disservice to her.

To put some dimension on what Dr. Healey has mentioned, may I add that the amount of hardness that will be brought into the wash water by a load of clothes can range from 2 to as much as 7 grains per gallon. The amount of hardness will depend on the soil in the particular load of clothes. So even when you are talking in terms of a soft water situation, where hardness may be only 1 to 2 grains per gallon, the load of clothes may elevate the wash water to the medium hardness range.

No load of clothes is washed in the absence of hardness, and product usage has to be adjusted to handle the hardness present.

Mr. VANDER JAGT. How about the other two companies, as to whether any effort is made?

Dr. WEARN. I think generally we suggest to the consumer on the package instructions how to go about using that product to wash her clothes. We will say, for instance, start with a cup, a full cup, and if you have heavy soil, use more—or if you have hard water, or unusual staining conditions.

We find that if you tell her too much, not only does she resent it, but she doesn't follow your instructions.

So many surveys have brought this home to us through the years. She has to find her way of using that product to attain her level, her standard of cleanliness, in the home. It will depend on how often she washes her clothes—many facts that they didn't like to discuss.

But it is vital we find out, so we know what minimum amounts of things go into the package. It is all very scientific.

According to our ability to assess these things, to research the consumers to find out, and then to formulate to her requirements. If we fail, she simply throws the product away and buys one from Lever Bros.

So we have no way of getting back at the consumer.

With all due respect to the advertising, I think it is difficult to convey a technical message in a simple way. You have to let the consumer find out for herself.

Mr. BRUCK. One way we attempt to guide her, and in fact do guide her, is by designing the sudsing properties of our products. The foam that was objectionable in the old hard ABS days was indeed useful in the waching machine itself, because it does indicate to her whether or not she has a proper amount of product to do the washing job. And we still find, through many years and many studies, that suds levels are indeed useful to the homemaker in determining whether or not she has the proper amount or if she has too much.

And indeed, our products, speaking for Procter & Gamble, are designed to be useful to the homemaker in just this way. And this means that even though we do ship the same product into soft water areas as we do into hard water areas, she indeed will use less of it, because the suds levels that we have built into these products will tell her to use less.

Mr. VANDER JAGT. With all sympathy and understanding for the independence of the housewife, knowing one very well myself, I am glad to see that industry does make an attempt to provide some guidance so that there is less phosphorus spewing forth in a soft water area than in a real hard water area—taking into account all of these other factors.

Miss LYNG. Mr. Vander Jagt, you asked me what women would think if we were to remove phosphate from detergents. I would like to point out that most of the light duty liquid detergents that are designed for hand dishwashing—a much easier cleaning job, generally speaking, than removing soil from fabrics—do not contain phosphate.

For this reason they do not clean clothes well. They can be used for very lightly soiled items. For example, they will serve for the lady who washes out hose every night. But I'm sorry to say that if your shirts were washed with this type of product, they wouldn't look very good. I don't think your wife would be very happy with the appearance of her laundry if she used a light duty liquid detergent.

Any reduction in the phosphate level of laundry products as they now exist would only lower the cleaning potential of that product.

Mr. HICKS (presiding). Mr. Gude?

Mr. GUDE. I was wondering, in the chart over here, concerning the lakes—on land drainage—is that actual measurement of phosphorous coming in water runoff? Is that not what has been applied to the land, but what is actually coming off the land?

Dr. HEALEY. Total, we believe.

Mr. BUELTMAN. It is our understanding from the report that this is the amount from land runoff that enters the lake. It is not that which is applied to the soil.

We are using someone else's data, and our interpretation of the data is that the red on the chart is that which is entering the lake from runoff. It is not that which is applied to the soil around the lake.

Mr. GUDE. Would this be agricultural and possibly storm drainage also?

Mr. BUELTMAN. Agricultural, storm drainage, also decaying vegetation—because every living thing on the face of the earth has phosphate in it. As it dies, it will put that back into the environment somehow.

Mr. GUDE. Does Monsanto supply phosphorus for agricultural fertilizers?

Dr. CALLIS. A small amount. Not a large amount, compared to some of the fertilizer companies.

Mr. GUDE. Do you know whether there is any research going on in this area? Does part of your total research concern agricultural products?

Dr. CALLIS. I know there has been work on different types of fertilizer, things that might be more slowly available or might stay in the soil much more readily. Not so much in the case of phosphorus, but in the case of nitrogen compounds. There has been work on different types of fertilizers.

Mr. GUDE. Is this part of your work?

Dr. CALLIS. It is not part of my work, but there has been work.

Mr. GUDE. Monsanto work?

Dr. CALLIS. It is part of the Monsanto work; yes.

Mr. GUDE. Thank you.

Mr. HICKS. Mr. McCloskey?

Mr. MCCLOSKEY. Gentlemen, if I understand it correctly, the reluctance to disclose publicly the amount of dollars spent on research in phosphate substitutes is primarily a matter of competition between the industry, not for any other purpose. Is that correct?

Dr. HEALEY. That is correct.

Mr. MCCLOSKEY. I think that poses a dilemma to those of us sitting in the Congress, trying to decide whether or not the Government research in this field is adequate or whether we should somehow stimulate additional research by you into this problem.

I am reminded of the question of the automobile, the big three, looking for smog control devices to learn whether or not this was commercially sound. Do I understand your testimony thus far correctly—that phosphate as an effective agent in a detergent are such that essentially all three of the major companies in competition with one another have to maintain a certain level of phosphate content in order to compete? Is that correct?

Mr. BUELTMAN. Yes, sir.

Mr. MCCLOSKEY. So, built into your industry is a desire in the present state of things to keep the phosphate level high—high enough for you to compete with your two competitors, because you don't wish them to know how much money you are putting into this research; is this correct?

Mr. BUELTMAN. From a product function point of view.

Dr. HEALEY. It is not the only factor that leads to the performance of a product, but it is one factor and we are all trying to make our product better than our competitors.

Mr. MCCLOSKEY. Yes, but as far as the phosphate ingredient is concerned, if you found that your competitor was spending 10 times as much as you are in phosphate research, you might think he was on the verge of a breakthrough that you would have to match; is that correct?

Mr. BUELTMAN. Well, I think——

Dr. HEALEY. It is possible.

Mr. MCCLOSKEY. I am merely exploring why you are so reluctant to let your competitors know this.

Mr. BRUCK. One of the factors you must be aware of is that dollars in themselves don't necessarily reflect the real scientific effort.

Mr. HICKS. It is a pretty good measure, though.

Mr. BRUCK. That's true. When you consider the total effort, not only of Procter & Gamble—and I don't know what my colleagues have in the way of research efforts—but of suppliers, investigators around the world, it has got to be millions of dollars involved in this today.

But the problem is very difficult.

Mr. MCCLOSKEY. I understand that, but let me just quote one part of the Soap and Detergent Association testimony of Mr. Bueltman, who properly represents you all:

> * * * it clearly follows that the elimination of detergent phosphate alone could not possibly mitigate or diminish excessive algae growth. The opinion, therefore, that removal of phosphates solely from detergents would help alleviate the algae problem is not supportable from a technical point of view. * * *

If we accept that statement, then it is absurd for Secretary Klein to suggest that by 1972 you should remove all phosphates from detergents; is it not?

Either you are right or he is right. Who is right? You have us to sit as a jury up here, but if this statement in your testimony is correct, then this committee should not be considering even permitting Mr. Klein to impose the removal of all phosphates from detergents by 1972. Isn't that correct?

Mr. BUELTMAN. Yes. I think the point we are trying to make is that from the information and data we have to date, and the technology available to us, we support the Department of Interior in their program for total nutrient removal, because you remove many other things as well. Until we find that trigger mechanism——

Mr. MCCLOSKEY. Gentlemen, I see some nodding of heads, but those won't be reflected in the record. I would like to make this point very clear in the record, as to what the position of the industry is.

Mr. Klein took the position this morning, and you were here, that the nature of this problem is such that we fully expect to insist that all phosphates be removed from detergents by 1972.

And he cited the 60-percent contribution these phosphates make to eutrophication.

Now, your testimony is squarely opposite that; is it not?

Mr. BUELTMAN. Yes, sir.

Mr. MCCLOSKEY. If your testimony is correct, then Mr. Klein is wrong in suggesting that the removal of phosphates from detergents would be at all helpful in diminishing or mitigating this problem; is that correct?

Mr. BUELTMAN. At this point in time.

Mr. MCCLOSKEY. All four of the companies involved agree with that?

Dr. WEARN. Until such time as the other things are taken out; the nutrients must go.

Mr. HICKS. Will you yield?

Mr. MCCLOSKEY. Yes, I will yield.

Mr. HICKS. I'm wondering: The research that Secretary Klein was talking about this morning was directed solely to pollution, or I assumed it was directed solely to pollution. In what percentage of your research do you have pollutional effects in mind, and in what percentage do you have getting a cheaper or better product in mind? Or do you even consider pollution, other than just as a byproduct?

Dr. HEALEY. I understand this effort by the industry to seek a phosphate replacement is done in response, really, to a commitment we made in January of 1968 to do so.

I think we made it to the Department of Interior—that we would seek as urgently as we could, and this is what we are doing. We are not looking for a cheaper replacement or anything else. We are looking for a replacement for phosphate that will do a satisfactory job.

Mr. HICKS. I understood Mr. Bueltman or someone to say a minute ago that as soon as you put an ingredient in a product, you immediately start researching it to see if you can't find a better one. So you would have had research on this, whether there had been pollution or not.

Dr. HEALEY. That is correct, and we have for many years. We are not a phosphate producer. We are selling cleaning compounds. For a long time we have sought better materials to use in place of phosphate.

Mr. HICKS. Excuse me; I have to go vote. I am sure the chairman will have many grueling questions for you.

Mr. REUSS (presiding). Dr. Wearn, would you resume your position over near that chart you had, so we can talk about that. Now just to straighten out the record, this chart of yours purports to represent Lake Erie; does it not?

Dr. WEARN. Yes.

Mr. REUSS. But it does not purport to represent any findings or observations by the International Joint Commission on Lake Erie; does it?

Dr. WEARN. No, it is using their numbers and pointing out this level which they recognized.

Mr. REUSS. Well——

Dr. WEARN. In other words, the experts on those boards talked about this level [indicating 10] in the same terms that other experts talk about it.

Mr. REUSS. This is what I would like to explore.

Dr. WEARN. It is not meant to imply that that the board reached any such conclusion.

Mr. REUSS. You have not implied it, you have just said it. Let us examine that.

As I read the report to the International Joint Commission on "Pollution of Lake Erie, Lake Ontario, and the International Section of the St. Lawrence River," dated 1969, I find not a scintilla of evidence to bear out your assertion that they claim that land drainage of phosphates into Lake Erie yields a level of 30 micrograms per liter which is three times the permissible nuisance level. Indeed, I find, and I would like to read this report with you, that they tend to minimize the significance of land drainage. I call your attention to page 9 of their report, their summary, in which they say, item 7, "Nutrient runoff from agricultural lands is considered to be a source of pollution, but there is limited reliable information at the present time on the magnitude of this contribution."

Then on page 80, when they give their control recommendations, they say: "Control of pollution from land drainage. Measures are required to reduce the amount of phosphorus lost from the lands of the drainage basins of the lower Great Lakes. This will require improved control of animal waste disposal, soil and river bank erosion

by those responsible for livestock and land management. Water pollution control agencies should insure that appropriate action is taken to reduce the input of phosphorus from these sources by encouraging government agricultural and other agencies to develop and implement plans directed toward this objective," et cetera.

So I put it to you, sir, that far from saying that all is lost and there is no point in the detergent industry doing anything about phosphates—because you have thrice the amount of phosphates needed to ruin the lake—that the Commission says that agricultural runoff of phosphates is a relatively minor problem, and, as part of the total program, can be cured and should be cured. But the report says that phosphates from detergents are much the greatest input and that unless you attack phosphates and direct their removal from detergents, you are not going to begin to make Lake Erie a live lake again. In light of that, would you point to the slightest evidence in the report that the International Joint Commission even suggests that nothing should be done about phosphates contained in detergents, because phosphates from land drainage have come up to a level of 30. I do not find anything like that in here.

Dr. WEARN. May I explain where we got the information. On pages 74 and 75 of the report, the data on land drainage phosphates exists in the tabulations, "Annual input of total phosphates (short tons per year)," and it breaks it down, you see. You can see "other major contributors," land drainage and so on. These numbers are their numbers off these tables. I cannot attest to the significance of those tables, sir. We merely point out that in this report they give those estimates.

Mr. REUSS. But in their estimate for land drainage for 1967, land drainage phosphate input is 3,870 short tons, out of a total of 30,100 short tons. In other words, here is just 10 percent of the total. And you are making that the total for the whole piece.

Dr. WEARN. Not at all. The detergent content was way up here [indicating], that part which we said we should take out by 1972. The concentration is arrived at by taking the amount of phosphate in tons and dividing it into the amount of water volume in the lake.

Mr. REUSS. But by what weird logic can you say—if you are saying—that a program to eliminate the main source of phosphate pollution should not be embarked upon because there is another, vastly smaller, source of phosphate pollution which is also subject to controls which are recommended in the report?

Dr. WEARN. I do not believe I said that. I certainly did not intend to say that. My point was that all of the measures proposed by those boards would only get down to this level by their own data.

Mr. REUSS. Oh, no. Their measures for disposing of land drainage phosphates would substantially eliminate that. And if the same thing were done for Lake Huron—if we had phosphate-free detergents and we stopped farm runoff by agricultural procedures—that problem would be eliminated and we would have a nice zero input. This is of course Utopian, but at least we would get it down below the 10 microgram nuisance level.

Dr. WEARN. Should they remove the land drainage phosphates, this would solve the whole problem, which was our point, too. The entire nutrient must go. If you look on page 66, as I said, they do point out

that this one one-hundredth of a milligram of phosphorus is the nuisance level.

Mr. REUSS. Right. Let me ask you this: You and the other representatives of the detergent industry have been very strong here today on saying that the major thrust must be at municipal waste water treatment plants. That is where ideally, you say, you can remove the phosphorus not only from detergents but from human waste. Is that not so?

Dr. WEARN. Treatment at that stage takes care of both detergents and human sources.

Mr. REUSS. However, using your own construction there, that would be all vanity and vexation of spirit, because you would still have 40 micrograms phosphate pollution, four times the nuisance level. So why are you fellows so gung ho about municipal waste water treatment removal of phosphates?

Dr. WEARN. It is a fact that we are not convinced Lake Erie will benefit as long as that situation remains.

Mr. REUSS. So they think that Lake Erie is dead forever, despite whatever man can do about it?

Dr. WEARN. No. I presume it would refer to the degree to which it can be improved. It may still have algae growth, but the question is how much it would reduce it.

Mr. REUSS. Well, we know from the International Joint Commission study that back in 1942, at about the time the detergent phosphate industry got into high gear, there were 14 micrograms per liter of phosphorus going into Lake Erie. Today there are about 40. Now, it would seem to me that that sort of suggests that the detergent industry has something to do with the death of Lake Erie.

Dr. WEARN. I suppose we would all like to turn back the clock from this advanced stage. I would not argue that.

Mr. BRUCK. Mr. Chairman, may I comment on those numbers? I am not familiar with the 14 and the 40, whatever it was; but the detergent phosphorus is not the only contribution to Lake Erie in terms of pollution.

Mr. REUSS. Nobody suggested it was. There is agricultural runoff, there are various industrial wastes, and there are municipal wastes. Detergent phosphates are only about 50 percent of the cause of death. But I fail to see why that is a reason for not doing something about the 50 percent.

Mr. BRUCK. Well, as we have said, there is a lack of evidence that we have been able to identify that what you suggest indeed would be helpful to Lake Erie. That is, the unilateral removal of detergent phosphorus.

Dr. HEALEY. Mr. Chairman, if I may, too: One point I think we are trying to make also is that the report concentrates heavily on phosphorus because it is supposedly the most controllable element. I think this chart tends to demonstrate the difficulty of controlling all of the sources of phosphorus into the lake. There may be a better way to solve the problem.

All we are asking is, let us not focus our attention too much on phosphates and so much on detergent phosphates that we forget there is possibly another way to solve the problem. Because Lake Erie may be dead unless we can find a better alternative to phosphate removal.

Mr. REUSS. But you have the fact that in 1942, before the phosphate detergent industry got going, Lake Erie was surviving and doing fine with slightly over the 10 micrograms per liter nuisance level. I think it was about 14 micrograms per liter then; and the whitefish and the cisco played merrily from Canada to Ohio. Everything was great. Then you suddenly started making phosphate detergents, which are the biggest single cause of phosphate introduction, in great numbers. How you can sit there and tell me, as representatives of the great detergents industry, that you can wash your hands of the whole thing, that you have nothing to do with it, I do not know.

Dr. HEALEY. We are not saying that.

Mr. BRUCK. No; no.

Mr. REUSS. You are trying to demonstrate there is no point in doing anything about phosphate detergents, because land drainage phosphates alone are now above the line of harm. The answer is, it seems to me, let us work on all elements, of which a primary culprit is the detergent industry.

Dr. HEALEY. We will go along with the first part of your statement. But I think as far as Lake Erie goes, it is a heavily contaminated eutrophied lake, and in addition to detergents, a lot of things happened between 1942 and today. The war was on, the steel mills went up in production, population moved into the area and so on. So a lot of things happened. All we are saying is we by ourselves cannot save Lake Erie. It is a total effort.

Mr. REUSS. Nobody suggested you can. But elementary logic suggests to me that all elements contributing phosphorus to Lake Erie must be promptly brought down to an absolute super minimum level so that all together they do not get above the 10 microgram line, and further that the principal pourer-inner that has to be pared down is the phosphate-containing detergents.

Dr. HEALEY. There may be a better way to do it. I think that story is not yet in. There may be an easier and more satisfactory and quicker way.

Mr. REUSS. But it has to be a way that elminates the phosphorus, because there is no dispute, is there, among my scientific friends, that phosphorus is what makes the algae grow and you are not going to be able to develop a form of phosphorus which does not make algae grow.

Dr. CALLIS. Mr. Chairman, I think that we are saying that there is not only one element that makes algae grow. There are 20 or more elements involved in the complex growth of algae. And all of these factors have to be there for the algae to grow. And in theory you can control algae growth by controlling any one of them. And this is part of what we are saying. There may be other things that can be controlled. And if you treat the water, you may be taking out other things that will control the algae growth in a better way. Because there is a lot of phosphorus everywhere in the environment.

Mr. REUSS. Well, this is a new one. Up until now the story has been that the reason the detergent industry has not achieved any diminution of its nationwide pollution is that it is hard to discover a substitute for phosphates that will clean clothes and not ruin the lakes. It was then suggested—but I think we have reduced that one to its proper dimensions—that there is no use attacking phosphate-containing deter-

gents because there are other, though smaller, sources of phosphates. I think we can put that to one side.

Now you are suggesting that the detergent industry can presumably keep right on making phosphate-heavy detergents and that some other way will be found to keep our lakes from being ruined?

Dr. CALLIS. I am only suggesting if you say that phosphorus is the only element that grows algae, this is scientifically wrong.

Mr. REUSS. No, I was not saying that. Nitrogen and many other things nourish algae.

Dr. CALLIS. There are many elements involved. You can control it by controlling any one of those elements.

Mr. REUSS. I am saying—and I want to get your views on this—that on the record so far it does appear that phosphorus is the element which in thousands of lakes has caused algae to grow out of control, so that they ruin thel ake. Is that not so?

Dr. CALLIS. We do not feel that is a scientifically proven conclusion.

Dr. HEALEY. No. In fact the report points out these minor elements are very difficult to analyze and to know about. I do not have the page reference, but I remember a statement to that effect. And they singled out phosphorus, I believe, because they thought it was controllable. Again coming back to the chart, all we are saying is it is not as controllable as it might appear on the surface. There are an awful lot of places from which phosphorus gets into the lake.

Mr. REUSS. Mr. Hicks, do you have questions?

Mr. HICKS. I was just going to ask something that is not really directly in point here, but you spoke of advertising earlier. If you did not advertise at all in the soap business would there be less soap sold?

Dr. HEALEY. That is a good question. As a scientist, I cannot say that I have any evidence. I do not think we have ever run a test. People have to wash.

Mr. HICKS. It is different from the cigarette ads, for example. They are competing to see who will sell what cigarette, but at the same time that may cause more smoking. You are not going to cause more washing by advertising, are you?

Dr. HEALEY. I think we will. We encourage cleanliness, which is of course something we would like to see, both for its social implications as well as for our personal good. I think advertising in our industry is what a sales force is in many other industries. We are dealing in large volume, relatively low-cost goods. And the most efficient way to get our message to the housewife is through the medium of advertising.

Mr. HICKS. The message, other than "buy our product"?

Dr. HEALEY. To tell her the advantages of our products, of the particular product we are advertising.

Mr. HICKS. Well, now, is your product to any extent, other than the box, any different than any of the other three products?

Dr. HEALEY. Yes; I can say I think they are all different, not only within the industry, but even within the company. We have several different detergents. Each is maybe best at one type of job, maybe aimed for one type of user.

Mr. HICKS. Your advertising does not do that. I watch it.

Dr. HEALEY. I know. I watch them, too. It is not always immediately obvious. We tend to claim they are good, and they are all good. But

some will take out stains better, some will brighten clothes better. I cannot defend all of our advertising, let alone our competitors' advertising, as to whether it has a technical content. But I think the message is to tell the housewife about the product, and if it is a technical message, to tell her why we think it is better. But we are definitely not here to discuss advertising.

Mr. HICKS. To get back to something that you do, though, do you feel—I believe it was a chorus in answer to the chairman's question—that phosphorus has not been proved guilty yet, that the jury is still out on that?

Mr. BUELTMAN. If I may, Dr. Wearn brought to my attention a section of the International Joint Commission Technical Committee's report to them, which I think conveys what our concern is. If you bear with me a moment, I will read this. "The evaluation—" this is page 77, the final paragraph—"The evaluation of the probable effects of phosphorus removal is the best assessment that can be made with our present knowledge. Perhaps the most difficult question to answer is whether or not eutrophication can be controlled by the reduction of phosphorus alone. * * *"

Mr. HICKS. Are you interested in eutrophication as such, or just on what effect phosphorus has on it?

Mr. BUELTMAN. We are interested in the total eutrophication picture. We are specifically interested in phosphorus because going back to the time of Secretary Udall, when he called the industry to meet with him, it was determined at that time by the Department of Interior that the element that lent itself to control was phosphorus.

Mr. HICKS. But you heard the testimony this morning that there might be a break in the chain someplace else. Somebody testified this morning—maybe it was Secretary Dominick or Dr. Bartsch—that there were a number of elements that go into making this plant and you could break the chain some place. Now, are you people interested in that?

Mr. BUELTMAN. Absolutely.

Mr. HICKS. Do you have research going on that?

Mr. BUELTMAN. We have funded work, on this bacteria involvement, the coexistence of bacteria and algae. We have sponsored that work. We have given a grant to the gentlemen who do that kind of work.

Mr. HICKS. This is something you are doing as an industry?

Mr. BUELTMAN. Yes.

Mr. HICKS. You are fragmented on a lot of this, but this is something you are doing as an industry.

Mr. BRUCK. As companies as well. We simply must be involved deeply in this matter of eutrophication and which elements are of consequence and which are not. If you consider the matter of replacement of phosphate—if we select some other element, any other element—we must know how that element fits into the natural ecology and what effect it will have before we introduce large amounts of that material into the environment.

Mr. HICKS. I can follow that and understand that. But that is different than seeing where you could break the chain someplace along the line.

Mr. BRUCK. But the study of eutrophication, which is actively pur-

sued in our company—and I presume by others as well, and by the industry in certain circumstances—is being studied. And I think with time, perhaps with the development of the PAAP test—I don't know specifically whether that will answer all of the questions we need to know—we will have some better idea of how to control eutrophication.

When we do, it might well not be phosphorus, it might well be one of the other elements or it might be the biological cycle, bacteria.

Mr. HICKS. That impresses me, that you are doing that.

Mr. BRUCK. We are deeply involved in it, sir.

Mr. HICKS. That is all I have, Mr. Chairman.

Mr. REUSS. Mr. McCloskey?

Mr. MCCLOSKEY. Gentlemen, you were here this morning when the Department of Interior indicated the funding that they are giving to research in this kind of field, the search for answers to eutrophication. If I recall the figure correctly, it was one grant of $100,000 for research on phosphates, plus several millions of dollars that go into improved sewage treatment plants. I am at a loss to know how to evaluate the Government's proper role in this research without having some idea of the magnitude of the research that is done by the three leading companies in the field. While I was out was any figure mentioned?

Mr. BUELTMAN. No. In fact, I have been waiting for you to return, Congressman McCloskey. As I recited in my testimony, I am also Chairman of the Joint Industry-Government Task Force on Eutrophication. And we have been trying to keep the Government—the Department of Interior, Agriculture, and TVA—apprised of what is going on in the companies, while protecting their competitive position.

We have had a program of inviting the Government people to attend the company laboratories where they can spend a day, sometimes a day and a half, being apprised of all of the research work that is going on. Now there is a degree of confidentiality about this. But it is the only mechanism that I could find as chairman of that joint task force to give them the opportunity to see really what is going on, to get a dimension and also to be brought up-to-date on an evaluation of the products we have looked at and have rejected. In some instances, because I am sort of a neutral and I can travel through all of them, some companies have gone to the extent of showing them in-house new products that they are looking at.

This is the one way that you can get a dimension. I think, in counseling with my members, this would be the time to extend an invitation to yourself, to your administrative aide, and to members of the committee at large to come and see this. I don't know of any other way to put a dimension on this for you.

Mr. MCCLOSKEY. Let me put it this way, Mr. Bueltman: We find ourselves in the position of being almost trustees for the preservation of the national waterways and trying to determine the thrust of Government, the priority of Government operations, to go into this. This is not to criticize your industry, but the job of our committee is to find out if the Government is doing an effective job, giving it a proper allocation of resources.

And when we find a situation like this, we are reluctant to suggest to industry that they do anything, where it appears from the testimony

that the research that you are doing far surpasses any amount of research that the Government is doing in this problem.

Dr. HEALEY. May I comment? It seemed to me this morning—and I am speaking a little beyond my area of expertise—that the testimony response was to the question "are you supporting work for a phosphate replacement to the Department?" I think that was the project at IITRI for $99,000, and I think that somehow got misunderstood as being the total amount of money they were putting in. But actually it seems there is a three-way attack we are making—the industry and Government together.

First on the problem of eutrophication, we say we don't understand it enough; there may be better ways than phosphate control to look at it.

Mr. MCCLOSKEY. Stop right there. Of that $46 million, how much do you understand goes into the eutrophication problem?

Dr. HEALEY. I don't know. I think they are to provide those figures. I think it is substantially more than the figure of $99,000. But this they should clarify.

The second point is the waste treatment. This again is logically Government work, because of the complexity involved, and it is certainly not an area of our own industry's expertise. Again, I think they are funding heavily recently in that area. They mentioned New York University work and the finding that a physical-chemical process might remove phosphate very inexpensively.

The third is the seeking of a phosphate replacement. This is where the detergent industry is most expert and it would be very difficult to find university or Government scientists who would have enough general knowledge of formulations and behavior of washing products, so most of our money is being poured into that area, with their urging and with their support.

So we are doing some work on eutrophication, as we mentioned to Mr. Hicks. But very little on waste treatment, which is not our area.

Mr. MCCLOSKEY. The question I want to ask you, though, is this: We find that industry, the primary contributor to pollution, is now perfectly willing, either through individuals or the companies, to devote tremendous efforts to stopping pollution. The problem is to devise the mechanism by which industry's talents can be put to use.

Now, in the jet engine noise area, the FAA let out contracts to Boeing and Douglas to compete with one another as to how many decibels they could reduce.

Do you think we might assist the solution of this particular problem through the Government's letting out research contracts directly to the three companies to compete for the means of reducing the phosphate impact on the environment?

Dr. HEALEY. My reaction is we couldn't find more competent people to put on the job, even if money was provided. That is a very quick reaction to that. But in our case it is not so much a question of money but the kind of people you need and the facilities with which you have to work.

Most of our basic scientists are aiming at this problem.

Mr. MCCLOSKEY. But how are we in the Government to know that the thrust of your research is to protect the environment rather than to promote the competitive products which you market?

Dr. HEALEY. I think a visit to the laboratories would be helpful, for one thing. We have a record of responsibility as an industry. We have too much at stake in this country, you know, to act irresponsibly. But rather than taking our word, we would be glad to share and show you what we are doing.

Mr. MCCLOSKEY. Part of our problem, of course, in taking your word, is when you are reluctant to disclose figures because of the competitive impact.

Dr. HEALEY. I think we all agreed to do that privately. It is not a matter of our not disclosing it, but just that we are sitting in the presence of our competitors now.

Mr. MCCLOSKEY. Let me complete this, then, with one final set of questions to clarify what I don't understand. When you reach a certain level of phosphate content in a lake, do you reach a point where the further addition of phosphates no longer increases the eutrophication? In other words, at a certain level is it enough to destroy the lake as we know it?

Mr. BUELTMAN. Yes.

Mr. MCCLOSKEY. What is that level on your chart?

Mr. BUELTMAN. It is 10. We have pulled this number from other people's work. I believe back in history this number was derived from work done by Sawyer, which is the 10-microgram-per-liter level.

Mr. MCCLOSKEY. What is a microgram compared with a gram?

Mr. BUELTMAN. A millionth of it.

Mr. MCCLOSKEY. Let me go back to the testimony this morning, where I think it was said that if the input into the lake is 0.2 grams per liter it will eutrophy in a short period of time, like 10 years. Can you help me on that, counsel?

Dr. CALLIS. That was a flow value, I believe, and not a concentration in the lake. This is a concentration in the water in the spring, and if the concentration is higher than this you can expect nuisance conditions, according to the literature.

Mr. MCCLOSKEY. How long did it take Lake Erie to reach this level of eutrophication in the sense we know it?

Dr. HEALEY. It was 0.14—I think the chairman said it was 0.14 in 1942.I believe that is the figure you quoted earlier.

Mr. REUSS. From the Joint Commission.

Dr. HEALEY. From the Board's report to the Joint Commission.

Mr. MCCLOSKEY. Do you know what Lake Tahoe is today?

Dr. HEALEY. It is much lower than that. Tahoe is shown in the report.

Mr. BUELTMAN. While he is looking that up, relative to Lake Tahoe, the evidence is that Lake Tahoe is nitrogen dependent, that phosphorus is not the controlling factor in Lake Tahoe. So that concentration on phosphorus in Lake Tahoe is not the point of attack that is going to make any difference in that particular body of water.

Mr. MCCLOSKEY. And yet if I recall correctly, that tertiary sewage treatement plant at the south end of Lake Tahoe was primarily for phosphate, not nitrogen, wasn't it?

Mr. BUELTMAN. I would say the tertiary treatment plant there is the most advanced and removes almost everything. It is truly a demonstration-type project where you are learning a lot about everything.

Mr. BRUCK. I think it was pointed out that the effluent from that

plant is not put back into the lake; it is pumped up into Indian Creek Reservoir on top of the mountain range.

Mr. McCloskey. Gentlemen, after all of this testimony can you explain where Mr. Klein is wrong in his suggestions this morning that by 1972 all of your companies shall no longer put phosphates in detergents; because we have a conflict of testimony, and I don't think that any of you have spoken to this point to challenge his findings, other than to give your own position here.

Mr. Bruck. I am not sure we have all of the evidence that Mr. Klein has. But on the evidence that we do have available to us—and we have looked arduously and long for evidence that removal of phosphate from detergents would help this situation—we have found none.

Mr. McCloskey. Yet you make up the bulk of the very task force which works with the Department of Interior which testified before us this morning.

How do we resolve this kind of dispute between you and them?

Mr. Bruck. I suspect appearing here today may be one thing that will lead to the resolution of that disagreement.

Mr. McCloskey. Let me go to the premises on which they base their testimony, because we have to believe one or the other of you on this.

If you have a chart like that for a watershed such as Lake Tahoe, where there is agricultural drainage of phosphorus: As far as we know, there is no industrial plant in the Lake Tahoe area; so all you have are human beings—human beings using detergents—plus the natural runoff, and what they mentioned as natural land being disturbed for construction purposes.

Under those circumstances, are you prepared to testify here today that a denial of the uses of detergents in the Lake Tahoe Basin would not materially mitigate or diminish excessive algal growth? [Chorus of "yes."]

Mr. McCloskey. On what basis, can you tell me?

Mr. Bueltman. Coming back to Lake Tahoe as a specific instance, the technical information available is that phosphate is not the controlling element in Lake Tahoe; nitrogen is. So that the importance of the phosphate input into Lake Tahoe is minimal compared to the criticality of the nitrogen level.

So if you were to control Lake Tahoe, eutrophication-wise, you would concentrate on removing nitrogen containing ingredients from the drainage basin of the lake.

Mr. McCloskey. Suppose that we control the nitrogen input into Lake Tahoe, so we stop that potential cause of eutrophication.

Given the present use of detergents and the present size of the population and the increase in that population, could Lake Tahoe possibly eutrophy solely from phosphates?

Mr. Bueltman. Again, I am not prepared to give you a yes or no answer technically. But here again, this is one of the reasons that we on the joint task force and the companies individually are spending tremendous inputs of manpower and money in the development of the PAAP test, which Dr. Bartsch explained this morning. This is a critical need in the whole intelligence on eutrophication—some simple method for reducing it down to testing in the laboratory rather than testing in the entire lake which would take decades to do.

You might have created an irreversible situation that you don't want to create. So we are making a tremendous effort in the development of this test.

Mr. McCloskey. Let me go back to another thing that disturbed me from the earlier testimony. From that New York Times article, products are marketed in Milwaukee that range from 1 to 43 percent phosphates and the company's products apparently are in a different range; and yet you don't need all of those phosphates in different geographical areas of the country, I assume.

Is that a correct assumption?

Mr. Healey. No; I don't think it is.

Mr. McCloskey. What is the meaning of these charts from the U.S. Geological Survey that indicate that water is harder in varying degrees in different places in the country?

Miss Lyng. I would like to speak to that point, if I may. I think perhaps you were absent when we discussed it before.

Regardless of what the hardness of the water supply in a given area is, no load of clothes is ever washed in the absence of hardness minerals because the soil on the clothes brings hardness into the wash water. The amount of hardness supplied by the clothes may range from two to five to seven or more grains per gallon, depending on the soil on the clothes. So you may, in fact, be raising soft wash water to a medium hardness or you may push the medium hardness water up to hard water with the clothes load.

Thus, there is always hardness present to be handled and the phosphate in detergents does this more efficiently than any material we have available.

Mr. McCloskey. But I gather that, depending on the product you use, some products can get by with 1 percent phosphate, some with 43 percent.

Miss Lyng. No, sir. I haven't seen the list but——

Mr. Bueltman. If I may speak to this as briefly as possible, there are probably six major categories of products—heavy-duty powder, heavy-duty liquid, automatic dishwashers, hard surface cleaners which can be used on table tops, walls, dishes, and so forth; this type of category.

The range of phosphate content that you see here—I want, by discussing it, not to give any credence to this until I have it checked out, because this is the first time I have seen this—but the range of phosphate content for a given functional purpose of the product—that is, heavy-duty powder products, will be in a narrow percent range, not from 1 to 43 as evidenced here.

There will be some slight variation depending on the formulation expertise of the individual companies as to what they might add to adjust their product.

Mr. McCloskey. Let me ask this simple question, because I haven't heard the answer yet:

If you have a hard water area and a soft water area, and in your soft water area the dirt on the clothes requires you to have phosphate of a level of say 20 percent in your product in order to clean the clothes, would you not have to increase that phosphate content in a hard water area?

Mr. BUELTMAN. Yes. There was a prior discussion on this, Congressman McCloskey, which I might ask Dr. Healey to bring up, as to the instructions on the package on how much you adjust the amount of the product used.

Or maybe Miss Lyng.

Miss LYNG. This is exactly the case. The directions on detergent packages provide a starting point for the amount to use. For all normal sudsing laundry detergents this will be between 1 and 1½ cups. Some recommend starting with one cup, some recommend a cup and a quarter, some a cup and a half, depending upon the formulation of the product. This is always stated as a starting point and we advise the homemaker to adjust usage as water hardness increases and depending on how dirty the clothes are. Still another factor is the large capacity of the washer. The large capacity automatic washers that hold more clothes require more detergent because, again, there is more soil to be handled.

In soft water, a homemaker will adjust product usage downward. She will not use as much product. The suds level will serve as a guide for her.

Mr. MCCLOSKEY. Is the sense of your testimony, then, that in the soft water areas we are not using a surplusage of phosphates, because the housewife herself recognizes she does not have to use that much?

Miss LYNG. Yes, sir.

Mr. MCCLOSKEY. So, there is a self-regulating thing in the product itself which reduces the phosphate and we can be assured as a committee that by permitting the national marketing at the same phosphate level we are not putting a surplus of phosphates into the soft water areas. Everybody is nodding their head.

Mr. BUELTMAN. Yes.

Dr. HEALEY. There is another complication, that within 50 miles of New York City I suspect the hardness goes from something like 40 parts per million, or 2 grains, to about 200 parts per million, or 10 or 12 grains, hardness. So, even though geologically it is called a soft water area, there are pockets of very hard water in the area.

It would be a great penalty to that housewife who happened to have hard water if she could not buy a detergent with enough phosphate.

Miss LYNG. I can cite another instance to support Dr. Healey's statement. Rochester, N.Y., happened to be my home for some time. According to the U.S. Geological Survey, Rochester, N.Y., I think is said to have hardness of 8 or 9 grains per gallon. There are, however, two communities located about 20 to 30 miles from Rochester where hardness will be about 100 grains per gallon. These communities are essentially sitting on top of limestone beds.

Mr. MCCLOSKEY. Let me ask another question of your industry. We had this same situation for the automobiles and the smog-control devices and the lawsuits that have resulted from that. Let us assume that one of your companies, in the privacy of its research laboratories, discovered a means to clean clothes to the standards you would like, without using phosphates at all. What guarantee would we have that that breakthrough would become known in the industry at large or to the Government?

Dr. CALLIS. I think the guarantee you have is that it is a highly competitive world, and I do not think all of the brains are in one company;

and if it is discovered one place, it is going to be discovered somewhere else. And the big advantage that a company gets in a competitive sense is to be there first with a product that is better.

Mr. BUELTMAN. I think there is another point to be made, too, that there might be a lag time before some other companies catch up. I can assure you that in their test marketing of the products, when a new product arrives on a grocery store shelf, in some city in the country there is a sample picked up by their competitors and within a matter of hours, in each company laboratory they are breaking it down to find out what it is.

Mr. MCCLOSKY. Let me draw the analogy to the birth control situation, where we found that the Government spends approximately $5 million a year for research to limit population, and private industry is spending three times that much, or $15 million. And if private industry should discover a means of a simple inoculation, which would wipe out its entire market for pills, in effect that scientific discovery militates against the product from which the company is making a profit. This is the problem of having Government research parallel to industry research.

Dr. HEALEY. But we can't afford to bury an invention or discovery. As they have said, it is too competitive. And think of the advantage in leadtime it would give us, you know. I would love to have something that my friends beside me do not have.

That is what we are working for all of the time. I am certainly not going to bury that when they might discover it later. You do not have that luxury of time in any competitive situation.

Mr. MCCLOSKY. I have no further questions.

Mr. VANDER JAGT. Just one general observation that I would like your comments on. As members of a committee, we are concerned with eutrophication of our water. We had the Government before us this morning—I think most of you heard the testimony—and the figure ranged from 50 to 70 percent phosphorus in the water than can be traced to phosphorus in detergents. This was the testimony as I understood it, and I would like your comments on it—if I correctly understood Secretary Klein this morning, that it is absolutely essential that we find a substitute for phosphorus in detergents.

But it was his further testimony that, and I paraphrase, "Well, it is really industry's job to come up with a substitute and that is why we have only spent $99,000 since the inception of this agency finding a substitute. Industry is going to do that."

Then, this afternoon we have industry before us. And industry tells us, and I paraphrase again, "Well, Secretary Klein may have said it is absolutely essential that we get phosphorus out of detergents, but it is our position as an industry that the evidence is not conclusive that phosphorus is the key element. You could eliminate all phosphorus from detergents and it would not deminish the euthrophication problem that we have."

So, after this morning, we are looking to industry to come up with a substitute, but industry tells us, "well, it is not as essential as you were told this morning."

Dr. HEALEY. We do not know; is it?

Mr. BUELTMAN. If I may lead off, and then they can individually make a statement, our position technically is that at this time we do

not feel that the removal of phosphates from detergents is going to diminish the problem. But concurrently with our working together with the Government in the area in which we can legitimately work together—in finding the causative factors and the controllable factors and so forth—the individual companies are pursuing finding a possible substitute for phosphates, should that time come when the evidence says it is needed, and that something constructive will be accomplished by using it.

Mr. VANDER JAGT. The evidence is that it is needed now, not "should the time come when it is shown that it is needed."

Mr. BUELTMAN. At this point in our technical judgment the evidence does not say it is absolutely, unequivocally, needed. This is in our technical judgment. You had the other technical judgment this morning.

However, no time is being lost, because for several years now, going

So, what we are trying to assure you is that, although we have this eutrophication, the companies have been researching for something to replace phosphate.

So, what we are trying to assure you is, that although we have this question mark, we are not losing time on the possibility of having an answer if it comes to the point where it is demonstrated it will do something constructive.

I do not think there is evidence that says detergent phosphates are guilty; I do not think there is evidence that says they are not guilty. It is a great big gray area at this moment.

Mr. VANDER JAGT. But Secretary Klein told us this morning—and his is the agency through which we operate—that in his opinion it is absolutely essential that we remove phosphates from detergents, and, yes, we are going to do this job and we are going to rely on industry to do it. But then industry tells us the evidence cannot show that removal of phosphates from detergents is needed.

So, what we are relying on for the solution to what the Government says is a problem is a group that does not really believe that it is necessary that a substitute be found, so that a solution can be found.

Would not that kind of shake your confidence, if you were representing the Government, in their proceeding full speed ahead? How can you proceed full speed ahead when you do not think it is needed?

Dr. WEARN. I think usually, in basic research of this nature, controversy speeds the solution to the problem. You have different points of view——

Mr. VANDER JAGT. If I could interrupt right there, would controversy as to whether the research is necessary in the first place speed the solution to the problem?

Dr. WEARN. I do not believe there is any disagreement between the Government and industry on that. We need to know; we must know; the whole aspect of eutrophication must be known.

Mr. VANDER JAGT. But there is controversy between the Government and your position as to whether it is necessary and essential that a substitute be found for phosphates in detergents.

Dr. WEARN. Yes; at this time.

Mr. VANDER JAGT. Would controversy on that point increase your efforts, then? Or if you were completely convinced that it were neces-

sary to find a substitute, would not that increase your efforts a little bit? Does not that just make sense, gentlemen?

Dr. WEARN. Of course——

Dr. HEALEY. It makes sense, but I do not think it could. We are working as hard as we can.

Mr. VANDER JAGT. Thank you.

Mr. REUSS. Mr. Gude?

Mr. GUDE. Is there any difference between molecules of phosphorus which comes from land drainage as opposed to detergents? Has there ever been any study of whether detergent phosphorus is actually what goes into algal growth, or whether another source would be more responsible than phosphorus?

Mr. BUELTMAN. I do not feel this would be a useful route of research to pursue. We use sodiumtripolyphosphate in our products, but through hydrolysis this ultimately gets down to phosphate. They all come down to a basic form which is the form used in water, whether it comes from fertilizers, human excrement or what, it is just the nature of phosphate—what is the word I am looking for?—molecules of various types, orthophosphate, tripolyphosphate, and so forth. They all eventually reduce down. It would not make much difference, once it gets there. Whether it is a detergent phosphorus element or whether it is human excrement phosphorus will not make a difference.

Mr. GUDE. Thank you.

Dr. CALLIS. The algae cannot tell the difference.

Mr. GUDE. You know that with certainty?

Dr. HEALEY. Yes, sir.

Mr. REUSS. Mr. Indritz?

Mr. INDRITZ. Mr. Bueltman, on page 4 of your statement, you list seven functions of phosphates in detergents. Why must the one material; namely, phosphates, pass all of these tests? Would it not be possible to have a combination of more than one material to take care of the different functions?

Mr. BUELTMAN. And this is being researched, Mr. Indritz. In my statement elsewhere, without searching for the words, is the report that any single material or combination of materials to date has not evidenced the ability to replace all of these functions that phosphate serves. We are not trying to find an element to replace phosphorus; we are trying to find any combination along with trying, hopefully, to find a single one.

Mr. INDRITZ. On page 9 of your statement, under the heading, "The Search for a Replacement," you state that the detergent industry has agreed to the Departmenet of the Interior's request to intensify the research efforts to seek a phosphate replacement "should one be needed."

Did the Interior Department add that qualifying phrase, "should one be needed" or is that simply part of your statement, or your view? Earlier today, the Interior Department made it very clear, I thought, that the Department believes that research efforts must be made to seek a phosphate replacement—period.

Could you explain that phrase, "should one be needed?"

Mr. BUELTMAN. That is a dialog we have been having, Mr. Indritz. This is our qualifying statement. The Department of Interior has asked us to intensify our efforts. We did intensify our efforts.

Mr. INDRITZ. Your sentence says, "The detergent industry has agreed to the Department of Interior's request to intensify the research effort to seek a phosphate replacement should one be needed."

What I am trying to find out is, was the phrase "should one be needed" a qualifying part of the Department's request, or is that a qualifying part of your agreement? In other words, do you disagree with the Department's request to intensify research for a phosphate replacement—period?

Mr. BUELTMAN. We are. Our actions lend credence to our statement that we have intensified our search in compliance with the Department of the Interior's request to do so.

Mr. INDRITZ. Why do you put in the phrase "should one be needed?" Are you trying to qualify your agreement, or are you in disagreement with the Department?

Mr. BUELTMAN. We are in disagreement that the finding of a phosphate replacement in detergents and the use of it will alleviate the eutrophication problem.

Mr. INDRITZ. That isn't what the sentence says.

Mr. BUELTMAN. It is poor sentence structure then, is all I can say.

Mr. INDRITZ. The members of the subcommittee have previously asked that there be provided a list of the expenditures by the detergent manufacturing companies during this calendar year on research, and also expenditures on advertising.

Will you add to that, please, some data on the average cost of the builder material per pound of product, so that the committee might have an idea as to the possible cost increase of the end product if the cost of the builder material or substitute builder material went up? Could you provide that information?

Mr. BUELTMAN. I believe so. But I would have to ask for a commitment from the individual companies, because you are asking for the cost of the ingredients in their product, which is information I do not have.

If they will agree to this; yes.

Dr. WEARN. Let me understand. We don't know what the replacement will be, so the cost has yet to be determined. You understand that?

Mr. INDRITZ. I understand. But the committee would like to have an idea of the average cost of present builder material, and what proportion that is of the total amount.

Dr. WEARN. That is known, of course, but were we to invent a new chemical, it would have to be commercialized before we could determine its cost.

Mr. INDRITZ. We have information, or statements in reports, that some substitute builders could be provided at 15 cents a pound, 25 cents a pound. So it would be helpful to the committee, in evaluating that information, to know the average cost of builder material per pound of product. That is why I asked the question.

Dr. WEARN. If you are talking about phosphate, the price of the detergent phosphate is well known. It is in the range of about 7 cents a pound.

But there are substantial amounts used, so that the cost is more than one might imagine from the price per pound.

Mr. INDRITZ. But there are other kinds of builders on the market. If we could have data so that——

Dr. WEARN. That would have to come from each company, and privately, I think.

Mr. INDRITZ. Can we ask each company if they would provide that?

Dr. HEALEY. You are assuming a 1-to-1 replacement in this? Did you want the cost per pound of builder that is being offered for sale? I'm not exactly clear on how you would like the information.

Mr. INDRITZ. A report was put out by John W. McCutcheon Associates entitled "Detergents and Emulsifiers, 1969 Annual," in which it describes various forms of substitutes that are now possibly suitable for replacement for phosphate.

In connection with one of them, for example, a substituted disphosphonic acid, it states on page 10, in an article entitled, "New Type Builders for Heavy Duty Detergents":

> Comparisons again show that builder cleaning effect [for this substitute] is twice that of sodium tripolyphosphate which means the builder can be reduced by half and still be as effective as sodium tripolyphosphate. At a cost estimate of 25 cents per pound for these phosphonate derivatives such products begin to be economically attractive.

That means a price of 12.5 cents per pound equivalent disphosphonic acid substitute for the sodium tripolyphosphate.

The committee would like to be in a position to evaluate what this means in terms of the average cost of the builder now being used, and the 12.5 cents per pound for the substitute builder. That is why I am asking the question.

Mr. BRUCK. Could I comment just briefly on that? I'm not sure which material you were referring to. I think I have that article here, but would you mind repeating that?

Mr. INDRITZ. You are from Procter & Gamble: aren't you?

Mr. BRUCK. Yes.

Mr. INDRITZ. Patent No. 3,159,581 is owned by you?

Mr. BRUCK. Yes.

Mr. INDRITZ. I am referring to page 10 of that article, which states:

> Comparisons again show that builder cleaning effect is twice that of STPP which means that the builder can be reduced by half, and still be as effective as STPP. At a cost estimate of 25 cents per pound for these phosphonate derivatives such products begin to be economically attractive.

Mr. BRUCK. If I could comment on that particular material, our further work with it—we do have a patent on that material—but our further work has demonstrated, and incidentally, through our substantial effort, in looking into water quality problems, or potential problems, that this material is not biodegradable, and therefore not usable.

I'm not sure we can provide a realistic cost, because as far as I know. this is not being manufactured. But let me add that cost is not a factor in our screening of these things at all. This particular material has been rejected by us, despite our patent, because after the patent was issued, we discovered the material was not satisfactory from the water quality standpoint.

Mr. INDRITZ. Do I understand, then, that so far as tripolyphosphate is concerned, the average cost of the builder material is 7 cents per pound?

Dr. WEARN. That particular material, I said that cost is well known, sodium tripolyphosphate. Other builder materials would be different, of course. And others are used.

So it is difficult to answer your question.

Mr. BRUCK. Mr. Indritz, we are anxious to be responsive to your question, but I must confess, I don't quite understand what it is you are after. If I have been helpful in this particular question, I'm glad. But if there is something more you would like, I would be glad to respond to that, too.

Mr. INDRITZ. Let me then ask Monsanto. Dr. Callis, I understand that Monsanto manufactures in the area of 150 million pounds of nitrilotriacetate, which is a builder material.

Dr. CALLIS. We manufacture nitrilotriaceate in small quantities.

Mr. INDRITZ. Is the figure of 150 million pounds that I mentioned inaccurate?

Dr. CALLIS. I wish we did manufacture that much. Yes, it is inaccurate.

Mr. INDRITZ. Is that the quantity manufactured in the United States by you and others, perhaps?

Dr. CALLIS. I do not know the answer to that question, but it sounds like too much material to me.

Mr. BRUCK. I might comment on NTA. I realize you addressed the question to Dr. Callis, but as Procter & Gamble, we are at least one company in the United States who manufacture products containing NTA. We have two in national distribution—Gain and Cheer. We use NTA on the basis of its ability to contribute a performance improvement over an all-phosphate product, and it needs to be used in conjunction with tripolyphosphate.

Mr. INDRITZ. When NTA is used in conjunction with tripolyphosphate, does that result in a lower amount of tripolyphosphate in the product?

Mr. BRUCK. It can. In the case of Gain, the phosphate level is in the same general range as those products without NTA. As a matter of fact, so is Cheer. We use it as an adjunct to phosphate, in order to produce a product performance improvement.

Mr. INDRITZ. Will the use of NTA result in use of less tripolyphosphates, while maintaining the washability characteristics within the range of necessary cleanliness, and at the same time helping to reduce the amount of phosphate which goes into the waterways?

Mr. BRUCK. Well, in the sense that it does provide an improvement in the overall product performance, and harking back to what we have referred to before, in the housewife's selection of the amount of product she needs to achieve a certain cleaning level, I think it is conceivable that some reduction in total amount might occur as a result of improved performance of these products.

In the case of Gain, it is not possible to answer your question. We started with a brandnew formulation. I have said the phosphate level we use in conjunction with NTA is in the same general range as other products without NTA.

Mr. INDRITZ. Dr. Healey, doesn't Lever Bros., or one of its associate companies, market in Sweden a detergent containing NTA and only 10 percent phosphate? I refer to the A. B. Sunlight——

Dr. HEALEY. A. B. Sunlight is the name of the company, and their product is called Radion. I don't believe that contains any NTA. I think it is primarily a soap product, containing a low, about 10 percent, phosphate, and other synthetic ingredients, but not NTA.

Mr. INDRITZ. It is being marketed in large quantities now?

Dr. HEALEY. It is being marketed—I don't know what size market it has gained at this point. It was only recently introduced, in the fall of this year, and I think it substituted for the former Radion. So presumably, it has about the same size market as the former one. But I don't have those figures.

(Subsequently, Lever Bros. Co., submitted the following evaluation of the New Radion:)

EVALUATION OF THE SWEDISH DETERGENT "NEW RADION," DECEMBER 15, 1969

SUMMARY

The recent introduction of a low-phosphate detergent, "New Radion," by a Unilever subsidiary in Sweden, A. B. Sunlight, has raised the question of whether a similar product could be marketed here in the United States. While "New Radion" may be suitable for Swedish washing conditions, when tested under U.S. conditions the product has been found to be generally unsatisfactory.

In the fall of 1969 A. B. Sunlight, a subsidiary of Unilever in Sweden introduced "New Radion," a heavy-duty detergent with low phosphate. News reports in this country of this development raised the reasonable question of whether a similar detergent could be marketed here. The product has now been evaluated both in terms of the Swedish manufacturer's statements and use directions and in terms of the differences which we understand to exist between the laundering habits in Sweden and in the United States. A. B. Sunlight as a subsidiary of Unilever is, of course, not controlled by any U.S. detergent manufacturer.

At the time of the introduction of "New Radion" the manufacturer issued a press release which stated this type of detergent cannot, in their opinion, measure up in all respects to the company's best synthetic detergents.

Sunlight's advertising copy points out some of the limitations of the product:

"New Radion is a low-sudsing washing preparation for your main laundry, based on soap and with the addition of syndets. It is suitable for all kinds of machine and tub laundry, but not quite so good for hand laundry because the powder is not so easily dissolved as before.

"Some phosphates are included as washing strengtheners, but the phosphate content is low. The new composition requires careful dosing. In order to reduce the risk of soap scum forming, we recommend prewashing in a syndet preparation if the water is hard."

The practice of prewashing is apparently widespread in Sweden and the "New Radion" package contains detailed directions for prewash and mainwash requirements for each machine type and size as well as water hardness. A copy of this package panel (and its translation) is shown in appendix I along with what we understand to be typical Swedish washing conditions.

Considering that some 60 percent of the water in Sweden is soft or relatively soft (less than 120 p.p.m. calculated as $CaCO_3$) and that the normal washing concentration of detergent product in the wash is about 0.6 percent (which is about 4 to 6 times the normal U.S. concentration), "New Radion" is expected to perform reasonably well in soft to medium-soft water areas in Sweden. "New Radion," however, is less adequate for hard water areas unless considerably overdosed in the wash or combined with a prewash using a regular phosphated detergent product.

In the United States, the inadequacy of "New Radion" becomes more apparent due to the use of low concentration levels (approximately 0.15 percent) of detergent product in the wash. Thus, "New Radion," or an equivalent product, is

inferior to regular phosphated products when used at the 0.15 percent level in hard water areas due to inadequate softening and cleansing capacity, not to mention the problems of scumming and rancid odors which are attendant with the use of soap-based products under such conditions (see app. II). To improve the wash, the consumer would have to use a considerably higher concentration (e.g. 2.3 times as much as a conventional synthetic detergent product in 180 p.p.m. water), thus making the product less economical than current detergent products. The amount of phosphate delivered to the wash solution under such conditions would, of course, be proportionately more than at normal usage levels.

The difference in washing results between Swedish and United States practice with soap products, like "New Radion," is in part a direct result of the difference in the design of washing machines in use. In the Swedish machine the wash liquor/cloth ratio is about 5:1, whereas in the U.S. machine the ratio is about 20:1. Since U.S. washing machines use substantially more water (about 17 gals.) than do Swedish machines (about 5 gals.), substantially more of a soap product would be needed to soften the water in U.S. machines. Also, the Swedish machine heats the water to near boiling (90–95° C.) (192–203° F.) which improves detergency compared to the less efficient low washing temperatures of 40–55° C. (104–131° F.) in use in the United States. The high temperature wash also provides a means of bleaching during the wash, since the Swedish detergent products also contain perborates which are more effective at higher washing temperatures (greater than 60° C.) (140° F.).

Recognizing that even under the favorable Swedish conditions for which "New Radion" was designed, the manufacturer believes it will not equal the best synthetic detergents, it is not surprising that the product cannot cope with the stringent requirements imposed by U.S. washing conditions.

APPENDIX I—DOSING TABLE

Machine type	Machine capacity	Prewash	Soft water 0–6° dH	Medium-hard water 7–12° dH	Hard water 13–18° dH
Drum	3–4 kg	½ dl	1¾–2½ dl	2½–3 dl	2¾–3¾ dl.
	4–5 kg	¾ dl	2½–3 dl	3–3¾ dl	3¾–4½ dl.
Automatic	5–7 kg	1dl	3–4½ dl	3¾–5 dl	4½–6½ dl.
	7–12 kg	1½ dl	4½–7½ dl	5–9 dl	6½–10½ dl.
Pulsator	2–3 kg	Soak in 1 dl. New Radion per 20 l water.	2¾–4 dl	3¾–5½ dl	4½–7 dl.
Agitator	4–5 kg		5½–6½ dl	7½–9½ dl	9–11½ dl.
Bowl 100 l. water	10 kg		10 dl	13 dl	16 dl.

Note: Tables based on 30 g New Radion per kg articles in soft water with drum-type machines. Dosings calculated according to the Consumer Institute amounts and standard filling for washing machines.

Note: kg=kilogram; l=liter; dl=deciliter (1/10 liter); °dH=°German Hardness (1°dH=17.85 ppm $CaCO_3$). For comparison with U.S. dosing, 1 cup is approximately equivalent to 2½ deciliters.

Swedish washing process.—The washing process in a typical Swedish drum washing machine involves both a prewash and main wash as follows:

	Prewash	Main wash
Washing time (minutes)	10/20	40/60
Liquor/cloth ratio (approximately)	~8.1	~5.1
Maximum temperature reached, °C	40/50	90/95
Amount of detergent used per kilogram of cloth in soft water (approximately)	~8 g.	~30 g.

Note: The 30 g. dosage corresponds to a detergent product concentration of 0.6 percent. Approximately 60 percent of the water in Sweden is less than 120 p.p.m. (as $CaCO_3$) in hardness. Washing machine capacities vary. A commonly used machine capacity is one which handles 4 kg. of cloth per load.

APPENDIX II.—EVALUATION OF NEW RADION UNDER U.S. WASHING CONDITIONS

I. Laboratory Data

1. Terg-O-Tometer detergency:

Hardness: 180 ppm (2:1 Ca/Mg); dacron/cotton vacuum cleaner dust soil cloth.

Temperature: 120° F. (48.9° C).

Product concentration: New Radion—0.14, 0.18, 0.21, 0.28 and 0.32 percent corresponding to 1, 1¼, 1½, 2, and 2¼ cups per 17 gallons of water; brand "Y"—0.12 percent (1 cup per 17 gallons).

DETERGENCY UNITS

	Percent—					
	0.12	0.14	0.18	0.21	0.28	0.32
New Radion		6.3	8.9	12.2	25.7	28.7
Brand "Y"	24.6					

Note: This data shows that about 2.3 times as much (by weight; 0.28/0.12) New Radion is required for equivalent detergency at 180 p.p.m. compared to a standard level of conventional heavy-duty phosphated product—brand "Y".

2. Redeposition (clean cloth—soil added to washwater)—small-scale washers—3 gallons (product concentration equals 1 cup per 17 gallons; 180 ppm water; vacuum cleaner dust-artificial sebum soil); 120° F. (48.9° C.).

	Reflects values after 5 washes [1]	
	Spun dacron	Startex (cotton)
New Radion	23.7	78.7
Brand Y [2]	77.5	77.9

[1] The higher the reflectance value the less redeposition on the cloth. The data shows the New Radion to be greatly inferior to brand Y on spun dacron and equivalent on Startex on repeat washing.

[2] A conventional heavy-duty phosphated detergent product.

3. Clotting characteristics: A 4,000-milliliter beaker was filled with 3,500 milliliters of 180 parts per million water at a temperature of 140° F. One-half cup of powder was rapidly dumped into the hot water and stirred vigorously for 10 seconds. The amount of undissolved product floating on the surface was then evaluated visually according to the scale: heavy, moderate, slight, none.

New Radion: Moderate (uneacceptable for U.S. conditions).

Brand "Y" [1]: None.

II. Washing Machine Data

1. Detergency:

Conventional top-loading, 17-gallon U.S. washing machine.

Hardness: 180 parts per million (2:1 ca./mg.).

Product concentration: 1 cup per 17 gallons.

Soil cloth: Dacron/cotton soiled with vacuum cleaner dust.

	Detergency units
New Radion	8.4
Brand "Y" [1]	23.8

[1] A conventional heavy-duty phosphated detergent product.

The data shows New Radion to be greatly inferior to brand "Y" in detergency under the 180 parts per million conditions.

2. Detergency—Natural soil.

Nine clothing articles were naturally soiled by consumers during use. These soiled articles were then split in half and each set of half articles were washed in a conventional top-loading, 17-gallon U.S. washing machine with the detergent products listed at 0.15 percent concentration in 180 parts per million water (55° C.). The split articles were then evaluated visually.

	Number of articles judged cleaner
Washed in New Radion	0
Washed in brand "X"	8
No difference	1

The results clearly show the inadequate cleansing power of the New Radion in 180 parts per million water compared to a conventional heavy-duty prosphated detergent product—brand "X."

3. Odor of washed clothes:

Conventional top-loading, 17-gallon U.S. washing machine.

Product concentration: New Radion, 2 cups per 17 gallons, brand "Y," 1¼ cups per 17 gallons.

Hardness: 180 parts per million.

Temperature: 130° F. (54.4° C.).

No soil: 3 pounds of a mixed terrycloth—Startex load repeat washed and dried five times and then evaluated for odor.

ODOR OF CLOTH AFTER 5 WASHES

	Terrycloth	Startex
New Radion	Moderate fatty odor.	Slight fatty odor.
Brand Y [1]	None	None.

[1] A conventional heavy-duty phosphated detergent product.

Mr. INDRITZ. Mr. Bueltman, in your discussion on the question of whether phosphates are a cause of eutrophication, had you read the works of Vollenweider and of Vallentyne, which were the scientific basis for the International Joint Commission report?

Mr. BUELTMAN. Yes.

Mr. INDRITZ. Aren't those pretty conclusive evidence that phosphates do cause the growth of algae, that they are related to eutrophication, and that phosphates are the limiting factor, certainly, in Lake Erie?

Mr. BUELTMAN. Yes, but there is evidence on both sides, and I believe—without getting into a long technical discussion of the work of these two gentlemen, who are excellent researchers in this area—we would not concur with a conclusion that their work as performed demonstrates that phosphates, per se, are the controlling element in all situations.

Mr. INDRITZ. You simply, at the moment, don't accept their conclusions?

Mr. BUELTMAN. That is right.

Mr. INDRITZ. Did you participate in the trip to Europe of the Joint Industry Task Force in April 1969?

Mr. BUELTMAN. Yes, I did.

Mr. INDRITZ. Did you either see or discuss how the Swedish people are reducing the phosphate content in Lake Langsjon by alum treatment?

Mr. BUELTMAN. I don't remember that specific lake, but there was work reported to us where they had added alum to the surface and let it settle, if this is the work you are talking about.

Mr. INDRITZ. Didn't that result in reduction of the blue-green algae bloom in the lake for the first time in many years?

Mr. BUELTMAN. For that specific lake, under the specific conditions under which they did that work.

Now they tried the same work in another lake with the addition of a specific physical form of alum to the water and to allow it to settle at a rate which would permit redissolving of the alum, and forming an alum phosphate recipitate which would settle to the bottom of the lake. They tried to duplicate this work in another lake, and did not have the degree of success in this other lake that they did in the one you mentioned.

I know Dr. Bouveng is in the room, and is scheduled to testify, and he can speak very specifically about that.

Mr. INDRITZ. Was your statement, Mr. Bueltman, circulated and specifically approved by all of the companies listed on the attachment which lists the members of the association?

Mr. BUELTMAN. This is an approved industry statement in behalf of the members of our association; yes.

Mr. INDRITZ. Does that include all of the members listed in the back of your statement?

Mr. BUELTMAN. Yes.

Mr. INDRITZ. Was it also approved by W. R. Grace & Co., Hampshire Chemical Division?

Mr. BUELTMAN. Yes, sir.

Mr. INDRITZ. We will have a witness from that division tomorrow. His statement does appear to be largely inconsistent with your statement.

Could you also submit to us a statement listing all of the detergent products made by the detergent companies manufacturing more than 1 percent of the detergents used in the United States, and listing the percentages of phosphate in each and the area wherein each such product is marketed?

Mr. BUELTMAN. May I consult with legal counsel for a moment?

No. 1, specifically—and this is the reason for needing counsel—our association ground rules are that we do not maintain information nor obtain information on any individual brands. I just wanted to be sure that this, being an official request, was one to which I could respond.

The answer for the record is that I would be pleased to provide you with the names of the companies to contact and they would respond individually to you. But as an association we do not obtain information on specific product brands.

Mr. REUSS. That will be satisfactory. We will appreciate it.

Mr. INDRITZ. On page 6 of your statement, you mention that phosphate cleaners are widely used in all phases of metal finishing.

Did you mean to imply that metal finishing could be accomplished only with phosphate cleaners?

Mr. BUELTMAN. Here again, phosphate cleaners for various functions serve a very specific purpose and I do not want to becloud the issue with the use of phosphoric acid as such, but one of the reasons for the use of phosphate in metal finishing is parallel to the reason

they are used in the household detergents; they have a buffering effect, a pH range that they will stay within.

Mr. INDRITZ. Are you aware that the A. O. Smith Co. of Milwaukee uses over 200,000 pounds of Freemont No. 325 to clean its metals which is just as cheap and effective and free of phosphate?

Mr. BUELTMAN. Yes, sir. But that is used for a very specific purpose, and if you would go back to some of our previous dialog on the range of phosphate content of products, this is a hard surface cleaner and there are many hard surface cleaners marketed not only by Freemont but by other companies that do not contain phosphate. So it is used for a specific purpose by the A. O. Smith people.

Mr. INDRITZ. On page 2 of your statement you refer to the motion picture, which you participated in preparing, concerning the construction of modern sewage treatment facilities.

Does that motion picture anywhere mention the question of the replacement of phosphates in detergents so as to reduce the amount of phosphate that the sewage treatment plants might have to remove?

Mr. BUELTMAN. I do not believe it does, sir. The date of preparation of the film was a few years ago and I am not sure that this was a public concern at that time. But without going back—I have not myself reviewed the film in about 2 years—I would have to see it again to answer your question responsively.

Mr. INDRITZ. Do you do it in any other part of your national public education program, to help develop public understanding and awareness?

Mr. BUELTMAN. We have quite an educational campaign underway trying to explain eutrophication, the role of phosphates, the role of phosphates in detergents.

We have another film, "The Pursuit of Cleanliness," which has been in public distribution less time than this one has, which gets into the whole area of what cleaning products are, how they are used, what is their involvement and so forth.

Mr. INDRITZ. On page 5 of your statement you state that phosphates do not interfere with other aspects of waste treatment operations. I call your attention to an article in the Journal of the American Water Works Association, February 1967 issue, by G. A. Missingham, "Occurrence of Phosphates in Surface Waters and Some Related Problems". At page 189, the author, after referring to an article by Mr. T. D. Brenner, in the March 1964 issue of that journal, stated as follows:

> Brenner also claimed that the orthophosphates do not cause any difficulties with coagulation and sedimentation, but this statement has been refuted by Dr. C. N. Sawyer. Dr. Sawyer stated: "The question of whether phosphates interfere with coagulation is not an academic matter. It is a real practical problem which many water works personnel have had to face up to and solve by using higher dosages of coagulant than otherwise would be the case."

How does that gibe with your sentence that phosphate does not interfere with other aspects of waste treatment operations?

Dr. BUELTMAN. It does not interfere in the sense that it is disrupting anything, or is changing the method of treatment.

I also might point out that Mr. Brenner also works for me.

Mr. INDRITZ. I am not trying to create an internal dispute on this. At this point I will yield.

Mr. REUSS. Mr. Wearn, I am still troubled with this graph. The chart you have here is designed to show that even if you took all of the phosphate out of detergents, and did several other things, you would still have a land drainage deposit of phosphates into Lake Erie about three times over the level which causes nuisance algae conditions.

Dr. WEARN. That is correct.

Mr. REUSS. Now let's look at the record of the International Joint Commission here. On page 74, that was the chart to which you referred me before——

Dr. WEARN. Yes.

Mr. REUSS. That shows that for the year 1967 there poured into Lake Erie a total of 30,100 short tons of phosphorus.

Dr. WEARN. That is right.

Mr. REUSS. And part of that that was caused by land drainage is 2,870 short tons from the Detroit River, and 3,870 from other major tributaries, making a total of somewhat over 6,000 short tons.

Is that not so?

Dr. WEARN. Adding up all of the land drainage column; yes.

Mr. REUSS. And 6,000 goes into 30,000 about five times? Is that not so?

Dr. WEARN. About 20 percent of it.

Mr. REUSS. Right.

Therefore one can say, can one not, that in 1967, 20 percent, or one-fifth, of the total input of phosphorus into Lake Erie was caused by land drainage?

Dr. WEARN. That seems approximately correct.

Mr. REUSS. We now turn to page 24, in which it is set forth that in 1967–68 the total phosphorus in Lake Erie was 40 micrograms per liter.

Now one-fifth of 40 micrograms is 8 micrograms per liter; is it not?

Dr. WEARN. Yes, sir.

Mr. REUSS. Therefore, instead of saying that we are three times over the danger point, we are in fact under the danger point—which is 10—because we are only 8. Is that not so?

Dr. WEARN. Is that—one has to—let's see now.

Mr. REUSS. The statement on page 29 of the report to the IJC, to which I was referring, says:

> With reference to total phosphorus concentrations, data over a shorter period of time from the western basin of Lake Erie show increases from 14 micrograms per liter in 1942, to 33 in 1958, 35 in 1959 and 40 in 1967 and 1968.

Therefore I put it to you, sir, that the whole case of the detergent association collapses; and that you should be concerned about phosphates in detergents, and that far from land drainage constituting a 3-for-1 overkill of the lake, if all we had to concern ourselves with was land drainage, all would be well. We would then have a total pollution of 8 micrograms per liter, which is considerably under the 14 micrograms per liter that we had back in 1942 when all was well.

Dr. WEARN. Can we reconstitute the total phosphorus and then see the 20 percent? The total input phosphate, which also is given in the report.

Mr. REUSS. It is given on page 74, where the annual input of total phosphorus was 30,100 short tons per year.

Dr. WEARN. This would be the Lake Erie situation prior to any change [indicating on chart].

This is with all of the detergent phosphates included in the municipal waste. You see, out of 130, approximately 20 percent of that would be close to 30 percent drainage. That is the situation you face.

Mr. REUSS. Where do you get——

Dr. WEARN. This is the total input of phosphates from all sources—regular inputs of phosphorus into the lake, including all of these sources.

Mr. REUSS. And the total input of phosphorus, according to this report, was 40 micrograms per liter in the year 1967. Therefore one-fifth of 40 is eight——

Dr. WEARN. That cannot possibly be, because the detergent phosphate alone exceeds that, far exceeds that.

Mr. REUSS. I am showing you the report which says that the phosphorus concentration was 40 micrograms per liter in1967, which is the year we are talking about.

Dr. WEARN. The book may have inconsistencies, I don't know that.

Mr. REUSS. But you have a consistency.

Dr. WEARN. I don't believe that. We took the total, and I believe all would agree that of the total about 20 percent is land drainage source.

Mr. REUSS. There is no doubt about that; we did the arithmetic.

Dr. WEARN. So this must be correct as a total.

Mr. REUSS. One-fifth is land drainage: that is stipulated.

Dr. WEARN. So that remains the same. So it must be approximately correct.

Mr. REUSS. Where do you get your 30 and your 130?

Dr. WEARN. This is the concentration of the water, the concentration in the lake. The total—in one case you have——

Mr. REUSS. Where do you get that from? I hand you the report and ask you to show me where you get it.

Dr. WEARN. In one case you have the contents of the lake; the other is the input into the lake. We are talking about two sets of numbers. It so happens they come down to these same ranges, but one is the total contents of the phosphorus in the water of the lake, the other is the rate at which it flows into the lake.

Most of the discussion has to do with input. That is the source of these numbers.

Mr. REUSS. The 130 figure is for the total existing there now with all of the inputs?

Dr. WEARN. Yes. There is a review paper, just published, which gives approximately this same conclusion, this level of phosphates, not including municipal wastes. If necessary, I can read that.

(Subsequently, Dr. Wearn submitted the following statement on "Phosphorus Levels in Lake Erie":)

PHOSPHORUS LEVELS IN LAKE ERIE

Since considerable discussion developed at the recently concluded hearings of the Subcommittee on Conservation and Natural Resources relative to phosphorus levels in Lake Erie, it seemed desirable to comment further on the data pre-

sented as part of the Soap & Detergent Association testimony. In addition, this discussion may tend to clarify the apparent discrepancies which became evident during the course of the public hearing regarding certain data which appears in volume I of the "*Report to the International Joint Commission on the Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River.*" Specifically this involved information presented on pages 24 and 74 of the report.

Data attributed to Beeton, which is summarized on page 24, indicates a phosphorus concentration of 40 $\mu g/1$ in the Western Basin of Lake Erie in 1967–68. (Interestingly, the Beeton paper was published in 1965 suggesting that the 1967–68 data came from some other, unidentified source.) This level, of course, represents the phosphorus in solution and is only directly related to the phosphorus inputs to the lake.

The tabulation on page 74 of the IJC report represents actual phosphorus inputs to Lake Erie. A portion of these inputs may stay in solution (the previously cited Beeton data), they may come out of solution and ultimately sink to the lake bottom, or they may be incorporated into algae, bacteria, and higher forms of plant and aquatic life. Whatever the physical form, however, all this phosphorus would ultimately be available as a nutrient and must be considered in the overall eutrophication picture.

The following calculations were used in converting tonnage inputs of phosphorus (p. 74) to concentrations. These data were used in the graphical presentation portion of the industry's testimony on December 15. In preparing these data, it was assumed that the Lake Erie ecosystem (i.e. the bottom muds, the water itself and the Lake flora and fauna) was in equilibrium. That is, the concentration of phosphorus in the incoming water was the same as in the lake ecosystem.

(1A) Total flow into lake (source: Lake Erie Report, FWPCA, August 1968, p. 22).

	Cubic feet per second
Inflow from upper lakes	187, 000
Precipitation	22, 000
Runoff	25, 000
Total	234, 000

CFS can be converted to pounds of water/day by the following calculations:

$$234{,}000\ \frac{\text{feet}^3}{\text{seconds}} \times 60\ \frac{\text{seconds}}{\text{minutes}} \times 60\ \frac{\text{minutes}}{\text{hours}} \times 24\ \frac{\text{hours}}{\text{days}} \times 62.4\ \frac{\#}{\text{feet}^3} = 1.25 \times 10^{12}\ \frac{\#}{\text{days}}$$

(1B) Various phosphorus inputs to the lake have been enumerated as follows (source: Vol. 1, summary report to IJC, 1969, p. 74):

	Tons per year
Lake Huron	2, 240
Land drainage	6, 740
Municipal wastes	19, 090
Industrial wastes	2, 030
Total	30, 100

(1C) These annual tonnage figures can be converted to concentrations in the following manner:

$$\frac{\text{Tons P/yr} \times 2000\ \#/\text{ton}}{635\ \text{days/yr} \times 1.25 \times 10^{12}\ \#\ \text{water/day}} = \text{Concentration in } \mu g/1$$

Thus:

$$\frac{30{,}100 \times 2{,}000}{365 \times 1.25 \times 10^{12}} = 132.000000132 \text{ microgram per 1 part phosphorus total concentration}$$

(1D) Considering the various phosphorus sources, the contribution from each is as follows:

	Micrograms per 1 part phosphorus
Lake Huron	10. 0
Land drainage	29. 5
Municipal wastes	83. 5
Industrial wastes	9. 0
Total	132. 0

(1E) Assuming that detergents contribute 70 percent of the phosphorus in municipal wastes and further assuming that this was totally removed, the following phosphorus reduction could be expected

83.5 micrograms per 1 part phosphorus $\times$ 0.7=58.5 micrograms per 1 part phosphorus

The net phosphorus concentration still going into lake would be:

Micrograms per 1 part phosphorus	132. 0
Micrograms per 1 part phosphorus	−58. 5
Micrograms per 1 part phosphorus	73. 5

(1F) Assume a further 80 percent phosphorus reduction in municipal and industrial wastes entering lake:

Micrograms per 1 part phosphorus (Municipal)	25. 0
Micrograms per 1 part phosphorus (Industrial)	+9. 0
Micrograms per 1 part phosphorus $\times$ 0.80=26.4 micrograms per 1 part phosphorus removed	34. 0
Micrograms per 1 part phosphorus	34. 0
Micrograms per 1 part phosphorus	−26. 4
Micrograms per 1 part phosphorus remaining	7. 6

The net remaining phosphorus entering Lake Erie would be:

Micrograms per 1 part phosphorus	73. 5
Micrograms per 1 part phosphorus	−26. 4
Micrograms per 1 part phosphorus	47. 1

(1G) If no industrial or municipal wastes entered Lake Erie approximately 40 micrograms per 1 part phosphorus would enter from other sources—*well above the so-called critical phosphorus level of 10 micrograms per 1 part.*

Another approach to this question involves the following assumptions:

(2A) 1. Lake volume=9,940 $mi^2 \times 60$ feet average depth (source: Lake Erie Report, FWPCA, August, 1968, p. 17)

$$9.94 \times 10^3 mi^2 \times 2.8 \times 10^7\ ft^2/mi^2 \times 60\ ft = 1670 \times 10^{10}\ ft^3$$

Weight of water in the lake then is:

$$62.4\S\ ft^3 \times 1670 \times 10^{10} ft^3 = 10.4 \times 10^{14}\ \#\ water/Lake\ Erie$$

2. The retention time in Lake Erie is 2.6 years (source: IJC report, p. 143)

3. At the beginning of a 2.6 year period, Lake Erie contains no phosphorus (a *most* conservative assumption).

(2B) Annual phosphorus input to lake (tons phosphorus per year*	30, 100
Annual phosphorus outflow from lake (tons phosphorus per year)*	4, 500
Net phosphorus retained in lake per year (tons)	25, 600
Net phosphorus retained in lake in 2.6 yrs (tons)	66, 500

66,500 tons $\times$ 2,000#/ton=133,000,000 (13.3×10^7)

*See 1B for source.

$$\frac{13.3\times10^{7}}{10.4\times10^{14}}(\#\text{water in Lake Erie})=128\ \mu g/1\ P\ \text{total concentration}$$

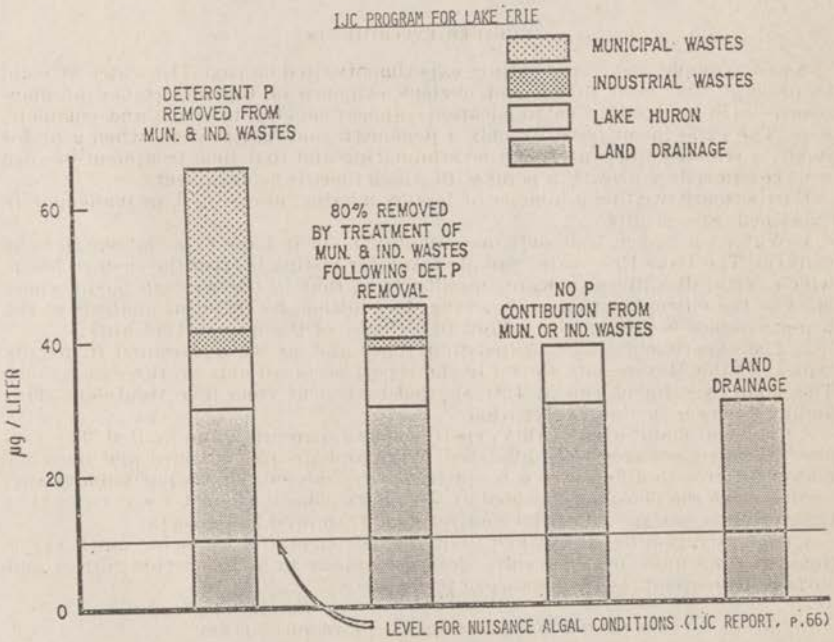
A value very close to that developed in section 1.

(2C) In terms of various sources, the contribution of each would be:

	Micrograms per part phosphorous
Lake Huron	9. 5 μg/1 P
Land drainage	28. 7 μg/1 P
Municipal wastes	81. 2 μg/1 P
Industrial wastes	8. 6 μg/1 P
Total	128. 0 μg/1 P

These values are in good agreement with those in section 1 and essentially the same conclusions can be drawn. That is, phosphorus input from land drainage alone is almost three times higher than the "critical" phosphorus concentration of 10 μg/1 P. Thus it would appear that the Lake Erie ecosystem contains phosphorus far in excess of the "critical" or controlling level from sources other than detergents.

THEODORE E. BRENNER.



Mr. REUSS. Are there any other questions?

Mr. VANDER JAGT. I have just one I would like to address to the representatives of the three companies. I am sure you would like to have an opportunity to answer "No" if the answer is "No." But we would like to know the answer if it is "Yes," in terms of evaluating this apparent conflict between this morning and this afternoon:

Do any of your companies or their subsidiaries own your raw material sources, such as phosphate mines or pits and so forth?

[Chorus of "Noes."]

Dr. WEARN. Speaking for Colgate, the answer is "No."

Dr. HEALEY. No, not for Lever Bros. We do not own any phosphate supply.

Mr. VANDER JAGT. Thank you.

Aren't you glad you had an opportunity to answer that?

Mr. BRUCK. Nor does Procter & Gamble.

Mr. VANDER JAGT. Thank you.

Mr. REUSS. Thank you very much, Mr. Bueltman, Miss Lyng, and gentlemen.

Mr. BUELTMAN. Thank you, Mr. Chairman.

(Subsequently, the Soap and Detergent Association furnished the following statement consisting of part of the testimony presented by Dr. Frank H. Healey, vice president, research and development, Lever Bros. Co., and member of the Soap and Detergent Association's Technical and Materials Division, at the International Joint Commission hearing on January 20, 1970, at Erie, Pa., concerning the findings and recommendations of the IJC:)

Our industry is concerned about the Boards'[1] preoccupation with phosphate and detergent phosphate in particular, while apparently overlooking other important factors. It also appears that some of the contents reflect an incomplete representation of the scientific thinking in a given area.

CULTURE EXPERIMENTS

As an example, the recent culture experiments cited on page 71[2] which attempt to provide "the most direct and obvious evidence of the importance of phosphorus" (in controlling eutrophication) appear lacking in scope and completeness. The experiment is really only a demonstration that sewage, when a major input to selected test water, can be stimulating and that lime treatment of such sewage can reduce growth, a point with which there is no argument.

Furthermore, we find a number of factors missing, unreported, or inadequately explained. Specifically:

1. Water was taken from only one sampling point in Lake Erie and one in Lake Ontario. The Lake Erie water sample taken for testing is from the eastern basin, which certainly differs in water quality from that in the western basin where most of the eutrophication is occurring. In addition, no chemical analysis of the water samples is presented to allow an estimate of the water's typicality.

2. The experiment was repeated four times and, as we understand it, results typical of the May results shown in the report occurred only on three occasions. The same experiment run in July showed no benefit from lime treatment. This finding deserves further explanation.

3. Chemical monitoring of this experiment is apparently quite limited. The variously treated sewages were analyzed for phosphate and nitrogen and no other reason for growth differences was apparently considered. This is particularly surprising since the phosphorus added by secondary effluent (flask C) was twice that from primary sewage (flask B) and yet flask C showed less growth.

A demonstration based on such limited experimentation, showing much variation and even unexplained results, does not appear to us to provide "direct and obvious evidence of the importance of phosphorus."

RELATION OF PHOSPHORUS TO TROPHIC LEVEL

In another instance, material based on an OECD report which is covered in the figure on page 68 and the text beginning on page 72, appears selective in that only phosphorus is examined. The figure relates annual lake loadings of phosphorus to the mean depths of these lakes. A logical correlation is established for these parameters based on known trophic levels. An equally logical correlation for nitrogen loadings was included in the original OECD report, but is omitted in the boards' report. The possibility exists that a similar correlation could have been developed for any other sewage waste ingredient, e.g. carbon, trace metals, sodium, and chloride. This is not to suggest that each and every such material could be established as having a causal relationship with eutrophication—but neither does such a correlation establish cause and effect between phosphorus and eutrophi-

[1] International Lake Erie Water Pollution Board and International Lake Ontario-St. Lawrence River Water Pollution Board.

[2] Report to the International Joint Commission on the Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River, Vol. 1 (1969).

cation. As the original OECD report pointed out, and as the boards recognized on page 73 in the case of Lake Mendota, Lake Washington, and Zurichsee, the relationship of phosphorus loading and trophic levels is far from exact.

In such a situation it would seem that the relationship represents perhaps only a useful hypothesis—one that may well be worth testing further—but certainly does not present incontrovertible proof that reduction only of the level of phosphorus loading will bring a corresponding reduction in trophic level. To promise an oligotrophic Lake Ontario and a near-mesotrophic Lake Erie based on phosphorus control alone appears to be most speculative.

OTHER CRITICAL NUTRIENTS

As an example of our concern that a less than optimum attack is being recommended to control the problem of eutrophication is the board's apparent concentration on a single nutrient, phosphorus, almost to the exclusion of all other algal growth factors.

There are obvious difficulties in doing the experimental work to investigate many of these factors but there is well-accepted work that demonstrates their potential importance.

Mr. Chairman, I have cited in my statement the observations of a number of researchers in this field which support this view. To save time, I shall omit reading them, but simply offer them for the record and for your review.[3]

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[3] Mackenthun in the FWPCA review, *Algal Growths, Aqueous Factors Other Than Nitrogen and Phosphorus, Selected Biological References.* (U.S. Department of the Interior, Federal Water Pollution Control Administration, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, 1966.)

"It is generally conceded that abundant major nutrients in the form of available nitrogen and phosphorus are important and a necessary component of an environment in which excessive aquatic growths arise.

"Algae, however, are influenced by many and varied factors. Vitamins, trace metals, hormones and auxins, extracellular metabolites, autointoxicants, viruses and predation and grazing by aquatic animals are factors that stimulate or reduce algal growths. Some of these may be of equal importance to the major nutrients in influencing nuisance algal bloom production.

"In man's quest to reduce major nutrients enriching waters, such as nitrogen and phosphorus and thereby restore such waters to a greater water use potential, other algal population influencing factors will have a role in the ultimate success of the restoration efforts.

"By placing all known algal population influencing factors in proper perspective and by intensifying investigative efforts directed towards the interrelationships of factors most likely to effect population controls, knowledge and nuisance rendering efforts will be enhanced."

Fruh (Proc. Special Lecture Series: *Advances in Water Quality Improvement,* University of Texas, Austin, Tex., April 1966), in his general review of eutrophication, stated:

"One cannot state 'a priori what the limiting nutrients in any lake or reservoir are. They might be inorganic or organic and persist in either macro- or micro-quantities. In particular, the current mental stagnation of the sanitary engineering field about the super importance of phosphorus should be broken.'

Some references to non-phosphorus algal growth factors are:

(1) Productivity experiments by Goldman on Castle Lake (*Ecol. Monographs,* 30: 207–230) showed that concentrations of Mo, K and S were definitely factors of productivity in these waters.

(2) Mackereth (*Journal of Experimental Botany,* 4:296–313, 1953) in Lake Windmere, Tucker (*American Midland Naturalist,* 57:330–333, 1957) in five small northern Michigan lakes and Hamilton (*Limnology and Oceanography,* 14:579–590, 1969) in Cayuga Lake all concluded that silicon was the key to increased growth.

(3) Provasoli (*Eutrophication, Causes, Consequences, Correctives,* National Academy of Sciences, Washington, D.C., 1969) found from comprehensive assay studies that vitamin B_{12}, thiamine and biotin have general importance to algae.

(4) Phinney and Peek (Trans. 1960 Seminars on Algae and Metropolitan Wastes, Robert A. Taft Sanitary Engineering Center, Tech. Rep. W61–3) showed that special organic factors present from humic acids provide a greater increase in growth than quadrupling the mineral content of algal medium.

(5) A number of workers as reported by Kuentzel (*JWPCF,* 41:1737, 1969) are developing data that suggests the decomposable organic matter combined with bacterial production of CO_2 has an important effect on growth.

Carbon, the major requirement for all plant growth, is often dismissed because of the assumed ability to dissolve CO_2 from the atmosphere. The rate of this transfer process has been inadequately studied and may well fall short of algal requirements in many situations. Certainly the coincidence of algal blooms with sewage effluent which has often been attributed solely to its PO_4 content may in many situations depend rather on the organic content.

Fogg (*Bacteriol. Rev.* 20:148, 1956) observed, "blue-green algae are of frequent occurrence in environments rich in organic matter and in freshwater lakes a distinct correlation exists between their abundance and the concentration of dissolved organic substances."

One potentially important source of CO_2 needed for overall algal growth can be conversion of carbohydrates by bacteria to CO_2 Holm-Hansen (Proceedings FWPCA Symposium, Corvallis, Oregon, 1966), Clesceri and Lee (*Intl. Jour. Air and Water Poll.* 9:723, 1965), and Lange (*Nature,* 215: 2177, 1967) have demonstrated the stimulation occurring when organic matter and bacteria are present in algal growth cultures.

The fact that many potential key algal growth factors are normally present in waste waters makes it important to consider the value of treatment methods which include combinations of physical, chemical, and biological removal to insure their elimination. It is obviously dangerous to substitute phosphorus removal as the only measurement of the effectiveness of this treatment or to equate elimination of a phosphate source with removal processes which remove many other growth factors.

PHOSPHATE INPUTS TO LAKE ERIE

We have strong reservations that phosphorus is sufficiently controllable to be a workable solution to the problem of excessive algal growth.

Arresting eutrophication by control of phosphorus alone requires the lowering of concentrations to a level at which phosphorus is always in limited supply; i.e., that the amount of growth of algae or other aquatic plants is always limited by the availability of phosphorus. A successful effort of this type would permit algal control; the uncertainty lies in whether phosphorus concentrations can be maintained at a controlling level. We do not believe they can, for the following reasons:

1. *The limiting phosphorus concentration is extremely low.*—Notwithstanding the fact that phosphorus is almost universally present because it is a requirement for any form of life, the level required to prevent blooms or excessive growths of algae is very low, with the commonly accepted figure being only 10 μg/liter (1⅓ pounds per million gallons). Considering the established fact[4] that phosphorus inputs to lakes and reservoirs come from such diverse sources as rainfall (dust in air), soil erosion, agricultural runoff, urban runoff, industrial wastes, treatment of potable water, animal feedlots, forest runoff, and human excrement, as well as from detergents, we believe it is unrealistic to conclude that concentration on any one, two, or even three of these sources could guarantee that phorsphorus levels would be 10 μg/l or less at all times.

2. *Complete eliminaton of phosphorus from detergents, sewage, and industrial wastes discharged into Lake Erie would still result in average phosporus concentrations of 40 μg/l. four times the accepted level required for agal control.*

Using data presented in the Boards' Report and in the FWPCA "Lake Erie Report" of August, 1968, average theoretical concentrations of phosphorus in Lake Erie can be determined. A simple calculation using the average flow of water into the lake of 234,000 cubic feet per second and an annual phosphorus input of 30,100 tons yields an average phosphorus concentration of 132 μg/l. This is some 13 times more than the limiting value of 10 μg/l.

Similar calculations on the various phosphorus inputs to Lake Erie show the theoretical average concentrations that would result from each.

Input from	Tons per year	P concentration, μg/l
Lake Huron	2,240	10.0
Land drainage	6,740	29.5
Municipal wastes	19,090	83.5
Industrial wastes	2,030	9.0
Total	30,100	132.0

Assuming, as the boards' report does, that detergents contribute 70 percent of the phosphorus in municipal wastes and that this fraction were totally removed, the average theoretical concentration would be reduced to 73.5 μg/l (132 μg/l $-(0.70\times83.5)=73.5$ μg/l).

Assuming further an 80 percent reduction in the residual phosphorus in municipal and industrial wastes would still leave a residual of 46.3 μg/l (73.5 μg/l $-(83.5\times0.30\times0.80)-(9.0\times0.80)=46.3$ μg/l).

Going one step farther, the removal of *all* phosphorus from municipal and industrial wastes would still leave a theoretical average concentration of 39.5

[4] JAWWA, vol. 59, p. 344, March 1967.

μg/l, some four times the so-called limiting number of 10 μg/l (132.0 μg/l —83.5 μg/l—9.0 μg/l=39.5 μg/l).

3. *The impact of the bottom muds, particularly in the western basin of Lake Erie, has been largely ignored.*—The boards' report acknowledges that bottom muds can be a significant source of nutrient phosphorus, but suggests on page 57 that it can be released only under "special circumstances." Again, on pages 76 and 77 of the report, it is suggested that phosphorus is released from bottom muds only under anaerobic conditions. This concept is not universally accepted. If the phosphorus is bound as *iron* phosphate, there is no question but that release would be enhanced if the iron were reduced from the ferric to the ferrous form. Some of the phosphorus, however, is bound as *calcium* phosphate, and its solubility is unaffected by dissolved oxygen in the water. While iron is unquestionably a factor, there is no technical reason to ignore calcium phosphate solubility and its effect on release of phosphorus from sediments. The data of Beeton (p. 24 and 26 of the report) showing about 40 μg/l of calcium and 40 μg/l of phosphorus, are consistent with calcium phosphate solubility data. Moreover, the phosphorus level of 40 μg/l, when compared to the theoretical average concentration of 132 μg/l, indicates phosphorus removal by some mechanism, most likely precipitation, which results when solubility product constants are exceeded.

If this is the case, then an equilibrium exists between the bottom sediments and the lake waters. Phosphorus would be released from the sediments any time the concentration in the waters fell below about 40 μg/l, regardless of the level of dissolved oxygen in the water. The only question is that of the *rate* of this transfer. It might be expected that the rate is much greater in shallow waters, where wave action can cause agitation at the mud-water interface. This is one reason why shallow lakes can tolerate less nutrient input than deep lakes.

That calcium phosphates, which are normally considered to be quite insoluble, can supply nutrients at rates sufficient to maintain high algal growth rates has been shown by Gerhold and Thompson, in a paper given at the American Chemical Society meeting in September 1969.

The authors grew the algae *microcystis* and *selenastrum* in the laboratory using calcium hydroxyapatite, normally considered to be extremely insoluble, as the sole source of phosphorus. They found growth rates equal to those obtained with soluble potasium orthophosphate. This indicates that the so-called "insoluble" compounds of phosphorus in the bottom muds cannot be ignored. The importance of this factor is emphasized by the national eutrophication research program of the FWPCA, which has a research section whose work is devoted to the nutrient contribution of bottom muds and its control.

4. *The rates of nutrient inputs and the effects of these rates have largely been ignored.*—The problems caused by algae are not just that they grow—we must have algae to maintain life in waters. Rather, the problems involve "excessive" growth, and particularly "blooms" which are massive growths occurring over a short period of time. This type of growth seems to be inconsistent with the fact that inputs derived from detergent phosphates occur at essentially a constant rate throughout the year. By contrast, run-off concentrations of phosphorus, which constitute over 20 percent of the annual total (p. 74 of the report), occur over short periods of time. Most of this contribution occurs in the spring, shortly before the onset of the maximum period of algal growth in the summer. This suggests that the concentrated seasonal inputs of phosphorus and other nutrients from land run-off may be much more important than has been assumed in the report.

5. *The emphasis placed by the board's report on detergent phosphates ignores the fact that serious eutrophication problems existed in Lake Erie before the advent of detergent phosphate usage.*—There are many references to massive growths of algae in Lake Erie many years before large-scale use of synthetic detergents began. The significance of this is perhaps best illustrated by the statement of A. J. Harris, director, Division of Research, Ontario Water Resources Commission, at the 34th Annual Conference of the Canadian Institute on Pollution Control, November 1967, in Toronto:

"In closing, I would like to quote some remarks from a report of the Conservation Department of New York State, entitled 'A Biological Survey of the Erie-Niagara system.'

" 'The plankton occurred in almost unbelievable abundance. I can best describe it, perhaps, by making a comparison with the ocean. One of the richest areas of plankton life in the Western Atlantic is the gulf stream, and yet hauls made during the same week in July with the same size and type of net in Lake Erie and in the gulf stream off New York City yielded the following results: In 5 minutes, 10 times the amount of plankton was obtained in the lake as in a 2-hour haul in the ocean.' "

Mr. Harris cites another quotation from the same source:

" 'In a number of places where the weed beds were very luxuriant, the water surface was covered with a dense blanketlike mat of algae, mostly *Cladophora sp* which made it almost impossible to row a boat through it.'

"This report was written in 1928, almost 40 years ago.

"It is quite apparent that not enough is known about the troubles in some of our lakes and caution should be exercised before reaching decisions on the cure."

To summarize

1. The limiting phosphorus concentration is extremely low.
2. Complete elimination of phosphorus from detergents, sewage and industrial wastes discharged into Lake Erie will still result in concentrations well in excess of the critical level.
3. The importance of the bottom muds as a nutrient source has been largely ignored.
4. The concentrated seasonal input of phosphorus and other nutrients from land runoff may be more important than has been assumed in the report.
5. Eutrophication problems in Lake Erie existed prior to the introduction of detergents.

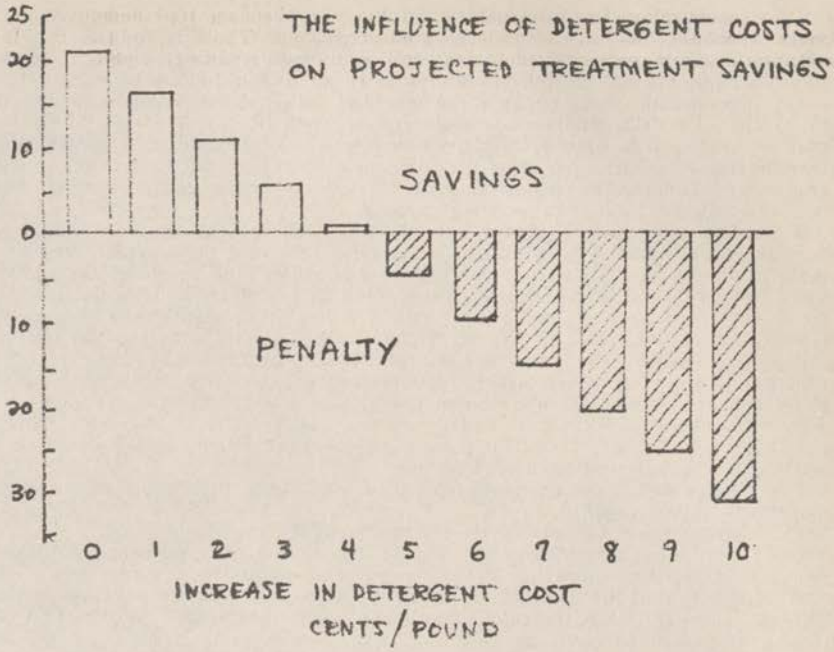
ECONOMIC AND OTHER ASPECTS OF DETERGENT PHOSPHATE REPLACEMENT VERSUS WASTE TREATMENT

The board has recommended that not only should phosphorus-removal equipment be installed (to be at least 80-percent effective), but that the level of phosphorus in detergents should be reduced immediately, and eliminated by 1972. There are several reasons why we think that this duplication is unfeasible and unnecessary:

1. *Cost.*—The board has stated (p. 79) that treatment costs for a given level of phosphorus in sewage effluent would be two to three times higher with phosphorus in detergents than with phosphorus replaced—a total extra cost of $22 million annually.

This calculation ignores three important factors:

(*a*) No allowance is made for a probable increase in product costs resulting from phosphate replacement. We believe this is a serious omission. While this cost increase is impossible to calculate since no satisfactory substitute is presently at hand, it is probable that any substitute would cost more than sodium tripolyphosphate. The impact of higher detergent costs on waste treatment is shown in the following chart.



You will note if there were zero increase in detergent cost through replacement of phosphate the savings might be the maximum of $22 million projected by the Board. However, for each penny per pound of increased detergent cost, the added cost of product to the people of the Lake Erie—Lake Ontario—St. Lawrence Basin would be $5.3 million a year. The treatment savings when adjusted for detergent cost thus begin to shrink as higher detergent costs are assumed.

If the detergent costs were increased by 5¢/pound, the added cost of product would exceed $26 million per year and therefore the savings disappear and the citizens begin to be penalized. The penalty becomes substantial if the detergent cost were to increase to 10¢/pound or more.

(*b*) No consideration was apparently given to the fact that a replacement material would also have to undergo waste treatment. There is no basis for the assumption that any replacement material would cost less to remove than phosphorus. Thus, the $22 million gross savings estimate could again be unrealistic.

(*c*) It would appear that none of the new physical-chemical processes developed by OWRC, FWPCA, Zimmerman-Molof (New York State), Weber, and others which promise to be significantly more economical, and which will be effective in removing a broad range of algal nutrients were considered in developing the treatment cost data. The cost of removing phosphorus in sewage treatment should be recalculated in light of these new processes.

2. *Timing.*—The boards' report has recommended (p. 10) the immediate reduction of phosphorus to minimum practical levels, and the complete replacement of phosphorus by 1972. As has been explained earlier, we do not presently know of a replacement which can be used broadly for phosphorus in detergents. Until such a replacement has been found, it is merely speculation to talk about schedules and timetables. However, it may be helpful to work out the timing following the point at which a new material has been found to be a satisfactory replacement; that is to say, after it has been demonstrated to clean acceptably, to be biodegradeable and to be environmentally harmless, and when we know exactly what chemical specifications the new material must have. The steps which would have to be taken from this point to the point at which the new detergents are in full-scale distribution are as follows:

(*a*) Design and installation of pilot plants to study production of the new phosphate replacement.

(*b*) Construction of plants for the production of this material.

(*c*) Design and modification of existing detergent plants, or construction of new plants, for the production of the many brands using the new material.

We estimate that it would take at least 4 years to accomplish these three steps. This is consistent with industry experience in the design and construction of plants based on new technology.

Let me reiterate that this schedule presumes the prior existence and evaluation of a phosphate replacement. There is no way of estimating how long it might take to develop such a material once it has been identified, but our judgment is that it would be irresponsible to introduce such a broadly used product into the environment without extensive testing which might require 3 years or longer. In light of the 1975 and 1978 dates suggested in the report for construction of the treatment facilities in the Lake Erie and Lake Ontario Basins, it is not reasonable to assume that detergent phosphate replacement could be accomplished before these dates. Thus, the removal of phosphates from detergents does not offer a potential short-term solution.

3. *Treatment in rural areas.*—The board has stated (p. 79) that it would not be reasonable, because of high cost, to require the same level of treatment in villages, individual homes and industries not served by a treatment plant.

The American States bordering Lake Erie have set a target of 80 percent phosphorus removal for each State area. If it is impractical for small towns and rural areas to have treatment, this can be compensated for by other municipalities whose treatment plants are operating at correspondingly higher efficiencies. We believe that this philosophy should be considered by the Commission for the entire lower Great Lakes region. We disagree with the boards' reasoning that because some areas do not have treatment plants, there is a logical basis for requiring the reduction or elimination of detergent phosphates.

While septic tanks are not usually considered to be adequate treatment devices, their soil systems can effectively remove phosphorus from household wastes. Thus, the unsewered population probably is not a significant contributor of phosphorus to the lakes.

The reduction or elimination of phosphorus from detergent formulations, as recommended by the board in preference to the removal of phosphorus solely by waste treatment, may not be cheaper, and will not be faster. This being the case, we do not think that it would be appropriate to make this move.

TOTAL WASTE TREATMENT APPROACH

We support the position of the FWPCA that advanced waste treatment to effect overall nutrient removal, along with programs to minimize nutrient contributions from other sources, such as control of agricultural runoff, offer the best opportunity to bring significant relief to the eutrophication problem.

This approach is in line with the recommendations of the boards' report, since to achieve substantial phosphorus removals, it is necessary to have the type of treatment which will remove other algal growth nutrients as well. This broad-scale attack would assure the people of the Great Lakes area that the control of eutrophication is achievable and practical. No such assurance can be made if a "one element" approach is taken.

In conclusion, as Mr. Chase indicated, we would welcome the opportunity to work more closely with the technical people in the governmental agencies of the United States and Canada who are responsible for the quality of our waters.

Mr. REUSS. We will now ask Dr. Darnell M. Whitt, vice chairman of the Joint Industry-Government Task Force on Eutrophication, and Dr. Gerard A. Rohlich, director, Eutrophication Information Center at the University of Wisconsin, to come forward.

STATEMENT OF DARNELL M. WHITT, VICE CHAIRMAN, JOINT INDUSTRY-GOVERNMENT TASK FORCE ON EUTROPHICATION; ACCOMPANIED BY THEODORE E. BRENNER, EXECUTIVE DIRECTOR

Dr. WHITT. May I have the executive director of the task force, Mr. Brenner, sit with me?

Mr. REUSS. Certainly.

Dr. Whitt and Dr. Rohlich, your papers are received in full into the record without objection. Would you now proceed, Dr. Whitt.

Dr. WHITT. Thank you.

Mr. Chairman and members of the subcommittee, I am Darnell M. Whitt, representing the Joint Industry-Government Task Force on Eutrophication. I serve on the Joint Task Force by designation of the Secretary of Agriculture, in which Department I am Director of the Plant Sciences Division of the Soil Conservation Service. I shall report on the history and organization of the Joint Task Force, its goals and objectives, and its activities to date. At the conclusion of this short presentation, I should welcome any questions or comments on the Joint Task Force that you may have.

The formation of the Joint Task Force was first agreed upon in August 1967, following a meeting between the Secretary of the Interior, senior Interior Department officials, and executives of the soap and detergent industry. The task force at that time had the stated goal "to make recommendations on the cooperative program to research the problem of controlling euthophication."

Since then, the task force membership has been expanded to include other segments of industry and Government concerned with this complex problem. I may say we from Agriculture were invited to join this group in April 1968. Today, the group consists of representatives of the Secretary's office and the Federal Water Pollution Control Administration of the Department of the Interior; the Soil Conservation Service and the Agricultural Research Service of the Department of Agriculture; the Tennessee Valley Authority; the Manufacturing Chemists' Association; the National Plant Food Institute; the Soap and Detergent Association; and members representing the detergent and fertilizer industries. The U.S. Army Corps of Engineers is also represented by an official observer.

Early in its deliberations, the task force adopted as its objective the consideration of the problems associated with man-induced eutrophica-

tion in the United States and to stimulate the development and demonstration of technical means for the management, control or prevention of these problems. Nine specific points were developed to accomplish this objective. These specific activities are appended to my statement as attachment A, copies of all of the appendices have been provided to the subcommittee.

Measurable progress can be reported in the ongoing effort to understand the causes and control of man-induced eutrophication. Some specific programs initiated and sponsored to date by the Joint Task Force are as follows:

1. The etablishment of a Eutrophication Information Center at the University of Wisconsin:

The Joint Task Force felt that an urgent need existed to provide a central repository or data bank for all pertinent eutrophication literature, as well as a means to distribute this information to interested workers in the field. Since a major eutrophication research effort was underway at the University of Wisconsin, and since the university maintained an outstanding library system, this seemed an ideal location to house the information center. In addition to the wide distribution of monthly abstracts of eutrophication literature, the center issues a semiannual critical review of this information. Referral, translation, and document service also is provided. A recent issue of the "Abstracts" is appended to my testimony as attachment B.

2. Development and publication of a provisional algal assay procedure:

At the beginning of 1968, the Joint Task Force announced that it would attempt to develop a standard procedure to measure the algal growth potential of various chemicals and waters. This work has been carried forward under the leadership of Dr. A. F. Bartsch, who is director of FWPCA's national eutrophication research program (NERP) based at the Pacific Northwest Water Laboratory, Corvallis, Oreg. Dr. Bartsch is also director of the laboratory and a member of the Joint Task Force.

A group of international eutrophication experts, representing Government, industry, and the academic world, met for 3 days in March 1968 to resolve differing approaches to a "standard" technique. The result was the Provisional Algal Assay Procedure, copies of which became available in 1969.

At the present time, three university laboratories, under Federal sponsorship, Government laboratories, and several industry laboratories are working on the procedure. Hopefully, by the spring of 1970, sufficient information will be in hand to correlate the procedure under actual conditions in the field.

Because of its fundamental and potentially far-reaching impact in evaluating the effect of various constituents on eutrophication, the early availability of a standardized algal assay procedure has the highest priority in this ongoing program. Particularly noteworthy in this activity has been the active cooperation of university, Government, and industry scientists. A copy of the procedure is appended to my testimony as attachment C.

3. Nutrient removal study—Pennsylvania State University:

This project was designed to determine the feasibility of removing nutrients from waste water through the addition of readily available

chemicals to existing waste treatment facilities. This is a 2-year program, now in its second year. It was jointly funded by the FWPCA and the Soap & Detergent Association. One significant feature of this project is that it is being carried out in a full-scale sewage treatment plant serving the university and an adjacent community. The project will provide valuable information on the cost and performance of the process under actual conditions of use.

In order to be fully aware of the many activities concerned with eutrophication control throughout the country, the Joint Task Force has met at locations where programs pertinent to its mission are underway. These have included recent visits to such sites as the FWPCA Southeast Water Research Laboratory and the USDA Southern Piedmont Conservation Research Center, both located at Athens, Ga.; the FWPCA Pacific Northwest Water Research Laboratory in Corvallis, Oreg., which, incidentally, is the headquarters of the national eutrophication research program; industry laboratories and manufacturing facilities in the New York City metropolitan area; FWPCA headquarters in Washington; and the University of Wisconsin in Madison. Other planned meeting sites include U.S. Department of Agriculture headquarters in Washington, D.C., and TVA facilities in Muscle Shoals, Ala.

These visits have permitted us to obtain a much better understanding of the scope and range of research underway at government, university, and industry laboratories throughout the country. In addition, some members of the Joint Task Force, in conjunction with attendance at an international water pollution research conference, took the opportunity to visit foreign laboratories specializing in eutrophication research. A report on this inspection tour is included as attachment D.

As a result of our activities, it has become increasingly clear to us that no single simple solution to the problem of eutrophication is presently in hand or can be expected in the near future. The great variations that exist between lakes and, in fact, even in the same lake makes the development of a single solution most unlikely. The need for a reliable predictive method such as the provisional algal assay procedure is basic, for without it any other judgments aimed at limiting accelerated eutrophication can only be subjective and of little technical substance. It is for this reason that the Joint Task Force has placed such importance on this fundamental development.

A letter report on our progress was sent to each organization represented on the Joint Task Force in June of this year. This report is appended as attachment E.

In summary—and I am quoting from this June status report—perhaps the Joint Task Force accomplishment of greatest long-range significance has been the establishment of a common meeting ground in an area where divergent and often controversial views have been frequently expressed. In our opinion, this experiment in intragovernment and Government-industry cooperation to attack a problem of social, political, industrial, and governmental concern has been a substantial success.

Thank you, Mr. Chairman.

(NOTE.—Attachments "B" ("The University of Wisconsin Water Resources Center Eutrophication Program—Abstracts—issue No. 7, September 1969"), "C" ("Provisional Algal Assay Procelure," Joint Industry-Government Task Force on

Eutrophication, February 1969), and "D" ("European Trip Report—April 1969"), submitted by Dr. Whitt, are in the subcommittee files. Attachments "A" and "E" follow:)

ATTACHMENT A.—JOINT TASK FORCE OBJECTIVE

It is the objective of the JTF to consider the problems associated with man-induced eutrophication in the United States, and to stimulate the development and demonstration of technical means for the management, control, or prevention of these problems.

In order to accomplish this objective, the following is recommended:

(a) Encourage the development of a fundamental and practical understanding of how accelerated eutrophication is caused by man.

(b) Stimulate the development of means to prevent or inhibit accelerated eutrophication through encouragment of an expanded scope of field scale experimentation and demonstration.

(c) Encourage the use of technically feasible methods for reducing man-induced eutrophication.

(d) Encourage and promote the development of an algae and other assay procedures for use in predicting the impact of changed levels of nutrient elements in natural water environments as well as of the addition of new nutrient or nutrient-synergistic compounds to the water environments.

(e) Recommend improved methods concerning how technical data on eutrophication, as it becomes available, can best be monitored, programed, and utilized in achieving practicable solutions to the problem.

(f) Review Government, academic, and other research programs and plans and provide advice on apparent imbalances and gap areas, as well as recommend projects suitable for joint Federal-private support.

(g) Encourage the development and operation of an information center for the collection, annotating, storage, and retrieval of technical information and further encourage that a continuously up-dated review and critical analysis of the literature on eutrophication be maintained.

(h) Encourage considerations of the economic aspects involved in alternative methods of eutrophication control.

(i) Enlist the cooperation and support of interested organizations and groups in meeting JTF objectives.

ATTACHMENT E.—JOINT INDUSTRY/GOVERNMENT TASK FORCE ON EUTROPHICATION

NEW YORK, N.Y., *June 13, 1969.*

Hon. CLIFFORD M. HARDIN,
Secretary of Agriculture, U.S. Department of Agriculture, Washington, D.C.

DEAR MR. SECRETARY: I am pleased to submit this progress report on the work of the Joint Industry/Government Task Force on Eutrophication (JTF). As you know, the JTF was established in the fall of 1967, following a meeting between Secretary Udall and representatives of industry.

Membership on the task force has been broadened in the past year to provide representation from the U.S. Department of Agriculture, Tennessee Valley Authority, Manufacturing Chemists Association, National Plant Food Institute, and the agricultural industry. The Corps of Engineers has an official observer in attendance at meetings.

Measurable progress can be reported in the on-going effort to understand the causes and control of man-induced eutrophication. Among the major Joint Task Force accomplishments are: Establishment of a Eutrophication Information Center at the University of Wisconsin; development and publication of provisional algal assay procedure; and initiation of a jointly funded (by FWPCA and the Soap and Detergent Association) full-scale nutrient removal study at Pennsylvania State University. Mr. Theodore E. Brenner, a professional sanitary engineer, has been appointed JTF executive director.

During 1968 and the first quarter of 1969, the Joint Task Force has met at locations throughout the country where work pertinent to its mission is underway. The JTF has reviewed research and development activities relating to eutrophication at Federal laboratories, industrial facilities, and municipal waste treatment plants.

Perhaps the JTF accomplishment of greatest long-range significance has been the establishment of a common meeting ground in an area where divergent and often controversial views have been frequently expressed. In our opinion, this

experiment in intragovernment and Government-industry cooperation to attack a problem of social, political, industrial, and governmental concern has been a substantial success.

Because of its fundamental and potentially far-reaching impact in evaluating the effect of various constituents on eutrophication, the early availability of a standardized algal assay procedure has the highest priority in the forward program.

The JTF concludes that it is vital that both the public and private sectors need to reevaluate their programs and budgets, with a view toward strengthening and expanding their commitment to eutrophication research. This may require the immediate diversion of manpower and funds from other less critical areas to this effort.

More detailed information on specific JTF activities is attached as appendix A. In addition, recent publications prepared under JTF sponsorship are enclosed.

Very truly yours,

CHARLES G. BUELTMAN, *Chairman.*

APPENDIX A

EUTROPHICATION INFORMATION CENTER

The establishment of the Eutrophication Information Center fulfills a long-felt need and has as its specific objectives and goals:

(a) Prepare abstracts of both domestic and foreign eutrophication literature and distribute them monthly. (Most recent issue is enclosed.)

(b) Prepare, publish, and distribute an annual or semiannual critical analysis of the international literature on eutrophication.

(c) Provide a referral and library search service for technical information on specific topics related to eutrophication.

(d) Provide a reference room facility to house a collection of international scientific reports, journal articles, and other literature on eutrophication for use by the staff and by individuals from universities, industry, government agencies, public organizations, and interested citizens.

The Center has a staff of qualified scientists, librarians, and clerical assistants to carry out its functions.

The Center is closely associated with the FWPCA sponsored eutrophication research effort at the University of Wisconsin.

Funds for the Information Center are furnished by the Federal Water Pollution Control Administration (FWPCA), USDI's Office of Water Resources Research, University of Wisconsin, U.S. Department of Agriculture, and the Soap and Detergent Association. Approximately $90,000 has been provided for the year's operations.

PROVISIONAL ALGAL ASSAY PROCEDURE

In 1968, the JTF determined the need for a standardized laboratory procedure to measure the algal growth potential of various chemicals and waters to help identify the causes and remedies for man-induced eutrophication. Development of this procedure has been under the leadership of Dr. A. F. Bartsch, a member of the JTF and Director of the FWPCA's national eutrophication research program (NERP).

A group of the world's experts in this field was assembled in Chicago in March 1968, to define the basic elements for an appropriate laboratory predictive procedure. The thoughts and experience of those experts have now been distilled by the NERP staff at Corvallis, Oreg., and a Preliminary Algal Assay Procedure (copy attached) was made available to interested scientists throughout the world in early 1969.

Under the auspices of the JTF, three universities have been commissioned by the FWPCA, through its national eutrophication research program, to develop the procedure into a workable, validated form. In addition, industry members of the joint task force have undertaken substantial programs in support of this test procedure development.

PENN STATE PROJECT

A project to determine the feasibility of removing nutrients in existing activated sludge treatment plants has been started at Penn State. The importance of this type project is that nutrient removal can be achieved through simple addition of chemicals. Preliminary results are encouraging.

This is a 2-year project, jointly funded by FWPCA and the Soap and Detergent Association, which began in January 1969.

Mr. REUSS. Thank you, Dr. Whitt. Dr. Whitt, the joint task force was established at a meeting on July 31, 1967, was it not?

Dr. WHITT. Yes, sir.

Mr. REUSS. And at that meeting the Department of Interior announced as its objective, and here I am quoting, "To recommend a cooperative research program on controlling eutrophication (overfertilization) of lakes, including the role of phosphates and their possible replacements." That was the objective, was it not?

Dr. WHITT. That was so stated in the press release, sir.

Mr. REUSS. I now show you a 1969 publication of the Joint Industry-Government Task Force on Eutrophication, entitled "Provisional Algal Assay Procedure," and ask you if that is indeed a publication of the Joint Task Force.

Dr. WHITT. Under the auspices of the task force, Mr. Chairman, yes, sir.

Mr. REUSS. On the flyleaf of that publication the Joint Task Force objective is set forth and there are nine points to the objective, but I do not find a word in those points about phosphates or finding replacements for them. How do you account for this whimpering death of the joint task force after only 2 years?

(NOTE.—The 9-point "Joint Task Force Objective," submitted by Dr. Whitt as "Attachment A" of his presentation, appears on p. 132 of this hearing record.)

Dr. WHITT. Well, Mr. Chairman, I joined the task force, as I indicated, in April 1968, and at that time the discussion was underway on a more definitive statement of the task force objectives. The task force has now been broadened in its representation. And I would say that the joint task force serves primarily as a bridge between the many Government and industrial bodies concerned with the problem of eutrophication, and one of its prime functions and perhaps the most important activity is to identify research needs and to undertake or recommend programs which will fill the void in our knowledge on eutrophication. It became apparent to us that there was no standard method available to determine the effect of the individual materials, including potential detergent phosphate replacements, on the algal growth potential of specific lake water and obviously such a method would be necessary before any meaningful evaluation of potential phosphate replacement could be made.

Mr. REUSS. What are you reading from now?

Dr. WHITT. I anticipated your question, Mr. Chairman, realizing that there was a difference between the early press releases developed in connection with the task force, prior to my joining it, and I would submit, sir, that the language presently used in the objective, while it does not specifically name phosphate replacement, includes two points in carrying out the objective that would cover, in our judgment, the matter of phosphate replacement.

Specifically, the item C, which says, "Encourage the use of technically feasible methods for reducing man-induced eutrophication." And down in item F, "Review Government, academic and other research programs and plans and provide advice on apparent imbalances and gap areas, as well as recommended projects suitable for joint Federal-private support."

Mr. REUSS. Yes. I have read this great outpouring of words, but I still want to know who it was who caused the elimination from the joint task force objective of the primary reason for its being set up; namely "the role of phosphates and any possible replacements." That is good plain English. Who did those words in?

Dr. WHITT. Mr. Chairman, I don't know that there was anyone who did them in. I think we approached the job, as we understood it on the task force, as trying to set down the objective in the manner in which we thought we might make a contribution to this subject area. We felt that it was not a primary responsibility of the task force to test or develop phosphate replacements. We felt that this was a job of industry and we felt it was our responsibility to keep current to the extent we could with industrial research aimed at finding replacements.

Mr. REUSS. Didn't you think it was the task force's task to make recommendations on programs to research methods of eutrophication control, including the role of phosphates and any possible replacements?

Dr. WHITT. Yes, sir.

Mr. REUSS. Then why did you delete that language from the statement of objectives?

Dr. WHITT. Well, the statement of objectives that we presently have in the forepart of that publication, Mr. Chairman, are those that were developed over a considerable period of time and I wouldn't say—at least it is my understanding of the discussions, and I was present at most of the meetings—that there was any deliberate effort on the part of anyone to delete them.

Mr. REUSS. You don't think the fact that the task force is stacked with the representatives of the detergent industry and the phosphate industry could conceivably have had anything to do with the removal of the primary directive concerning the role of phosphates and any possible replacements?

Dr. WHITT. No, so far as I'm concerned, Mr. Chairman. We presently, as now constituted, have nine Government representatives and 12 industry representatives on the task force. And being a Government employee, I will stack up nine of us against 11 or 12 of them on any question.

Mr. REUSS. Do you count the TVA people as Government?

Dr. WHITT. Yes, sir.

Mr. REUSS. They are in the phosphate business, aren't they?

Dr. WHITT. Yes, sir.

Mr. REUSS. But you include them among the nine Government people.

Dr. WHITT. Well, we could count TVA as Government since they are, I believe, Mr. Chairman, a Government corporation. Are they not, sir?

Mr. REUSS. Right, and part of their income comes from the sale of phosphates; does it not?

Dr. WHITT. I am not completely familiar with the organizational structure nor their sources of income, Mr. Chairman, but I believe that is correct.

Mr. REUSS. Dr. Whitt, when was the last meeting of the Joint Task Force?

Dr. WHITT. Our last meeting was November 24 and 25 at the University of Wisconsin.

Mr. REUSS. Before that when was your last meeting?

Dr. WHITT. The last one before that, Mr. Chairman, was August 12 at Corvallis at the FWPCA water laboratory.

Mr. REUSS. August 12, 1969?

Dr. WHITT. Yes, sir.

Mr. REUSS. Do you have the record of that meeting in front of you?

Dr. WHITT. Yes, sir.

Mr. REUSS. Would you refer to it and tell me whether it is not a fact that a proposal was made at that meeting that the Joint Task Force prepare a movie on eutrophication, with the following objectives, "To present an objective, factual explanation of eutrophication. To show that there are no quick or easy solutions to eutrophication; also to indicate that, while serious, it is not a crisis problem except in a few areas." Is that an accurate reflection of the resolution that was presented?

Dr. WHITT. I would say, Mr. Chairman, the film had been discussed prior to the Corvallis meeting. But at the Corvallis meeting we did again discuss the film.

Mr. REUSS. Have I accurately related the objectives of the film which were to show that there are no quick or easy solutions to eutrophication, and also to indicate that, while serious, it is not a crisis problem except in a few areas?

Dr. WHITT. I believe that would adequately describe our discussions at that time, Mr. Chairman.

Mr. REUSS. And was action on that proposal taken at your November meeting?

Dr. WHITT. Action to the extent that the task force is still trying to obtain sufficient funds to go forward with the project, Mr. Chairman.

Mr. REUSS. What was the exact nature of the action on the movie in November?

Dr. WHITT. Well, we have a small committee assigned to go forward with working out the details, so they can be presented to the task force at its next meeting.

Mr. REUSS. And the purpose of this movie will be to show that the phosphate detergent problem isn't a crisis problem except in a few areas; is that correct?

Dr. WHITT. Mr. Chairman, I don't believe I would restrict it to that narrow an approach.

Mr. REUSS. But that is the stated purpose in the minutes of the August 12 meeting, is it not? Have I misread that in any way?

Dr. WHITT. Well, let me read from the film objectives. I thought the chairman was reading those:

> To present an objective, factual explanation of eutrophication," which we hope to do. "To show there are no quick or easy solutions to eutrophication; also to indicate that, while serious, it is not a crisis problem except in a few areas. To achieve public support for funds and research programs. To prepare the interested public for the long-range aspects of the proposed solutions. To show recent, current and projected progress in meeting the serious consequences of eutrophication. To inform the public about the work of the Joint Industry/Government Task Force on Eutrophication.

That is about the objective that we hope to accomplish, Mr. Chairman.

Mr. REUSS. Will you file for the committee the minutes of the November meeting?

Dr. WHITT. We can, Mr. Chairman, if I may explain how we handle the discussion record. We do not take verbatim notes such as you do here, sir, in your hearings. We take sufficient notes to provide what we call a discussion record and those are mailed to the members of the task force prior to the succeeding meeting and at that time they are corrected and adjusted to see if they do adequately reflect the discussions that transpired.

As soon as they are reviewed at our February meeting, the next scheduled meeting of the task force, we will be very glad to file a copy with the committee.

Mr. REUSS. Thank you. Mr. Gude?

Mr. GUDE. No questions.

Mr. REUSS. Dr. Rohlich, may we hear from you, sir.

STATEMENT OF DR. GERARD A. ROHLICH, DIRECTOR, EUTROPHICATION INFORMATION CENTER AND UNIVERSITY OF WISCONSIN WATER RESOURCES CENTER, MADISON, WIS.

Dr. ROHLICH. I am Gerard A. Rohlich, director of the water resources center at the University of Wisconsin.

Much of what I am going to say here has been brought out in the questioning earlier today.

The process of enrichment of water with nutrients is refered to as eutrophication. In general, as a lake ages it undergoes change and a "natural" or "normal" process of maturation takes place. Precipitation and natural drainage from forest or plain areas contribute nutrients which support and enhance the growth of phytoplankton and littoral (inshore) vegetation, but the activities of man in altering the landscape by agricultural development, urbanization, and the discharge of sewage, industrial wastes, and waste treatment plant effluents increase the amounts of nutrients and the organic and inorganic sediments entering the lake.

The processes of enrichment and sedimentation that occur naturally are thus frequently accelerated by man's activities and the quality of the water may change materially and often at a relatively rapid rate.

An obvious effect of eutrophiction is an increase in the biomass which can be supported in a body of water. Although the increase in yield of a crop after fertilization is desirable in terrestrial situations, the effects of eutrophication of waters are often undesirable. Generally, the esthetic value of a lake is lowered through excessive growth of aquatic weeds and algae and production of floating algal scums which are a nuisance to those who use the water for recreational purposes. Other effects include undesirable odors and tastes, and impairment of water treatment operations, for example, through clogging of filters by algae.

The biological productivity in oceans, lakes, streams, and estuaries throughout the world has been the subject of research by many investigators for the past century. During the past decade there has been unprecedented activity directed toward an understanding of the enrichment process and the measurement of changes which occur in lakes and streams.

Despite this activity a simple relationship between the maturing

process and the amount of nutrients present or entering the receiving body of water, or to other variables in the terrestrial and aquatic environment, has not been found. The interrelationships of climatic, physical, chemical, and biological factors which affect the metabolism of a lake are indeed complex.

As illustrated in figure 1, the morphology of the basin, the geological nature of the surroundings, temperature, the nutrient input, and many other variables influence the trophic nature of the lake. Because of the complex interrelationships involved, establishing reliable measurements of lake eutrophication rate and stage has been a major problem.

Interest in control of eutrophication has focused mainly on limiting the amounts of nutrients entering the water. The success of the approach depends on whether the available nutrient supply can be reduced to the extent that growth of aquatic plants is limited. Nutrients which have received the most attention are nitrogen and phosphorus because, following carbon, they are required in the greatest amounts for the production of green plants. Growth of aquatic plants is also influenced by many other substances including potassium, sulphates, iron, magnesium, cobalt, molybdenum, manganese, and organic growth factors.

Research to further our understanding of eutrophication is being supported at the University of Wisconsin with funds from the Federal Water Pollution Control Administration, and the Office of Water Resources, Department of the Interior.

As Dr. Whitt mentioned, we also have the eutrophication information program at the university. One of the research projects is the development of an algal assay procedure to evaluate biostimulation resulting from constituents in various wastes and receiving bodies of water. Other projects are concerned with nitrogen and phosphorus cycles in the aquatic environment and related problems.

The amount of nitrogen and phosphorus available to aquatic plants in lakes depends not only on the amounts entering the body of water from point sources, such as sewage, industrial wastes, and urban drainage on one hand, and diffuse sources such as natural and agricultural drainage on the other, but also on the chemical, biochemical, and physical processes occurring within the lake.

In situations where the influence of sewage or other sources of nutrients has affected, or is a potential threat, to the quality of the receiving waters, one recourse has been to divert the sewage around the lake or stream immediately affected. This, of course, does not eliminate nutrients in the effluent; however, diversion may prove to be a feasible method for reducing the nutrient influx to levels which may retard eutrophication.

The fact that substantial quantities of nutrients are present in sediments has been well documented. Therefore, consideration has been given to dredging in an effort to remove this concentrated source of nutrients. Questions arise as to what will be done with these sediments once removed.

Harvesting of weeds and algae and rough fish are also under investigation. The total amount of nutrients removed by such methods in comparison to the amount present in the water may be too small to make these methods economically practicable.

The zoning of residential, industrial, recreational, and natural areas is important if man is to preserve and protect our lakes and streams from exploitation as the population burgeons. Good farming practices, such as strip cropping and terracing, provide benefits not only for the the farmer but also for the other inhabitants in the drainage basin. In addition, studies are needed to reduce nutrient transport from agricultural and urban runoff as well as from sewage and sewage effluents.

During recent years it is fortunate that a variety of physical, chemical, and biological processes for nutrient removal from waste waters, especially phosphates, have been developed and are beginning to be applied.

Control methods should be considered, however, as only interim approaches until research provides a better understanding of the relationship between nutrient levels and the many other factors influencing the trophic nature of the lake.

Although the reduction or elimination of nitrogen and phosphorus from point sources will result in improvement in many situations, in others, however, the supply of these nutrients from diffuse sources can be adequate to provide the concentrations considered critical for excessive plant production. It is hoped that quantitative measurement by the algal assay procedure now under development will provide a tool to evaluate effects of nutrient reduction.

Despite the shortcomings of present knowledge, it is important that comprehensive progress for the control and reduction of nutrients from both point and diffuse inputs go forward in order to protect the water quality of lakes and streams.

As noted previously in many instances point sources are a major contributor of phosphorus and in municipal waste waters a high percentage of the phosphates is attributable to the use of detergents with the remaining phosphorus from diverse wastes from the community.

Inasmuch as detergents are a principal source of phosphates in municipal waste waters, it would be desirable if a suitable replacement for this nutrient could be made.

From the standpoint of the eutrophication problems, a substitute or substitutes should be evaluated in the light of the following three principal questions.

(1) What is the extent of biodegradability of the substitute or substitutes under aerobic and anaerobic environmental conditions?

(2) Do substitutes show any toxic effects on aquatic life?

(3) Will substitutes have a biostimulatory effect and what is the effect as compared to phosphates?

Recently there has been a sharp awakening of the public to the problems associated with eutrophication. In the State of Wisconsin alone, there are more than 8,500 lakes which must meet future demands resulting from a growing population in the midwest and the increased desire of that population for high-quality water-related recreation.

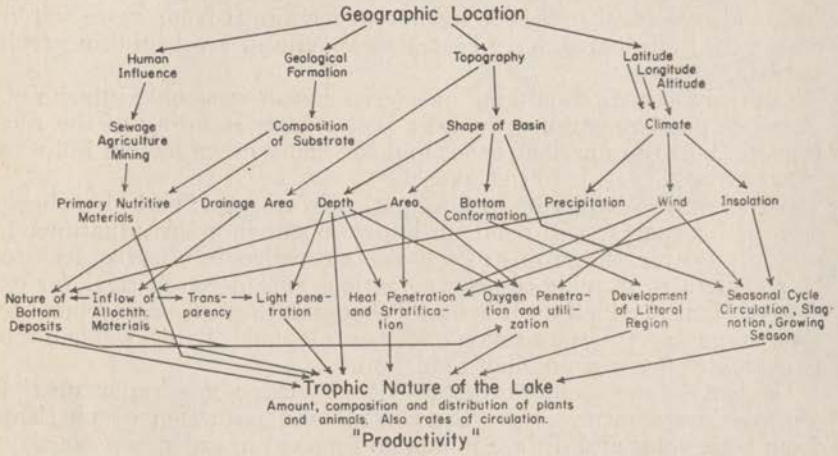
It would indeed be unfortunate if the professional advice, agency control, and legal decisions affecting the development of the lake areas were inadequate for their protection and preservation because of limited factual information and analysis.

Since it is well recognized that the state of the art in providing for the protection and rehabilitation of lake environments is sketchy and virtually untested under comprehensive monitoring, demonstration

projects would be of major importance in establishing improved management procedures.

(The chart referred to by Dr. Rohlich follows:)

CHART SUGGESTING THE INTERRELATIONS OF FACTORS AFFECTING THE METABOLISM OF A LAKE
(RAWSON, 1939)



Mr. Reuss. Thank you very much, Dr. Rohlich.

Is there any doubt in your mind, sir, that phosphates cause algae and the death of lakes?

Dr. Rohlich. There is no question about the importance of phosphates in stimulating algal growth. I think it should be brought out, however, that each lake is a microcosm in itself, and in some instances phosphate may be limiting, while in other instances nitrogen may be limiting. There are in the literature instances for example where cobalt or molybdenum have been limiting.

Mr. Reuss. But there is no doubt in your mind that phosphates are a killer in thousands and thousands of lakes by their over-fertilization and the breeding of algae. Is there?

Dr. Rohlich. Well, I don't think I would use the word "killer."

Mr. Reuss. What word would you use?

Dr. Rohlich. The word I would use is that phosphates are a vital element in the stimulation of the algal growth in these lakes.

Mr. Reuss. And there is no doubt in your mind that stimulation of the algal growth in many cases, causes the eutrophication of lakes?

Dr. Rohlich. I might say, Mr. Reuss, I don't use the word death myself.

Mr. Reuss. What word would you use?

Dr. Rohlich. It causes, it brings about overproduction to the level—if I might take just a moment, the word eutrophication is from two Greek words, "e-u-" which means "well," and "trophy," which means "to nourish." This is not to be confused with the word pollution, which we define as the introduction of a material into a resource which de-

grades or interferes with or destroys some beneficial uses of the resource.

However, from that point on, excessive eutrophication, excessive production, brings about pollution, because it does bring about the effects of interfering with beneficial usage; and the continued increase of nutrient influx to our lakes through man's activities is bound to bring about continual degrading and over-production to the nuisance level.

Mr. REUSS. There is no doubt in your mind, is there, that household detergents are an important source of phosphates in our waterways?

Dr. ROHLICH. Indeed they are.

Mr. REUSS. Is there any doubt in your mind that the prompt reduction, or even elimination, of the phosphates in detergents, combined with efforts to control other inputs of phosphates into our waterways, would be in the public interest?

Dr. ROHLICH. It would be.

Mr. REUSS. Thank you. Mr. Gude?

Mr. GUDE. No questions, Mr. Chairman.

Mr. REUSS. Thank you, gentlemen, both of you, Dr. Whitt and Dr. Rohlich, for your contributions.

Mr. REUSS. Our last witness for this afternoon will be Dr. Hans O. Bouveng of Sweden.

Dr. Bouveng, we appreciate deeply your coming all the way from Stockholm and the Institute for the Water and Air Pollution. We apologize for keeping you so late.

Thank you, sir.

Would you proceed in your own way? We have your excellent statement, and under the rules it will be made a part of the record.

STATEMENT OF DR. HANS O. BOUVENG, INSTITUTE FOR WATER AND AIR POLLUTION, STOCKHOLM, SWEDEN, ON "DETERGENTS, SEWAGE TREATMENT, AND EUTROPHICATION IN SWEDEN"

Dr. BOUVENG. Mr. Chairman, thank you first for your kind words. May I first apologize because there might be linguistic shortcomings in my statement. It is natural, because we had only about one week to prepare it.

Secondly, I come from Europe, and we are a few hours ahead of you in time. While you are now perhaps longing for your drink and dinner, I am longing for a nightcap and bed.

But I will try to do my best.

Mr. REUSS. Thank you, sir.

INTRODUCTION

Dr. BOUVENG. In continental Europe, the water polluting capacity of detergents is associated almost exclusively with their content of surfactants. The situation is quite different in Sweden, Finland, and Norway. Sparse population, ample water resources in most regions, short distances from the upstream part of the catchment areas to the coast are factors which all combine to bring the reuse of water down to a

minimum. A resulting buildup of harmful concentrations of ABS in the surface waters did never occur, therefore. The principal concern has instead been the increasing use of polyphosphates as builders and the connection of these with the accelerating eutrophication of lake basins and certain coastal waters.

About 1.6 grams of phosphorus per person a day was discharged with domestic sewage before synthetic detergents were introduced in the 1950's. A fairly recent study indicates that this figure has increased to close to 4 grams per person a day. The major part of this increase could be attributed to the changeover to synthetic detergents and to the steadily increasing consumption of such products.

The increased loading of some surface waters with phosphates cannot be related exclusively to an increased use of synthetic detergents, however. Changes in the population distribution and, perhaps to a certain extent, increased connection of households to municipal sewerage systems have also contributed to the present high levels of phosphorus in surface waters which receive sewage.

The construction of facilities for secondary treatment of sewage did not reach a large scale in Sweden until the middle of the 1950's. It became apparent within a few years, however, that secondary treatment did not give the expected results. A rapidly proceeding eutrophication of, for example, Lake Mälaren and the inner part of the Stockholm archipelago showed clearly that additional measures for reducing discharges of plant nutrients were urgently needed. Estimates made obvious that domestic sewage was the principal source of these nutrients. Runoff from farmland was found to contribute only to a minor extent. Inadequate handling of manure plays an important role locally.

ADMINISTRATIVE MEASURES

All involved parties agree on that phosphorus is one of the key factors when eutrophication is concerned and also that it is the most easily controlled factor.

In 1965, the former National Water Conservancy Office (not included in the Swedish Nature Conservancy Office, NCO) invited the detergent manufacturers and their suppliers of raw materials to discuss the pollution problems caused by the increased use of household detergents.

The discussion resulted in an agreement that the problems would be considered jointly and that preference would be given to activities which might bring about a reduced use of phosphate builders. The ABS problem was touched, too, but found to be less urgent. (A switch to soft surfactants was agreed on later; the agreement has been effective since the beginning of this year.)

The discussion led to the forming of a cooperative committee, the Detergent Committee of the Association of the Swedish Chemical Industries. The fact that an industrial association organizes a committee with members recruited both from the governmental agencies and from the industry, reflects the intimate cooperation on pollution problems which has been established between the Swedish Government and the industry.

The detergent committee has been very active in promoting research,

collecting information, et cetera. Several decisions taken by the NCO or by the manufacturers find their background in discussions within the committee.

The NCO presented its present views and policy in a memorandum of September 19, 1969. I have provided Dr. Stephan of the Federal Water Pollution Control Administration with a copy of that and he said he would get it translated, so I suppose you will have that.

The major points made may be summarized as follows:

A discontinued use of polyphosphates in detergent would not stop the deterioration of lakes in heavily urbanized regions but would maybe reduce its pace. A more pronounced positive effect may be expected in regions where the population is small in relation to the capacity of the receiving waters.

You should remember that our hydrography is rather similar to that of Wisconsin. Lakes form a dominant part of it, and, therefore, eutrophication is our essential water pollution problem just now.

The technique for extensive removal of phosphorus from sewage has advanced considerably since 1965 when the detergent committee started its work. It was not expected then that all communities in the Stockholm region and in some other regions will within a few years be served by treatment plants capable of reducing phosphorus in sewage by at least 90 percent. A consequence of this is that measures for reducing the detergent phosphates are somewhat less urgent today. The demand for such a reduction still remains, however, as the construction of facilities for the removal of phosphorus from the sewage arising in small communities and scattered households in rural areas will require some time.

The memorandum states that the following should characterize any compound used to substitute polyphosphates in detergents:

No hygienic (toxic or allergic) risks should be involved; it should not cause deterioration of product performance or damage to textiles to any practical extent; it should cause no negative effects in the environment, either directly or indirectly by adversely affecting treatment processes; it should cause no damage to washing machines or to the sewage; the cost should be acceptable.

It could further be mentioned that a governmental committee is presently considering a new legislation concerned with the use of individual chemicals or composite products which, when used or disposed of, might affect the environment adversely. Such a legislation might create the situation that manufacturers of such chemical or products will have to submit information concerning their nature and composition to a governmental board. The board would have the authority to prescribe restrictions or other general rules for the marketing or use of materials which might cause damage to the environment. It may be assumed that the board will guarantee secrecy. The secretary of the Detergent Committee is a member of this legislative committee. With reference to the considered legislation, the NCO has requested that the detergent manufacturers would report to the office their use of certain raw materials, the phosphate content of their individual products and any major changes in product compositions. The last item refers to their heavy-duty products, the ones most widely used. The report would be given annually and treated confidentially. The manufac-

turers have recently agreed on this. The agreement will be effective from January 1, 1970. The details for this will be worked out just now.

Two of the principal manufacturers informed the NCO in April 1969 of their intention to reduce the phosphate content of their main products by about 15 percent or from 35 to 29–30 percent. The NCO has accepted the claim that a further reduction would result in a less good performance of the concerned products.

ALTERNATIVES TO POLYPHOSPHATES OR MEANS FOR REDUCING THE POLYPHOSPHATES CONTENT OF PRODUCTS

NTA

It was proposed early in 1966 that the sodium nitrilotriacetate (NTA) should replace polyphosphates in detergents. Reference was made to the eutrophication problem. It was claimed that NTA could replace up to about 70 percent of the polyphosphate builders with no adverse effect on the performance. A replacement to such an extent was indeed attractive as it would at that time reduce the discharges of phosphorus from a secondary treatment plant by close to 50 percent.

The ability of NTA to chelate trace metals in a manner which might make them more available to organisms justifies its classification as a compound with possible biological activity. An evaluation of its possible effects on a receiving body of water was therefore an urgent task. In the absence of suitable information, a research program had to be set up.

The results were reported to the NCO in January 1968. They may be summarized as follows:

Although NTA, according to pilot plant studies, degrades fairly extensively (70–90 percent) in an activated sludge plant, this is achieved only after a long period of adaptation. It seems therefore justified to characterize it as a less preferred substrate.

NTA degrades in natural waters although with a very slow rate at low temperatures.

NTA affects the assimilation of carbon dioxide slightly in some waters but mostly to an insignificant extent.

As chelating agents may have genetic activity, that aspect was examined, too. No significant effects were observed, however.

With reference to the results obtained in Sweden and to those obtained simultaneously in several laboratories in the United States, the NCO—or rather its advisory board—took the position that NTA might be used in detergents but that complementary studies must succeed. The purport of this was obviously that, albeit NTA had been proven to be nonrefractory and biodegradable, the presence of certain amounts of the compound in waters receiving sewage had to be expected in practice and, further, that the possible consequences of this had been evaluated incompletely in the submitted reports.

Participants in the public debate have demanded on several occasions that the NCO should recommend the detergent manufacturers officially to change into NTA-based products as no adverse effect on the environment had been made obvious by the submitted reports. Arguments to that effect are still put forward quite frequently and in a rather militant manner. It appears from the aforementioned memorandum, however, that there is a considerable distance between the

present attitude of the Office and the one heading for a strict recommendation.

The Cooperative Co. in Sweden interpreted the statement of the advisory board of the NCO as an all-clear signal for the company to pursue its plans to market household detergents with NTA as the principal builder. The consequent marketing activities have had the result that about 15 percent of the Swedish market is covered by NTA-based products today. The heavy-duty products contain about 19 percent NTA—as the trisodium salt—and about 10 percent tripolyphosphate.

The Consumer's Institute has compared one of the NTA products with conventional detergents. The performance of the latter was slightly better than that of the NTA product. The initial formulation of the NTA product gave rise to corrosion problems but later modifications have improved the properties from that point of view.

TWO-STAGE WASHING

The Consumer's Institute has found that prewashing with a small quantity of a synthetic detergent followed by washing with a soap product affords equally good or better results than a one-stage washing with the synthetic detergent alone. This is valid for certain applications, but not for all. It applies to those types of material which make up the bulk of the household washing, however. But when it comes to heavily soiled clothes and synthetic fibers and so forth, it is at least possible that this will not hold.

These findings seem to be valid not only in soft waters, but also in hard waters (19° dH). The two-stage procedure will reduce the quantity of tripolyphosphate used to about one-third.

MODIFIED SOAP PRODUCTS

The Consumer's Institute found later that a one-stage washing using a mixture of a synthetic detergent and a soap product in the proportions used in the two-stage process gave an equally good result in the same field of applications.

Two manufacturers have adopted this idea and market now modified soap products containing about 10 percent of tripolyphosphate. It is not established yet whether the consumers will accept this type of product or not.

It must be observed that these modified soap products are designed for washing at temperatures execeeding 60° centigrade and using the types of machines which are normal in Sweden and which, as far as I know, are different from the types used here. So these products may not be compatible with the low-temperature washing procedures and the types of machines which are employed in the United States. But that is a matter which must be left to other people to find out.

PRESENT RESEARCH RELATED TO NTA

The position taken by the NCO in 1968 implied that further studies of NTA had to be carried out. Large-scale field studies of the type applied to ABS were considered initially. It was recognized almost immediately, however, that such studies would be unpractical in the

present case inasmuch as the desired information would not be obtained within a reasonable time.

It was decided instead that the studies of the degradability of NTA by activated sludge would be extended to include also less sophisticated treatment systems such as trickling filters and oxidation ponds. Such a study is now carried out in a treatment plant north of Stockholm, which serves a community of 2,000 persons and a big laundry using an NTA-based detergent. Incoming sewage will contain around 5 milligrams of NTA per liter at dry weather flow. The treatment plant consists of a primary clarifier, a trickling filter, a second clarifier and an oxidation pond with a detention time of about 6 days.

There are not sufficient data available yet for a more detailed discussion. It could be mentioned that the rate of degradation of NTA decreased during the autumn from 75–80 in October to 60–65 percent in November in the trickling filter and from 65–70 to 35–40 percent in the oxidation pond.

I will be happy to provide you with complete data when this study proceeds.

It may be assumed that any attempt to evaluate the possible effects of discharges of NTA must be preceded by a careful study of the role and character of the chelating compounds which are normal constituents of aquatic ecosystems. This field has been very lightly touched by the limnologists, if at all.

It has been known for many years that the addition of chelating agents to laboratory cultures of certain algae is a prerequisite for a healthy growth. Very few studies have been devoted to the materials which maintain a well-balanced supply of essential trace elements to the organisms in a natural aquatic system, however.

Here I would like to make an addition with reference to the previous discussion. Our food should represent a well balanced composition of various nutrients, among which are trace elements. The same trace elements are essential nutrients for algae and for other organisms. It is definitely so that the sewage which we discharge to our waterways contain well balanced quantities of trace elements.

Dr. Rohlich referred to molybdenum and cobalt and some others. The role of these trace elements has been more or less disregarded where eutrophication is concerned. We believe that these materials ought to be studied with equal care as the role of phosphorous.

W. Lange at Tanner's Research Council in Cincinnati has opened an interesting field for studies by observing that the growth of blue-green algae, such as Microcystis and Oscillatoria, is stimulated by the presence of an organic substrate, that certain phenomena connected with blooms of blue-greens are readily explained by a symbiosis of algae and bacteria and, finally, that the growth of some species of blue-greens was normal only when chelating agents were supplied from an external source.

Some chance observations in our laboratory indicated that both sewage and natural waters contain appreciable amounts of chelating material, a main part of which may be flocculated with aluminum sulphate. In order to make an extended study possible, a suitable technique for studying some chelating functions was developed. Dr. Peter Solyom and Mr. Jan Werner have participated in this work.

In order to create a suitable base for further theoretical considerations and for programed laboratory studies, samples from five lakes in the Stockholm area were collected weekly and analyzed. The lakes represent different types concerning both the limnological character and the degree of pollution. The characteristics of the three lakes which were studied most carefully are the following:

Lake A (Albysjön): Eutrophic through upstream discharges of sewage. Total phosphorus ranging from about 200 to 350 μg/l.

Lake B (Bornsjön): Situated close to A and having the same basic characteristics but receiving no effluents (total P about 20 μg/l; transparency in July about 11 meters).

Lake L (Lilsjön): A hypertrophic small bay of Lake Malaren subject to discharges of storm water and possibly leakage water from sewerage. Total phosphorus 500 to 700 μg/l.

The following parameters proved to be of special interest: pH; O_2; organic carbon in filtered samples; chelating capacity, presented as μ moles of apparent NTA per liter; a thermodynamically defined function *f*.

Some of the results obtained since the end of June are summarized in the attached diagram. The arrows are intended for identification purposes. Both total chelating agents (the zero level of "NTA" is not quite established yet; it may be situated somewhat above the zero level of the diagram) and organic carbon tend to increase during the vegetation period and to decrease when the period of active algal growth ceases. The variations taking place during the vegetation period are correlated in such a way that an increase in organic carbon and in dissolved oxygen (not shown in the diagram), indicating increasing algal activity, is accompanied in most instances with a decrease in the concentration of chelating agents. When the dissolved organic carbon is degraded, there is a simultaneous rise in the concentration of chelating materials. The changes of these parameters go on the other hand in the same direction when the surface waters are brought in contact with deeper layers or bottom sediments and in the absence of active algal growth.

This occurred at one hurricane at the end of September and one on November 1 and also at the fall turnover. Lake L behaved anomalously in the beginning of August after a period of extremely heavy blooms and an oxygen deficit in the surface waters, probably caused by decaying algae.

The parameter f has the mathematical form of 10^{-f}. It may thus be expressed in a manner which is analogous to pH. The method for measuring *f* is still provisional. The average values for *f* in lakes B, A, and L were 8.1, 8.6, and 8.9 respectively by the applied provisional method. A series of samples from the effluent of an activated sludge plant had the average 9.0 and samples from an oligotrophic lake 7.7 *f* changes toward low values, when algal growth ceases. Flocculation of lake water samples with 40 mg of aluminum sulfate reduced the *f* values with almost one unit.

The interpretation of the *f* function is not clear yet. It appears to be related to the trophic level and may indicate the rate of turnover of trace metals in an aquatic ecosystem. It is also related to the concentration of chelating materials.

The described work is in progress and still far from any final conclusions. The results hitherto obtained provides some information concerning the use of NTA in detergents, however.

The following could be said:

The growth of algae in eutrophic lakes is accompanied by a synthesis of chelating materials in quantities which most probably will exceed the quantities of NTA which will remain in sewage after secondary treatment. Discharges of NTA in sewage into such lakes may therefore be expected to have no effect at all. The chelating material normally present in sewage will be removed upon treatment with aluminum sulfate while any residual NTA will pass unaffected through such a treatment.

Future studies of the possible effects of NTA on aquatic ecosystems may presumably be restricted to those cases where NTA containing sewage undergoes tertiary treatment with precipitating chemicals and where it is finally discharged to a lake system that is low in nutrients by nature. Lake Superior and parts of Lake Michigan may be given as examples of such systems. The degradation of NTA in a preceding biological treatment unit and in the receiving water must be paid attention to, of course.

The NTA problem is linked to the utilization of trace quantities of certain essential metals by algae and other aquatic organisms. Any experiments made for the elucidation of the effects of NTA and similar compounds on aquatic ecosystems require a good understanding of the chemistry of metal complexes at very low metal concentrations. It is our opinion that the continuation of the work on naturally occurring chelating materials, and their relation to similar materials in detergents, which we started and perhaps others have started simultaneously, will require an intimate cooperation between qualified physical chemists and biologists. The work may provide evidence that any aquatic ecosystem has the ability to synthesize the chelating agents required. NTA and similar compounds will not involve a water pollution problem in such a case. The results may also indicate the opposite, of course.

SEWAGE TREATMENT

The prospect of a rapid supplementing of the sewage treatment plants with facilities for phosphorus removal were not very good when the detergent committee started its work in 1965. The situation is quite different today. The number of treatment plants employing phosphorus removal will at the end of this year pass 23. Some 183 are planned or under construction. The NCO has judged the technology of phosphorus removal to be sufficiently well advanced to justify the demand that all cities and municipalities within certain regions install the corresponding treatment facilities before 1972.

It is generally accepted that the removal of phosphorus should exceed 90 percent and that—for the purpose of efficient process control—it had better be made in a separate treatment unit succeeding the biological treatment of the sewage. The biological treatment may be omitted in some places where the capacity of the receiving water is large enough to make discharges of BOD a minor problem. The resulting treatment process will include a primary clarification followed by

treatment with a precipitant. The BOD removal will be around 70 percent in such a process and the removal of phosphorus better than 90 percent. The NCO may in fact give priority to chemical treatment over biological in those communities which still have no facilities for sewage treatment at all or only primary treatment.

The addition of a precipitant to the aeration tank of an activated sludge unit—simultaneous precipitation—has been subject to full scale testing in several treatment plants. The results obtained were negative. The phosphorus removal did not exceed 80 percent and the efficiency of BOD removal deteriorated.

It was found instead that the addition of a calculated quantity of a precipitant—aluminum sulfate—ahead of the primary clarifier offers a much better method for the removal of phosphorus than the simultaneous precipitation method, at least as a provisional arrangement. If the added amount of precipitant is balanced well, the excess sludge will "extract" the remaining phosphorus to an extent which will give an overall phosphorus removal which exceeds 90 percent. This "preprecipitation" procedure has been subject to full scale testing in two treatment plants in Stockholm, serving about 30,000 and 125,000 persons, respectively. Very good results are obtained in the smaller plant. Some difficulties, possibly related to the proper balancing of the added amount of precipitant, have been encountered in the larger plant, however. The preprecipitation method seems to offer a good corrective to overloaded plants.

It should be mentioned that the primary sludge obtained when the preprecipitation is applied is very thin compared to normal primary sludge. It is therefore less suited for anaerobic digestion. When anaerobic stabilization is attempted, there is a definite risk for digester failure. The same seems to apply to the sludge obtained at simultaneous precipitation. The view taken in Sweden is, therefore, that the introduction of chemical sewage treatment must be combined with an unprejudiced reconsideration of the various methods now employed for sludge treatment.

Aluminum sulfate is the preferred precipitant in Sweden, although lime will be used in some instances. As the reuse of water is limited in Sweden, a buildup of harmful concentrations of sulfate ions in the surface waters is not expected to take place.

The problem of handling the voluminous aluminum hydroxide sludge was until recently looked upon as a difficulty overcome one, at least when the larger treatment plants were concerned. New or improved equipment for sludge dewatering has changed this situation, however. A centrifuge, constructed by the Danish company I. Kruger in Copenhagen is of special interest as it provides an efficiency of separation better than 99.5 percent. It will bring the dry solids content of digester sludge and of aluminum hydroxide sludge from tertiary treatment to exceed 25 and 15 percent. The reject from dewatered digester sludge had a BOD of less than 150 mg/1. The reject from partially digested sludge from a preprecipitation unit contained less than 0.1 mg of phosphorus per litre.

It is well recognized that the installation of facilities for precipitative treatment of sewage is only one of several measures required for

improving the present situation concerning eutrophication. Better training of treatment plant operators, reconstruction of old and inadequate sewerage, proper handling of storm water are other necessary features of an efficient program for controlling eutrophication. An improvement of certain agricultural practices is required, too.

Equipment for removal of phosphorus in sewage from small villages or single households in rural areas is also needed. Such sources correspond to about 20 to 25 percent of the total discharge of sewage in Sweden. There are now made considerable efforts to develop such units technically and commercially to meet this demand. A few types are already in the market, perhaps prematurely. It is expected, however, that technically sound constructions will be available within 1 or 2 years. The relatively high per capita cost will naturally present a problem.

It should finally be pointed out with some emphasis that the phosphorus removal is not held as the only merit of precipitative sewage treatment. Better and safer BOD removal, improved removal of bacteria and parasitic worm eggs, are further advantages to which attention must be paid. An important object for studies is whether sewage contains factors other than phosphorus of importance for the eutrophication process and whether these factors are removed on treatment with e.g. aluminum sulfate.

I might end with a question put forward by Mr. Indritz concerning the treatment of a lake in Sweden with aluminum sulfate. The treatment reduced phosphorus, but it reduced also other materials and it reduced also the trace metal activity, as measured by physico-chemical methods, by a factor of about 10.

SUMMARY

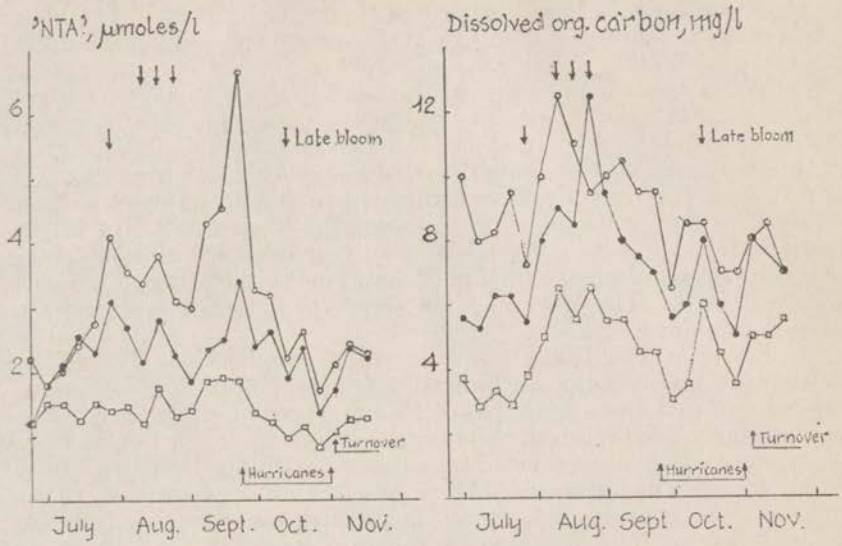
A substitution of alternative detergent builders for the conventional polyphosphates is highly desirable. An alternative builder must fulfill certain given conditions to be acceptable from the consumer's point of view.

Three alternatives are available today. All of them afford a reduction of the output of detergents phosphates by about two-thirds. Two of the alternatives could be characterized as modified washing procedures. The third one is characterized by a substitution of NTA for about two-thirds of the polyphosphates.

Results obtained have made it possible to define those cases where NTA might exert an effect on an aquatic ecosystem. The number of such cases is restricted. No effect is expected when NTA is discharged to eutrophic systems or with sewage which has not been subject to tertiary treatment.

The removal of phosphorus from sewage by precipitation will be required from the majority of the communities in Sweden. The corresponding technology, including the handling of the resulting sludge, is advancing rapidly.

(The chart referred to by Dr. Bouveng follows:)



Mr. Reuss. Thank you very much for your very constructive contribution, Dr. Bouveng. There is no doubt in your mind that phosphates are an important cause of the autrophication of lakes.

Dr. Bouveng. They contribute. But one should be very careful in stating the effect of removing detergent phosphates. When discharges of phosphorus with sewage are concerned, phosphorus from detergents constitutes a maximum 50 percent of that portion of phosphorus going into the lakes. It was perhaps so in Sweden a little more than a year ago. But by the mentioned reduction of the detergent phosphates, it may be slightly less than 50 percent today.

It is my personal opinion, and I think Dr. Rohlich shares it, that if you could reduce that, take it away completely, the maximum effect would be that nuisance blooms in eutrophic lakes were reduced by half. But that is aboslute maximum. It may well be so that it is perhaps reduced by 5 or 10 percent, or by nothing. We have not the answer for that. And that is, as we see it, one of the important tasks of your Task Force to find out. The effect of any nutrient describes an "S" curve. When the eutrophic waters, the polluted waters, are concerned we don't know where on the "S" curve of phosphorus we are.

Mr. Reuss. We are embarrassed, Dr. Bouveng, we have no chalk, but you were dong quite well in describing it.

Dr. Bouveng. It is desirable that we should take any reasonable chance to reduce the nuisance, the eutrophication. But whatever we do, whether it takes the form of improved sewage treatment or reduction

of detergent phosphates, we must try to understand what we are doing. And if you sacrifice the performance of the products—and that is the view of the NCO, as it will appear in their memorandum—you must know what you are sacrificing in performance and hygienics and so forth.

The NCO recommends the modified soap products. They do not yet recommend the use of the NTA products, but they might do it in half a year or in 1 year, when they are satisfied with the evidence.

Mr. REUSS. So that the experience of Sweden at the present time is that there are in existence two methods of producing a detergent that safely does the cleaning job and lessens the phosphate effect in the waste water. These two methods are both modified washing methods. One involves a prewash, with a phosphate containing detergent, then a wash with soap. The other involves about the same thing, except the two are combined.

Dr. BOUVENG. Yes. But it is only for certain applications. I asked the Consumer's Institute the day before I left for their opinion. They gave the opinion that there are types of clothes, types of soil, where this is perhaps not a good solution. An example is heavily soiled clothes from work, where people get a lot of oil and similar things in their clothes.

Mr. REUSS. For the average home laundry, your experience is that these modified washing substitutes do an adequate job of cleansing?

Dr. BOUVENG. The experience hitherto gained, but these products are rather new in the market, and you must follow their performance throughout the use of a linen, a sheet, and so forth, to see if it makes the same good job even when the textile material is worn. You change the textiles gradually when you use them, and, well, perhaps in a year or so the experience is more conclusive.

Mr. REUSS. If one had a lot of money, so one could have a mechanical device giving the sheet about the same wear that it gets between washings, but all in a few seconds, you could then expedite this testing; could you not?

Dr. BOUVENG. It is very difficult to simulate the everyday use of textiles, because there is not only mechanical wear, it is oxidation going on and so forth. But the use of these detergents is followed very closely by both the Consumer's Institute and by the Nature Conservancy Office.

Mr. REUSS. The third alternative, NTA, is not yet in your judgment a realistic alternative, since the tests have not gone far enough.

Dr. BOUVENG. It is not recommended as an alternative yet, but it might be.

Mr. REUSS. So we have two recommended alternatives.

Dr. BOUVENG. Yes.

Mr. REUSS. And a possible third.

Dr. BOUVENG. Yes.

Mr. REUSS. Thank you very much. Mr. Indritz?

Mr. INDRITZ. Dr. Bouveng, is the program for the reduction of phosphates in detergents meeting with acceptance among the people of Sweden?

Dr. BOUVENG. It is met with acceptance among the small proportion that is actively interested. But you will find, and I think you would find it here too, that the bulk of the consumers are rather conservative and perhaps not so interested as you would like them to be.

Mr. INDRITZ. Well, I will acknowledge we have not yet had in the U.S. parades and demonstrations for phosphate-free detergents such as appeared to have been held in Sweden. I read a translation—because I do not read Swedish—but in a Swedish magazine, "Allt i Hemmet," there is a story of a demonstration by various women's organizations in Sweden demanding reduction of phosphates in detergents. In fact the article says, and I am reading the translation, that—

> Political and nonpolitical groups got together to demonstrate against the phosphates and pro a more environmental-kind type of detergent. The shops in the town joined in and removed the "villains" from their shelves. (May they never come back.)

That seems to indicate a good deal of feeling in Sweden.

Dr. BOUVENG. I must say about that type of demonstration, that in that case the receiving water is so heavily eutrophied that no responsible authority in Sweden will believe that removal only of the detergent phosphates would help a bit. It is just a pea soup outside that city. And for further comments on that demonstration, I would suggest that you write to the General Director of the Nature Conservancy Office because that demonstration is extremely hot stuff and I will make no comments on it.

Mr. REUSS. Outside agitators.

Dr. BOUVENG. Yes. But he might give you a view on it, an authorized view on it, and you would be astonished.

Mr. REUSS. Well, we are enormously grateful to you for telling us what your scientists and industrialists and governmental people have done in Sweden.

Are your research efforts made available to our people here in the Department of Interior?

Dr. BOUVENG. I am happy to communicate with them and to discuss these things with them. I got so much information from this side of the ocean that we would be happy if we could provide a tiny little bit for your help.

Mr. REUSS. We are tremendously grateful to you, and we look forward to your helping our subcommittee once again.

Thank you so much.

The subcommittee will now stand in recess until 10 o'clock tomorrow morning in this room.

(Whereupon at 6:15 p.m., the subcommittee was recessed, to reconvene at 10 a.m., Tuesday, December 16, 1969.)

PHOSPHATES IN DETERGENTS AND THE EUTROPHICATION OF AMERICA'S WATERS

TUESDAY, DECEMBER 16, 1969

House of Representatives,
Conservation and Natural Resources Subcommittee
of the Committee on Government Operations,
Washington, D.C.

The subcommittee met at 10 a.m. in room 2247, Rayburn House Office Building, Hon. Henry S. Reuss (chairman of the subcommittee) presiding.

Present: Representatives Henry S. Reuss, John E. Moss, Floyd V. Hicks, Guy Vander Jagt, Gilbert Gude, and Paul N. McCloskey, Jr.

Staff members present: Phineas Indritz, subcommittee chief counsel; Laurence Davis, assistant counsel and F. Clement Dinsmore, legal assistant. Also, J. P. Carlson, minority counsel, and Tom Saunders, minority staff, Committee on Government Operations.

Mr. Reuss. Good morning.

The Conservation and Natural Resources Subcommittee will be in session for a further hearing into the problem of phosphates.

We are very pleased to have with us at this time our distinguished colleague, Congressman James C. Cleveland of the Second District in New Hampshire, who has a couple of our honored witnesses to introduce this morning.

Jim, would you proceed to tell us who your constituents are?

Mr. Cleveland. Thank you very much, Mr. Chairman.

It is a particular pleasure for me to appear before your committee this morning. It is a pleasure for several reasons.

As you know, Mr. Chairman, I serve on the Public Works Committee of the House, and we on that committee have been concerned with the problem of water pollution. This is a problem that is of great concern to an ever-increasing number of people.

One of the aspects of water pollution in which I have taken a particular interest, Mr. Chairman—and there are many aspects to it, there are many factors involved—has been the fact that although the Public Works Committee has steadily increased the authorization for expenditure to fight water pollution, we have apparently done so at a rate greater than the Appropriations Committee has felt able to fund these authorizations. And with this in mind, I have personally felt that at some point in time we may want to explore the possibility of establishing a trust fund to finance the fight against water pollution. This would be funded somewhat as the highway trust fund has been so successfully funded, by a system of user fees and excise

taxes, with the understanding that those that use water and pollute water will have to pay at least part of the enormous cost of keeping this water clean.

I know that this isn't the immediate purpose of your hearing today, but I mention it as background because of my interest in the subject.

It is also my understanding—and I think your committee is to be commended for focusing attention on this—that at least in one phase of this problem, which is the eutrophication of water, and which apparently is caused by too many phosphates being used in our detergents and perhaps in our fertilizers, this aspect of the problem may yield itself to technological improvements by industry.

Of course you and I both agree that if improving our waters could be done, by technological breakthrough, this would be far more desirable than by Government fiat.

The witnesses you will hear now, Dr. John J. Singer, Jr., the president of the Hampshire Chemical Co. of Nashua, N.H., and the gentleman with him, Mr. Robert Pollard, will bring you what I consider to be some fairly good news in this connection.

They will describe to you their product which they feel may give us a little hope that an overdose of phosphates may not be as necessary as some people think it is; but I will let them speak for themselves.

I might just say in concluding my introduction that one of the reasons it is a particular pleasure for me to be here introducing these two distinguished scientists and industrialists is the fact that many years ago, when their company was first being started, I was able to persuade the founder of the company—a very distinguished scientist, Bradley Dewey, of my hometown of New London, N.H.—that the best place to build this new company was in New Hampshire and not in Massachusetts, where he has originally thought he might establish the company.

I might say one more thing, Mr. Chairman:

In urging your consideration of Dr. Singer's paper, although I am very fond of this company, I regret to say I have no stock whatsoever in the company or its parent company.

Mr. REUSS. Your absence of a conflict of interest is noted.

Mr. CLEVELAND. Thank you very much. And I regret I have another hearing and will have to leave now.

Mr. REUSS. We thank you, Jim, for that grand introduction, and we congratulate you on combining righteousness with good political realism in getting Hampshire Chemical to locate in New Hampshire. Thank you.

Dr. Singer and Mr. Pollard, you are both very welcome here. You have a prepared statement with some appendices, which under the rules are received in full into the record.

Would you now proceed, sir, to present your testimony? You may either read it or summarize it or proceed in any manner you wish.

STATEMENT OF DR. JOHN J. SINGER, JR., PRESIDENT, HAMPSHIRE CHEMICAL DIVISION, W. R. GRACE & CO., NASHUA, N.H.; ACCOMPANIED BY ROBERT POLLARD, VICE PRESIDENT

Dr. SINGER. Mr. Chairman, members of the subcommittee; we have been asked to appear before this subcommitte to offer testimony on a

chemical known as NTA (the sodium salt of nitrilotriacetic acid), which is now being used as a component of detergent formulations and which has been proposed as a possible alternate to the use of polyphosphates in detergents.

NTA is a member of a class of compounds known as synthetic amino acids. Its principal functional characteristic, like that of the polyphosphates, is water softening by a mechanism known as chelation or sequestration, or simply, complex-formation with the hardness constitutents of water.

NTA itself is an old chemical, having been first synthesized in Germany in the mid-1930's. It was, however, an expensive compound used and sold primarily as a specialty chemical. In 1962 Hampshire patented a process which for the first time permitted NTA to be manufactured at relatively lower cost and sold at significantly lower prices.

NTA has found wide acceptance in the United States as a water softener and conditioning agent; but it was not until 1966, when large volume production became available, that the compound was used in substantial quantities in consumer products.

Since the introduction of NTA, Hampshire has always stressed its belief that the best detergent could be made by using both NTA and polyphosphates in a formulation. In effect, the NTA would serve as an adjunct in detergents having a somewhat reduced phosphate content. This recommendation of Hampshire was based on data which we gathered and reported quite a few years ago [1 2 2a-d*] and is substantiated by the published and private work of others.[3 4 5 6]

In addition to this work, numerous United States and foreign patents [7a-v] teach the art of using NTA as a constituent of the "builder" portion of a detergent formulation. The range of suggested concentrations is from as low as one part NTA to four parts polyphosphates to as much as four parts NTA to one part polyphosphate and even the use of NTA as the sole builder component.

The role of a builder in detergents has been described most simply as being a compound which permits or helps the surfactant to be effective and efficient. Builders in themselves have little or no detergent ability but without them, synthetic surfactants are of little use. Polymeric phosphates are unquestionably effective and have been the favored and most widely used detergent builder for the past 30 years.

In a synthetic detergent formulation the builder performs such functions as lowering the critical water hardness, peptizing or defloculating soil, buffering the washing solution, and lowering what is known as the critical micelle concentration.[8]

Mr. REUSS. What in Heaven's name is that?

Dr. SINGER. If you have a detergent solution, you have a lot of small "charged" particles in the water. The particles clump together in essentially the same way as a group of magnets would clump together to form a "micelle," which is this rather large flexible structure which is attracted to a dirt particle, causing it to be lifted off the dirty surface and to be suspended.

It is a nice name that a physical chemist would use but for all intents and purposes, it is of little significance in describing how a

*NOTE.—Reference numbers refer to items appearing in the bibliography accompanying the prepared statement. Reference numbers were not read by Dr. Singer during the verbal presentation of the statement.

detergent functions or how effective it is in a washing machine. It is a scientific term which you find in technical papers.

These are functions which are provided, at least in part, by the familiar polyphosphates, by NTA, or by other ingredients such as silicates, alkalies, and carboxymethyl cellulose, or by combinations of these ingredients. However, the most important single function of either the polyphosphates or NTA is that first mentioned; namely, to soften the wash water. Research conducted both in this country [9] and in Europe [10 11] indicates that this is the only significant characteristic attributable to detergent builders such as the polyphosphates and NTA. In this important respect, NTA has been reported to be from 1.4 to 1.8 times as effective as sodium tripolyphosphate, which at the present time is the most widely used polyphosphate, and NTA is even more effective relative to the other common polyphosphates.[5 12a]

Although a tremendous amount of work has been done, there are still only two compounds which are effective as builders and which, at the same time, are economical and commercially available. These are the polyphosphates, which are now widely used, and NTA which has been used in significant quantities for approximately 4 years.

While Hampshire still feels that the best possible detergent is made with a combination of both NTA and polyphosphates, there are references and publications which indicate that NTA either alone or with greatly reduced polyphosphate levels can fill the role of the builder in a detergent.[8 2 2a-d 3 4 13 14] In addition to the published technical data and references, there has been commercial development of detergent compounds particularly in Sweden and Finland where polyphosphate has been substantially reduced and where NTA is a major component of the formulation. While it is recognized that Scandinavian washing conditions differ from those in the United States, the differences do not affect the role NTA plays in the washing operation.

With minor exceptions, the detergent-building characteristics of NTA and the polyphosphates are similar and complementary; but while NTA and the polyphosphates are similar in their chemical function, they differ physically.

Since builders account for high percentages of the bulk of the detergent, the physical characteristics of the builder tend to dominate and strongly influence the physical characteristics of the finished product. Although functionally synonymous with polyphosphates, NTA cannot be exchanged for polyphosphates at high levels without changes in manufacturing and packaging techniques, and, most likely, changes in the physical characteristics of the finished product as well.

It goes without saying that the safety of using NTA, if it were to be a major detergent ingredient, is of extreme importance. While there can never be enough data, more experience with NTA would certainly be desirable.

Significant data exist today which speak for the safety, biodegradability, and harmlessness of NTA. Animal feeding studies have been conducted which demonstrate the fact that NTA is nontoxic at levels that would be encountered in household use and in waste water.[15] NTA displays no sensitization or topical toxicity in studies on both animals and humans. [15 16] Also, a Swedish geneticist has reported work showing the genetic safety of NTA.[17]

Technical reports show NTA to be safe to fish life.[8] In fact, work done at fishery experimental stations both in Canada [18] and the United States [19] has shown that the presence of NTA in water contaminated with copper and zinc, as would be the case in copper and zinc mining operations, permits fish to live in water which would otherwise kill them.

NTA has been considered for use in a new drug application and in this connection the FDA has our master file (No. MF 540) and related toxicological information. Based on extensive animal feeding studies,[20] the FDA has recently approved the use of NTA in boiler feed water which might contact foodstuffs.[21]

Finally, numerous studies have reported the biodegradability of NTA both under typical sewage treatment and in natural bodies of surface water.[22a-g] Work has been reported and published showing that NTA in no way affects normal sewage treatment processes.[8 22e]

Obviously, more data would always be desirable to cover the broadest range of conditions under which NTA might be used. For this reason it would be in everyone's best interest to increase the use of NTA slowly over a period of time so as to preclude the possibility of substituting one problem for another in the event NTA becomes a major component in detergent formulations.

The biodegradability of NTA demonstrates the fact that NTA in itself is a potential food for plants and animals and gives rise to the question, "Are we, by introducing NTA into formulations, going to promote eutrophication by increasing the nitrogen content of lakes and streams?"

It is, of course, well known that nitrogen is a major plant nutrient. There are some bodies of water in the United States where nitrogen is said to be the growth-determining factor rather than polyphosphate. In most instances, however, nitrogen is not believed to be the major contributing factor to excessive plant growth and consequently the small nitrogen concentration contributed by NTA would not be significant.

It is, however, interesting to note when NTA is compared with polyphosphate as a source of plant nutrients, that 100 pounds of NTA contributes the equivalent of approximately 5 pounds of nitrogen (as elemental nitrogen) while 100 pounds of sodium tripolyphosphate contributes the equivalent of approximately 25 pounds of phosphorus (as elemental phosphorus) which would commonly be expressed as 57 pounds of P_2O_5 in a fertilizer. This spread becomes larger if one also takes into consideration the fact that 100 pounds of NTA is equivalent to from 125 to 175 pounds or more of polyphosphate [2 5 8] when these materials are used as builders.

At the present time two companies, the Hampshire Chemical Division of W. R. Grace & Co. and the Monsanto Co., manufacture NTA in large quantities. Existing production capacity totals approximately 150 million pounds per year and could be relatively easily expanded if and when warranted. There is no foreseeable long-term shortage of any of the raw materials used to manufacture NTA.

In summary, we believe NTA to be a satisfactory and safe detergent builder.

While we, probably more than anyone else, would stand to gain by

any trend toward the use of NTA in detergents, we very strongly recommend against any precipitate action which might result in the forced elimination of polyphosphates in detergents or the adoption of NTA with undue haste and pressure. Such a forced change could create serious problems and one of our main concerns is that a valuable compound such as NTA could, by misuse, be discredited and its potential value in obtaining and maintaining "clean" water be lost.

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Mr. REUSS. Thank you very much, Dr. Singer. Will your NTA detergent work in existing types of washing machines?

Dr. SINGER. To the best of our knowledge, yes.

Mr. REUSS. Have you tested it?

Dr. SINGER. There are detergents containing NTA which are on the market today, and which are being used in existing washing machines. I would like to point out the difference between synthesizing and supplying a chemical and manufacturing a detergent compound. In making a chemical, we try to make ourselves as familiar as possible with the chemical ingredient itself. We do not make any attempt to formulate detergents, or to test the product in other people's formulations.

We try to be as expert as we can in what we make.

Mr. REUSS. Is NTA useful for things other than detergents?

Dr. SINGER. Yes, sir.

Mr. REUSS. Like what?

Dr. SINGER. One of the widest uses today is in the treatment of boiler water. As a water conditioner it prevents scale from forming on the inside of boiler tubes. It is used in agriculture and in formulations that other companies use in manufacturing their products. NTA is a chelating agent. Chelating agents historically have been used in small quantities by a host of chemical industries for everything from making synthetic rubber to dyeing cloth. It is a chemical speciality when used in that way.

Mr. REUSS. Would you say as a matter of your personal opinion that NTA is a suitable replacement in whole or in part for phosphates in detergents?

Dr. SINGER. That is our opinion, yes.

Mr. REUSS. I notice that the statement of the Soap & Detergent Association yesterday says the following, on page 3:

> Although . . . the industry is intensively searching for replacement materials, should they be needed, there is at this time no suitable phosphate replacement available for detergents.

You do not agree with that statement?

Dr. SINGER. I would say that there are people who are using NTA as a substitute or a partial replacement for polyphosphates, and that

the requirements of each customer differ. So what may be satisfactory to one person may not be satisfactory to another.

Mr. REUSS. But there are those who are satisfied with NTA?

Dr. SINGER. Yes.

Mr. REUSS. And thus your opinion is that there is a suitable total or partial replacement for phosphates in detergents?

Dr. SINGER. Yes.

Mr. REUSS. I notice in the statement of the Soap & Detergent Association that your company, W. R. Grace & Co., Hampshire Chemical Division, was listed at the end of the statement. That doesn't mean that you agree with the statement, then?

Dr. SINGER. We are a part of the membership of the Soap and Detergent Association, and our opinion was solicited and offered to the association.

Mr. REUSS. But not accepted?

Dr. SINGER. It was accepted in part.

Mr. REUSS. But not wholly.

Dr. SINGER. Not wholly.

Mr. REUSS. Your opinion is that NTA is a valid total or partial substitute for phosphates; is it not?

Dr. SINGER. Our opinion is that NTA is preferably used with phosphates in a detergent; but under certain conditions, and in some formulations, it can be a complete or partial replacement for phosphates. That has been our position for the last 10 years.

Mr. REUSS. And in view of the language I just read, that opinion has not been accepted by the Soap and Detergent Association. Is that correct?

Dr. SINGER. I would say that is essentially correct.

Mr. REUSS. Now, there are listed three pages, single spaced, at the end of their statement, the other members of the Soap and Detergent Association. You would not know how many members, other than W. R. Grace & Co., Hampshire Chemical Division, disagree with the "there's-nothing-but-phosphates" belief of the association.

Dr. SINGER. I can't speak for the others.

Mr. REUSS. Some of them may agree, others may not. Is that about it?

Dr. SINGER. That is correct.

(NOTE.—The membership list of the Soap and Detergent Association appears on pp. 75–77 of these hearings.)

Mr. REUSS. I want to congratulate Hampshire Chemical Division on what seems to me to be a most promising breakthrough possibility. I wonder if there isn't a way in which we can answer some of the as yet unanswered questions a little faster than just by letting nature take its course?

Would you agree that the principal question which has not been entirely answered is whether NTA, which has a nitrogen-like effect, may not itself cause overfertilization?

Dr. SINGER. That is a possibility. I think Dr. Bouveng's work is really quite significant and we will be looking forward to its completion, which I understand will be in the spring, with a great deal of interest.

Mr. REUSS. Why couldn't one set up a ponding experiment, in which

great amounts of NTA are injected into a body of water under controlled conditions and see what happens.

Dr. SINGER. This is essentially what was done in Sweden. This is why I say the results of this particular series of experiments will be of great interest when they are published.

Mr. REUSS. Are you familiar with the tentative results so far?

Dr. SINGER. Yes, sir.

Mr. REUSS. Would you capsulize for us what those results appear to be?

Dr. SINGER. I dislike reporting on Dr. Bouveng's work when he is present, but I would say that the work to date has shown that NTA is degraded biologically. It does go through a sewage treatment plant without hurting the process and there is no harm done to the environment by the inclusion of the quantities of NTA which were used in that particular test.

Bob, do you have anything specific to add to that?

Mr. POLLARD. Well, again I wouldn't like to speak for Dr. Bouveng. He has done a great deal of work on this subject. We are familiar with the work and I certainly think it is safe to conclude that after 5 or 6 years' work in evaluating the environmental effects of NTA, its toxicity and safety everything so far is "go."

Dr. Bouveng, I think, I will reserve official final judgment until the completion of the so-called winter studies, which will, as he said yesterday, be concluded this spring. I believe by next spring he will have the final results and a recommendation.

One observation that he has made lately, I believe, is that the biodegradation of NTA slows down under winter conditions. This is not unexpected. Every chemical reaction slows down under low temperature conditions and would be expected to speed up again in the spring and summer. Certainly, it is our own conviction, based on a great deal of evidence already collected and listed in our bibliography, that NTA is safe and biodegradable.

I might add that even the question of whether the nitrogen in NTA contributes to eutrophication is still to be answered. There are authorities who feel that, because NTA contains so little nitrogen compared to carbon, the micro-organisms that devour NTA in the sewage treatment plants and surface waters will be left with a net demand for nitrogen to enable them to consume the carbon that is contained in NTA. In an activated sludge treating plant this means that the effluent could actually contain less nitrogen if NTA were used than if it were not.

Thus, the nitrogen in NTA will perhaps never reach the algae. This is an area that might be explored further. Frankly, we feel that the majority of the evidence demonstrates that NTA is perfectly safe. There are some unknowns but no negatives at present.

Mr. REUSS. Do you consider me impatient when I say that since phosphates do seem to be threatening the eutrophication and death of thousands of American lakes and the acceleration of the phosphate composition of our lakes is coming on apace, it would be a good idea to use every known scientific means of checking out NTA? Seemingly, it is quite clear it washes as well, it doesn't poison anybody. But what we don't quite know is whether it will cause this hyperproduction of algae.

Now, we do know that if you inject phosphates into a lake or pond, in a summer or two it develops these algae matters that make the lake unusable. Why can't we in the next year or two run through an NTA experiment which will give us some answers? It couldn't be worse than phosphates. Maybe it is better.

Mr. POLLARD. Yes. We agree with that position. Let me say, though, that we don't view ourselves as experts on eutrophication. We contributed nothing to the SDA presentation in that area. We did comment on the performance attributes of NTA.

Mr. REUSS. You make NTA?

Mr. POLLARD. Yes.

Mr. REUSS. Do you make phosphates?

Mr. POLLARD. No, we do not.

Mr. REUSS. Does the fact you do not make phosphates perhaps lead you into your aggressive position in developing NTA?

Dr. SINGER. I can speak to that and say no, sir; because we first came out with the process for making NTA in 1958, which was long before the phosphate-eutrophication discussion arose. In fact, in our bibliography you will find reference dates which go back to those years putting forth our position on NTA as a potential additive or component of detergents.

This current discussion on eutrophication really has no bearing at all with respect to our position that NTA is a potential detergent component.

Mr. REUSS. I am going to conclude my observations with this: If I understand your position correctly, you are officers of Hampshire Chemical, you make NTA, you think it does a good job of cleaning, it doesn't poison anybody and it won't overfertilize algae. But it is your job to make NTA, and it is somebody else's job to conduct the tests which will determine whether your chemical gives our lakes and streams a better chance of survival than somebody else's chemical.

Dr. SINGER. Yes, because we are not competent to run these tests. But we do feel it is incumbent on us to help these people who are conducting such tests and we have cooperated in a lot of research.

Mr. POLLARD. I might add that having acted as a "clearinghouse" we perhaps could suggest some directions in which research could go. Certainly competent microbiologists could probably do a lot of work quite quickly in the laboratory or even state from their own knowledge what a microorganism eats—how it eats it, that sort of thing. It could be done quite quickly.

Mr. REUSS. Your testimony convinces me more than ever that what our pollution problem needs is somebody who will be to it as Jim Webb was to space, as General Groves was to the atom—someone who will pull this whole thing together and see that your contribution gets a fair test. And if it does do the job, then take steps to see that we use NTA to a greater extent and phosphates to a lesser extent.

Would you agree with that?

Mr. POLLARD. Yes. We have tried to carry the message of the performance attributes of NTA for a long time. We have published on the subject ourselves, pulling together the work of others, and there has been a lot of work done by others. This (our bibliography) is testimony to some of it. NTA has some obstacles to its adoption. It is not an easy proposition. It is difficult to reformulate detergents.

And mind you it isn't an easy one-to-one substitution. It does require the preparation of detergents from the ground up, perhaps with radically new surfactant ingredients, possibly with new compounding methods. It is not easy. And thus we recognize it will take quite some time. We have been talking about NTA now in this light since about 1961.

Dr. Singer delivered the first of some papers we have given; I subsequently delivered another one and that received wide circulation. But it is a slow process.

Mr. REUSS. I congratulate you both.

Mr. Vander Jagt?

Mr. VANDER JAGT. Thank you, Mr. Chairman.

You mention that in 1962 you developed a process which enabled you to produce NTA?

Dr. SINGER. That was when the patent was issued. The development was prior to that.

Mr. VANDER JAGT. But it was at a lower cost. What is the relative cost of NTA and phosphate?

Dr. SINGER. As of this moment the cost of NTA is in the lower teens.

Mr. VANDER JAGT. The lower teens per what?

Dr. SINGER. Per pound, I am sorry. Phosphate I think is selling for roughly 7-plus cents per pound. That order of magnitude. NTA—depending upon what reference you check or who has done the work or what the formulation is—is anywhere from 1.4 to 1.8 times as effective as tripoly, which means a smaller weight will do an equivalent job. This tends to bring the price discrepancy together. I would say at the present time there is a price premium or cost premium if NTA were to be substituted for tripolyphosphate. It is relatively small, however.

Mr. VANDER JAGT. Also there is the fact that you are producing it in relatively small volume compared to what the volume would be if it were adopted as a substitute.

Dr. SINGER. No, I would not say that that is the case. If you are making a chemical and if you are trying to break into a market, you have to price it at a point which will be acceptable to your customers. We realized a long time ago that the detergent market was potentially a very large one, and that we would have to compete with tripolyphosphates. So consequently our price, shall we say, even on introduction, was the kind of price that it would take to break into this market—assuming that if you broke in, you were going to have a large volume. We have sold NTA as a specialty chemical; where you really have to go out and teach the distributors how to sell it to the customers at prices in the 30-cents-a-pound range. The detergent market would be a bulk-volume market. We appreciated this from the start, and priced NTA accordingly.

Mr. VANDER JAGT. So if you increased the present production by 500 percent, it would not substantially reduce the price?

Dr. SINGER. No.

Mr. VANDER JAGT. But if NTA is in the lower teens, and phosphate is now about 7 cents per pound, if you accept the 1.8 times as an effective figure, the cost is relatively close.

Dr. SINGER. Yes, sir.

Mr. VANDER JAGT. You also mentioned, however, that NTA could be substituted for phosphates at high levels in terms of putting it together in the detergent without a substantial change in the manufacturing and packaging.

Dr. SINGER. Yes.

Mr. VANDER JAGT. Could you elaborate on that a little bit?

Dr. SINGER. Yes. One of the nice characteristics of the tripolyphosphate, as far as its use in the detergent formulation is concerned, is that it forms hydrates which are stable to humidity. You can have polyphosphates sitting out in a wet summer humid atmosphere and it stays fluffy. NTA absorbs moisture from the air, when the relative humidity gets to about 50 percent. This does happen in the summertime, in which case the NTA sticks together in one lump.

I have literally seen samples of detergent formulations where there was one particle in the box. It was the size of the box. This of course is a rather severe detriment, let us say, to this type of product. One of the approaches which we have suggested is the mixture of the two (NTA and phosphate). Since the physical characteristics of the builder very strongly influence both the manufacturing techniques and the physical characteristics of the final product, a phosphate based detergent has a lot of the physical characteristics of phosphates. You cannot substitute NTA into such a product and expect the final product to be manufactured with the same equipment or, let us say, sold in the same form.

Mr. VANDER JAGT. So we are talking in terms of a manufacturing changeover, which involves a significant amount of dollars in terms of capital cost. Is that correct?

Dr. SINGER. That is correct.

Mr. VANDER JAGT. Would that tend to make an industry a little resistant to the idea of using it, because it would be incurring a large capital cost in bringing about a changeover?

Dr. SINGER. Yes, I would say that would be a strong influence.

Mr. VANDER JAGT. Now, as I understand the basis of your study and research, it is that NTA is a good substitute for phosphate in detergents in terms of doing the cleaning job?

Dr. SINGER. This is our opinion.

Mr. VANDER JAGT. Also, if I understood your testimony correctly, on the question of whether or not NTA would do damage to our lakes and streams, the evidence is about 90 percent in at this point, and thus far that evidence indicates that it is perfectly safe.

Dr. SINGER. That is correct.

Mr. VANDER JAGT. I gather that the reason you say 90 percent of the evidence is in—and you are 90 percent sure it is perfectly safe, rather than 99 percent sure it is perfectly safe—is this lingering question as to what the nitrogen would do. Is that the basis of the problem?

Dr. SINGER. Yes.

Mr. POLLARD. I think that is safe to say.

Mr. VANDER JAGT. If there were a method to remove 100 percent of the nitrogen in the sewage treatment plants, in those areas where that can be done, then you would not have any question but what NTA would be perfectly safe?

Dr. SINGER. No, because it has been pretty well demonstrated that the bugs which naturally occur in either a sewage plant or a natural

environment in a lake are capable of eating up NTA. This automatically reduces the concentration and precludes the possibility of accumulating NTA in the water.

Mr. VANDER JAGT. So then you would go from 90 percent certainty to 99 percent certainty, under those conditions, that NTA is perfectly safe.

Dr. SINGER. Yes.

Mr. VANDER JAGT. Thank you very much. Thank you for your contribution.

Mr. REUSS. Mr. Moss?

Mr. MOSS. No questions.

Mr. REUSS. Mr. Hicks?

Mr. HICKS. No questions.

Mr. REUSS. Mr. McCloskey?

Mr. MCCLOSKY. Dr. Singer, can you elaborate on the reasons that the industry uses as to why they might adopt a mix of one NTA to four phosphates, or four NTA to one phosphate? You have discussed the fact that these choices are made. Can you tell us what criteria affect those choices?

Dr. SINGER. Yes, physical characteristics depend in large part upon what the detergent is intended to do. For instance, consider the formulation of a liquid detergent. This is an area where you would most likely go to 100 percent NTA and little, if any, phosphate simply because phosphates have a tendency to hydrolize or decompose when in contact with water over protracted periods of time. As far as a dry detergent is concerned, it depends in large part on what you are trying to do with the detergent and what it is to be used for. I honestly do not know any specific reason why you would select any specific ratio. Perhaps Bob, who is more familiar with this than I, could answer the question.

Mr. POLLARD. Those particular ratios came from some of the patent literature, which is included here (in our bibliography), referenced in our statement. It is obviously the desire of a patentee to cover as broadly as possible the scientific know-how in a patent. It is commonplace to cover everything from zero to 100 percent if you can: or if you think the actual practical range is somewhat narrower, you cover the narrower range. There are patents in the public domain that teach the full replacement of phosphates by NTA, and I would say those fall mostly in the liquid category. I would guess that clearly there is some optimum from a performance standpoint. Frankly, some of the data we have assembled here speak of total replacement, as far as performance is concerned, and do not consider formulation complications.

In fact, the abundance of the data stressing performance are based on total replacement and show that NTA performs better.

Mr. MCCLOSKEY. Let me ask you this question: With a cost which you indicate is roughly twice the cost of phosphates, and a performance by weight which is 1.4 to 1.8 times as much, what in the world would ever cause a detergent manufacturer to use NTA rather than phosphates?

Dr. SINGER. Chelates have some characteristics which make them particularly useful. For instance, NTA, if boiled or if kept in hot solutions for long periods of time, is completely stable. The polyphosphates gradually revert back to the so-called orthophosphates which are not

particularly effective as a builder. One of the components of a detergent formulation are optical dyes. These are the brighteners, the things which, when you get under an ultraviolet light makes your shirt a little blue, offsetting any residual yellow color of the cloth. These are rather expensive components of the formulation, and are a very desirable component of the formulation. If for instance the water pipes in your house, or in the waterworks are corroding, you are apt to get traces of iron, copper, or manganese in the water. These seriously interfere with the performance of the optical brightener. Consequently, the inclusion of some of the NTA or EDTA, which is another material which is quite widely used in Europe, will prevent and make the optical brightening component more effective. Since this is a very expensive part of the formulation—an optical dye costs several dollars a pound—it behooves one to make sure this component is used effectively.

In Europe chelates are also used to stabilize bleaches which are included in the detergent formulation.

Mr. McCloskey. Mr. Chairman, these questions might more properly be directed to the gentlemen from the three major industry companies who testified yesterday. Are they still in the room?

Mr. Reuss. Yes. I see Mr. Bueltman here.

Mr. McCloskey. I saw the Colgate-Palmolive man, I thought. Is the team still here?

Mr. Chairman, I would like to ask for our record if the last question that I directed to Dr. Singer—as to what the criteria are for the decision to use NTA as some part of your detergent ingredient and why you use it in varying mixes—may also be directed to the three major companies. I think it would help if we had that in the record. I would like to ask also what the increase would be percentagewise in the cost of a box or bottle of ordinary detergent to the housewife if NTA were used to replace the phosphates?

Mr. Reuss. Would it be agreeable to you, Mr. McCloskey, if the staff submits those questions to the three gentlemen from the three major detergent companies for answer in the record?

Mr. McCloskey. Fine.

Mr. Reuss. Because I think they are innocent bystanders in the courtroom this morning.

Mr. McCloskey. They are probably very anxious to respond.

(The subcommittee's letter to the presidents of the Colgate-Palmolive Co., Lever Bros. Co., and the Procter & Gamble Co., and the three responses follow:)

House of Representatives,
Conservation and Natural Resources Subcommittee,
Committee on Government Operations,
Washington, D.C., January 9, 1970.

Dear Sir: This subcommittee would appreciate receiving, as early as possible, the following information:

(1) Do any of your detergent products currently on the market contain NTA?

(2) Do your products containing NTA, if any, also contain phosphates?

(3) Please list the name of each such product, and the percentage therein, by weight, of (*a*) NTA and (*b*) phosphate.

(4) What is the exact phosphorus compound referred to, and what factor should be used to determine its content of phosphorus as P?

(5) What were the criteria you used in deciding to include NTA in such products?

(6) What were the criteria you used to determine the ratio of NTA to phosphate?

(7) In the case of each product containing NTA which you market, what would be the percentage increase in unit cost if the formula were varied to replace the phosphate entirely by NTA?

We would appreciate your continued cooperation with this subcommittee.

Sincerely,

HENRY S. REUSS, *Chairman.*

COLGATE-PALMOLIVE CO.,
New York, N.Y., January 19, 1970.

Congressman HENRY S. REUSS,
Chairman, Conservation and Natural Resources Subcommittee, Rayburn House Office Building, Washington, D.C.

DEAR CONGRESSMAN REUSS: Mr. Lesch received your letter of January 9 on the 14th and referred it to me for a reply.

None of our detergent products currently on the market contain NTA and, accordingly, we believe the balance of the questions are inapplicable to our situation.

Very truly yours,

LEROY H. HURLBERT,
Vice President and General Counsel.

LEVER BROS. CO.,
New York, N.Y., January 23, 1970.

Hon. HENRY S. REUSS,
Chairman, Conservation and Natural Resources Subcommittee, Committee on Government Operations, Rayburn House Office Building, Washington, D.C.

DEAR MR. CONGRESSMAN REUSS: Mr. Carroll has been away from the office on business and has asked me to respond to your inquiry of January 9 relating to the use of NTA in detergent products.

No product of Lever Bros. Co., currently on the market contains NTA. In view of this fact, the remaining questions in your inquiry are inapplicable to us.

Sincerely,

LEE H. BLOOM,
Vice President and General Counsel.

THE PROCTOR & GAMBLE CO.,
Cincinnati, Ohio, January 30, 1970.

Hon. HENRY S. REUSS,
Conservation and Natural Resources Subcommittee, Committee on Government Operations, U.S. House of Representatives, Rayburn House Office Building, Washington, D.C.

DEAR SIR: This is in response to your letter of January 9, concerning the use of NTA in Procter & Gamble products. The questions asked in your letter are answered below in the order in which they were asked.

1. Yes, Gain and Cheer contain NTA.
2. Yes, both products contain phosphates.
3. The percentage by weight of NTA and phosphate in these two products is:

[In percent]

	NTA	Phosphate	Phosphorous as P
Gain	10.3	41.5	10.5
Cheer	11.8	37.9	9.6

4. The phosphate compound used in these two products is sodium tripolyphosphate. One pound of this phosphate contains 0.25 pound of phosphorous as P.

5. NTA incorporation into these products was to improve laundry end-result performance and to provide experience with a material which may prove to be a replacement for a portion of the phosphate contained in detergents.

6. The decision to use the ratio of NTA to phosphate, noted in point 3 above, was based on our judgment of the proper balance between providing improved laundry end-result performance versus difficulties connected with high levels of NTA. Using present day detergent technology and processing equipment, it is not feasible to produce products in which NTA completely replaces phosphates. Furthermore, high level NTA products suffer from caking and stickiness to a major degree, as well as certain performance negatives.

In essence, we are undergoing a learning process with the use of this new builder. Our use of NTA in Gain and Cheer was and is designed to provide us with initial experience with the use of NTA.

7. We don't know what the cost of an all-NTA product would be because we don't know how the problems involved with such a product, as mentioned above, could be resolved. In addition, capacity to produce NTA at these levels is presently unavailable, so that the cost of this material in these quantities is unknown.

We hope the above information will be helpful to the subcommittee. If we can be of any more assistance, please let us know.

Very truly yours,

J. G. SMALE,
Vice President, Packaged Soap and Detergent Division.

Mr. POLLARD. Mr. Chairman, may I perhaps, being still on the stand, add something to that?

Mr. MCCLOSKEY. Certainly.

Mr. POLLARD. Dr. Singer mentioned two or three things as attributes derivable from NTA, in addition to those derivable from tripolyphosphates. There are some things, call them anything from fringe benefits to substantial contributions to detergents, which NTA contributes which tripoly does not.

I might add to those we have set forth previously: Reduction of the ash content, which is sometimes called mineralization of a shirt which is washed repeatedly. The cloth will pick up, over a period of time, some hardness elements. Phosphates alone, based on data published in Sweden, and on work which is patented in the United Kingdom, will not contribute to the reduction of this mineralization of the fabrics, where as chelates such as NTA will.

In certain synthetic detergent formulations, NTA may add to the foam stability which, at least as long as it lasts in the washing machine, is desirable.

Improved rinsability of the fabrics is another attribute of NTA. For example, using a detergent now containing NTA my wife points to a significant advantage, which is that she can avoid using a softener. She likes that; she thinks the clothes are softer when they are done this way than with other detergents which do not contain NTA.

Another advantage that has been spoken of by others in the detergent busines is that NTA, being a more effective sequesterant or water softener per pound, can overcome the housewife's tendency in some cases to underuse the product. There are some housewives who tend to skimp, underuse, and if it were not for the NTA perhaps she would have a more disastrous result than she would with the NTA-containing product. The NTA builds in a safety factor in that respect. We have mentioned the protection of some of the ingredients, the optical brighteners, and perhaps the sanitizing agents.

Another advantage is reduced loss of tensile strength during chlorine bleaching. If NTA is in the detergent, thus completely demineralizing the water and fabric, subsequent chlorine bleaching has less detrimental effect on the fabric.

We have mentioned some of the advantages of NTA in liquid deter-

gents. I think I will let it go at that. But there are several, from minor to significant, advantages obtainable through the use of NTA, that go part way at least towards offsetting the cost disadvantage.

Mr. McCloskey. No further questions.

Mr. Reuss. Mr. Gude?

Mr. Gude. Thank you, Mr. Chairman.

Would you be ready at this time to suggest this as a total substitute for the phosphorus detergents?

Dr. Singer. No, we are not prepared to recommend that NTA be substituted totally for tripolyphosphates. Primarily because it is our basic opinion that you can make a better detergent with a combination of the two materials.

As I pointed out before you came in, for the last 10 years we have been talking NTA as a component of the best detergent that could be made, and we were talking this way long before eutrophication became a problem. We don't see any reason from a technological point of view to suddenly say that everything we have said in the past is wrong, and that now we should remove all of the phosphate in favor of NTA. From a performance standpoint, it is our opinion that NTA works best with some phosphate in the formulation.

We have documentation to say that people have successfully made detergents which contain no tripolyphosphate, but which do contain NTA. In our opinion the best formulation will contain both materials, setting aside for the moment any potential problems of phosphate eutrophication.

From a technological point of view, we would prefer a detergent to have both NTA and tripolyphosphate in it.

Mr. Gude. If you had a fair trial in the field, of comparing the kind of formulation you propose against a formulation that had only the phosphate in it, wouldn't this have to be done on a watershed basis or a lake basis?

I mean you couldn't base test results on a small portion of the detergent in an area. In other words, you would almost have to have a watershed or a lake field trial, wouldn't you, to really see what would happen?

Dr. Singer. Of course this work is being done over in Sweden at the present time. This is Dr. Bouveng's work and he reported on it yesterday. His final results will be in this spring. He has done widespread work which was very closely controlled and examined.

Our expertise, if you went to call it that, is in the manufacture of these compounds, not necessarily in their use. We are not competent in the field of eutrophication and we do not manufacture or do we sell detergents as such. It is a coincidence more than anything else that NTA is a potential compound to help solve this eutrophication problem.

Our stance from the beginning has been to use the product to make a better detergent, not to eliminate phosphates.

Mr. Gude. In the work so far in Sweden, has this been carried out in a variety of ecological setups? We had testimony yesterday that a treatment of a lake overcame eutrophication in one instance, but in another type of lake it did not overcome it.

Has there been a span of experience in the Swedish experiments that could cover the variety of conditions we would have in various streams and lakes in this country?

Dr. SINGER. We are under the impression that when the Swedish tests are concluded they will go practically all of the way in demonstrating the safety of using NTA in the United States.

I think the test that you were referring to was seeding a lake with aluminum sulfate, which was not the NTA experiment—it was a part of the Swedish program, but it was not concerned with the actual use of NTA.

Mr. GUDE. But it demonstrated that from one type of lake to another or from one stream to another, you have a variety of conditions.

Dr. SINGER. I think that is the big problem—the conditions are so varied no one has been able to pin them down.

Mr. GUDE. Thank you, Mr. Chairman.

Mr. REUSS. Dr. Singer, Mr. Pollard, thank you very much. You encourage us. We appreciate your coming.

I will now ask Dr. Eldib, Dr. Bregman, and Dr. Jones to step forward, please. Welcome, gentlemen.

Dr. Eldib, we will call on you first. Dr. Eldib, you have prepared a very comprehensive statement of 29 pages and then a briefer summary.

STATEMENT OF DR. I. A. ELDIB, PRESIDENT, ELDIB ENGINEERING & RESEARCH, INC., NEWARK, N.J.

Dr. ELDIB. Right.

Mr. REUSS. Under the rule, your comprehensive statement will be put into the record in full and you may now proceed in your own way to present your summary.

Dr. ELDIB. Yes, Mr. Chairman.

Mr. Reuss, Honorable members of the subcommittee, ladies and gentlemen: Before beginning my testimony before this committee, I wish to introduce myself. I am Dr. Ibrahim A. Eldib, president and founder of Eldib Engineering & Research, Inc., of Newark, N.J., a chemical engineering firm which specializes in the research and development of practical means for the alleviation and elimination of environmental pollution. For at least 5 years, we have concentrated our efforts on the development of economically and technologically feasible substitutes for polyphosphates in synthetic household and industrial detergents.

As a scientist, I little imagined I would ever be so honored as to be requested to appear before such as esteemed body of men as is seated before me. I wish to thank you sincerely for this opportunity to aid you in aiding our country. It would of course be quite presumptuous of me to stand before such a learned group of men and expound upon such a serious matter without first demonstrating my eligibility to do so.

I hold a bachelor's degree in chemical engineering and a master's in petroleum engineering. I earned my doctorate in the field of chemical engineering. Even before the establishment of Eldib Engineering

& Research, I was deeply involved in the problem of water pollution from detergents. I managed an important project at the Esso Research & Engineering Co., under a research grant from the advanced waste treatment section of the U.S. Public Health Service.

Incidentally, my project officer was Dr. David Stephan, who testified before you yesterday. I believe he is in the room today, also. At that time the appearance of the detergent foams in water supplies, which originated from nonbiodegradable ABS and other undegraded components of detergents, brought forth a furor of complaints in Europe and the United States.

Under this Government grant I developed an effective method for the removal of foam-causing constituents from sewage water. In 1962 I left Esso to form my own company, convinced the best solution to a problem such as this is prevention of pollution. Since that time I and the technical staff of my corporation have dedicated ourselves to remedying pollution in the United States and abroad.

One of the specific problems we worked on is the minimization of polyphosphates in detergents. We all know, of course, that I am but one of many who recognize the great threat that water pollution constitutes to our highly industrialized society. This is not the first time that our Government has, in its attempts to achieve a better America, demonstrated sincere concern over this problem.

A bill was introduced in January 1963 in the U.S. Congress by the distinguished chairman of the subcommittee, Representative Henry Reuss.

Mr. REUSS. This might be a good time for me to modestly interrupt, Doctor. I am glad you got this far, and the history of foaming detergents is instructive, and is before the subcommittee. We are, however, intensely interested in your observations about phosphates, and since your whole long statement will be printed in the record in full, we would appreciate it if you could just bear down on the phosphate question before us.

Dr. ELDIB. I will skip then and go into that. We at Eldib, the U.S. Public Health Service and many universities have determined by extensive research that polyphosphates in detergents are an undeniable major cause of water pollution. It has also been demonstrated by laboratory and field research that the percentages in which these highly detrimental components of synthetic detergents are present in our water supply far exceed any degree of insignificance.

Fully 50 to 70 percent of the phosphates present in our water supply come from these synthetic detergents. As much as one-half pound of almost every pound of laundry detergent sold in the United States is comprised of these polyphosphates which are known to stimulate algal growth. Only one pound of phosphorous is capable of supporting the growth of 82.6 pounds of algae. In 1968 alone, 2.6 billion pounds of these phosphates were included in the detergents marketed to the American consumer, and almost all of these phosphates ended in our waterways.

There is no question in my mind that the elimination of phosphates from detergents will be a giant step toward solving the problem of lake aging and loss of our natural resources.

The most obvious solution to the phosphate pollution problem is, of course, the removal of phosphates from sewage. Eldib Engineering

and Research has carefully studied the technical and economical practicability of eight such processes. Our most recent data show that the use of great amounts of chemicals is required, thus presenting economic difficulty and the possibility of additional pollutants being released into waters.

I am in complete agreement with the Department of the Interior's recognition of the need to develop technology for the removal of phosphates, for there will always be such a need.

My greatest objection to falling back on phosphate removal from sewage, as a substitute for the removal of phosphates from detergents, is basically in the interest of the taxpayer.

For purposes of discussion, I will use Lake Erie—one of our most endangered waterways—as an example. If polyphosphates continue to be used in detergents, the estimated phosphorus level in the sewage to be treated will be 10 parts per million. On the other hand, if these phosphates are removed from detergents, the phosphorus level in the sewage will be substantially reduced to three parts per million.

If polyphosphates are removed from detergents, we may therefore not be required to immediately remove phosphates from sewage. We would realize a savings of $125 million in construction costs for a treatment plant just for the removal of phosphates in the Lake Erie basin alone. If phosphates are not removed from detergents, construction of such plants is an unavoidable necessity. This would cost a minimum of $125 million just for the Lake Erie basin. This money, in my opinion, would be much better used to build treatment plants in areas where all sewage is directly discharged into the waterways.

With a new plant in the Lake Erie basin, chemical costs alone for the removal of phosphates from sewage coming from detergents, as well as from other sources, will be $17.5 million annually, above the original $125 million outlay. If these polyphosphates are removed from detergents and the construction of a treatment plant is still necessary, chemical costs will total only $5.3 million a year. The comparative cost advantage for the case with phosphates removed from detergents is, at the very minimum, $12.2 million annually just for the Lake Erie basin.

The $12.2 million realized in chemical cost savings exceeds the amount spent yearly by the 10 million people living in the Lake Erie Basin for the phosphate ingredient in the detergents they buy. There is a rather grave irony to this situation. The 10 million people living in the Lake Erie Basin must first spend $10 million for the phosphate component of their detergents. They are then required to turn around and pay out more than $24.5 million for removal of these same phosphates from sewage.

One's imagination may magnify the above in order to project this cost for the entire Nation. The expense would indeed be monumental. The total amount of phosphates sold in the United States for household detergents averages out to a cost of slightly less than $1 per capita. Yet, to eliminate these same phosphates from waste water necessitates an expense which is equivalent to $2.45 per capita ($1.20 for chemicals, plus $1.25 for amortizing the plant over 10 years). We would undoubtedly be better off substituting the phosphates with some other equally efficient cleaning substance.

This, gentlemen, is the course which we have pursued, and which I

will now present to you in the hope that it will be the course which you will adopt to preserve our country's pure water supply. One can hardly expect the phosphate industry to put forth the required effort to formulate a substitute for its own products. Because of this understandable lack of exertion, imaginative and knowledgeable people outside of the industry—and the staff of Eldib Engineering and Research, Inc., falls into this category—must seize the opportunity and go to work.

Our company has done just this, laboring day and night for at least 5 years to devise substitutes for polyphosphates in deteregents. We have, I believe, produced results of major importance. By replacing polyphosphates in detergents by other nonphosphorous and nonnitrogen based components—namely organic polyelectrolytes, we can eliminate problems before they arise. These polyelectrolytes, some of which are known as the polycarboxylates, are highly versatile and frequently humanly consumable high molecular-weight polymers, derived from both natural and manmade sources. They are composed of nothing more than carbon, hydrogen, and oxygen, and therefore pose no danger whatsoever. Substitutes for phosphates must be good water softeners, hydrolytically stable and capable of preventing soil redeposition in clothes after they are washed.

We have determined by extensive research that polyelectrolytes are equal to the presently employed polyphosphates in this water softening ability. One of the most acknowledged and serious shortcomings of the current polyphosphate detergent builders is their strong tendency to hydrolyze or break down into less condensed compounds which are relatively inferior builders. Such a recognized drawback of modern polyphosphate-based detergent builders is nonexistent with their potential substitutes, the organic polyelectrolytes.

In reference to soil suspension and/or redeposition prevention, we and others have found that here, too, organic polyelectrolytes are superior to polyphosphates. The detergent industry itself has previously recognized the detergency potential of organic polyelectrolytes, using them to inhibit soil redeposition on the washed clothes. For example, carboxymethylcellulose, CMC, a polyelectrolyte, is so efficient in this area that as little as 1 percent of this compound in a synthetic detergent formulation is sufficient to perform this function and has been used in almost every laundry detergent for years.

Economically speaking, polyelectrolytes are also an entirely feasible replacement for polyphosphates in detergents. In a laundry powder, increasing the price of the builder from 6.75 cents per pound for sodium tripolyphosphates to 15 or 20 cents per pound for an organic polyelectrolyte would increase the price of the detergent to the consumer by only 13 percent to 21 percent in nationally advertised brands. In liquid detergents, the tetrapotassium pyrophosphate builder presently used costs 14.75 cents per pound, so it is obvious that the use of a polyelectrolyte builder at 15 to 20 cents per pound would not be at all an exorbitant amount.

Polyelectrolytes, whether they are made from petrochemicals, starch, cellulose, or other natural substances, are still more expensive, pound for pound, than the polyphosphates. However, there are important economical factors which will favor the use of polyelectrolytes.

First, the anticipated high volume production of these compounds

to satisfy the 2.6 billion pounds per year demand for polyphosphates will assuredly reduce the price of these substitutes to a level suitable for their inclusion in detergents.

Second, available data obviates the polyelectrolytes' superior building power over that of the polyphosphates. The consumer will accordingly receive greater value for his increased outlay. Polyelectrolytes are expensive now because they are used only in special situations. With research, processes can be developed to manufacture these materials at much lower costs. This is exactly what happened with SNTA.

The idea of substituting nonphosphate based compounds for present polyphosphate builders is neither a new nor an untested one. The practicability of such substitutes has actually been demonstrated on the commercial market as well as in the laboratory and on paper. The Swedish detergent industry, in its cooperation with public demands to keep the water of its lakes pure and clean, concentrated on the task of developing satisfactory replacements for polyphosphates.

AB Helios, which makes detergents sold in the 3,000 supermarket outlets of the Swedish Consumer Cooperatives, reformulated their major all-purpose detergent (Tendalltvatt). Seventy percent of the phosphate builder ordinarily used in this detergent has been removed and substituted by sodium nitrilotriacetate or SNTA. The Consumer Cooperatives market their products to about 25 percent of Sweden's consumers.

Glykocid, another manufacturer of Swedish detergents, recently introduced a laundry detergent (Tvatt) which contains only 7 percent phosphates compared to the normal level of 30–50 percent. This manufacturer is now using 5 percent of a nitrogen-free and phosphorus-free builder called gluconate.

The Swedish Government has recently announced that it, too, will make a nitrogen-free and phosphorus-free "nature-friendly" detergent.

Besides the fact that polyelectrolytes have no performance weaknesses, they are, contrary to previous misinformation, biodegradable. And later on, I shall elaborate on this point. Proponents of the theory that polyelectrolytes, including those made from starch, are poorly biodegradable present no sewage treatment data to support their conclusions, for to my knowledge there are none. Concern was previously demonstrated over the biodegradability of surfactants because they caused foaming in our waterways. Polyelectrolytes do not foam.

Furthermore, one cannot discredit the starch based or any other polyelectrolytes as a group because of the inferior performance of a few. Starches for example vary in chemical structure, much as ABS varies from LAS although they both come from the same family. Therefore, there are polyelectrolytes which are biodegradable and those which are not. We have no desire, nor should we, to make a detergent builder which is as biodegradable as simple starch.

The high biochemical oxygen demand of starch has caused the textile industry great difficulty, and has caused severe water pollution problems attending the disposal of starch effluents resulting from the desizing of fabrics. The chain-like chemical structure of organic polyelectrolytes allows us to vary the length of their chains and thus control their biodegradability to suit our needs.

I am quite pleased to report to this committee that we at Eldib Engineering and Research, Inc., have quite recently completed spray drying trial runs in which we have discovered that a laundry household detergent built only with organic polyelectrolytes, completely free from polyphosphates and nitrogen, can indeed be successfully spray dried into a product suitable for the housewife. Preliminary testing, moreover, shows quite favorable cleaning effectiveness.

It may be argued, of course, that polyelectrolytes are an unknown entity, whereas polyphosphates are quite familiar to us. We understand the effects of phosphates on sewage, and we know how to remove them from wastewater. This information is not yet completely understood in regard to polyelectrolytes, and I am the first one to admit it.

If it is the case that the knowledge of effects are a necessary prerequisite to the utilization of new materials, why, then, was the substitution made in 1966 from the nonbiodegradable surfactant ABS to the more biodegradable LAS? Furthermore, it has always been the fear of change which has been the greatest deterrent to needed progress in all fields of endeavor.

We know, then, that there is a solution at hand which is readily available for implementation if the members of this distinguished committee, associated industries, and the general informed public, are prepared to take prompt and positive action toward the betterment of America and her people.

Yet, I do not have all the answers, nor does anyone else. There is a great need for additional research and funds to support these changes. There must be an organized effort to encourage the involvement of additional manufacturers of basic materials for detergents, and of additional scientists, to search for the best possible substitute for polyphosphates. The detergent industry must embark upon a decisive and clearly-defined program for the marketing of detergents based on new substitutes.

At the same time present producers of polyphosphates must cooperate with the detergent industry and the Government in this effort.

I will now present to you a definite program of legislative action for the alleviation of this pollution problem:

(1) Congress should request from the major producers of polyphosphates a public statement that they will not expand their manufacturing capacities in the United States to make polyphosphate detergent builders beyond the planned capacities available on January 1, 1969. This date marked the end of a period of expansion and modernization in the United States of the elemental phosphorus industry.

(2) The Departments of Agriculture, Interior and Commerce must encourage, through grants and contracts, the research and development of new nonphosphorus and nonnitrogen based synthetic based synthetic detergents.

(3) The Department of Agriculture should promote the production, marketing, and consumer use of agricultural products as detergent builders to replace polyphosphates.

(4) The Department of the Interior should establish definite standards of water eutrophicationability which must be met by all synthetic detergents.

To implement the above proposals:

(1) Congress should stipulate that a $5 million portion of the $46 million appropriated to the Interior Department for the prevention of pollution by industry be used for the synthesis and performance evaluation of nonphosphorus, nonnitrogen, detergent builders.

(2) Then Congress should direct the Secretary of Commerce to appoint by February 28, 1970, a committee to determine the status of immediately available technology on substitutes for polyphosphates, and to present to Congress by June 30, 1970, a report on the technical and economic feasibility of phosphate removal from detergents within 4 years from today. This committee should consist of representatives from the Department of Commerce, manufacturers of nonphosphorus and nonnitrogen based builders, manufacturers of finished synthetic detergents, manufacturers of polyphosphates and NTA products, and independent and recognized consultants in the field of detergents.

(3) Congress should direct the Secretary of the Interior to continue the functions of the present Joint Industry-Government Task Force on Eutrophication with the specific objective of devising definite eutrophication standards to be met by all detergents entering waterways. These standards should be submitted to the Secretary of the Interior by June 30, 1971.

(4) Congress should direct the Secretary of the Interior to enlarge the present Joint Industry-Government Task Force on Eutrophication to include representatives of manufacturers of nonphosphorous, NTA and polyelectrolyte builders, and independent consultants recognized in this field.

Based on the findings of these two committees, the representatives of the Secretaries of Agriculture, Interior and Commerce should recommend to Congress no later than September 30, 1971, a timetable for a 4-year conversion to phosphate free, nonpolluting detergents with a complete conversion target of September 30, 1975.

(5) The Secretaries of the Interior, Agriculture, and Commerce, beginning July 1, 1970, and for each of five subsequent fiscal years, should appropriate $10 million for the required development. Not less than $5 million of this should be available for contracting research and service work.

I hope that my presentation of the problem and my recommendations for positive action have been of assistance. The urgency of the situation makes this hope an even more earnest one.

Thank you for giving me this opportunity to aid you in your efforts toward positive action for alleviation of water pollution in the United States.

(Dr. Eldib's prepared statement follows:)

PREPARED STATEMENT OF DR. I. A. ELDIB, PRESIDENT, ELDIB ENGINEERING & RESEARCH, INC., NEWARK, N.J.—"THE POLLUTING ROLE OF PHOSPHATE DETERGENT BUILDERS AND THE PROGRESS TOWARDS SUBSTITUTION"

Representative Reuss and distinguished members of this subcommittee, prior to commencing my testimony before this committee, I wish to do several things. The first is to introduce myself. I am Dr. Ibrahim Andrew Eldib, president and founder of Eldib Engineering & Research, Inc., of Newark, N.J., a chemical engineering firm which are specialists in the research and development of

practical means for the alleviation and elimination of environmental pollution.

As a scientist, I little imagined that I would ever be so honored as to be requested to appear before such an esteemed body of men as is seated before me now. I wish to thank you sincerely for this opportunity to aid you in aiding our country.

This is truly a land of promise. There is literally no other nation in this vast world which produces so much for so little money for so many people. If you will excuse my use of a much worn but highly apropos phrase, it is our "Yankee ingenuity" which has brought us to our current position of preeminence But it is also this same "Yankee ingenuity" which has created a problem that imperils virtually all ramifications of the American dream. In our relentless and ambitious drive for progress, we have unfortunately been negligent. We have failed to keep in mind that progress always has its price. It is because of this price, gentlemen, that I am speaking to you today. As a thankful American I stand prepared to offer to you a workable and economical solution to a dilemma which faces every person in this land—namely, water pollution. I put forth my efforts in the hope that you, as the guardians of our national well-being, may utilize them for the betterment of all.

As you know, water pollution is a problem which we can ill afford to ignore. This problem will not disappear of its own accord if left alone. To the contrary, a laissez-faire policy in this area can lead only to an alarming increase in polluted water and to the eventual annihilation of one of our most vital commodities. We dare not offer excuses for ignoring this situation; it exists and it must be dealt with, both rapidly and determinately. Research, altruism, and endless discussion are not enough. Something workable must be made to come from all three. As I will demonstrate shortly, the main cause of water pollution has been quite clearly determined, and, as Eldib Engineering & Research, Inc., has discovered, can be counteracted in a both practical and economical manner.

It would, of course, be quite presumptuous of me to stand before such a learned group of men and expound upon such a serious matter without first demonstrating my eligibility to do so. I hold a bachelor's degree in chemical engineering and a master's degree in petroleum engineering. I earned my doctorate in the field of chemical engineering. Even before the establishment of Eldib Engineering & Research, Inc., I was deeply involved in the problem of water pollution. I managed an important project at the Esso Research & Engineering Co. under a substantial research grant from the advanced waste treatment section of the U.S. Public Health Service. At that time, the appearance of detergent foams in water supplies which originated from nonbiodegradable branched chain alkylbenzene sulfonate, or ABS, and other undegraded components of detergents, brought forth a furor of complaints in Europe and the United States. Under this grant, I developed an effective method for the removal of foam-causing constituents from sewage water. In 1962, I left Esso to form my own company, convinced that the best solution to a problem such as this is prevention. Since that time, I and the technical staff of my corporation have dedicated ourselves to the remediation of pollution in the United States and abroad, most specifically, to the minimization of polyphosphates in detergents.

Our success in this area has received worldwide recognition, as is evidenced by various articles which appeared in "Newsweek," "Chemical Week," "Chemical and Engineering News," technical publications and newspapers both here and abroad.

We all know, of course, that I am but one of many who recognize the great threat that water pollution constitutes to our highly industrialized society. This is not the first time that our Government has, in its attempts to achieve a better America, demonstrated sincere concern over this problem, hoping to mitigate it before it reached crisis proportions. A bill most responsible for a number of subsequent legislative actions was introduced in January 1963, in the U.S. Congress by the distinguished chairman of this subcommittee, Representative Henry S. Reuss. This bill, H.R. 2105, forbade the sale or use of any detergents after January 30, 1965, unless they conformed to specific standards of decompositability. In 1964 and 1965, numerous bills were introduced on all three levels of Government to replace the nonbiodegradable ABS by more degradable washing compounds. On June 30, 1965, all producers of washing and cleaning products manufactured for U.S. household and industrial use converted to compounds based on the more biodegradable surfactant, LAS. It is difficult to assess the precise effect of legislation on the effort and speed of industry to develop biodegradable surfactants, or wetting agents. Major companies, especially those using

ABS, were probably going to move voluntarily in a positive direction. Pending legislation, however, most likely accelerated this move and, moreover, convinced the major producers that such action was mandatory.

On March 21, 1967, as a further movement in the continuing battle against water pollution, Senator Gaylord Nelson of Wisconsin introduced in the U.S. Senate bill S. 1343, to be cited as the "Detergent Pollution Control Act of 1967." Although Mr. Nelson's bill did not directly prohibit the use of polyphosphates in detergents, it proposed regulations for the use of practically every component of almost every washing formulation, specifically stipulating that synthetic detergents must be required to conform to certain standards of water eutrophicationability. These standards were to be devised by a committee appointed for that purpose, and were to be based on algal growth studies in media containing synthetic detergents. U.S. Congressmen Eilberg of Philadelphia, Pa., and McCarthy of Buffalo, N.Y., introduced bills H.R. 8752 and H.R. 8759 respectively. These bills were analagous to the previously mentioned S. 1343. I do not know the exact fate of these three bills, but I assume that they never came to a hearing before the 90th Congress. The individual States of the Union, too, introduced bills prohibiting the sale or use of detergents containing pollutant materials. The first State bill of this kind was introduced in Pennsylvania on November 30, 1965, by Mr. Bossert. On February 14, 1966, a bill, No. 4345, was put before the New York Assembly by Assemblyman Greco. Two-thirds of the Wisconsin Senate (19 Senators) and 22 Wisconsin Assemblymen presented a bill, SB-626, to the Wisconsin Legislature on July 17, 1969, that would prohibit the sale and/or use of detergents containing phosphorus in the State of Wisconsin after December 31, 1971. Current bills on the topic, on all levels of government, directly attack phosphates as the major component of detergents causing water pollution.

In January, 1968, the soap and detergent industry issued the following statement:

"Research on possible substitutes for phosphates in detergents is being vigorously pursued by detergent manufacturers and their suppliers. Because of the possible effect of phosphates in detergents on euthrophication, the Department of the Interior has urged that this effort be intensified.

"Concurrent with its work on possible replacements for phosphates the industry is supporting, jointly with the Government, programs dealing with the removal or control of nutrients through sewage treatment and other means."

The problem, then, is far from being an unrecognized one. It is the absence of an economically practicable and efficient solution which has heretofore inhibited ameliorative action in the area of water pollution. Yet, as I will now verify, phosphates are undoubtedly a severe hindrance to our national welfare. They must no longer be permitted to devastate our country's pure water supply.

I. THE CASE AGAINST PHOSPHATES IN DETERGENTS

In a press release by the Department of the Interior on July 31, 1967, Secretary of the Interior Stewart L. Udall, in an address before representatives of the soap and detergent industry, clearly stated the case against phosphates in detergents in this manner.

"We enlist the aid of your industry in this work, asking that you intensify your program to research and develop substitutes for phosphates in detergents.

"We know that phosphate additions stimulate the growth of aquatic plants which age our lakes and pollute and clog rivers, harbors, and estuaries. It is clear * * * that our priceless and often irreplaceable resources—our lakes, rivers and estuaries—are threatened. We must promptly restore and protect the wealth that is ours from these resources * * * We feel certain that phosphates are a very real culprit in the pollution of these water resources.

"* * * Control of these phosphates today is urgent and intensifying * * * The aging of lakes, clogging of estuaries and harbors, and killing of fish is stepping up with industrial and agricultural development, polluting practices, and rising standards of living.

"Equally important, our perception of these pollution problems is sharpening. The public, the President, and the Congress expect and are demanding cleaner waters than 10 or even 5 years ago. More corrective action is expected today of each segment of American life that contributes to the degradation of our waters."

Laboratory research directly supports this statement by Stewart L. Udall. Research in our own laboratories verifies the Secretary of the Interior's statement that phosphates definitely stimulate algae growth. A published paper, "Deter-

gent Phosphorous Effect on Algae," by Thomas E. Maloney, published in the "Journal of the Water Pollution Control Federation," January 1966, summarized the problem posed by phosphate detergent builders and related the author's discoveries in this field. Mr. Maloney's detailed laboratory studies demonstrate, as do Eldib's studies, that a synthetic detergent containing phosphates stimulates the growth of unicellular green algae, *chlorella pyrenoidosa*, and that the sodium tripolyphosphate (STPP) ingredient of the detergent is responsible for this stimulation. The remaining components of the detergents have no apparent effect on algae growth. The results of this research further confirm that the algae present in lakes, rivers, and estuaries are either capable of utilizing STPP directly for growth, or, more probably, possess the extra cellular enzymes needed to accelerate the hydraulytic breakdown of this phosphate compound into less condensed and therefore more easily assimilated phosphates. These algae are, moreover, capable of sorbing phosphorus in excess of their normal metabolic requirements, and the amount of phosphorus sorbed is directly related to the phosphorus content of the medium in which it is growing. These phosphate-nourished algae multiply rapidly until they develop into large polluting masses called algae mats. Duringthe winter, these algae mats are killed off and decay, thus depleting the water of its oxygen supply, choking other forms of more desirable aquatic life and giving our water a highly unpleasant odor and taste which must be disquised by chemicals.

Research evidence against phosphates in detergents stimulating algae growth was also obtained in Sweden by Curt Forsberg, Dane Jinnerot and Lennart Davidson of the Institute of Physiological Botany at Uppsala. In their paper, "The Influence of Synthetic Detergents on the Growth of Algae," published in Vatten .1. 1967, they confirmed the findings of Maloney and Eldib.

Quite recent work by Vallentyne, completed in 1969, provides the most direct and indisputable evidence on the major role which phosphorus plays in the stimulation of algae growth. Vallentyne's culture experiments prove that phosphates are undeniably the cause of algae growth.

Following a report by Prof. C. N. Sawyer, published in 1952, on the levels of phosphorus and nitrogen and their relationship to the eutrophication, or aging, of lakes, numerous other studies, in addition to those presented above, have appeared which directly relate excessive algae growth in lakes to the rapid increase in synthetic detergent use. It is known that almost all laundry, mechanical dishwashing, household, industrial, and institutional detergents contain in comparatively large quantities the inorganic condensed phosphate salts STPP (sodium tripolyphosphate), TKPP (tetrapotassium pyrophosphate), and other polyphosphates. Detergent phosphates are not consumed by the living microorganisms used in the sewage process; they therefore pass right through sewage treatment plants and enter rivers and lakes, where they are not destroyed but rather serve to nourish algae. They therefore constitute a serious pollutant.

The very fact that the concentrations of phosphates in sewage plant effluents and in our national waterways have been rising for the past 20 years at a far greater rate than can be accounted for by human excretion or rising population, further supports the argument that the presence of phosphates and the consequent algal growth are a direct result of the increase in the use of synthetic household detergents.

Further testimony to this effect can be obtained from the "Report to the International Joint Commission on the Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River," as summarized by this commission:

"The report gives special emphasis to the implementation of a phosphorous control program to reduce the adverse effects on water quality and water use resulting from excessive growths of algae, weeds and slimes. The program would require an immediate reduction in the phosphorous content of detergents to minimum practical levels and, by 1972, complete replacement of the phosphorous compounds by substitutes less harmful to the environment. An 80-percent reduction of phosphorous complexes in municipal and industrial waste effluents discharged to Lake Erie and the Detroit River would be required by 1972, and a similar reduction in discharges to Lake Ontario by 1975."

It has been previously established that these same nutrients are comprised primarily of polyphosphates from synthetic detergents.

Channel 13 TV, part of the National Educational Television System in the United States, in a program broadcast on December 2, 1968, also recognized the

severe need to eliminate phosphates from detergents, as well as praised the contribution of Eldib Engineering & Research, Inc., to this field of endeavor.

There is, consequently, no doubt that any phosphate-bearing products, most specifically synthetic household detergents, which enter water contribute to algae blooms in lakes and streams. This excessive algal growth has two highly deleterious effects. The first is a direct effect whereby the algae mats formed are a nuisance to fishermen and swimmers as well as a severe deterrent to shippers on rivers. The second is an indirect effect whereby the algae degrades water quality, giving it an unpleasant odor and taste, and reduces the efficiency of water purification plants.

I will now more definitely present the case against phosphates by providing you with concrete data with which to evaluate the above conclusions.

II. DATA ON THE EXTENT OF PHOSPHOROUS IN DETERGENTS AND IN OUR WATERWAYS

I have been speaking about the polluting nature of the phosphates found in synthetic household and industrial detergents, but I have not as yet stated exactly to what extent these phosphates are present in our detergents, nor to what extent they are to be found in our waterways. At the present time, laundry household detergents are the largest volume users of phosphate builders and will account in 1971 for 85% of all phosphate builders in detergents, unless some definite action is undertaken to prevent such an occurrence. Furthermore, 40 percent to 50 percent of every pound of laundry detergent consumed in this country is comprised of these very polyphosphates which are known to promote algal growth. Mechanical bottle and wishwashing detergents are also very high in phosphates. More alarming is the numerical fact that almost 6 billion pounds of synthetic detergents were sold in 1968 alone, of which more than 2.6 billion pounds of phosphates, most of which ended up in our lakes, rivers, or ground water.

It is not sufficient to merely determine that polyphosphates are a more than substantial ingredient of common household detergents. One must also substantiate the fact that these polyphosphate-based detergents are directly related to the excessive algal growth and consequent pollution of our national waterways. As has been previously stated, the per capita contribution of phosphorus to domestic raw sewage and biologically treated sewage has been increasing at a rate which cannot be reasoned away on the basis of known population growth. Synthetic detergents and fertilizers are the two principal uses of phosphates. From 1946 to 1965, the consumption of fertilizers has doubled. It is possible, then, to attribute some of the additional phosphate concentration in water to this increased fertilizer use. On the other hand, the consumption of phosphorus compounds by synthetic detergents has increased sixfold in the same period. It is generally conceded that the application of chemical fertilizers to farmlands does not cause significant fertilization of streams by surface runoff because of the fact that they are applied during the growing season and are tilled into the soil. It is reasonable to assume, though, that the majority of the phosphates used in synthetic detergents are carried by sewers which eventually transport them to receiving waters.

The true significance of synthetic detergents, based on phosphorus in the increased fertilization of algae in waterways, can be more fully appreciated by the following comparison. The average person in the United States excretes approximately 1.1 grams of phosphorus per day; this corresponds to about 1 pound per year per capita. In 1946, before the rapid increase in the use of synthetic detergents, raw sewage received almost no phosphates from detergents. Consequently, the phosphorus contributed to raw sewage was only about 1.2 pounds per capita per year. In 1965, I calculated that a total of 500 million pounds of elemental phosphorus were included in synthetic detergents. This averaged out to 2.6 pounds per capita for the total U.S. population that year. Assuming uniform distribution and use, this reveals an increase of 2.6 pounds per capita per year which can only be logically attributed to the phosphorus content of synthetic detergents.

A 1967 report by the Lake Erie Conference Technical Committee showed that only 4 percent of the phosphate pollution in Lake Erie is industrial, and only 13 percent agricultural, while 70 percent comes from city sewage. Fully two-thirds of the phosphates in city sewage come from synthetic detergents.

Such evidence as has been given above clearly delineates the role which synthetic detergents play in the promotion of water pollution. What yet remains to be seen is the extent to which these phosphates are present in our waterways, and to what degree they aid in their pollution and/or eutrophication.

An estimated 26 million pounds of phosphates from detergents enter Lake Erie alone every year. It has been resolved that only 1 pound of phosphorus will support the growth of 82.6 pounds of algae. This has caused the western part of Lake Erie to be coated by algae mats during the summer months which frequently cover 800 square miles and have a thickness of 2 feet.

Lake Erie is not the only one of the Great Lakes threatened with extinction. Lake Michigan and Lake Ontario are facing similar ends due to the presence of phosphate nutrients in their waters. Dr. Alfred F. Bartsch, chief of the national eutrophication research program of the Federal Water Pollution Control Administration, at the Federal Government's presentation at a four-State conference on water pollution in Lake Michigan, held in Chicago on February 1–3, 1968, stated that over 14 million pounds of phosphates are discharged into Lake Michigan every year. Only 800,000 of these 14 million pounds of phosphates are removed, obviously indicating that they are building up in the lake.

At the present time, it is computed that 50 percent to 70 percent of the total input of phosphorus from all municipal and industrial wastes into the lower Great Lakes is ascribable to detergents. It is projected that this upper limit of 70 percent will be exceeded by 1986 if no effective controls are initiated.

A survey conducted in 1965 by the American Water Works Association indicated that 65 percent of all of our total surface water supply is used for domestic purposes. Most of this water is detrimentally affected by algal growth caused by phosphates in synthetic household and industrial detergents.

III. THE FIRST POSSIBLE SOLUTION: REMOVAL OF PHOSPHATE FROM WASTEWATER

We have now seen that polyphosphates in synthetic detergents are the undisputed malefactors in the incessantly worsening pollution of U.S. waterways. The next reasonable measure in an inquiry such as this is the investigation of the potential means for alleviating this predicament. It is manifestly clear that a solution must be found to rescue us from our plight.

The most obvious answer to this problem is, of course, the removal of phosphates from sewage and wastewater so as to prevent them from entering our waterways. Attention has previously been focused on phosphorus removal from treated sewage effluents as the only practical method of controlling the growth of algae. Eldib Engineering & Research, Inc., carefully studied the technical and economical feasibility of eight such processes. Our most recent data show that the use of great amounts of chemicals is required thus presenting economic difficulty and the possibility of additional potential pollutants being released into waters. Furthermore, by necessity the chemicals used end up in mountains of ash after incineration of the phosphate-rich sludge. This ash alone presents a formidable land pollution problem.

Without the use of chemicals various ways of modifying conventional activated sludge plants have been attempted to increase phosphorus removal efficiency. The most recent endeavor to manipulate the operating factors of this procedure was announced by the Department of the Interior in 1967. Scientists at the Federal Water Pollution Control Administration reported high phosphate removal under special operating conditions at sewage treatment plants in San Antonio, Tex. I understand that phosphate removal is also being attempted in Baltimore, Md., and Lake Tahoe, Calif.

Despite the fact that sewage treatment may indeed be to some degree successful in the removal of phosphates from wastewater, there are several major and unignorable drawbacks to such a procedure. The first potential disadvantage of the sewage treatment solution is the necessity of discharging the phosphorus removed from the sewage and concentrated in the sludge to a nearby lake which acts as a sink. When either land conditions or the inaccessibility to nearby lakes is a factor, such a process is totally impracticable.

A second and quite severe limitation is the fact that a mere 15 percent of the population of the United States is now served by activated sludge plants. Only 20 percent is served by trickling filter plants which are, anyway, incapable of removing phosphates. The remainder of the population must resort to the use of septic tanks or primary treatment plants or to having their sewage directly discharged into waterways. Hence, today 85 percent of the population of the United States cannot take advantage of any manipulation of activated sludge plants for phosphate removal.

The third objection to the removal of phosphates from wastewater embraces the two preceding criticisms, as well as explaining concrete economical barriers

to this possible solution. For purposes of discussion, I will use Lake Erie, one of our most endangered waterways, as an example. If polyphosphates continue to be used in detergents, the estimated phosphorus level in the sewage to be treated will be 10 parts per million (or, 10 milligrams per liter). On the other hand, if these phosphates are removed from detergents, the phosphorus level in the sewage will be substantially reduced to three parts per million. If polyphosphates are removed from detergents, we may not be required to immediately remove phosphates from sewage, as the level of phosphorus in waste water will have dropped from 10 parts per million to three parts per million. We would therefore realize a savings of $125 million in construction costs for a treatment plant just for the removal of phosphates in the Lake Erie basin alone. If phosphates are not removed from detergents, construction of a plant specifically for the extraction of phosphates is an unavoidable necessity, incurring a minimum expense of $125 million just for the Lake Erie basin.

With this new plant, chemical costs alone for the removal of phosphates from sewage coming from detergents as well as from other sources will be $17.5 million annually above the original $125 million outlay. If these polyphosphates are removed from detergents and the construction of a treatment plant is still deemed expedient, chemical costs will total only $5.3 million a year. The comparative cost advantage for the case with phosphates removed from detergents is, at the very minimum, $12.2 million annually just for the Lake Erie basin.

The $12.2 million realized in chemical cost savings exceeds the amount spent yearly by the 10 million people living in the Lake Erie basin for the phosphate ingredient in the detergents they buy. There is a rather grave irony to this situation. The 10 million people living in the Lake Erie basin must first spend $10 million for the phosphate component of their detergents. They are then required to turn around and pay out more than $12 million for the removal of these same phosphates from sewage.

One's imagination may magnify the above in order to project this cost for the entire Nation. The expense would indeed be monumental. The total amount of phosphates sold in the United States for household detergents averages out to a cost of slightly less than $1 per capita. Yet, to eliminate these same phosphates from waste water necessitates an expense which is equivalent to $2.25 per capita. We would undoubtedly be better off substituting the phosphates with some other equally efficient cleaning substance.

In 1967, Stewart L. Udall, then Secretary of the Interior, in a speech to representatives of the soap and detergent industry, quite clearly designated the correct path to be taken:

"As you know, the Federal Water Pollution Control Administration has an active program underway to investigate the removal of phosphates from domestic wastes. While this is important, because removal of impurities will always have to be conducted, we are stressing generally the added advantage of preventative techniques of pollution control, rather than treatment techniques. Phosphate-minimized detergents will be a significant and giant step forward to cleaner lakes, rivers, and estuaries."

This, gentlemen, is the course which I have pursued, and which I will now present to you in the hope that it will be the course which you will adopt to preserve our country's pure water supply.

IV. THE SECOND POSSIBLE SOLUTION: THE REPLACEMENT OF PHOSPHATES

As early as 1964, I predicted that there would be a major technological change in detergents, and that this change would be likely to have an important economical impact by prompting the establishment of new industries.

It is my firm belief that new technology does not arise by any law of spontaneous generation. An industry cannot anticipate technological results merely because it invests manpower and funds. Sincere and concerted human effort are the only successful harbingers of technological advance. One can hardly expect the phosphate industry to put forth this required effort to formulate a substitute for its own products. Because of this understandable lack of exertion, imaginative, and knowledgable people outside of the industry—and the staff of Eldib Engineering & Research, Inc., falls into this category—must seize the opportunity and go to work. Our company has done just this, laboring day and night for at least 5 years to devise substitutes for polyphosphates in detergents. We have, I believe, produced results of major import. We researched starches, cellulose, gums, petrochemicals, products of fermentation, and virtually all other phosphate-

competitive compounds. By investigating those compounds used in lieu of phosphates in various areas, we acquired our potential phosphate replacements.

We, therefore, wasted no time in searching for phosphate substitutes as the logical solution to the detergency problem. Concentrating all of our efforts in this one direction, we developed the needed technology with comparatively little funds and much effort. I am now prepared to present to you the results of our labors.

You have already seen that polyphosphates in detergents are an undeniable major cause of water pollution. It has also been demonstrated that the percentages in which these highly detrimental components of common household and industrial detergents are present in our water supply far exceed any degree of insignificance. Furthermore, I have presented quite valid reasons for declaring the most obvious remedy to such a crisis—namely, phosphate removal from waste water—economically and technologically inferior. Removal of phosphates from sewage is important to develop, for as Mr. Udall said, "Removal of impurities will always have to be conducted." But, removal of phosphates entering sewage as a result of detergent usage is illogical and unscientific, and places an undue burden on the taxpayer.

I now propose what I and many others believe to be the most satisfactory answer to this problem. By replacing polyphosphates in detergents by other nonphosphorus and non-nitrogen based components—namely organic polyelectrolytes, which are highly versatile and frequently humanly consumable high molecular weight polymers derived from natural and manmade substances—we can eliminate this difficulty a posteriori, or "before the fact." These molecules are composed of nothing more than carbon, hydrogen, and oxygen, and, therefore, pose no great problems.

Such a substitue must of necessity possess qualities equal to those of phosphates as a detergent builder. The three most essential functions of a detergent builder are as follows: A chelatin sequestration, or water-softening ability; hydraulytic stability, and a soil suspension or redeposition prevention ability.

A chelatin-sequestration ability to remove hard water ions from solution and prevent the destruction of the surface active properties of the surfactant, or wetting agent, which would cause the minerals in solution to be deposited on the surface being cleaned, is an essential criterion for a good detergent builder. It has been determined by extensive research that polyelectrolytes are equal to the presently employed polyphosphates in this water-softening ability.

Hydraulytic stability, which prevents the decomposition or breakdown of the detergent builder in water solution, which would decrease its cleaning effectiveness, is the second vital requirements of a good detergent builder. One of the most acknowledged and serious shortcomings of the current polyphosphate detergent builders is their strong tendency to hydrolyze into less condensed compounds which are relatively inferior builders. Such a recognized drawback of modern polyphosphate-based detergent builders is nonexistent with their potential substitutes, the organic polyelectrolytes.

In reference to soil suspension and/or redeposition prevention, it has been found that here, too, organic polyelectrolytes are superior to polyphosphates. The detergent industry itself has previously recognized the detergency potential of organic polyelectrolytes, utilizing them to inhibit soil redeposition by forming a protective coating on the fabric being washed and by keeping the removed soil in suspension so as to prohibit it from reentering the cloth. For example, carboxymethylcellulose (CMC), a polyelectrolyte, is so efficient in this area that as little as 1 percent of this compound in a synthetic detergent formulation is sufficient to perform this function. I am not advocating the utilization of CMC as a detergent builder in its presently known chemical state, but am merely using it to point out the potential of polyelectrolytes.

Economically speaking, polyelectrolytes are also an entirely feasible replacement for polyphosphates in detergents. In a laundry powder, increasing the price of the builder from 6.75 cents per pound for sodium tripolyphosphates to 15 cents or 20 cents per pound for an organic polyelectrolyte would increase the price of the detergent to the consumer by only 13 percent to 21 percent in nationally advertised brands. In liquid detergents, the tetrapotassium pyrophosphate builder costs 14.75 cents per pound, so it is obvious that the use of a polyelectrolyte builder at 15 cents to 20 cents per pound would not be at all an exorbitant amount. Polyelectrolytes, whether they are made from petrochemicals, starch, cellulose or other natural substances, are still more expensive, pound for pound, than the polyphosphates. However, there are two important economical factors which

will favor the use of polyelectrolytes. First, the anticipated high volume production of these compounds to satisfy the 2.6-billion-pound-per-year demand for polyphosphates will assuredly reduce the price of these substitutes to a level suitable for their inclusion in detergents. Second, available data obviates the polyelectrolytes' superior building power over that of the polyphosphates. The consumer will accordingly receive greater value for his increased outlay.

The idea of substituting nonphosphate based compounds for present polyphosphate builders is neither a new nor an untested one. The practicability of such substitutes has actually been demonstrated on the commercial market as well as in the laboratory and on paper. The Swedish detergent industry, in its cooperation with public demands to keep the water of its lakes pure and clean, concentrated on the task of developing satisfactory replacements for polyphosphates.

AB Helios, which makes detergents sold in the 3,000 supermarket outlets of the Swedish Consumer Cooperatives reformulated their major all-purpose detergent (Tend-alltvätt). Seventy percent of the phosphate builder ordinarily used in this detergent has been removed and substituted by an organic nitrogen compound. The Consumer Cooperatives markets its products to about 25 percent of Sweden's consumers.

Glykocid, another manufacturer of Swedish detergents recently introduced a laundry detergent (Tvätt) which contains only 7 percent phosphates compared to the normal level of 30–50 percent. This manufacturer is now using 5 percent of a nitrogen-free and phosphorus-free builder called gluconate.

The Swedish Government has recently announced that it, too, will make a nitrogen-free and phosphorus-free "nature friendly" detergent.

It may be argued, of course, that polyelectrolytes are an unkonwn quantity, whereas polyphosphates are quite familiar to us. We understand the effects of phosphates on sewage, and we know how to remove them from waste water. This information is not yet completely understood in regard to polyelectrolytes. If it is the case that the knowledge of effects are a necessary prerequisite to the utilization of new materials, why, then, was the substitution made from the nonbiodegradable surfactant ABS to the more biodegradable LAS? Furthermore, it has always been the fear of change which has been the greatest deterrent to needed progress in all fields of endeavor.

Stewart L. Udall stated in his address before representatives of the soap and detergent industry:

"The Department of the Interior wants to aid in finding substitutes for phosphates, wherever they are harmful. I hope that representatives of your industry and this Department will conduct an active and continuing dialogue, so that our efforts will compliment yours and accelerate the development of a phosphate-free detergent."

We know, then, that there is an economically and technologically practicable solution to water pollution. We need not resign ourselves to a situation which is, at best, highly inconvenient and unpleasant, and which threatens to become an extremely destructive and incontrovertible reality as early as the year 1986. There is a solution at hand which is readily available for implementation if the members of this committee, associated industries, and the general informed public are prepared to take prompt and positive action toward the betterment of America and her people. I sincerely hope, gentlemen, that the solution I offer is seen to be as potentially beneficial as it actually is. It is the best available remedy. Polyphosphates in detergents must be replaced by nitrogen-free and phosphorus-free polyelectrolytes.

One might easily assume that the question is now closed, that I have said the final word. This is not the case. I do not have all the answers, nor does anyone else. There is a great need for additional research and funds to support this project. There must be an organized effort to encourage the involvement of additional manufactures of basic materials for detergents and of additional scientists to search for the best possible substitute for polyphosphates. The detergent industry must embark upon a decisive and clearly-defined program for the marketing of detergents based on new substitutes.

The Departments of Agriculture, Interior, and Commerce must encourage, through grants and contracts, the research and development of new nonnitrogen and nonphosphorus based synthetic detergents. The Department of Agriculture should promote the production, utilization, marketing and consumer use of agricultural products as detergent builders to replace polyphosphates. The Department of the Interior should establish definite standards of water eutrophicationability which must be met by all synthetic detergents. To implement these pro-

posals Congress should form a committee which should consist of an equal number of representatives of the Departments of Agriculture, Interior, and Commerce, manufacturers of nonphosphorus and nonnitrogen based builders, manufacturers of finished synthetic detergents, manufacturers of polyphosphate-based products, and independent and recognized consultants in the field of detergent evaluation, testing and development. The primary functions of this committee should be three in number. *First*, the technical feasibility of substituting phosphates with new builders which are known to not stimulate algae growth should be undertaken. *Second*, the committee should determine the costs of these new builders when they are mass produced in the same volume as the present phosphate builders. *Third*, the committee should recommend to the Secretary of the Interior before January 1, 1971, specific norms of water eutrophicationability which must be met by all synthetic detergents. The Bureau of International Commerce shall advise this committee of substitutes for polyphosphates which have been introduced in detergents in countries outside the United States. A timetable must then be set up for the conversion to new, nonpolluting detergent builders.

The appropriation of governmental funds for the execution of such a program of research and development is an absolute necessity. The Secretary of Agriculture, the Secretary of the Interior, and the Secretary of Commerce, beginning July 1, 1970, and for each of 5 subsequent fiscal years, should appropriate $10 million for the required research, of which not less than $5 million shall be available for contracting research and service work.

I hope, gentlemen, that my presentation of the problem, my preferred solution, and my recommendations for positive governmental and industrial action toward the elimination of phosphate-caused water pollution have been of assistance. The urgency of the situation makes this hope an even more earnest one.

Thank you again for giving me this opportunity to aid you in your efforts towards positive action for the alleviation of water pollution in the United States.

Mr. REUSS. Thank you, Dr. Eldib. Dr. Bregman?

STATEMENT OF DR. JACOB I. BREGMAN, PRESIDENT, WATER POLLUTION RESEARCH AND APPLICATIONS, INC., WASHINGTON, D.C.

Dr. BREGMAN. My name is Jacob I. Bregman. I am president of Water Pollution Research and Applications Inc., which is a Washington-based consulting and research firm. Prior to joining that firm in June 1969, I had served as Deputy Assistant Secretary of the Interior Department, where as staff man I was actively involved in the creation of the Joint Task Force, and in setting up the dialog that Secretary Udall instituted with the detergent manufacturers. I would be happy to answer questions about that.

I came to Washington from Illinois, where I was manager of the water research center at IIT Research Institute and where I also served as chairman of the Illinois Air Pollution Control Board. It seems to me that some of the arguments I heard yesterday are very reminiscent of those I used to hear when I was chairman of that board. The polluters would appear before us, and the arguments would be as follows: First of all, why should we cut down on our pollution until everybody does? It should be a hundred percent or zero percent.

Secondly, it costs too much. And third, we have to do more research anyhow.

I believe, gentlemen, those arguments are not enough any more. I believe that things have to happen today and cannot be put off. I have heard a lot in the last day or so about cleanliness. I have heard discussion of movies being made to promote cleanliness. I have heard discussion of advertising to promote cleanliness. I think that is fine. I believe cleanliness is truly next to godliness. But I think there is more to clean-

liness than clean shirts or pillow cases or clean handkerchiefs. I am concerned with clean lakes, I am concerned with a clean environment, I am concerned with a clean America.

Clean lakes are as important as clean shirts, but I do not think we are faced with a choice between clean shirts and clean lakes. I believe we can have both. I do not think you have to clean your shirts and then take the material with which you clean it and dump it into the lake, so you pollute the lake. You do not clean your house by taking out the garbage and dumping it into the street. You pay to have it taken away.

And you also are going to have to pay to have something done about the phosphates in the detergents. You know, the detergent industry, or one company in the detergent industry, used to promote the concept of Mr. Clean. Mr. Clean was a magic little man that cleaned everything. But I do not think the detergent industry is Mr. Clean any more. I think Mr. Clean is Assistant Secretary Carl Klein of Interior. I think Mr. Clean is Commissioner David Dominick. I think he is Assistant Commissioner David Stephan. I think Mr. Clean is you gentlemen, the Congress of the United States, which has said "let us clean up our waters; let us do something about it." In fact, if I had to characterize my friends who spoke yesterday, I would say definitely that the detergent industry is *not* Mr. Clean any more.

I look around and I see our lakes dying, I see blue green algae, and I would have to call the detergent industry Mr. Dirty Blue-Green. Gentlemen, the time has come for us to help the detergent industry to clean up. Let us clean them up; let us wash their faces; let us help them to clean our shirts and our lakes both—it need not be one or the other.

There has been a lot of conversation about how you do not have to remove phosphates from detergents, since you can remove them at the advanced waste treatment plants. I say nonsense. I say, of course you have to remove them at the advanced waste treatment plants, because there are other sources of phosphates other than detergents. But, first of all, not all municipal wastes go to waste treatment plants and not all municipal wastes will be subjected to advanced waste treatment for years and years and years.

Secondly, in those cases where the wastes don't go to waste treatment plants, many of them go to septic systems. Yesterday we heard a statement that this is fine, because what goes to the septic systems is absorbed by the ground and does not get into the rivers and that is all there is to it. I say nonsense to that also.

Congressman Cleveland appeared before you a little while ago. I had the pleasure of talking with Congressman Cleveland about eutrophication in his district about a year ago. He represents a district in New Hampshire which has very little in the way of urban areas. It is mostly rural. Yet many or most of the lakes in his district are eutrophying. One reason is because phosphates from septic systems are getting into them.

Septic systems are not perfect. First of all, they leak; secondly, the ground is not always completely permeable. I believe that most septic systems today are so poorly designed that much of the phosphates that get into septic systems eventually find their way into our streams and lakes, and into our drinking water supplies. Therefore, I believe

that you must remove phosphates from their sources of origin—the detergents. They are doing it in Sweden. They are actually reformulating detergents to make them lower in phosphate content. One of the companies doing this is a subsidiary of an American firm. According to "Chemical Week," October 29 of this year, when that firm was asked why they are doing this, the reply was "to meet demands by the National Conservancy Board and the Swedish Consumers Institute for lower phosphate content detergents."

Gentlemen, I think it is time that the people of this country demanded lower phosphate detergents. I think if we demand them, we are going to get them. If we can have lower phosphate detergents in Sweden, why can we not have them in this country?

"Chemical Week" of September 20, 1969, published a table showing typical synthetic detergent formulations throughout the world. Sodium tripolyphosphate in heavy duty products in the United States and Canada ranged from 40 to 60 percent, but in Latin America and the Middle East and Africa, 20 to 40 percent, and in Europe and Australia, 30 to 35 percent. I say let us start cutting down on the amount of polyphosphates we have in detergents right now. I believe we are ready to do it. There are many, many different detergent formulations. We do not need to develop a new formula. We can switch from 40- or 45-percent to 20- or 25-percent-phosphate formulations. Of course we may not get the complete cleaning we would like, but perhaps we will help to save our lakes.

I believe most people do not realize that we have a new economics today. I like to call it environmental economics. The Congress and the people of this country have decided we must spend money to clean our waters.

Congressman Cleveland today said to you that those who pollute the water must pay to clean it. And this is now happening all over the country. The steel industry, the oil industry, and the chemical industry, and almost all of the other industries are spending money to clean up their wastes. I think the detergent industry is going to have to do the same, whether it means it is going to cost them more to make a better product, or wheher it even means that they may have to pay a little bit of the cost of building the advanced waste treatment plants that take out the phosphates that the detergent industry puts in. The fact is that they are going to have to spend money for pollution control, along with the rest of American industry, because these are the new economics. These are the environmental economics that the Congress has insisted on and that we are going to have to have.

I would like to suggest a legislative program, if I may. First of all, I would suggest a legislative proposal that the detergent suppliers must make public a list of the phosphate contents of their respective detergents.

Secondly, I would suggest that the phosphate content of every box of detergent be labeled—that the box say, this detergent has 30-percent or 40-percent phosphate content, or whatever it is. We have heard a lot of talk about the American housewife and that she is going to insist on high-phosphate detergents. I do not think she will. I say, let us give the American housewife the choice; let us let her decide whether she wants to buy a high-phosphate detergent or a somewhat lower-phosphate detergent. I have a lot of confidence in the American house-

wife. I have a lot of confidence in the League of Women Voters. I think you will see that the American housewife will tend toward the product which causes less eutrophication and which saves her lakes.

Third, I would recommend legislation to require that phosphates in detergents be reduced in a series of steps over a fixed period of time down to a predetermined minimum level. I think there should be created a committee of scientists and economists, who would consider the factors of eutrophication, detergent washing power, economics, and so forth, and establish this sequential drop. I do not think we have to worry about new formulas. As I said earlier, I think there are plenty of low phosphate formulas that could be substituted for high phosphate formulas today.

I think we should give the industry time to adjust, which is why I recommend the time phase drop. But I do not see why we need ever to have phosphate contents of more than 25 or 30 percent in this country.

I would like to thank the subcommittee for the opportunity of appearing here. Perhaps the actions I have suggested are radical, but I think the time for radical action is here. If we had taken radical action 5 or 10 years ago, our lakes would not be in the condition they are now, and if we wait another 5 or 10 years, even radical action will not help.

(Dr. Bregman's prepared statement follows:)

PREPARED STATEMENT OF DR. J. I. BREGMAN, PRESIDENT, WATER POLLUTION RESEARCH AND APPLICATIONS, INC., WASHINGTON, D.C.

Mr. Chairman, honorable members of the subcommittee, ladies and gentlemen, my name is Dr. Jacob I. Bregman and I am the president of Water Pollution Research and Applications, Inc., a Washington-based consulting and research organization. Prior to joining the firm in June 1969, I served as Deputy Assistant Secretary of the Interior for Water Quality and Research. I helped organize the Joint Government-Industry Task Force on Eutrophication and served as its first vice chairman. My training is in chemistry, and the problem of eutrophication is one with which I have been concerned for some time.

I think that the issue confronting us these days is no longer whether or not phosphate is a major contributor to the degradation of our Nation's streams and lakes. That question has been answered positively. Substantial evidence has been presented to prove it and will, I am sure, be further outlined by other witnesses at this hearing. The finality of the evidence is shown by the fact that the State and Federal representatives involved in the Lake Erie and Lake Michigan Enforcement Conferences have set schedules for the removal of 80 percent of the phosphates from municipal wastes entering those lakes, and the International Joint Commission has recently taken a stand on the need for phosphate reduction in Lakes Ontario and Erie.

The question before you now is whether 80 percent removal of phosphates from municipal sewage is sufficient. Should phosphates also be reduced in the sources from which they originate? I believe that the answer to this question must be a positive one. The removal of most of the phosphates at some municipal waste treatment plants alone simply is not sufficient because (*a*) all municipal waste treatment plants are not covered by phosphate removal requirements, (*b*) there are many locations where household wastes do not find their way into municipal sewage treatment plants, but instead go to septic tanks or directly to receiving waters, and (*c*) 80 percent of a small amount is much less than 80 percent of a large amount.

Let me reemphasize that fact that phosphates come from many sources other than detergents and that those sources must also be controlled. An intense effort must be made to reduce the use of phosphates that may find their way to receiving waters, whatever their origin. I believe that this subcommittee would be well advised to hold hearings in connection with phosphates in fertilizers. The out-

look there is very bleak indeed. Vast quantities of phosphates enter our water bodies by runoff from agricultural lands, and little or nothing is being done about it. What is worse is that little or nothing is being planned to be done about it. I can sympathize quite strongly with the detergent suppliers when they demand equal treatment—at least they admit that they contribute to the problem and they are looking for ways of solving it.

But, let us return to the subject of the reduction of phosphates in detergents since that is the subject of today's hearing. The October 29 issue of "Chemical Week" magazine, page 106, made the following statement:

"Phosphate-containing heavy-duty detergents are on their way out in Sweden. Lever's Swedish subsidiary, AB Sunlight, has introduced a new, low-phosphate-content detergent dubbed New Radion. It contains 10 percent phosphate, compared with the 30 percent phosphate content in the Radion brand previously marketed. New Radion was launched, says Sunlight, 'to meet demands by the National Conservancy Board and the Swedish Consumers Institute for lower-phosphate-content detergents.' Sunlight is promoting the product heavily and is offering 3-million rebate coupons (Swedish population: 8 million).

"The leading heavy-duty detergent on the Swedish market was similarly reformulated earlier this year by Kooperativa Forbundet, a supplier to Sweden's large cooperative retailing business. The co-op product, labeled simply 'low-sudsing laundry detergent,' contains 28 percent chelating agents (a mixture of about 40 percent sodium nitrilotriacetate and 60 percent sodium tripolyphosphate). It also contains 13 percent surfactant, 20 percent sodium perborate, 9 percent silicates, 21 percent soda ash, 1.8 percent sodium sulfate, 1.5 percent carboxymethyl-cellulose, 0.45 percent optical brighteners, 0.06 percent perfume and moisture. The Swedish product was sold on the west coast by Associated Cooperatives (Richmond, Calif.) through its 12 affiliated retail co-ops as part of a one-shot, 'products from Sweden' promotion. Associated moved 125 cases, says consumer acceptance was good, but has no plans to stock the product as a regular shelf item."

If this report is accurate, it would indicate that major detergent suppliers in Sweden, one of which is a subsidiary of one of the largest American firms in this business, feel that it is practical to reduce the amount of phosphates in heavy-duty detergents. If this is the case in Sweden, then why is it not being done in the United States? I think that the obvious answer is legislative pressure to make it happen.

I would respectfully suggest to the subcommittee that it concentrate its efforts on achieving a reduction in the amount of phosphates that go into detergent formulations—a reduction, not an elimination. The FWPCA testimony before this subcommittee shows that there are still unanswered questions about the effect of substitutes for phosphates on eutrophication, and the detergent manufacturers make a strong case for a substantial decline in the quality of their products if all of the phosphates are removed. It may never be possible, or even desirable, to remove all of the phosphates from detergents, but I believe that we are ready now to start a program of planned reduction of substantial quantities.

Not all detergents contain phosphates, and, indeed, there is a wide spectrum of phosphate contents in detergents, depending upon the supplier and upon the use of the detergents. I would therefore respectfully suggest that the subcommittee's first legislative proposal should be a requirement that detergent suppliers make public the phosphate content of their various detergents in a report to Congress, and, further, that the phosphate content of every box of detergent be required by law to be stated on the box itself. This then would give the consumer, the American housewife, the choice of whether or not she wanted to use a detergent mixture that had a high-phosphate content. I think that the answer from the American housewife will be a resounding "No," even if she has to pay more for a lower phosphate type, and that the usage of the high-phosphate detergent will drop off sharply. The beauty of this approach is that the American public itself will make the decision.

As the second part of a legislative package on phosphate minimization, I would recommend to you that a schedule be established for the reduction of phosphates in detergents in a series of steps over fixed periods of time down to a predetermined minimum level. An impartial committee of scientists and economists could be set up which would consider the factors of eutrophication, detergent washing power, and economics, and recommend what this minimum phosphate value should be, as well as fix the sequence of step reductions to achieve it.

Since I am not an attorney, I cannot be certain of the legal ramifications of the two actions that I have proposed. I do know, however, that the leaders of the detergent industry, and particularly the heads of their trade association, have been unusually responsive to the public needs, and it may well be that they might choose to voluntarily adopt my recommendations as a matter of public service. If not, then certainly appropriate legislation to require these procedures should be enacted.

I thank the subcommittee for this opportunity to appear before it to state my views on this subject which is of such great concern to us today. I will be happy to answer any questions you may have.

Mr. Moss (presiding). Thank you.

At this time we would like to hear from Dr. Jones.

STATEMENT OF DR. P. H. JONES, ASSOCIATE PROFESSOR OF CIVIL ENGINEERING AND ASSOCIATE DIRECTOR OF THE GREAT LAKES INSTITUTE, UNIVERSITY OF TORONTO, TORONTO, CANADA

Dr. JONES. I have presented a formal document, too, and I think certain aspects of it have been touched on already—that alga blooms are a problem and phosphorus is somehow related to this.

Mr. MOSS. I think it might be well to read the statement, because all of the members do not have copies.

Dr. JONES. The problem of eutrophication of the fresh water bodies of the world, as well as some salt water bodies, has emerged slowly. Man's acceleration of this phenomenon has occurred far more rapidly but his recognition of the problem is of quite recent origin. The result of over fertilization of the aquatic environment is the production of algae in excessive quantities. The problems resulting from this overproductivity are legion, well documented and known to almost all the people in North America. It might even be said that all segments of society agree that excessive algal blooms destroy a water body for all practical purposes other than the production of algal protein.

How do we associate algae with phosphorus? If we examine the nutrients required in significant proportions to promote the growth of algae we find that carbon, hydrogen, oxygen, nitrogen, and phosphorus are required in biologically available forms. Photosynthetic organisms have the greatest synthetic ability of all organisms and thus the biologically available form of nutrient is the simplest inorganic form and they only require radiant energy to perform the photochemical reaction.

Carbon dioxide and water are, of course, universally available and cannot be controlled; sunlight energy is similarly not controllable. Thus we are left with two further nutrients which must prove limiting; otherwise all fresh water bodies would be overgrown with weeds and algae. A certain biological principle provides that only one nutrient at a time can be limiting so we must now make a judgment as to which one is easiest to control. I would add that only one nutrient at a time can be limited.

A further complication is that some forms of algae (blue green—Cyanophyta) are capable of "fixing" (making use of as a biological nutrient) atmospheric nitrogen. Eighty percent of the atmosphere is nitrogen, so under these circumstances we are unlikely to show that nitrogen would be limiting for those species.

We are thus left with phosphorus, which is a material which is not widespread and generally available in nature.

The vast majority of phosphorus reaching the lakes does so through a number of manmade and mancontrollable routes.

Some people would claim that there is already so much phosphorus in the lake systems that reduction of the sources would have little effect. We heard this testimony yesterday. In fact it was quite belabored, I thought. This, of course, is a point of view wich deserves consideration before dismissing in the case of large lakes like the Great Lakes; but in the case of smaller lakes which enjoy frequent washout (displacement by inflow) the claim is meaningless. In the case of the larger lakes, there is evidence that further addition of phosphorus is annually aggravating the situation. This is borne out by analyzing the waters of the Great Lakes during the algae growing season.

As an aside, I would mention I am associate director of the Great Lakes Institute of the University of Toronto, and we have been conducting not only monitoring, but research programs into the phosphorus levels of the Great Lakes for many years. We are probably one of the few agencies which have the temerity to go out into the Great Lakes when they are largely covered with ice and it is cold as blazes.

Most biological studies are done in the summer when it is warm and pleasant. But if you go out on the Great Lakes in the middle of the wintertime, you will find there is a lot of phosphorus present.

Analyses in summertime will yield almost no soluble orthophosphate. This indicates that it has all been used by the photosynthetic organisms present. If there were any significant concentration of the phosphates left it would be reasonable to suppose that some other nutrient had become limiting and thus phosphorus were not the controlling influence.

I think it was mentioned yesterday that demonstration had been observed that other nutrients had become limiting in certain cases. I wouldn't deny this. However, it is well known that even if trace concentrations of Strontium 90 were the limiting nutrient, in the absence of phosphorus all life will cease and in a limited phosphorus situation the degree of productivity can be controlled.

So I would make an aside here, too. That magic number of 10 micrograms per liter which was referred to from the IJC report yesterday is simply a number. It really has no true basis as being something magic. Where on one side of it you get one effect, on the other side of it you get another effect. It is really a white-to-black situation, or white-to-green in this case—and we get all shades therein.

We will find that we have large areas of Lake Erie, the western basin in particular, which are covered with algae during the summertime. And if we were to go out and measure this—and many people have done this, particularly in terms of zero dissolved oxygen (which is the net effect of this)—we would find that this area is increasing year by year.

So I don't really believe this business that if we stay below 10 we have no nuisance condition; and if we reach 11 micrograms per liter, suddenly the lakes are too thick to swim in and too thin to walk on.

So if it is agreed that a case exists for controlling phosphorus dis-

charge to the lakes, rivers, and streams we should now reason out how this is best accomplished. In order to do this we must examine the various sources which exist and which are under man's control.

In ascending order of magnitude the following sources are listed:

1. Agricultural runoff.
2. Human waste.
3. Synthetic heavy duty detergents.

If we discuss these sources in the order stated, we will find that the relative contribution of these sources will vary considerably depending upon the particular part of the country. It is this fact which permits the confusion or controversy surrounding this argument of whose source is most significant. If you wish to prove that agriculture is the most serious offender you simply select a watershed primarily agricultural and determine the sources, and you will have evidence to indicate agriculture is the biggest contributor.

Alternatively, if you wish to show the reverse is true you study a "typical" watershed, which is primarily urban and industrial, and you will find the opposite is true. So it is due to this type of distortion, and really who is ahead in the publishing game, that caused me particularly to sit down and try to reason this thing out—rather than to refer extensively to all of the publications on the most significant contributions in different watersheds.

Certainly we will have to use experimental evidence, and a good deal of judgment and logic in reasoning it out.

AGRICULTURE SOURCES

The public generally think of chemical fertilizers as being the primary cause of the agricultural contribution to eutrophication. And I would detect that from the discussions here yesterday that the subcommittee may even be feeling the same way.

This, in my opinion, gentlemen, is in all probability quite erroneous. It has been shown that phosphate ions are rapidly and tenaciously removed by adsorption to the soil.

The phosphates so adsorbed are taken up by the crops and removed at harvest time. Thus the reason to add more phosphates in the spring. It is quite unlikely that farmers are so unconscious of economics as to apply chemical fertilizers at a time of heavy rains and so it is therefore unlikely that runoff will carry away significant quantities into adjacent streams and rivers.

However, the farmers do not come out of this debate completely blameless. There is a tendency to apply liquid animal wastes to the land whenever the holding facilities require emptying.

This has nothing to do with the crop growing, it is a convenience; the farmer has a full tank and he wants to get it out of there.

These animal wastes contain high concentrations of biologically available nitrogen and phosphorus. Application of such wastes during cold frozen conditions or during torrential rains will have equally disastrous effects upon the nearby streams. The controls which could be applied here are simply that the application of fertilizers to the land be restricted to certain times of the year.

The question only arises where confinement of livestock is practiced.

2. HUMAN WASTE

Man is himself a great concentrator of phosphorus and nitrogen. Like animals, approximately 75 percent of the phosphorus ingested food is excreted, whereas a great deal of the carbon intake is dissipated as carbon dioxide. This, of course, results in a lower C/P ratio in human excrement than in the food, and the phosphorus is thus in a more concentrated form. This necessarily means that steps must be undertaken to remove phosphorus in particular from the effluent of municipal sewage treatment plants.

This in itself would provide a splendid solution except for the fact that today a very large percentage of the population have no sewage treatment facilities at all; and to wait until even all municipalities have adequate primary, secondary, and tertiary treatment facilities is a considerably longer time than we have at our disposal in many instances. Thus, we must consider this as a step which must be immediately taken; but we must also realize that the benefit of this step may not be fully realized for 40 years or more, in fact, if it ever is.

3. THE SYNTHETIC HEAVY DUTY DETERGENTS

By far the most significant source of phosphorus is the commercially available heavy duty laundry detergents. A large volume of evidence has been produced through research to suggest that this source is twice as significant as human wastes. In the most recent report to the International Joint Commission on Boundary Waters, IJC (published in September 1969), it was shown that of the 10 mg./l P in wastes entering Lakes Erie and Ontario, 7 mg./l. is contributed by detergents in the U.S. wastes. I differentiate here between U.S. and Canada wastes, because they come out with slightly different figures.

Since I am speaking to you gentleman, I will speak of U.S. wastes. Apparently there is some difference, either in their cleanliness or their habits.

This leaves 3 mg./l. as coming from other municipal waste sources. While the residual 3 mg./l. is still too high and demands treatment, the detergent contribution is so great as to also demand attention. To remove phosphorus from the heavy duty detergents would be an act that is under the control of a small number of agencies and therefore more rapidly accomplished than the construction of a vast number of waste treatment units under the direction of an equally vast number of agencies.

It should also be pointed out that substantially no change of capital investment would be required by the soap and detergent industry to blend alternative materials into their mix and eliminate phosphorus. This is of course an area which might be open to discussion. But in a moment I will add something to substantiate it.

Any industry, however, to be successful, must consider the profitability and acceptability of their product. In the highly competitive field of the soap and detergent industry, where they won't even divulge in public their research effort, it is clear that research personnel are conditioned, and quite properly so, to seeking a product that is either cheaper or performs its task in a superior manner.

Perhaps the people who should be blamed for there being no ap-

parent substitute to phosphorus for heavy detergents are the nondetergent researchers. Those people whose aim it is to develop solutions to ecological and pollution problems should have examined this matter instead of crying, "something should be done about it," or "there ought to be a law." Perhaps this is the area where this philosophical difference in approach would have borne some fruit.

We at the University of Toronto have an environmental and engineering program where we have a consortium of all of the various aspects of the biosphere in terms of the disciplines which are related to pollution. By assembling this group and generating this interest, we are now able to look at the broad aspects of the problem from human points of view—zoological, fisheries, engineering, economics, legal. This is quite an active group at our university now.

One part of this group has been working on the development of alternatives to phosphorus in detergent formulations. Our approach has followed another philosophy. We are quite prepared to accept a material which is both marginally not as good—it is only white, not whiter than white—and even marginally more expensive. This philosophy would, I am sure, not be acceptable to the major industries. However, the Wright brothers' airplane was not as safe as the balloon and dirigible and therefore represented a step backward in aviation. This minor step backward permitted the development of the jumbo jets in a relatively brief period of time. So it will be with detergents. The first step which we are currently studying, while not measurably backward, will lead, I am sure, along a more satisfactory path than our current one.

SOLUTIONS TO THE PROBLEM OF EUTROPHICATION

1. Pass Federal legislation to cause the sale of phosphate built detergents illegal by some target date.

2. Undertake to control, by legislation at the State level, the spreading of fertilizers (natural or artificial chemical) at certain times of the year. These times will vary according to the climate and location.

3. Launch a Federal and State aid program to assist municipalities to install nutrient removal facilities at their sewage treatment plants. Also have plants built with such facilities at locations where no plants exist.

4. Engage United States-Canadian cooperation to harvest and remove algae at times and in places where blooms occur. This step is complicated and expensive but so is dredging. It is furthermore the only way in which large lakes can accelerate a reverse trend away from eutrophication.

It can be readily seen that items 1 and 2 could be effected immediately. This step would reduce by more than 50 percent the current rate of eutrophication. Item No. 3 is a long-term venture which must be started at once and programed at such a rate as to catch up on the backlog and prevent reoccurrence in the future. Item No. 4 will require development and perfection of the necessary equipment and vigilance network. Also the disposal of the algae when harvested must be planned and perhaps a profit could be realized or at least some recovery to offset the cost.

I would like to add a little bit concerning the developmental work we are doing. I believe there are certain philosophical differences in

approach here. They as researchers must, I am sure, be charged with finding something which is cheaper or better. I, as an engineer, and a microbiologist—incidentally, I am also a professor of microbiology—am more interested in something which will serve the purpose, will not be so expensive as to be prohibitive, but will not affect the environment badly.

So we have been developing what we hope is a practical detergent which contains no phosphates and is completely degradable. I am, of course, far more familiar with the tests which are involved in degradability than I am in launderability. We have reason to be very encouraged with these results. We have undertaken reflectance tests to determine whether it is whiter than white or just white, biodegradability tests to make sure if it goes through a conventional biological waste treatment plant it is going to be degraded.

We have even undertaken manufacturing tests, which is totally foreign to me. We have made by commercial methods sufficient material that limited domestic testing has been underway for some 3 months. Patent applications are now being processed. While we make no excessive claims for this material, we are sufficiently confident to proceed with a number of further tests which we feel will be necessary before it is completely acceptable. The material has not only satisfied a small number of particular housewives operating in a variety of water hardnesses; it has also proven better than the presently available best commercial brands when tested on some particularly difficult washes, involving heavy soil conditions. Don't ask me why. I know why it doesn't go through a sewage plant, but I don't quite know why it does better in the laundry.

We are patenting this material to insure it is not buried and forgotten. I, together with my associates, are ready and willing to talk to any group who is legitimately and seriously interested in the widespread testing and marketing of this material. The objective here is to make available a satisfactory laundry detergent which contains no phosphate, is less of a risk to the environment, and can be produced and marketed for a competitive and a fair price.

Now there is nothing magic about this that we have done. In fact, our ignorance of the detergent industry probably allowed us to start with less constraints than the detergent industry itself. We simply looked through the literature and we find nitrilotriacetate appears to be a suitable substitute for the polyphosphate.

I, as a microbiologist, in a moment will describe my reasons for believing that nitrilotriacetate will be an extremely acceptable material to the microorganisms which naturally occur in the environment. By adjusting this NTA as a primary builder and a number of other readily available materials to serve the complementary functions, we believe we now have a material which fulfills this function.

The University of Toronto will become a beneficiary of whatever happens to this particular material, together with a group of people which were gathered to insure that the product was practical. The further tests which we are proposing are primarily ecological and will be followed by test marketing. Having produced a limited quantity—and I would add we haven't produced grams of the stuff, we have produced 500 pounds of it—we are aware of some of the handling problems of this material.

In fact, they are not too significant.

The shirt I have on has been washed for about the last 3 months in this material. My wife claims it is perfectly all right. Maybe I am not as fussy as some people, but it looks fine to me.

So this is the additional information I wanted to add to my testimony.

However, as a microbiologist—probably the only microbiologist which has appeared before you—I think there are an awful lot of misconceptions floating around.

With the permission of the Chair, I would like to briefly give a first-year graduate 15-minute capsule of the microbiology of this system. Because I am quite convinced, in fact in talking to people, that many of the things which I consider to be quite self-evident in this case in fact many people really don't know. And they perhaps don't understand why all of these things are happening.

Why is phosphate a problem? Why is NTA suspect as an alternative?

Do I have the permission of the Chair to do this?

Mr. Moss. You do indeed have permission. I think it will be helpful to the committee.

Dr. Jones. If I might, as a professor, I have to work with a blackboard and a piece of chalk. Did you ever find any chalk yesterday? The affluent society—we now have two pieces of chalk.

If we start by addressing ourselves to the problem why is phosphorus bad in the first place, everybody says it makes algae grow. Lots of things make algae grow. But the one thing that all microorganisms like is a balanced diet, just as we like a balanced diet. They require so much carbon, so much nitrogen, so much phosphorus. There are many ways of demonstrating this.

But microorganisms require a certain amount of carbon, a certain amount of nitrogen, a certain amount of phosphorus. Let's say for the sake of argument that it may be 33 to 5 to 1. This simply means that if there are 33 units of carbon present in the form that organisms can use, an organism will at the same time pick up, if available, five units of nitrogen and one unit of phosphorus.

If, however, we have a situation where 33 units of carbon are available, and we have five units of nitrogen, and 20 units of phosphorus, it will still only pick up one unit of phosphorus. And therefore it releases 19 to the environment. What I am really talking about here is a waste treatment plant in which the waste goes in; and if it goes in in the proper ratio, fine; the water coming out of the other end will be clean; it won't have anything in it. It never does go in in that ratio.

Some industries, for example, have 3,333–5–1. You can see what will happen: 3,300 units of carbon are going to be discharged into the stream. What is the industry to do? They add nitrogen and add phosphorus to make the bugs a balanced meal, so they will use all of the carbon up.

So what is happening? We have got a situation where we have excess nitrogen and excess phosphorus going through a sewage plant. So this is the demonstration of this limiting situation.

I would appreciate any questions on this as I go along, to make sure I am explaining it.

Mr. DAVIS. You are talking about bugs in the sewage treatment plant?

Dr. JONES. Yes, and when you get into the river, you have the same situation. You have the nannoplankton, which are the microorganisms, which in fact, consume the polluting substances.

Mr. GUDE. Dr. Eldib mentioned that when you have an excess of phosphorus in the solution, evidently the organism absorbs more than it actually utilizes. Does this in some way make for greater growth than when you have exactly the right level of phosphorus in proportion to the other elements?

Dr. JONES. This is the introduction of a more sophisticated thought before the primary thought was planted. This is why I wanted to go through this exercise.

This so-called luxury uptake phenomenon is highly questioned by many people. I don't hold a position one way or the other on it.

Dr. ELDIB. It is not my theory.

Mr. GUDE. Right, but you presented it.

Dr. JONES. It is highly questionable to many people.

Now this is what goes on in the sewage. Supposing now we throw all of this out into the lake. Where does the carbon come from? It comes from carbon dioxide. Where does the nitrogen come from? In the case of blue-green algae it may come from nitrogen gas in the air. In the case of nonnitrogen fixing forms, it must come in some biologically available form, nitrate, ammonia, or amine. There are a variety of ways it could get there.

The carbon is completely available; it is in the atmosphere. The hydrogen and oxygen is the water; there is nothing you can do about this. So it is one of these two that is going to be controlling.

Why don't we pick on nitrogen? This was proposed yesterday. Why don't we pick on it as being the material to control in order to limit this growth?

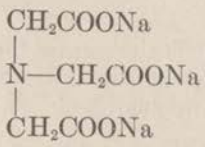
My reason for not picking on nitrogen is because nitrogen is what is known as a mobile nutrient. It is a mobile nutrient. This means that nitrogen will pass through the soil beautifully. If you pour a jug of nitrate—water containing potassium nitrate—through some soil and catch it, you get practically all of the nitrate out. If you do the same thing with phosphate, you get practically no prosphate out. In other words, phosphate stops nitrogen flows. Where else does nitrogen come from? The whole world is full of nitrogen fixers. This is the reason we get a protein diet—because there are some micro-organisms that are there for the purpose of converting nitrogen gas into available nitrogen, so we can get protein nitrogen for our food.

They are all over the place. Every time it rains over an industrial city, the rain dissolves the ammonia in the gases coming down.

Good work was done on this in Hamilton, where we have steel plants. The nitrogen coming out of the rain was probably enough to support, enough to cover, Lake Erie. That is why I come back to phosphorus.

What about NTA? This is being discussed here. We are all a little worried about NTA. To me we are on a collision course; we are driving 60 miles an hour into a brick wall and we are afraid to turn the wheel in case there is a curb or something small we may hit. We are going to hit the brick wall instead of the curb.

I want to look at NTA and as a scientist I want to be as sure as I can that it does not represent a further environmental problem. NTA is a chemical which has a structural formula which looks something like this (drawing on board):



I look at that and, as a microbiologist, I say to myself, this item here (acetate) is an essential intermediary metabolite for all microorganisms, for all organisms. If we look at the metabolic pathway of microorganisms—and this is a second lecture I could go into—if we start with a sugar, a bacterial cell or a rat's liver, it doesn't matter, it will take it through a certain series of steps into a circle and so that certain materials for growth and energy are produced in this process.

Lo and behold, right here at the crossroads of this whole thing the organism uses acetate.

So nobody is going to convince me acetate is not going to be acceptable to microorganisms. I am sure it will be.

I am not concerned about this, then. Another argument is raised: What about the nitrogen concentration in NTA? I look at the nitrogen versus the carbon that is available here and see that organism has a balanced diet right there. There won't be any nitrogen left over.

One other thing which then becomes apparent when you follow this reasoning is that there is no phosphorus here at all.

Now we have all just said that man is a phosphorus concentrator, and therefore there is still an excess of phosphorus going into the plant. One of the proposed methods of removing phosphorus from a sewage treatment plant was to add more carbon with no phosphorus. In other words, to build this end of the equation and not touch that. The more we put in here, the more of this will be used.

Here we have thrown in a bunch of carbon and no phosphorus. I don't know how significant this will be, but this will in fact demand phosphorus to satisfy its oxidation. The organism will be looking for phosphorus, which it will not find here, so it will start to take some of the excess sources of phosphorus. To what extent that is significant is open to challenge. I really don't know. I do know it will happen, but whether it will solve all our problems, I wouldn't attempt to claim.

Thank you, gentlemen.

Mr. Moss. Thank you very much, Dr. Jones. And I would like to express my personal appreciation for the excellent quality of the papers submitted to the committee by you three gentlemen. Mr. Vander Jagt?

Mr. Vander Jagt. I would like to join in the expression of that appreciation. After attending just one lecture, I do have some questions.

This thought occurs to me: We may have to have this extra phosphorus, so shouldn't we encourage the detergent industry to continue using phosphorus, so there will be plenty to go around in using up the carbon and the nitrogen?

Dr. Jones. Man is pretty good at providing that.

Mr. VANDER JAGT. No problem in terms of a source. Dr. Eldib, on page 14 of the statement which you submitted—I am not sure whether it was in the summarized one—you said that it has been resolved that only one pound of phosphate will support the growth of 82.6 pounds of algae.

Dr. ELDIB. Right.

Mr. VANDER JAGT. What is the source for that?

Dr. ELDIB. The source is the calculations which I made and which were based on work that has been published by Professor Stumm of Harvard University.

Mr. VANDER JAGT. I also learned from the lecture of Dr. Jones that, when we are talking about the source of phosphate in lakes and streams, it depends on the lake that you pick. The results from an agricultural area will be different from those of an industrial area. That is why I am interested in page 15. You mention there a figure we discussed somewhat yesterday. You said that 50 to 70 percent of the total input of phosphorus in the lower Great Lakes can be traced to detergents.

Dr. ELDIB. Yes, sir.

Mr. VANDER JAGT. What is the source of that?

Dr. ELDIB. There are two references. The first is the 1969 report to the International Commission, United States and Canada, on the pollution of Lake Erie, Lake Ontario, and the International Section of the St. Lawrence River. The second reference is an earlier report in 1967 by the Lake Erie Enforcement Technical Committee.

Mr. VANDER JAGT. You were present yesterday, weren't you?

Dr. ELDIB. Yes.

Mr. VANDER JAGT. We were told as a committee that you could eliminate all of the phosphorus going into Lake Erie from detergents and it wouldn't stop the growth of the algae or the eutrophication, because there would be so much phosphorus from other sources.

What is your reaction to that statement?

Dr. ELDIB. My reaction is that there may be some truth to this statement; but I also believe that we must start some place. We now know that a big segment of the pollution in Lake Erie comes from phosphates, so I cannot buy the argument that, if we do not remove 100 percent of the phosphates entering Lake Erie, we should not remove the 50 percent coming from detergents.

Since we know that detergents are a major contributor to phosphates buildup in water, we should remove the phosphates from detergents. If one goes to a doctor because he is sick, and the doctor thinks that maybe the patient has bronchitis and high blood pressure, if he can cure the bronchitis, he goes ahead and cures it right away, rather than saying he is going to wait to find something that will cure everything.

Mr. VANDER JAGT. I wonder if either of the other witnesses would care to comment on this statement made yesterday—especially, Dr. Jones, with your background in the Great Lakes, and particularly Lake Erie. That is the statement that if you removed all of the phosphates from detergents going into the lake, you would not reduce the eutrophication or the growth of the algae, because we are already past the threshold of the phosphorus that is required.

Dr. JONES. As I thought I tried to point out in my formal presentation, there is no real threshold here, because first of all, the phosphorus threshold concentration varies according to what type of algal cell is growing. The rivers are different. This is why for the longest time there was no number. The biologists refused to give a concentration which was critical, because it was a growing situation.

I would say that the evidence indicates that since all of the phosphorus is consumed in the summertime, if you put in more phosphorus, more algae will grow. Therefore, by not putting in any phosphorus next year—supposing we could stop it all—we would have a very, very distinct possibility of a reversal of the trend, because the phosphorus does have two sinks and neither of these two sinks are too rapid in the larger lakes. One sink is the geochemical reaction of fixing in terms of sedimentary rock, which is a slow process. The other sink is natural washout into the ocean. This is also pretty slow in the Great Lakes system.

But these two would allow some sort of a reversal of the eutrophication trend to take place and it would probably become apparent within the next 5 years if we were able to magically stop the introduction of phosphorus tomorrow.

Mr. VANDER JAGT. That is if we could eliminate the introduction of all phosphorus. The emphasis yesterday was "if they eliminated phosphorus from detergents."

In the suggested solutions included in the statement which you submitted, Dr. Jones, you mentioned the need for legislation to make illegal, by a certain target date, the sale of phosphate-built detergents; and you also mentioned the need for control of agricultural runoff. You said that those two steps would reduce by more than 50 percent the current rate of eutrophication.

Dr. JONES. Right. The rate.

Mr. VANDER JAGT. Now except for the addition of agricultural runoff control—which makes it a little different—the statement was given to us yesterday that complete elimination of phosphorus from detergents would not minimize or diminish eutrophication. You are saying it would reduce it by 50 percent?

Dr. JONES. The rate of eutrophication, please. It has been going on for several years, so therefore all we are changing is the rate.

Let's try to put some numbers—and please don't try to use these numbers any way other than for demonstration of a point. Supposing right now there is sufficient phosphorus in the orthophosphate form in Lake Erie to support a bloom of let's say 50 square miles. And supposing every year we are adding sufficient phosphorus to increase this bloom area by 4 square miles. If we don't put in all of that phosporus next year, instead of increasing from 50 to 54 square miles of algae, we will go from 50 to 52 square miles of algae—if we simply control the phosphorus from the detergents. To me that is significant.

Then, of course, we must attack the other points which I mentioned also.

Mr. VANDER JAGT. So there is no question in your mind, then, that if we did eliminate phosphorus from detergents going into Lake Erie it would substantially reduce the rate of eutrophication?

Dr. JONES. Correct.

Mr. VANDER JAGT. Dr. Eldib, I want to come back to you on a point that I think is critical. Mr. Klein stated yesterday, and perhaps you heard it when you were questioning him—he was asked whether if you reduce the amount of phosphorus in a sewage treatment plant by 50 percent that would reduced the cost of sewage treatment; and he said no, there wouldn't be a reduction in cost because you have got to have the sewage treatment plant anyway, because you are going to be dealing with the other 50 percent of the phosphorus.

As I understand your testimony, the more you reduce the phosphorus content in a sewage treatment plant, the more you reduce the cost of sewage treatment. Do I understand your testimony correctly?

Dr. ELDIB. Yes, sir. If I may elaborate on this point: The removal of phosphorus as it is practiced now is done by the use of chemicals. So if you have x pounds of phosphorus to remove, you need y pounds of chemicals. If you have half x pounds of phosphorus, then you need about half y pound of chemicals. Any time you are trying to remove phosphorus, as you lower the concentration of phosphorus, you need less chemicals; so you save on chemicals costs as you reduce the phosphates concentrations in the sewage to be treated. Therefore the cost, the operating cost, of a sewage treatment plant will go down.

Mr. VANDER JAGT. Thank you. Now, Dr. Jones, you suggested that we control the times when the farmer puts the phosphorus on his land and that he not put it on in times when there is going to be rain.

Isn't that precisely the time the farmer wants to put his fertilizer on the land—in the spring, which is the time when you have heavy rains, and he isn't going to be able to tell when the rain will come? I am sure he hopes it doesn't wash away, yet he has to plant in the rainy season, doesn't he—in the spring?

Dr. Jones. Well, I have a farm myself, and I certainly expect rain and wet conditions in the spring. But I don't expect to put fertilizers on the field when I am expecting torrential rains. In fact, I am not even going to plow the field when I am expecting torrential rains.

I think that this will vary, and it is something which I am not proposing as a blanket statement there, because obviously the United States and Canada both vary widely in terms of climatological conditions. I think this should be a judgment made in the local area, perhaps by the local agricultural representative. I am more concerned, I believe I am saying there, with the animal waste aspects of it than the chemical fertilizers, because the chemical fertilizers will be put on at a time when the crop is about to take it up. And the animal wastes will be put on at any time. I could take you to Canada now where the ground is frozen even maybe 2 feet thick and you will find liquid manure being spread on the ground because the tank is full and what else can he do with it? This is simply a logistics problem—he has one tank, it is filled up, he throws it on the field. In the spring we get the thaw from the top down, so it will wash off into the streams and rivers and lakes.

Mr. VANDER JAGT. You also pointed out, Dr. Jones, that in your opinion there would be no substantial capital investment for the soap and detergent industry to mix elements other than phosphate in their detergents.

When we had the NTA witnesses on the stand it was their opinion

that there would be a substantial cost in terms of the capital investment, because you need new machines, new ways of manufacturing. Could you comment on that?

Dr. JONES. I don't purport to be an authority on the manufacture of detergents; far from it. In the limited experience we have had in the manufacture of our own particular product—using NTA as a primary builder, plus other materials to fulfill the other functions—I don't believe we have had any significant problem in the mixing, the blending, operation.

Mr. VANDER JAGT. But if you were going into a tremendous volume production, it is possible on the basis of their experience with NTA, that you would run into substantial investment on the part of the detergent industry to make this changeover. Is that true?

Dr. JONES. It is quite possible. I don't believe for a moment that they could simply haul out the sacks of phosphorus and haul in the sacks of NTA and just press a button. There will be more to it than that. But I am not convinced that it will be so significant for it to be the sole reason for delay.

Mr. VANDER JAGT. You spoke, I felt, with understanding and a certain empathy for the researchers of the detergent industry and their mission which is to cut costs and come up with something that cleans. And you pointed out that that is the direction in which they are moving, so that really they aren't concentrating too much on coming up with a substitute—understandably—just because of their mission.

Yet Mr. Klein told us yesterday that he thought it was essential that we come up with a substitute for phosphorus in detergents, but that it was the job of the industry to come up with it.

Do you think we have placed that responsibility in the right hands? Have we given the ball to the right quarterback?

Dr. JONES. My opinion would be no.

Mr. VANDER JAGT. Thank you. Thank you, Mr. Chairman.

Mr. MOSS. Mr. Hicks?

Mr. HICKS. I thought that Dr. Eldib wanted to add a point there when Dr. Jones was talking about the increased rate. Do you remember what that was?

Dr. ELDIB. Yes. I was going to explain the word "rate." May I use the blackboard?

You have a body of water and you have got atoms or molecules floating in it. Let's assume these atoms or molecules are made of carbon, phosphorus and nitrogen, all of which are trying to react to produce algae.

Now if there are just the right amounts of nitrogen, carbon and phosporus required to form algae, you don't get the yield that you expect theoretically because the probability is that only some of these molecules will collide together and form algae. But if you have a lot of phosphorus, for example, the probability is much higher for the right combinations to collide, and the amount of algae formed is much higher. So the more phosphorus you put in, the more complete your reaction will be. By allowing the phosphorus content of lakes to build up, you essentially increase the driving force to make more algae.

Mr. HICKS. I have no other questions, Mr. Chairman.

Mr. MOSS. Mr. Gude?

41-607—70——14

Mr. GUDE. Dr. Jones, getting back to this magic number that was discussed yesterday: Were you here when they had the chart which was evidently developed from a paper concerning Lake Erie, as I understood it, and that magic number was 10 micrograms of phosphorus. When you went over that to 10½ or 11, algae started forming, and the implication I got was that it didn't matter how much more phosphorus you put in, the production of algae went along at the same rate.

What you are saying is that with the additional phosphorus, the other elements come along. There is sufficient of the carbon and the nitrogen and oxygen, so there is practically a limitless amount of algae that can be formed. If you go up to 80 micrograms evidently it is utilized, because in testing the water during the summer, there is no phosphate solution in there. Is that your interpretation of that chart?

Dr. JONES. That chart—I believe I am familiar with the source of it—

Mr. GUDE. Is that your interpretation of what would happen under those circumstances, I mean.

Dr. JONES. Well, the interpretation as to what would happen under those conditions I thought was left very much in doubt due to some mix-up that took place over here late in the discussion.

Mr. GUDE. I wanted to get your perspective of it. Did I paraphrase it correctly—that additional phosphorus does make the condition that produces additional algae?

Dr. JONES. Yes.

Mr. GUDE. Is this a different variety or is this just the blue green starting at the 10 micrograms?

Dr. JONES. Every variety has its own requirements. And that 10 micrograms per liter concentration was quote as the concentration above which you obtain nuisance conditions. Just precisely how you define "nuisance conditions" is what leaves me a little mystified. Because nuisance conditions are strictly a regional concern, and not a lake-wide concern. You may have nuisance conditions offshore at Sandusky, Ohio, or Port Clinton in the west basin, and have no nuisance conditions in the central and eastern basin of Lake Erie.

The concentration of any particular element in a lake the size of those is not uniform throughout the lake. It arrives from a point, it must be dispersed from that point, and there is a certain diffusion rate which takes place. And obviously it will pass through a critical range somewhere, going from too concentrated to too dilute. Somewhere in the middle of that diffusion band you will grow algae. This is a very necessary part of the productivity of the lakes. It is only when that band grows too broad and the production of algae is no longer a diffuse thing throughout the lake but has actually surfaced and forms a scum—something which is identifiable—and then washes up on the beach, this is when to me it becomes a nuisance. Now it does not become a nuisance throughout the whole lake at any one time. Nobody has ever tried to say that Lake Erie is completely covered with algae during the summertime. Some portions of it are. My claim is if we put in more phosphorus every year, as we are doing, the degree of nuisance will increase.

Mr. GUDE. And there is a potential of covering the whole lake?

Dr. JONES. Yes, indeed. You might be able to walk on it one of these days.

Mr. GUDE. Would you care to comment in regard to the input of phosphorus from agricultural runoff? The chart they had showed that it was 30 micrograms, I believe, for Lake Erie; and then also we had testimony from Mr. Dominick that the Potomac River received phosphorus from agricultural sources three times over what—I imagine he was referring to the nuisance level.

Do you think the development of new types of fertilizers and the application of them has brought about an increase of phosphorus from agricultural sources, or do you believe it is not really a serious problem in this whole eutrophication business?

Dr. JONES. I don't have any specific evidence to support this belief. But it is my belief that through the years the farmers and the agricultural industry, including Government, have been attempting to minimize the requirements to produce a unit crop. And clearly if you try to optimize this situation, the theoretically best condition would be when you put 1 pound of phosphate on some given area, and come harvest time you take off a pound of phosphate in a crop. This would be the optimum situation. I don't think we can achieve this.

But I don't think they are going the other way. This is not true in urban areas, where I believe the attitude among most people who have small gardens in subdivisions is that if one bag of goodies will make your grass green, then two will make it a lot greener. Here is a source of fertilizer eutrophication that would be very difficult to control.

I have no suggestions. Education, perhaps. I don't know.

Mr. GUDE. Well, my thought was that there is a range of phosphorus available in different types of fertilizers. In the advancement of agricultural technology, I wondered to what extent new fertilizers were being developed where the phosphorus would be very readily available to plants, at the sacrifice of producing more runoff. I wondered if there was a new fertilizer that would give a greater yield; but at the same time more phosphorus as a byproduct, which you would want to avoid if you could but would accept for the sake of the yield.

In other words, you would be getting more production so you could afford the waste.

I just wondered if—this undoubtedly comes to the Department of Agriculture in their research—this development of new fertilizers possibly is giving us more runoff along with greater yield.

Dr. JONES. Do you gentlemen fully understand the difference between runoff and percolation?

Percolation is where the phosphorus does not travel very far, it is not a mobile nutrient. And a good deal of experimental work has been done on this, and on a full scale and on a microscale in the lab, to indicate that phosphate ions do not percolate very much. Nitrogen in its biologically available form does. So therefore we are strictly talking about runoff, that stuff that runs across the field and down into the creek. That is all we are talking about.

If I understood your question correctly, and I am not sure I did, the developers of new fertilizers I believe have attempted to balance the available nitrogen to the available potash, to suit the particular

conditions. And these are pretty well tailored. You will find fertilizers in use in one area are not in use in another area, due to soil conditions in one area which aren't prevalent in another area.

So I think that every effort is being made to try to optimize this situation. Whether it is very successful or not, I wouldn't like to discuss.

Mr. GUDE. What I was suggesting is: You take a pound of superphosphate and apply it to the soil, and maybe till it in. There is probably very little runoff of soluble phosphate from this treatment, as opposed to a phosphorus compound that is soluble in water that would be applied on the land. And a heavy rain—which the farmer wants to avoid, but he can't always avoid—comes after the application of the phosphorus. Would you then get more runoff of the soluble phosphate?

Dr. JONES. You are getting into an area which I don't confess any expertise in.

The rate of dissolving phosphates in some of the new fertilizers—where they have retarded the rates of solution, versus quick rates of solution, like the tiny time pill concept—I don't claim any vast fund of knowledge here I am afraid.

Mr. GUDE. Thank you, Mr. Chairman.

Mr. MOSS. I have a couple of questions I would like to ask at this time.

First of all, it is my understanding that yesterday the committee requested that the phosphate content of domestic manufacturers' products be supplied to the committee.

And I will refer the further suggestion of a label requirement to my Interstate and Foreign Commerce Subcommittee on Commerce and Finance, which has jurisdiction over labeling, for staff consideration.

I think that the thrust of all of the statements today demonstrates quite clearly that the public is going to be called upon to pay in one manner or another for the use of phosphates. They will need to have more efficient sewage treatment plants or ultimately they are going to pay perhaps more for a detergent having a substitute for phosphate.

None of your comments has been directed at another item being introduced into this field of detergents—one that is supposed to even outdo the whiter-than-white—and that is the enzymes. What is the effect of the enzymes?

Dr. BREGMAN. When I was in the Interior Department we referred this question to Dr. Stephan, the Assistant Commissioner for Research and Development, and the Federal Water Pollution Control Administration came back with a report to the Secretary that indicated there was no concern in terms of water pollution by the enzymes.

Mr. MOSS. Is that an expression of "no concern" based upon careful research on it, or is it just an off-the-top conclusion?

Dr. BREGMAN. It was based on a study of the literature and of the best facts available to the FWPCA.

Mr. MOSS. Is there any difference in opinion on this matter?

Dr. ELDIB. I don't have a difference of opinion, but perhaps I can expound on this point.

In the manufacture of enzymes, it is possible that live spores remain in the enzyme after it is produced.

Mr. Moss. This is the main point with which, from a public health point of view, the Government should be concerned. Do the enzymes incorporated in detergents contain any live spores?

Dr. ELDIB. I don't have the answer to this, but I understand that the detergent manufacturers have been concerned, and are setting standards to their suppliers of enzymes saying that the enzymes which they supply should not have any more than probably zero live spores, or perhaps some other very low level.

Mr. Moss. I think your statements leave really very few questions at this point. Do you have any questions, Mr. Indritz?

Mr. INDRITZ. No, sir.

Mr. Moss. Gentlemen, I want to express the appreciation of the committee for your appearances here today. I am certain the statements will be of great value to the committee. Thank you very much.

We will now hear from Dr. John R. Sheaffer.

STATEMENT OF DR. JOHN R. SHEAFFER, RESEARCH ASSOCIATE, CENTER FOR URBAN STUDIES, UNIVERSITY OF CHICAGO

Dr. SHEAFFER. Mr. Chairman, gentlemen, I submitted a formal statement to the staff. What I would would like to do is make some observations on the statement and relate it to some of the preceding testimony which you have heard.

Mr. Moss. Would you like to have your prepared statement included in the record?

Dr. SHEAFFER. Yes; along with the exhibits.

Mr. Moss. Is there objection?

(No response.)

Mr. Moss. The request is granted and the statement and exhibits will be included in the record.

(The exhibits submitted by Dr. Sheaffer are in the subcommittee files. Dr. Sheaffer's prepared statement follows:)

PREPARED STATEMENT OF JOHN R. SHEAFFER, CENTER FOR URBAN STUDIES, UNIVERSITY OF CHICAGO; FRED ROLAND AND WAYNE COWLISHAW, BAUER ENGINEERING, INC., CHICAGO, ILL.—"A COMPREHENSIVE APPROACH TO THE MANAGEMENT OF PHOSPHATES"

Gentlemen, it is a pleasure to meet with you this morning and to present our views concerning the effects of phosphate-based detergents on water quality. You will notice that my presentation may deviate somewhat from those which have preceded. The main purpose for this deviation is to present a comprehensive or nonmyopic approach to the phosphate problem. Such an approach is required because of the complex nature of the phosphate problem and the uncertainties regarding the relationship of phosphates to excess algal growths.

SOURCES OF PHOSPHORUS

Phosphorus can be contributed to a watercourse from a number of sources. The major sources are:

(1) domestic and industrial wastewater;
(2) urban runoff;
(3) agricultural runoff;
(4) precipitation and ground water inflow;
(5) aquatic plants;
(6) waterfowl, fish, and bottom fauna; and
(7) muds under water bodies.

Studies at Lake Mendota,[1] Wis., have allocated the phosphorus input among the following sources:

43 percent from rural runoff.
36 percent from domestic and industrial wastewater.
17 percent from urban runoff.
4 percent from precipitation and groundwater inflow.

This analysis of phosphate sources is in general agreement with the work of Ferguson[2] who estimated man-generated phosphorus to constitute 57–74 percent of the total.

Phosphorus found in domestic and industrial wastewater generally exists as different types of inorganic phosphate compounds and as part of organic complexes. Before the advent of the synthetic detergent, the phosphorus level of sewage influent was about 3 to 4 mg/1. Today, it is about 10 mg/1. Therefore, it can be surmised that 60 percent of the phosphorus is due to detergents—this would amount to 22 percent of the total source. Most phosphorus compounds will break down to soluble inorganic orthophosphate. This is the form in which it is most readily available for biological utilization. Biological treatment processes (activated sludge, trickling filter and oxidation lagoons) can accelerate the process.

The presence of phosphorus and nitrogen above certain threshold concentrations have been associated with excess algal growth in lakes and streams. Various concentration levels and relationships of the two constituents have been identified as precipitating growth of algal blooms by different researchers. The one study frequently referenced is Sawyer's evaluation of 17 Wisconsin lakes. This produced the conclusion that soluble phosphorus concentrations in excess of .01 ppm and inorganic nitrogen in excess of .30 ppm at the spring turnover would produce algal blooms.[3]

THE NEED FOR A COMPREHENSIVE APPROACH

The effects of phosphate-based detergents on water quality can be best assessed within a comprehensive framework. The adoption of such an approach will help to avoid the results of incomplete analyses (failure to consider external effects) and short range planning which have charactedized current water pollution abatement efforts. Disjointed incrementalism is a graphic description of the effort. Water pollution abatement is generally promoted by the entire range of governmental bodies so that it tends to be decentralized or disjointed. Also, the effort seeks to extend or enlarge upon existing technology thereby producing only incremental changes in water quality. A continuation of disjointed incrementalism will tend to avoid the development and application of comprehensive global planning which can produce the programs necessary to bring about dramatic changes in water quality.

The need to abandon disjointed incrementalism is illustrated by the report entitled "Examination into the Effectiveness of a Construction Grant Program for Abating, Controlling and Preventing Water Pollution." This report, which has been prepared by the Comptroller General of the United States, observed that the benefits from the construction of more than 9,400 projects having an estimated cost of about $5.4 billion have not been as great as they could have been. A case study presented in the report contained an analysis of water quality, treatment, and standards on the Meramec River. The apparent ineffectiveness of many of the expenditures leads one to conclude that perhaps the technology being applied is inadequate and that the answer is not one of seeking to meet minimum standards with a programed expenditure for selected treatment plants, but rather to adopt a new technology which could provide a solution and at less cost.

A résumé of the present pollution effort is necessary to provide a framework for our statement regarding the effects of phosphate-based detergents on water quality. As we view the national effort, it is characterized by reaction to problems as they become apparent, e.g., biodegradable detergents, phosphates. As such, it is a defensive battle which provides no vision or leadership. It is truly myopic.

If the phosphorus is to be replaced in detergents, the question of what is to take its place must also be considered. Based on past experience, the replace-

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[1] Lake Mendota Problems Commission, *Report on Nutrient Sources of Lake Mendota* (Madison: By the Author, 1966).

[2] F. Alan Ferguson, "A Nonmyopic Approach to the Problem of Excess Algal Growths," *Environmental Sciences and Technology*, Vol. 2, No. 3 (1968), pp. 188–193.

[3] C. N. Sawyer, "Some New Aspects of Phosphates in Relation to Lake Fertilization," *Sewage and Industrial Wastes*, 24:6:768 (1952).

ment may turn out to be just as serious a pollutant as the phosphorus. What effect will 600 million pounds of starch derivates per year have on water quality? Methods of phosphorus removal from waste water effluent generally involve some type of chemical replacement. For example, the use of ferric chloride to precipitate phosphates will add 20 mg./l. chlorides and 4 mg./l. iron. Would widespread use of this method lead to problems of chlorides and iron in water?

Many water pollution abatement efforts simply transfer pollutants to another location or another media, e.g., from water to the air or the land. If phosphorus is precipitated out into the sludge of a sewage treatment plant and the sludge is then incinerated, it is likely that some of the phosphorus will be discharged into the atmosphere and will be brought back to the land and water with the rain.

The concentration of phosphorus in rain is estimated to be from 2 to 17 million pounds per year—without the removal of phosphorus. If phosphorus is removed at sewage treatment plants and the sludge incinerated, the amount of phosphorus in rainfall will greatly increase.

There is increasing evidence to suggest that viruses are the cause of many of the most serious diseases plaguing the United States. Yet, it is startling to discover that such health-related organisms as viruses are not covered in any of the water quality standards now in effect in the United States. In fact, few measurements are made of viruses.

Many viruses are found in waste water and should be considered in any waste water management program. Viruses certainly warrant as much attention as dissolved oxygen in our water quality standard. We need to assign priorities to pollutants in terms of their potential effects rather than in terms of our ability to remove them.

The most widely used method of secondary treatment, activated sludge, has been shown to be totally ineffective in removing viruses. An analysis of alternative treatment methods in terms of virus removal was carried out by P. H. McGauhey [1] of the Sanitary Engineering Research Laboratory at Berkeley, Calif. He obtained the following results:

(1) Samples of raw sewage, primary effluent, and activated sludge effluent were 100 percent positive. (Thirteen different viruses were identified.)

(2) Effluent from oxidation pond (30 days detention) showed 30 percent of samples positive.

(3) Recreational pond influent, after 2,500 feet in soil system, was 100 percent negative.

The results show no removal of viruses by activated sludge treatment plants. Nevertheless, this process is being advocated as the answer to the water quality problems which are plaguing the Nation.

A NEW APPROACH TO WASTE WATER MANAGEMENT

An appraisal of the effectiveness of the current pollution abatement efforts shows the need to formulate a new approach to waste water management. Such an approach would provide an offense or a vision. As stated in Proverbs, "Where there is no vision, the people perish." [2] This new approach or vision is undergirded by three concepts. They are:

(1) pollutants are resources out of place,

(2) waste water management systems must be designed as closed systems, and

(3) the environment is a total entity.

Viewing pollutants as resources out of place is analogous to a botanists' viewing a weed as a plant out of place. It is not difficult to see how this concept applies to waste water management, for the primary elements which create the problem of excess algal growth in water—nitrogen, phosphorus and potassium—are the principal elements in fertilizer. If these elements were on the land they would be considered as resources, but when they are discharged into the water they are pollutants—resources out of place. The second concept calls for the design of closed systems. Historically, waste water management systems have been designed as open-ended systems, which can function only if they discharge into some receiving body of water. The reason for the design of such systems was the belief that wastes could be carried away by streams which could purify themselves.

However, urban sprawl and population explosions have shown that it is no

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[1] P. H. McGauhey, *Engineering Management of Water Quality* (New York: McGraw-Hill Book Co., 1968).

[2] Proverbs 29:18.

longer possible to throw things away because there is no longer an away. Waste water management requires a closed system. Systems can be closed by recycling pollutants (resources out of place) back into the productive cycle, thereby avoiding direct discharges.

The final concept is that the environment exists as a unit and all of the elements relate and interact with one another. The relationships tend to be in balance but are constantly changing; hence the environment is described as a "dynamic equilibrium."

A NEW WASTE WATER MANAGEMENT PLAN

The three concepts presented above underlie the waste water management programs that have been developed for Muskegon and Ottawa Counties. These plans offer total solutions to the total phosphorus problem including that of detergent-based phosphorus. These plans are attached as exhibits to this statement. Exhibit A is a copy of the Muskegon County waste water management plan and exhibit B is a copy of a prefeasibility study prepared for Ottawa County. The waste water management systems outlined in these reports constitute solutions to the water quality problems.

The systems are made up of the following components. A pipeline is used to transport all of the wastes from an urban area to a site which environmental geologic studies have shown to be safe for the operation of a waste water management program. A series of treatment lagoons are constructed at the site which provide for aeration to satisfy biological oxygen demand, settling to remove settleable solids, aerobic bacteria to consume soluble organic wastes, and photosynthetic cells to convert nitrates and phosphates into algal cell material that can be retained by the soil.

The lagoon treatment facility produces an effluent superior to that of a secondary sewage treatment plant. In addition, the lagoon facility offers several distinct advantages. First, large amounts of storage can be provided in the treatment lagoon to hold and treat unusually large flows of water generally associated with stormwater runoff and combined sewer overflow. Second, because of the large volume of water held in the lagoon treatment facility, it has the capacity to assimilate toxic shock loads associated with industrial spills. Even if the bacterial colony is killed off by the toxic material, the incoming wastes are stored until another colony can be established. This is quite different from an activated sludge plant, where a colony kill results in the discharge of partially treated wastes for 7 to 10 days until a new colony is established. An analysis of a large activated sludge plant in the midwest showed that such colony kills are likely to occur as frequently as six times per year.

Another advantage is the effect of lagoons in terms of virus removal. Research has shown that 30 days retention in a lagoon removed 70 percent of the viruses in comparison to the 0 percent removal obtained by secondary treatment plants.

After the waste water is treated in the lagoon system, it is applied to geologically suited land areas. In the Muskegon-Ottawa County plans, these areas tend to be glacial outwash plains which are unproductive because they lack water-holding capabilities and nutrients. By spraying the treated waste water on these sites, both of the missing ingredients are provided and the barren land will become productive. The waste water is applied to the land by large automated rotating spray irrigation rigs which cover 160 acres from a central point. These rigs require low-labor inputs to operate and will produce little, if any, aerosol or drift effect. Because the pipe rotates around the field, the water does not have to be projected high into the air to gain coverage. The harvesting of crops from the irrigation site completes the treatment process and essentially closes the systems.

Nutrients may be looked upon as moving in the following cycle. Corn is grown to feed animals which are slaughtered and sent to the city as a food supply. The meat is eaten and is discharged to the waste water treatment system as sewage. The sewage is pumped out to the lagoon treatment facilities where, after treatment, the nitrates, phosphates and potassium are applied to the land where they are taken up by the corn planted on the site, and the animals are fed the corn, thus completing the cycle.

Another example of a closed system relates to the water. Drinking water is taken from Lake Michigan and, after treatment, is piped through the city where it is used and discharged into the waste water treatment system. When the waste water enters the lagoon treatment facility, suspended solids, heavy metals, and other materials settle to the bottom, 70 percent of the viruses are removed, and

those materials which are dissolved in the water (the remainder of the viruses. the nitrates, the phosphates, the potassium and the soluble heavy metals) are applied to the land. The living filter, which is the biological zone of the soil, treats these wastes. Research has shown no viruses present after the waste water has moved through a biological zone. In addition, heavy metals are held by the organic matter in the soil, the clay particles, and some are taken up as trace elements in the plants. The waste water, after purification in the lagoons and treatment by the living filter, moves to the ground water table where it either flows as base flow or is pumped from wells to a river and then back into the lake.

Waste water management programs of this nature appear to be feasible in virtually every urban area in the United States. Such programs would render the direct discharge of wastes into the water resource unnecessary. In addition, there is strong evidence that suggests that a synergistic effect would result. The total effect will be greater than the sum of the two programs—waste water management and agricultural production—if they were taken independently.

The availability of land will not be a deterrent to the adoption of such programs. As a rule of thumb. If waste water were to be sprayed at a rate of 2 inches per acre per week, approximately 130 acres of land would be required to accommodate a million gallons of water a day. Using simple mathematics, if 100 million gallons of water were to be disposed of, 13,000 acres of land would be required; if a billion gallons of water per day were to be disposed of (the largest water system in the country) 130,000 acres of land would be required. A preliminary evaluation of the major metropolitan areas in the United States strongly suggests that such land areas exist within 100 miles of most major metropolitan areas. Furthermore, these land areas are generally unproductive and add little return to the economic base of the region.

THE EVALUATION OF THE MUSKEGON COUNTY AND OTTAWA COUNTY WASTE WATER MANAGEMENT PLAN

Muskegon and Ottawa Counties, in Michigan, are striving to provide a vision for our waste water management effort. With respect to phosphorus, these plans regard it as a resource out of place. It becomes obvious that an alternative to the replacement of phosphorus in detergents with some other substances (that is, starch derivatives) should be pursued. Your subcommittee could be instrumental in bringing about waste water management systems which would view phosphorus as a resource out of place rather than an element to be replaced. The beneficial use of phosphorus in the manner proposed in Muskegon and Ottawa Counties will avoid the direct discharge of any pollutants into the water resources.

Soil systems are capable of removing certain forms of soluble nitrogen compounds, soluble phosphorus compounds and various other pollutants from percolating waste water. These removed materials become available as nutrients for plants.

The principal mechanisms of removing and holding these nutrient materials are:

(1) Adsorption, and
(2) Chemical replacement.

Adsorption is the process whereby ions are chemically or physically attracted to and held by molecular complexes existing in the soil medium. Clays and organic materials are the principal complexes present. Nitrogen and phosphorus compounds can become part of the intricate lattice structure of these complexes at the surface and subsurface layers. Ion exchange and satisfaction of lattice bond deficiencies are the mechanisms of retention. Electrical potential influence fields are also responsible for the retention of ions present in the percolating water.

Progressing from sand to clay, the soil increases in its retention capabilities. The effect of soil type has a greater influence on nitrogen retention than phosphorus retention. Nitrogen in the ammonia or ammonium form will be readily retained in clay and organic soils. Nitrate nitrogen appears to be leached readily out of most soils. Considerable amounts of ammonia will likely be converted rapidly to nitrates by the bacteria in the soil. These would also be readily leached. The chemical replacement mechanism is one by which ions bound to the soil molecular structure are replaced by ions in the percolating water.

Studies in a number of areas have shown that even with high application rates of phosphorus, only negligible amounts will be leached by most soil systems. Certain soil-phosphorus bonds can be broken by the nutrient uptake processes of

plant roots and the phosphorus utilized for plant cell structure. The growth of plants utilized in man's food chain would in effect produce a closed system which would utilize phosphorus and other compounds that now are disposed of as useless pollutants.

The economic and technical potential of soil systems results from their ability to virtually eliminate a host of difficult pollutants in one single process. In addition to phosphorus removal, soil systems provide advanced treatment for biological and suspended matter, for nitrogen compounds, detergents, toxic heavy metals, and for bacteria and viruses.

Reduction of only phosphorus in waste water by changing the compounds used for detergents would reduce the combined economic benefits of the soil treatment system. The net result of such an incremental approach to the long-range needs of water quality management could be the elimination of land application as a feasible alternative.

For the proposed Muskegon system benefits of the land application approach extend beyond the direct benefits of waste water reclamation. One important resulting benefit is the prospective expansion of employment opportunities due to the ability of the system to handle the solids problems of important industries. A waste management system such as this, that effectively deals with present and anticipated waste treatment needs of industry, constitutes a potent incentive for industrial expansion and influx. The following table summarizes the quantified benefits of the Muskegon County waste water management plan. Investment in waste water management becomes an economic endeavor yielding a 69-percent yearly return on the investment.

The approach we have outlined not only deals with the effects of phosphate-based detergents on water quality but also provides a total solution to the water quality problems. It can provide a vision for our efforts. As Solomon stated "Where there is no vision, the people perish." We are faced with the same dilemma, for without a vision, our water resource will perish.

Economic Analysis of Muskegon County Waste Water Management Plan

Benefits from Muskegon County waste water management plan—Average annual benefits

1. Revenue from crop production in excess of costs (corn yield 120 bushels per acre at $1.20 per bushel, $70 production cost by 10,000 acres)	$740, 000
2. Equivalent value of fertilizer contained in waste water ($17 per acre by 10,000 acres)	170, 000
3. Appreciation of land ($100 per acre value as wasteland; $400 per acre value as fertile land with buildup of humus, tilth, and nutrients; $300 per acre appreciation by 10,000 acres equals $3,000,000 in 20 years	150, 000
Agricultural subtotal	1, 060, 000
4. Employment opportunities generated by plan:	
a. Agriculture (100 jobs by $10,000 with 100 percent credit)	1, 000, 000
b. Papermill sanitation division (500 jobs at $10,000 with 20 percent credit)	1, 000, 000
c. Shoreline development (600 jobs at $10,000 with 33⅓ percent credit)	2, 000, 000
Employment subtotal	4, 000, 000
5. Recreation benefits through enhancement of water quality for boating, fishing, and esthetic purposes through the removal of all direct discharges into the lakes (Mona, Muskegon, and White Lakes) equals 7,361 acres. Increased use benefit estimated at $120 per acre per year	883, 000
6. 200-boat marina made possible by waste water plan	30, 500
Recreation subtotal	913, 500
Total benefits	5, 973, 500

Costs of Muskegon County waste water management plan—Average annual costs

1. Capital costs of $23,728,000. (Annual debt service, 30 years at 6 percent equals 0.07265)	$2, 623, 839
2. Operating costs	900, 000
Total	3, 523, 839

Benefit/cost=1.69.

Mr. Moss. Please proceed.

Dr. SHEAFFER. What I would like to do is take a few moments to deal with what might be called a resources management approach to the problem before the committee. We are here because we recognize a problem with water quality. We might ask ourselves why do we still have such a problem. I would like to suggest that we have a problem because of the approach we have followed in our efforts to deal with the problem of deteriorating water quality. The approachs can be labeled as disjointed incrementalism. All levels of government are attacking the problem in an uncoordinated manner and are promoting a technology which has been in existence since 1914. As a result, only incremental changes are accomplished. The approach reacts to problems as they appear and fails to provide a vision to deal with the total problem of water quality management.

Our approach also is characterized with a replacement strategy. When a substance emerges as a pollutant, an effort is made to replace it with something currently not recognized as a pollutant. Of course, we become frustrated as other pollutants appear. Our approach includes transfers. We transfer the pollutants from the water to the air, from the air to the water, or from the water to the land. Finally, as was very evident this morning, our approach specializes in incomplete analysis. We seldom make an effort to consider the external effects of our water quality management decisions. With the growing medical evidence on the importance of viruses, it is appalling to note that not one of the 50 States mentions viruses of any kind in their approved water quality standards. Particularly in the light of medical evidence which suggests that viruses may be the cause of leukemia, certain types of cancer, mononucleosis, and infectious hepatitis.

It appears that our current approach does not consider viruses because they are difficult to deal with. Our efforts appear to retreat to the easy to deal with pollutants. We seek to identify a large body of pollutants produced from a single source or generated within a single area and focus our attention on them, but fail to keep the effort in proper balance with the total water quality problem.

A Resource Management Approach

With that background of the current approach, there is obviously a need for a conceptual framework to provide structure for our efforts. I would like to suggest one for the committee which perhaps could be used in dealing with the problem of phosphate based detergents. Three basic concepts make up the framework.

The first concept is that pollutants can be looked upon as resources out of place. This concept is an extension of the botanist's viewpoint which defines a weed as a plant out of place. It is not difficult to apply this concept to waste water management. As we look at the water resources we see nitrates, phosphates, and potassium as serious pollutants,

but we all know that on the land these three substances are the primary ingredients of fertilizer. These pollutants are simply resources out of place.

A second concept is the recognition of closed systems in the environment, the need to get away from what we might call open ended or discharging systems. We seem to have embraced the idea that we can throw things away. We thought we were successful for many years except we are now finding out that what we threw away is still with us. Since we cannot, in essence, throw anything away, we need to close the systems by recycling pollutants back into the production cycle.

The third concept is that the environment is a single entity. The environment—air, water, and land—is a unit. There is an increasing amount of evidence to show that we have been transferring pollutants from one medium to another. For example, if we would use ferric chloride to precipitate phosphates from waste water and would incinerate the sludge containing the phosphorus, the phosphorus would be discharged into the atmsophere and could be delivered back to the land and water by rainfall. Conceivably we would get the same amount back.

Application of the New Approach

Using these three concepts to form a conceptual framework, a resource management approach can be formulated to deal with the problems of water quality pollution. A plan to illustrate the resource management approach was developed by a team of scientists and practicing engineers. The pilot areas selected were Muskegon County and Ottawa County, Michigan. The approach is as follows. It is no longer desirable to construct sewage treatment plants which must discharge to function. What is needed is a closed system that will use pollutants as resources out of place. The system developed consists of a pipeline which carries the waste water to a site which is geologically suited for the management of wastewater. At the site, a lagoon treatment system is developed to reduce the settleable solids, reduce the BOD to avoid odors, reduce heavy metals, reduce the virus concentrations, and to convert some of the nitrates and phosphates as algal cell material which could be held on the land. The treated wastewaters are then applied to the land in a managed manner.

I stress the word "managed" in contrast to having a pipe outfall, like is found in a few locations, where wastes are discharged until the ground is saturated and then the pipe is moved a few hundred feet where it again flows until that site is saturated. Such practices obviously cause damage to the vegetation because an anaerobic zone develops in the soil. Obviously the trees are going to die. In a managed system, large rotating irrigation rigs apply the treated waste water uniformly. These rigs can apply water to a 160-acre plot from a single central point. The application of these waters can convert wasteland into productive land. In Muskegon and Ottawa Counties, much of the glacial outwash plain is totally unproductive and has nothing but a few scrub trees growing on it. It is unproductive because it cannot hold moisture and it contains very few nutrients. The application of the waste provides both the the needed ingredients—the nutrients and water.

With respect to the issue of the effects of phosphate based detergents on water quality, the resource management approach takes what is now considered to be a problem and turns it into a resource.

Phosphorus, which is a problem in the water, is something needed on the land. If we apply waste water from our treatment system at a rate of two inches per acre per week, we are in essence adding $33 of fertilizer to each acre of land per year. The resource management approach offers a solution to the water quality problem—I might add, a total solution.

I made reference to viruses; virus removal is one of the side benefits of using pollutants as resources. Research at the Sanitary Engineering Research Laboratory at Berkeley, California, used 13 viruses as indexes and found that after primary treatment, every sample taken was positive. After secondary treatment in an activated sludge plant, the type which are being advocated nationwide, every sample was 100 percent positive. When the waste water was put in a lagoon and held for 30 days, only 30 percent of the samples were positive. When the waste water was sprayed on the land, and intercepted after it moved through what is called the living filter, there were no positive samples.

In other words, 100 percent removal of the viruses. And I should add that seven years of research at Penn State University showed little migration of phosphates into the ground water. It was difficult to find even a trace of phosphates after the water had moved through 12 inches of the biological zone.

The resource management approach provides economic returns. The last two pages of my statement show that we can get a favorable return on investments in sewage treatment facilities; a benefit cost ratio of 1.69. And I think if you examine the benefits, you will agree that they are conservatively estimated. There are no benefits claimed for disease reduction, even though one could say we could claim such benefits. There are no benefits claimed for less cost in treating drinking water supplies, although it is quite obvious one could claim such benefits.

The resource management approach is an alternative that, I think, merits a few pages in your record and perhaps merits further analysis on the part of your committee. It looks upon phosphorus not as something bad, but a resource that is desired. The problem is its location. Widespread adoption of the approach I think will provide vision and direction for our efforts to deal with water quality for they are advancing a total solution.

I am not as pessimistic as some of the witnesses who appeared this morning and suggested that it may be 40 years before we treat our wastes in the United States. I think the $800 million appropriation this year is enough evidence to suggest that we are going to move very quickly. What we need is a vision to provide direction. We need to have a vision which deals with the total problem as an alternative to what I referred to as disjointed incrementalism. In Proverbs we read, "Where there is no vision, people perish." I think we have the same situation before us. Without a vision, our water resources are going to perish. We will destroy them through incrementalism.

I tried to summarize my statement. If there are any further details that you want me to go into, I would be very happy to.

Mr. Moss. This is a very provocative statement. How many years do you feel it would take to achieve this vision?

Dr. Sheaffer. I think, if there were proper guidance from the Federal Government, there would be widespread public acceptance of the

resource management approach. I am speaking concerning the general public. The public sees this approach as a solution to the water quality problems. In addition it has the potential of producing an economic return to the community. Most sewage treatment efforts are what we might call nonproducing efforts. After an expenditure of money, the environment looks just about the same, and there is no perceptible economic return. Because the resource management approach shows the potential for a solution and an economic return, I think it could snowball and gain momentum.

I will go out on a limb. I would say, with respect to Lake Michigan, the vision could be achieved in the next five years. I have analyzed the geology of the Lake Michigan basin and I find that every city has access to waste land which is unproductive, within 100 miles of the city, which could assimilate all of the waste without any direct discharge to the water courses. As a rule of thumb, 130 acres are needed, to handle a million gallons a day.

Mr. Moss. As I said, I think it is a thought provoking statement. But it takes time to sell communities even wise investments. It takes dollars to build them and these are very, very competitive dollars, because, while we are talking about this part of our environment, we have air pollution, noise pollution, and other pollutional problems. The entire environment is being hit with increasing pressures from an ever-growing number of sources.

At the same time, local governments have almost reached a breaking point in so far as their limited tax base is concerned. So the practical question is, how many years would it take?

Let's take the Lake Erie Basin, or Lake Michigan. How many communities contribute to the pollution there?

Dr. SHEAFFER. I don't have the exact number here.

Mr. Moss. How many millions or billions of dollars would it take to construct a series of the type of plant proposed here and have it operational? And while I think the figures are conservatively stated, you are going to utilize land that is not now productive, while we are at the same time paying to keep other land from producing. How do we realize this benefit from the addition of that land to what appears at the moment—I recognize that it is a transitory period in our history, but at least at the moment land is excess in this country. It produces more than we can consume. And apparently more than we can market, without some very complex and rather sophisticated means of giving away part of that product.

Dr. SHEAFFER. I think you have raised three points and I would like to refer to them in order. First, you raised a question of acceptance. Here I will speak of the two pilot areas where both county governments have been reapportioned on a one man one vote basis. These governments are the voice of all of the people within the governmental unit.

Muskegan County adopted the resource management approach, with an unanimous vote. To my knowledge it is the only unanimous vote they have ever had. But nevertheless, on this issue they adopted it unanimously.

In Ottawa County, also, the approach was adopted unanimously. These two counties accepted this approach which was developed in the last 6 months. In Michigan, Muskegan County moved first and

Ottawa County followed suit. The idea has since taken hold in Allegan County to the south and Oceanic and Mason Counties to the north. This chain reaction has taken place in a period of approximately three months and could be encouraged to extend to other areas. There is obvious evidence of acceptance.

The next question relates to cost. The costs of the resource management approach compare favorably with the costs which are going to be superimposed upon communities in order to comply with adopted water quality standards. For example, the four State Lake Michigan Conference requires that by 1972, 80 percent of the phosphates will be removed. An analysis of Muskegan County which compares the resource management approach with the activated sludge plant approach, showed that the new approach would save the local citizens an average of $3 per capita per year. There is another potential savings. The four State Lake Michigan Conference requires the separation of storm and sanitary sewers by 1977. Because of the storage in the lagoons included in the resource management approach combined overflow could be stored and treated, thereby, making separation unnecessary in many locations.

The final point deals with surplus. Apparently we have not been able to figure out a way to prevent half of the people in the world from going hungry. But I think as long as half of the people in the world do go to bed hungry each night, our perception of a surplus is a myth. It is a surplus which we want and need. I think institutionally we will devise programs so that half of the people of the world need not go to bed hungry.

Mr. Moss. Doctor, I wish you could sit on this side of the table when you make the statement that it is a surplus which we want, and take some of the heat that goes with that surplus and with seeking the solutions.

You mentioned $800 million as an appropriation. We don't know how much of that is going to be permitted to be spent. Congress has shown it is willing to appropriate, but we have other problems which impinge upon the matter of availability. Until we have a clearer statement from the Administration or from the Bureau of the Budget, we have no way of knowing how much of that is going to be available.

(Note.—On February 2, 1970, the President approved the release of the $800 million for waste treatment works construction grants provided for in Public Law 91-144 (80 Stat. 1248, December 11, 1969).)

Mr. Moss. That brings me to the next question I have, which is how much time have we to move to effect a solution?

Dr. SHEAFFER. The testimony that you have heard in the last two days suggests great uncertainty about how much time we have. I am all for moving as expeditiously as possible, because I think that our environmental condition is rapidly deteriorating. Efforts in all areas must move forward concurrently, we need action as quickly as we can get it.

I would not advocate waiting five years. I advocate all areas tributary to the Great Lakes implement a resource management approach to water quality management in time to meet the 1972 deadlines.

Mr. Moss. We have a situation out in my State, in which Lake Tahoe appears to be rapidly approaching the point of becoming a dead body of water. We have a somewhat comparable situation in

San Francisco Bay. I could name a considerable number of other bodies of water where we have serious pollution problems. I don't think we have very much time.

Dr. SHEAFFER. I agree.

Mr. MOSS. I recognize you did not say in your statement that you would view the approach of controlling the amount of pollutants entering our streams as being unrealistic, but you would advance your proposal as a means of more complete recovery of these polluting factors.

Am I correct in placing that interpretation upon your statement?

Dr. SHEAFFER. Right. I am proposing a total solution, and what you are saying is perhaps we need an incremental interim solution. I would agree.

Mr. MOSS. I am afraid we do. I might point out there is another factor here—the American public. I recently polled my district and I asked questions in some detail on pollution. The response to that questionnaire, running some 15,554, was put through a computer, so that we have a demographic breakdown on every single response. It is an area where the average person replying had an income of more than $10,000 a year, was a university graduate, 98 percent of them voted in the last election. They are actively interested people, and 96.4 percent of them felt we were not doing enough to deal with the problem of water pollution, while just under 95 percent of them felt that it was primarily a Federal responsibility to undertake the funding of the programs and to do it promptly.

So there is a great public demand that is building up. And I think it is going to require that we have that interim solution.

Mr. Vander Jagt?

Mr. VANDER JAGT. Thank you very much.

Dr. Schaeffer, yesterday we were told by Assistant Secretary Klein that the primary emphasis in the removal of phosphates that get into our system will be for the time being—while they look for a substitute—on the sewage treatment plants and the facilities. And he is talking about the sewage treatment plants that you just described, that are based on 1914 technology.

The pilot program that you described is rather startling stuff. If I understood you correctly, you said for this whole county of Muskegan, and the whole county of Ottawa, no sewage treatment plant as such is needed at all.

That would lead me to conclude that in our present efforts, through FWPCA, we are heading in the wrong direction; and as I understood your testimony, it was not doing the job, in that we only have 80 percent removal of phosphate pollutants.

It does not even touch the viruses. Is it your opinion that this Nation is headed down the road in the wrong direction in its efforts to clean up its water?

Dr. SHEAFFER. I think the General Accounting Office report more or less concluded that we spent over—what was it—$5.4 billion to build over 9,000 projects and there was very little improvement in the environment.

Now it did say that it perhaps would have been worse had we not spent this $5.4 billion. But this is strictly conjecture. There is no evidence to suggest how much worse it would have been.

I think one can look at that report and especially interpret the Merrimac Basin analysis, which was kind of highlighted in that report, and conclude it indicates that we are applying an ineffective technology.

If we can spend $8 million and increase it to $232 million and only produce incremental improvements in quality, this would indicate that the treatment plant approach is not the right one. Particularly when the parameters elected for analysis is dissolved oxygen, a parameter for which activated sludge is deigned because it removes the oxygen demanding materials.

Mr. VANDER JAGT. This is startling stuff. We are talking about a program that approaches $10 billion and $20 billion in terms of our sewage treatment plants. And you are telling us maybe it is the wrong approach. Earlier Chairman Reuss said in our efforts to clear up our environment, waybe what we needed was a James Webb to do for the war on pollution what James Webb did for space, or someone to do for pollution what the Manhattan project did for releasing energy from the atom.

You mentioned in your oral statement that we are suffering from disjointed incrementalism in our efforts to clean up our environment. What did you mean by "disjointed incrementalism"?

Dr. SHEAFFER. I meant that we have governmental agencies at every level—Federal, State, and local—acting independently and often in conflict. This is what makes it disjointed. There is no centralized planning, there is no vision as to how we are going to cope with the problem. The incremental aspects are evident from the subject of this hearing. We can get at phosphate based detergents, because there are only a few corporations which make them. It is analogous to SO_2 reduction in air pollution control. The power plants make an easy target. The problem with the incremental approach is that we do not keep the target pollutants in context. We seldom consider the whole array of problems and pollutants which are associated with it. This is what makes it incremental.

The approach is also incremental in its effects. I am somewhat skeptical about sewage treatment plants as now being advocated. In the twenties and thirties people were told if they built a certain kind of treatment plant, there wouldn't be any water pollution. They built the treatment plants, but still have the water pollution.

I think we are moving again toward a repeat in history. Chemical replacements which are becoming very much in evidence will be adding substances to the water which in a few years may be problems.

Mr. VANDER JAGT. When we were told yesterday that the major thrust of FWPCA right now is in the area of sewage treatment plants, as I understand it, they were talking about 80 percent removal of phosphates. You say that yours is a total solution. Do I understand that 80 percent removal of phosphates is really not so much related to what is necessary to make our lakes and rivers pure and clean again as it is to what under the 1914 technology we are capable of achieving?

Dr. SHEAFFER. That is right.

Mr. VANDER JAGT. You say yours is a total solution. What do you mean by that?

Dr. SHEAFFER. First of all, 80 perecent removal is very misleading It is 80 percent removal of some pollutants. It obviously is not 80 per

cent removal of viruses, color, potassium, nitrates, and chlorides. It generally means 80 percent removal of suspended solids and BOD. These two parameters are often highlighted because our current approach is designed to cope with them.

The resource management approach can effectively reduce the whole range of pollutants, because it encompasses a number of treatment mechanisms. In the treatment lagoons, the solids settle out, heavy metals settle out, the aeration reduces the BOD; the nitrates and phosphates are fixed in the algal cell material. The wastes, when applied on the land, are treated by the biological zone or living filter. Dissolved nutrients are removed along with heavy metals and viruses. The heavy metals that pass through the treatment lagoons are held by the organic matter, and the clay, or are taken up by the plants. The viruses are held by the sand and clay particles. The nutrients are taken up by the plants. And we have more or less good quality water moving down to the water table where it moves as base flow or is pumped into a stream and returned to the original water source.

By closing the system, we can use the pollutants in the water, get an economic return from them, and still have the water available for reuse.

Mr. Vander Jagt. Perhaps that relates, Dr. Sheaffer, to what Congressman Moss was asking you about acceptance by total solution. As I understand the system, then, you aren't just talking about the sewage that comes from the household, the detergent that flows in, or the human sewage. It handles industrial sewage as well.

You mentioned that people were told in the twenties that if they built these sewage treatment facilities, we wouldn't have water pollution and the problem would be solved. They did, and it is not adequate. So there has been resistance to move forward. What has been the acceptance of industry in the areas when you offer them a total solution?

Dr. SHEAFFER. I think the acceptance has exceeded anything we could have hoped for. There is a large paper mill in Muskegon County. This paper mill like many other paper mills is having a solids problem. The conventional sewage treatment plan has difficulty handling solids. So the industry has to pre-treat, it has to remove the solids before it can discharge into the conventional treatment plant.

This creates a huge problem of storage and disposal of the removed wastes. The resource management approach, incidentally handles solids. When the waste water is applied on the land, the solids can be included with the waste water.

When this point was brought up in Muskegon, the immediate reaction of the industry was if you can solve our problem in that way, in a total solution, we then are in a position to consider building a new division to produce sanitary products. Something of importance in a county which is plagued by unemployment and in an EDA area.

I don't know of any other cases where a plan to solve the waste water management problems triggered the type of economic discussions which have taken place there. And this leads me to believe that industry would move very quickly on such a solution. I was told by the director of the local Manufacturers Association, that industry is eager to get a solution. They are not interested in an incremental approach which calls for periodic and unscheduled add-ons.

Mr. VANDER JAGT. Well, this is a grand and glorious vision you have given us, Dr. Sheaffer. If the Nation changes the direction it is going in terms of its sewage treatment plants, we will be putting water back into the lakes and rivers that is as pure as when the white man first saw them. This system that you are proposing must be phenomenally expensive, isn't it?

Dr. SHEAFFER. No, it is not. I think if we put it on a comparable basis, it will cost less than the activated sludge plant approach.

Mr. VANDER. JAGT. It costs less than the 1914 technology that we are using today.

Dr. SHEAFFER. That is right.

Mr. VANDER. JAGT. And instead of 80 percent, it gives a total solution.

Just one last question: What you have presented here in the detailed supporting documents looks like great theory and it is a beautiful vision. It is a great theory. Will it work?

Dr. SHEAFFER. There are a lot of people who have laid their total professional careers on the line and said it will work. This represents a team of scientists—engineers, sanitary engineers, microbiologists, virologists, resource managers, environmental geologists—who have worked with the system, and they feel that every component of it has been tried independently and proven.

So we are simply taking the best out of a number of systems, putting it together in a little different manner, and offering a new way of managing our waste waters. Furthermore, if it is good theory it obviously would work.

Mr. VANDER JAGT. Thank you very much, Dr. Sheaffer, and thank you very much for presenting before this committee a vision of clean water. Thank you, Mr. Chairman.

Mr. REUSS (presiding). Mr. Hicks?

Mr. HICKS. No questions.

Mr. REUSS. Dr. Sheaffer, I did read your full statement with great interest. Unfortunately I had to be absent while you were testifying. I would have just one question. Yours is a proposal for a complete waste water recycling; is it not?

Dr. SHEAFFER. Yes.

Mr. REUSS. If it should turn out that phosphates can, on an admittedly incremental basis, be eliminated or greatly reduced in detergents, that would in no way lessen the reason for adopting proposals like yours, if they are feasible, would it? There is still plenty of waste water with the phosphates removed, and even with the removal of phosphates from detergents there would still be a considerable amount of phosphates left in the waste water. So you would get your fertilizing effect, would you not?

Dr. SHEAFFER. That is what I would want. If one were able to remove enough sources of phosphates that there wouldn't be the fertilizing effect, then obviously it would be counter. But to reduce phosphate content to 25 to 30 percent would still be compatible. It is conceivable that if all the phosphates were removed from detergents the other sources of phosphates in waste water would provide an adequate supply.

Mr. REUSS. Thank you. We do appreciate your contribution.

This concludes our witnesses for this extraordinarily interesting two days of hearings.

We shall now ponder the testimony. Speaking for myself, some tentative conclusions of a general nature certainly emerge. That phosphates are a leading cause of the degradation of a great deal of our waste water; that the detergent industry is a leading introducer of phosphates into our waste water; and finally, that a very considerable reorganization of our battle against pollution is going to be necessary if we are going to cope with this problem.

Mr. Vander Jagt, would you like to comment?

Mr. VANDER JAGT. I would just say, Mr. Chairman, that I think you have summarized very well the conclusions that I think many of the other members of this committee and I have reached. I have not been at all satisfied myself with the efforts that are being made to deal with the problem of phosphates spewing forth into our lakes and streams.

Mr. REUSS. Mr. Hicks?

Mr. HICKS. Well, I found the hearings very interesting, Mr. Chairman, and I have learned a great deal.

Mr. REUSS. We will keep the hearing record open for a reasonable period of time in order to permit the introduction of any additional materials.

If there is no further business, the Subcommittee on Conservation and Natural Resources will now stand in adjournment.

(Whereupon, at 1:25 p.m., the hearing was adjourned.)

APPENDIXES

APPENDIX 1

91st CONGRESS
1st SESSION

H. R. 12435

IN THE HOUSE OF REPRESENTATIVES

JUNE 25, 1969

Mr. REUSS introduced the following bill; which was referred to the Committee on Public Works

A BILL

To amend the Federal Water Pollution Control Act to protect the navigable waters of the United States from further pollution by requiring that synthetic petroleum-based detergents manufactured in the United States or imported into the United States be free of phosphorus.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*
3 That the Federal Water Pollution Control Act (33 U.S.C.
4 466–466n) is amended by redesignating sections 12 through
5 19 as sections 13 through 20, respectively, and by inserting
6 immediately after section 11 thereof the following new
7 section:

I

41-607 O - 70 - 16

1 "REGULATION OF DETERGENTS

2 "SEC. 12. (a) The Congress finds that the navigable
3 waters of the United States are being irreparably polluted by
4 excessive algae growth fertilized by phosphates discharged
5 into such waters as constituents of synthetic petroleum-based
6 detergents. The Congress further finds that to prevent the
7 further pollution of the navigable waters of the United States
8 in the public interest it must regulate the phosphorus content
9 of detergents which will eventually be discharged into the
10 navigable waters of the United States, but because of the
11 impossibility of determining and thereby effectively regu-
12 lating only those detergents it must regulate all detergents
13 manufactured in the United States or imported into the
14 United States. Therefore, it is the policy of the Congress by
15 the enactment of this section to invoke and exercise its fullest
16 constitutional powers in order to effectively regulate the phos-
17 phorus content of all such detergents.

18 "(b) It shall be unlawful after June 30, 1971, for any
19 person to import into the United States or manufacture in the
20 United States any detergent containing phosphorus.

21 "(c) (1) Any detergent containing phosphorus im-
22 ported or manufactured in violation of this section shall be
23 liable to be proceeded against on libel of information and con-
24 demned in any district court in the United States within
25 the jurisdiction of which such detergent is found.

1 "(2) Such detergent shall be liable to seizure by process
2 pursuant to the libel, and the procedure in cases under this
3 subsection shall conform, as nearly as may be, to the proced-
4 ure in admiralty; except that on demand of either party any
5 issue of fact joined in any such case shall be tried by jury.
6 When libel for condemnation proceedings under this subsec-
7 tion, involving the same claimant and the same issues, are
8 pending in two or more jurisdictions, such pending proceed-
9 ings, upon application of the United States or the claimant
10 seasonably made to the court of one such jurisdiction, shall
11 be consolidated for trial by order of such court, and tried in
12 (A) any district selected by the applicant where one of
13 such proceedings is pending; or (B) a district agreed upon
14 by stipulation between the parties. If no order for consolida-
15 tion is so made within a reasonable time, the United States
16 or the claimant may apply to the court of one such jurisdic-
17 tion, and such court (after giving the other party, the claim-
18 ant, or the United States attorney for such district, reasonable
19 notice and opportunity to be heard) shall by order, unless
20 good cause to the contrary is shown, specify a district of
21 reasonable proximity to the claimant's principal place of
22 business, in which all such pending proceedings shall be
23 consolidated for trial and tried. Such order of consolidation
24 shall not apply so as to require the removal of any case the
25 date for trial of which has been fixed. The court granting

1 such order shall give prompt notification thereof to the other
2 courts having jurisdiction of the cases covered thereby.
3 "(3) Any detergent condemned under this subsection
4 shall, after entry of the decree, be disposed of by destruction
5 or sale as the court may, in accordance with the provisions
6 of this subsection, direct and the proceeds thereof, if sold,
7 less the legal costs and charges, shall be paid into the Treas-
8 ury of the United States; but such detergent shall not be sold
9 under such decree for a use which would result in the pollu-
10 tion of the navigable waters of the United States contrary to
11 subsection (a) of this section; except that after entry of the
12 decree and upon the payment of the costs of such proceedings
13 and the execution of a good and sufficient bond conditioned
14 that such detergent shall not be sold or disposed of contrary
15 to the provisions of this section, the court may by order direct
16 that such detergent be delivered to the owner thereof to be
17 destroyed or brought into compliance with the provisions of
18 this section under the supervision of an officer or employee
19 duly designated by the Secretary, and the expenses of such
20 supervision shall be paid by the person obtaining release of
21 the detergent under bond.
22 "(4) When a decree of condemnation is entered against
23 the detergent, court costs and fees, and storage and other
24 proper expenses, shall be awarded against the person, if any,
25 intervening as claimant of the detergent.

1 "(5) In the case of removal for trial of any case as pro-
2 vided by paragraph (2) of this subsection—
3 "(A) the clerk of the court from which removal is
4 made shall promptly transmit to the court in which the
5 case is to be tried all records in the case necessary in
6 order that such court may exercise jurisdiction; and
7 "(B) the court to which such case is removed shall
8 have the powers and be subject to the duties, for pur-
9 poses of such case, which the court from which removal
10 was made would have had, or to which such court would
11 have been subject, if such case had not been removed.
12 "(d) (1) The United States district courts shall have
13 jurisdiction, for cause shown and subject to the provisions of
14 rule 65 (a) and (b) of the Federal Rules of Civil Proce-
15 dure, to restrain violations of this section.
16 "(2) In any proceeding for criminal contempt for vio-
17 lation of an injunction or restraining order issued under this
18 subsection, which violation also constitutes a violation of this
19 section, trial shall be by the court or, upon demand of the
20 accused, by a jury. Such trial shall be conducted in accord-
21 ance with the practice and procedure applicable in the case
22 of proceedings subject to the provisions of rule 42 (b) of the
23 Federal Rules of Criminal Procedure.
24 "(e) All libel or injunction proceedings for the enforce-

1 ment, or to restrain violations, of this section shall be by and
2 in the name of the United States. Subpenas for witnesses
3 who are required to attend a court of the United States in
4 any district may run into any other district in any such
5 proceeding.

6 "(f) The Secretary of the Treasury and the Secretary
7 shall jointly prescribe regulations for the efficient enforce-
8 ment of the provisions of subsection (h) of this section,
9 except as otherwise provided therein. Such regulations shall
10 be promulgated in such manner and take effect at such time,
11 after due notice, as the Secretary shall determine.

12 "(g) (1) The Secretary is authorized to conduct exami-
13 nations, inspections, and investigations for the purposes of
14 this section.

15 "(2) For purposes of enforcement of this section, offi-
16 cers or employees duly designated by the Secretary, upon
17 presenting appropriate credentials and a written notice to
18 the owner, operator, or agent in charge, are authorized (A)
19 to enter, at reasonable times, any factory, warehouse, or es-
20 tablishment in which detergents are manufactured, processed,
21 packed, or held, or to enter any vehicle being used to trans-
22 port or hold such detergents; (B) to inspect, at reasonable
23 times and within reasonable limits and in a reasonable man-
24 ner, such factory, warehouse, establishment, or vehicle, and
25 all pertinent equipment, finished and unfinished materials;

1 and (C) to obtain samples of such materials. A separate
2 notice shall be given for each such inspection, but a notice
3 shall not be required for each entry made during the period
4 covered by the inspection. Each such inspection shall be
5 commenced and completed with reasonable promptness. If
6 the officer or employee obtains any sample, prior to leaving
7 the premises, he shall give it to the owner, operator, or agent
8 in charge a receipt describing the samples obtained. If an
9 analysis is made of such sample, a copy of the results of such
10 analysis shall be furnished promptly to the owner, operator,
11 or agent in charge. If the owner, operator or agent in charge
12 of the factory, warehouse, establishment or vehicle refuses
13 to permit the Secretary's designee to enter, inspect or obtain
14 samples as authorized by this subsection, the Secretary's
15 designee may seek a warrant from any court or magistrate
16 to enter, request or obtain samples as authorized by the sub-
17 section, and such warrant shall be granted if the court or
18 magistrate finds probable cause to believe that detergents
19 containing phosphorus which were imported or manufactured
20 in violation of this section are in the factory, warehouse, es-
21 tablishment or vehicle.

22 "(h) (1) The Secretary of the Treasury shall deliver to
23 the Secretary, upon his request, samples of detergents which
24 are being imported or offered for import into the United
25 States, giving notice thereof to the owner or consignee, who

1 may appear before the Secretary and have the right to intro-
2 duce testimony. If it appears from the examination of such
3 samples or otherwise that such detergent contains phos-
4 phorus, such detergent shall be refused admission, except as
5 provided in paragraph (2) of this subsection. The Secretary
6 of the Treasury shall cause the destruction of any such deter-
7 gent refused admission unless such detergent is exported,
8 under regulations prescribed by the Secretary of the Treas-
9 ury, within ninety days of the date of notice of such refusal
10 or within such additional time as may be permitted pursuant
11 to such regulations.

12 "(2) Pending decision as to the admission of a deter-
13 gent being imported or offered for import, the Secretary of
14 the Treasury may authorize delivery of such detergent to
15 the owner or consignee upon the execution by him of a good
16 and sufficient bond providing for the payment of such liqui-
17 dated damages in the event of default as may be required
18 pursuant to regulations of the Secretary of the Treasury.

19 "(i) The following terms used in this section shall have
20 the meanings listed below:

21 "(1) 'Detergent' means any synthetic surface active
22 cleaning agent.

23 "(2) 'Phosphorus' means phosphorus in excess of such
24 minimal quantities as the Secretary shall determine by regu-

1 lation not to be economically susceptible to removal, or
2 needed for medical, scientific or special engineering use
3 under such conditions and safeguards against pollution of
4 navigable waters as he may prescribe by regulation."

F. Alan Ferguson

A NONMYOPIC APPROACH TO THE PROBLEM OF EXCESS ALGAL GROWTHS

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A Nonmyopic Approach to the Problem of Excess Algal Growths

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One of the more serious results of water pollution that prevails in the United States is excess algal growths. Even though some localities have struggled to control these growths for many years, the extent of the problem and the consequences if it is not controlled have only recently received nationwide attention.

The desirability of controlling algal growths is now generally acknowledged. Unfortunately, developing control programs is hampered by the problem's complexity and by the lack of adequate information on the effectiveness of possible control measures. Therefore, some authorities argue that a myopic approach is necessary and that any control measure with a chance of improving the situation should be imposed. Others insist that more research should be undertaken to provide some of the important information now lacking. Otherwise the enforced controls are apt to be unnecessarily costly, ineffective, or both. This article presents a case for the nonmyopic approach.

Character of the problem

Excess growths of algae occur in water wherever abundant quantities of food and nutrients are present and other conditions—such as adequate sunlight and proper temperatures—are favorable for growth. Reports indicate that more than 50% of the total municipal water suppliers are affected by the problem.

The near-term consequences of the excess growths are bodies of water (particularly lakes and slowly moving rivers), so filled with algae that even they can't survive. Foul odors emanate from the decay of the dead algae, and the water tends to lose dissolved oxygen, causing extensive fish kills. The growths also create problems in raw water supplies for municipal and industrial use, since water containing excess algae costs more to clean up. Another serious result is lessened desirability of the water for recreational pursuits.

Eventually the body of water becomes so committed to the growth of algae that few forms of fish can survive and it gradually fills with dead organic matter.

The growth of algae is currently more serious a problem in lakes than in rivers and streams. Frequently, if algae grow in rivers or streams, the organisms are swept along and do not fill the river bottom. In many rivers, the silt load is so heavy that algae cannot grow abundantly, even though the water is polluted with growth-prompting materials. Unfortunately, as more dams and reservoirs are constructed along major rivers to improve navigation and flood control, large portions of rivers also will be subjected increasingly to periods of excess algal growth.

Studies into the causes of excess algal growths have tended to concentrate on the importance of nitrogen and phosphorus compounds with relatively little attention being given to the other substances known to promote the growths or to determining the unknown causes of such growths. Technical journals of the past 20 years contain numerous technical articles on the role of phosphorus and nitrogen in excess growth of algae.

This concentrated attention has led the advocates of the myopic approach to propose that the quantities of nitrogen and phosphorus must be reduced to prevent excess growth of algae. Everyone agrees that if no phosphorus or nitrogen were available, algae would not grow. But equating a reduction in nitrogen and phosphorus concentrations to a proportional reduction in the growth of algae is not justified. Too many other factors contribute to the growth of algae. In order to control algal growth we need to know which are the major factors, how they contribute individually and collectively to algal growth, and how much control of each is necessary and possible. Few of these questions have been answered and I believe they should be answered before any extensive control measures are instituted.

Current state of knowledge

The rate and amount of algal growth depend on:

- The amounts of growth-promoting factors in the algae's environment.
- The relative importance of these factors to the growth.

The relative importance of temperature is known: The rate of algal growth roughly doubles with every 20° F. rise in water temperature between 32° F. and 90° F. Some data are available on effects of varying con-

Some authorities feel that something—anything—must be done at once to control excess algal growth in lakes and rivers. Yet, some additional study could prevent the adoption of unnecessarily costly or ineffective controls

centrations of nitrogen and phosphorus. Studies of Wisconsin lakes show that excessive growths can be expected if the average concentration of inorganic nitrogen exceeds 0.3 p.p.m. and the inorganic (soluble) phosphorus content exceeds 0.01 p.p.m. during the seasons of algal growth. Other research shows that excessive growths can occur in waters containing less than 0.001 p.p.m. inorganic phosphorus. However, some waters containing as much as 0.05 p.p.m. soluble phosphorus do not support excess algal growths.

These wide ranges of phosphorus concentrations suggest that:

- In some cases drastic reduction in the availability of this element is necessary to prevent growth.
- Excess growth might be prevented in other instances, even though the phosphorus concentration might remain relatively high, by reducing the concentration of other materials that affect algal growth.
- Better means for inhibiting algal growth may exist than the reduction of the phosphorus concentration in algae infested water.

Among the materials that might be controlled to prevent excess growth in these waters are some trace elements: manganese, boron, cobalt, and vanadium, which are known to be required for optimum algal growth. Vitamins and hormones are also known to stimulate algal growth. As far as I have been able to determine, little has been done to establish how much of any of these materials can be present in surface waters and still have them free of excess algal growth.

Once we get information on the relative effects of these other materials, we will then need to know their sources and how to regulate them and also the sources and mechanisms for regulation of phosphorus and nitrogen before excess algal growths can be controlled. Here again, the available information is sparse.

Sources of nutrients

Man and nature both supply nutrient materials that increase algal growth in surface waters. (Thermal energy added to surface waters from man-generated sources, such as waste cooling water from power plants, also increases algal growth, but the effect of such thermal energy is not examined here.)

The major natural sources of algal growth materials or AGM (see Table 1) identified to date are:

- **Air.** Provides carbon dioxide, as well as nitrogen, which some algae can fix or utilize.
- **Rain.** Contains not only carbon dioxide or carbonates, but also such nutrients as phosphorus and nitrogen. Nutrients are more prevalent in rainfall near urban areas, suggesting man contributes them to this source.
- **Water plants and animals.** Materials in the aquatic environment have the most direct impact on algal growth. Carbon dioxide is supplied as inorganic carbonates, from aerobic decomposition of natural organic matter, and by the breathing of water animals. Nutrients go through the biological cycle, being stored, used, and discarded by all water plants and animals, including bacteria.
- **Muds under water bodies.** Muds receive dead and fecal matter from aquatic life, plus man-generated wastes heavy enough to settle. At least a portion is decomposed and returned to the water in soluble form. Muds, therefore, are potential sources of all the types of food and nutrients algae need.
- **Runoff from land.** Waters that run off natural or uncultivated land contain organic matter and at least some nutrients.

Man-generated sources include:

- **Sewage.** Domestic sewage from households contains decomposable organic matter, bacteria, and all known nutrients. They are present even after secondary treatment in a sewage plant. Industrial sewage may contain the same ingredients with, on occasion, just one or two nutrients in relatively high concentration.
- **Runoff from land.** The same materials will be in the runoff from the urban and agricultural land used by man as in the runoff from natural land.

Quantities of nutrients

Relatively few studies have been conducted in the U.S. to determine how much growth material is contributed by individual sources. The data from these studies have been used to estimate the total nationwide contribution from each source (as shown in Table 2).

Due to the paucity of data, some of the figures presented in Table 2 are

TABLE 1

Sources of algal growth materials

Source	Material contributed				
	Organic matter	Nitrogen	Phosphorus	Potassium	Other
NATURAL					
Air	[a]	X			
Rainfall	X[a]	X	X	X	
Aquatic plants	X	X	X	X	X
Waterfowl, fish, bottom fauna, and the like	X	X	X	X	X
Muds under water bodies	X	X	X		
Runoff from					
Forest land	X	X	X	X	
Other land	[b]	[b]	[b]	[b]	
MAN-GENERATED SEWAGE					
Domestic					
Human and food wastes	X	X	X	X	X
Washing wastes	X	X	X	X	
Industrial					
Food processing wastes	X	X	X	X	X
Other wastes		X	X	X	
RUNOFF FROM					
Urban land	X	X	X		
Cultivated land					
Fertilized	X	X	X	X	
Unfertilized	X	X	X	X	
Land on which animals are kept	X	X	X	X	

[a] Source of carbon dioxide
[b] Quantity undetermined

gross extrapolations of the available information. For example, the 200 million pounds of nitrogen expected from urban runoff is based on the assumption that the average runoff from the entire urban area in the country (close to 23 million acres) will be the same as that from a single 27-acre plot studied near Cincinnati, Ohio.

The AGM data are also subject to considerable uncertainty. In some instances, the reported values vary more than twentyfold. For example, nitrogen entering surface waters in the United States through rainfall might be anywhere from 30 to 590 million pounds a year.

The runoff from cultivated land is the only source that has been the subject of several studies. The data on phosphorus contribution from runoff from cultivated land show surprising consistency, considering the variations in rainfall, crops raised, amount of irrigation, and types of soils. Apparently the per-acre contribution of phosphorus to surface waters by small plots can vary widely. For example, phosphorus from runoff from cultivated land varied from 0.2 to more than 0.9 pound per acre per year from specific areas within 358 acres of cotton in the San Joaquin Valley in California. However, if the area studied is large enough, the variations seem to even out. Approximately a fourfold variation in runoff, from 0.35 to 1.33 pounds of phosphorus per acre, exists if averages are taken for each of the several areas studied (as shown in Table 3).

Data analysis

On the basis of available data (Table 2), U.S. surface waters receive 5.0–8.2 billion pounds of nitrogen and 0.9–1.7 billion pounds of phosphorus annually from natural and man-generated sources. While the total quantities of nitrogen and phosphorus would be higher if data on sources such as industrial wastes and bottom muds were available, the percentage contribution from natural and man-generated sources would probably remain the same (see Table 4). Not enough data on organic matter are available to make a meaningful comparison.

As much as 80% of the nitrogen and 75% of the phosphorus apparently come from man-generated sources.

These high levels indicate the tremendous impact man has on his environment. And, yet, they hold forth the hope that, by exercising proper control, man can restore balance to that environment.

Restoring that balance may not be easy. The largest identified man-generated source of nitrogen is runoff from cultivated land (see Table 5). While farming practices might be altered to reduce the amount of runoff, a sizable reduction is unlikely. Another possible approach might be to use slow release fertilizers that would not dissolve readily in the rain and irrigation water that constitute runoff.

Domestic sewage, which contributes about a third of the nitrogen known to enter surface waters, also presents a difficult control problem. Even though most of the sewage will be collected and treated in large plants, no economic means is currently available for removing nitrogen. Growing algae in sewage plant effluent should reduce the quantity of soluble nitrogen. However, removal of algae before effluent discharge has proved difficult and expensive. Anaerobic denitrification after secondary treatment can convert the nitrates to nitrogen, but this procedure requires addition of organic materials that do not themselves contain nitrogen, and, of course, adds to this treatment cost.

The distribution is somewhat different for the man-generated sources of phosphorus (compare Tables 5 and 6). Roughly half of this phosphorus comes from domestic sewage. In some situations, removal of phosphorus is simpler than removal of nitrogen, because, unlike compounds of nitrogen, many inorganic phosphates are insoluble in water.

For example, more than three quarters of the phosphates entering one Chicago treatment plant are removed by the plant. The raw sewage to this plant comes from both residences and industry. The nature of the industrial portion of the sewage is such that it contains a greater than normal proportion of metal ions. These ions react with the phosphates to form precipitates that are removed as part of the sludge. Few treatment plants have such a fortunate combination of sewage sources. On the other hand, deliberately adding metal ions to sewage plant

TABLE 2

Approximate quantities of algal growth materials

(from sources either in or entering U.S. surface waters)

Source	Quantities available (millions of pounds per year)		
	Organic matter	Nitrogen	Phosphorus
NATURAL			
Air		15–300[a]	
Rainfall (direct into surface water)	4,200–7,400 (COD)	30–590	2–17
Aquatic plants	n.a.	0–1,070	0–107
Waterfowl, fish, bottom fauna, and the like	n.a.	n.a.	n.a.
Muds under water bodies	n.a.	n.a.	n.a.
Runoff from			
Forest land (including commercial forests)	n.a.	990–2,250	243–587
Other land	n.a.	n.a.	n.a.
MAN-GENERATED SEWAGE			
Domestic			
Human and food wastes / Washing wastes	5,200 (COD)[b]	1,330[b]	137–166[b] 250–280[b]
Industrial			
Food processing wastes	n.a.	n.a.	n.a.
Other wastes	n.a.	n.a.	n.a.
RUNOFF FROM			
Urban land	5,500 (COD)	200	19
Cultivated land			
Fertilized	17,900 (COD)[c]	2,040[c]	110–380
Unfertilized	n.a.	n.a.	n.a.
Land on which animals are kept	n.a.	420	170

n.a. Not available
[a] Approximately half the quantity entering from rainwater
[b] Data based on the assumption of 70% removal of COD and 30% removal of nutrients in treatment plant
[c] Estimated

TABLE 3

Phosphorus entering surface waters with runoff[a] from cultivated land

	Size of site (acres)	Phosphorus entering surface water (pounds per acre per year)	
		Range	Average
Kaskaskia River, Ill.	3,320,000	0.02–0.76	0.35
Madison, Wis.	140,000	n.a.	0.40
San Joaquin Valley, Calif.	358	0.20–0.90	0.55
Yakima Valley, Wash.	265,000	0.9–8.9	1.33
Coshocton, Ohio	1.45	n.a.	1.2

[a] Includes runoff through drain tile under the crop land

streams has not always been so successful in removal of phosphates.

Control of phosphorus in runoff from cultivated land could be affected by the same measures used to control nitrogen from this source—that is, better irrigation practices and use of slow release fertilizers.

Control of runoff from areas where animals are kept also appears necessary, since about 20% of the man-generated phosphorus (as this kind of phosphorus is categorized) may come from such areas. The tendency in animal husbandry is to grow animals in greater numbers in more controlled environments—feed lots and commercial broiler plants, for example. Thus, the time may soon come when the waste from these operations will have to be treated much as domestic sewage is treated.

Elimination of detergent phosphate

Many solutions have been proposed to alleviate local problems of excess algal growth, but the only proposal that would have a nationwide effect is to prohibit use of phosphates in household detergents.

The effectiveness of this proposal would depend on how much the phosphorus concentration could be reduced in receiving waters. If the available data are correct, about 280 million pounds of phosphorus would be kept from the surface waters annually if no phosphates were put in detergents. At the very least, 680 million pounds would still enter these waters from other sources. The total annual streamflow in the continental U.S. is nearly 450 trillion gallons. If phosphorus from sources whose contribution to surface waters has been estimated were distributed equally in this streamflow, the average concentrations based on the minimum quantities would be as shown in Table 7.

Reduction in average concentration from 0.26 to 0.18 p.p.m. is significant, but the 0.18 p.p.m. figure is still more than 10 times the concentration believed to induce excessive algal growth. If the maximum, rather than the minimum, quantities of phosphorus were distributed in the streamflow, average concentrations would be 0.46 p.p.m. from all such sources and 0.38 p.p.m. from all such sources except detergents.

TABLE 4

Natural and man-generated sources of phosphorus and nitrogen

	Nitrogen		Phosphorus	
	Quantities (million pounds per year)	Per cent	Quantities (million pounds per year)	Per cent
Natural	1,035–4,210	21–51	245–711	26–41
Man-generated	3,990	79–46	686–1,015	74–57
TOTAL[a]	5,025–8,200	100%	931–1,726	100%

TABLE 5

Man-generated sources of nitrogen

Source	Quantities (millions of pounds per year)	Per cent
Domestic sewage	1,330	33%
Runoff from Urban land	200	5
Cultivated fertilized land	2,040	51
Land on which animals are kept	420	11
TOTAL[a]	3,990	100%

TABLE 6

Man-generated sources of phosphorus

Source	Quantities (millions of pounds per year)	Per cent
Domestic sewage	387–446	56–44%
Runoff from Urban land	19	3–2
Cultivated land	110–380	16–37
Land on which animals are kept	170	25–17
TOTAL[a]	686–1,015	100%

TABLE 7

Phosphorus concentration (hypothetical) in surface waters

	Total phosphorus (million pounds per year)	Average concentration (p.p.m.)
All estimated sources	980	0.26
All estimated sources except detergents	680	0.18
If 90% of phosphate in sewage is removed	560	0.15

[a] These totals do not include what may be substantial amounts of phosphorus and nitrogen from as yet unknown and unmeasured sources. Such additional phosphorus and nitrogen may have an effect on methods of controlling algal growth

Furthermore, since sizable quantities of phosphorus unquestionably enter the surface waters from sources such as industrial wastes and bottom muds (whose contribution is not included), the entering concentrations could be even higher. Thus, the benefits of prohibiting use of phosphates in household detergents seem marginal at best. If algal growth promoted by the presence of phosphorus is to be reduced significantly, means must be found to remove virtually all phosphorus arising from man-generated sources.

Those data also suggest another somewhat surprising possibility. A minimum of about 250 million pounds of phosphorus a year would still enter surface waters from natural sources even if all phosphorus from man-generated sources were excluded. The resulting average concentration in the total U.S. streamflow would be close to 0.07 p.p.m.—more than four times the concentration needed to induce excessive algae growth. Several explanations are possible:

- Excess algal growth from natural causes is more prevalent than generally believed.
- Estimates of phosphorus and nitrogen in runoff from natural or uncultivated land need to be revised downward.
- The frequently quoted concentration limit for phosphate (0.015 p.p.m. or less) is unduly low because the concentration of phosphate may not determine the extent of algal growth in many surface waters.

A course of action

This brief review of the present state of knowledge indicates that, before adequate solutions to the problem of excess algal growth can be found, we need to know more about the conditions leading to such growth and more information on the source of AGM.

For example, we need research to determine the effect of various forms of organic matter on excess algal growth. Can algal blooms occur when air and rain are the only source of carbon dioxide? If so, does the concentration of nutrients have to be higher than in water containing bacteria populations supported by biodegradable organics? Also, why is it that excess algal growths occur in some waters containing 0.001 p.p.m. soluble phosphorus but do not occur in waters where the concentration is 15 or even 50 times greater? The effect of the so-called micronutrients on algae growth should also be determined, as should the effect of other aquatic life.

Much of this work has already been done for phosphorus and nitrogen, although additional information is required on the quantities that come from sources for which no data exist—bottom muds, uncultivated land, and industrial sewage. Data on industrial sewage will be the most difficult to acquire because of the variey of materials in this type of sewage and the varying degrees of treatment it receives. Some additional work will also be required to establish how typical the nitrogen and phosphorus data are from a single area compared with those for the nation as a whole.

However, judging from the amount of effort expended to collect the information already available, completion of the tasks outlined above does not appear to be formidable. With this added knowledge, it should be possible to attack the problem of excess algal growth with a reasonable degree of assurance that the solutions proposed will have the desired effect.

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Effect of Carbohydrates on the Symbiotic Growth of Planktonic Blue-Green Algae with Bacteria

PHOSPHORUS and nitrogen have been suggested to be limiting agents in the unwanted growth of Cyanophyta. Removal of phosphorus from sewage effluents is being considered as the preferred method to control eutrophication. The significance of organic matter in lake water has been largely disregarded, although carbonaceous material is always found in productive lakes, for example, from 22 mg to 99 mg/l. of dissolved organic matter in the Great Lakes[1]. Massive growths of blue–green algae have been documented before the use of industrial phosphates, and they probably occurred always after a heavy influx of organic matter. Maximum growth of phytoplankton does not require high concentrations of phosphorus. As little as 0·02 mg of phosphorus/l. in natural lake water may sustain it[2]. Additional phosphorus alone does not increase growth because algal growth will depend on the presence and availability of not less than fifteen essential elements[3].

Planktonic Cyanophyta are always associated with bacteria, and I have found that abundant algal growth results from a symbiotic relationship within their systems. In particular, the results reported here suggest that the bacteria assimilate added carbonaceous material and produce carbon dioxide which accelerates algal photosynthesis. The addition of a source of carbon also apparently delays the bacterial assimilation of organic chelating agents which are necessary if nutritional elements are to remain accessible at a high *p*H. Reports[4–10] are consistent with various findings and, as a whole, support my conclusions.

I have grown the algae in Zehnder and Gorham's medium No. 11 (ref. 11) which contains, among other minerals, 6·9 mg of phosphorus/l., 81·7 mg of nitrogen/l. and only 6·7 mg of carbon/l. Half of the heavily inoculated growth medium was mixed with an aqueous solution of sucrose, the other half (the control) received an identical volume of distilled water. Quantities of 50 ml. of the two cultures were placed in 250 ml. Erlenmeyer flasks which were loosely capped with aluminium foil. The flasks were exposed to fluorescent illumination of 50 ft. candles (540 lux) in a 16–8 h cycle of light and dark at 22° C. The

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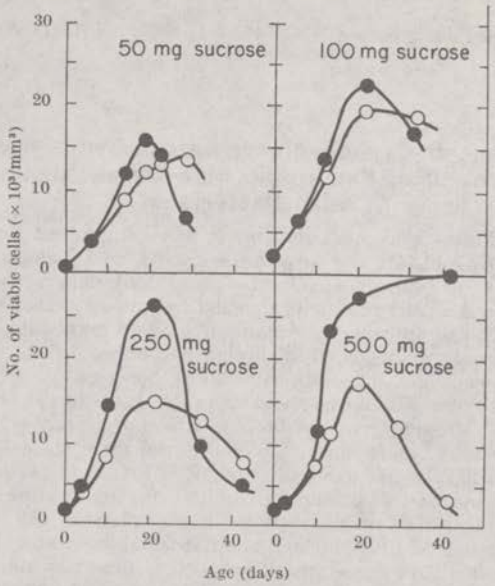

Fig. 1. Effect of added sucrose mg/l.) on *Microcystis aeruginosa* Kütz. Wisc. 1036 cultures containing bacteria. Starting concentrations were: 6·2 mg of phosphorus/l. as orthophosphate, 73·5 mg of nitrogen/l. as nitrate. Light was 50 ft.-candles (540 lux) at 22° C. Numbers of viable cells plotted versus age of cultures; ●—● sucrose cultures, ○—○ sucrose free control cultures.

*p*H of the cultures ranged from 8·9 at inoculation to 10·5 when growth was at a maximum, and it decreased when bacterial growth and cell lysis prevailed. For analysis, cells appearing viable on the basis of colour and refraction were counted in a haemocytometer, or the lengths of filaments were measured. Chemical oxygen demand was determined on the total culture and on the membrane filtrate; the difference was taken as the biomass.

The unialgal cultures of Cyanophyta containing bacteria which were used are shown in Fig. 1 and Table 3. Professor O. Jaag and Miss B. Egli of the Swiss Federal Institute of Technology provided axenic cultures[12] and bacteria-containing cultures of *Oscillatoria rubescens* (Fig. 2).

In four separate experiments with bacteria-containing *Microcystis aeruginosa* systems at different concentrations of sucrose (Fig. 1), the cultures containing sucrose showed greater growth than the controls. Maximum growth was often achieved within 3 weeks, and then the number of viable cells declined simultaneously with their discoloration. This decline seemed to coincide with the disappearance of the added carbonaceous matter and often was more rapid in the cultures fed sucrose.

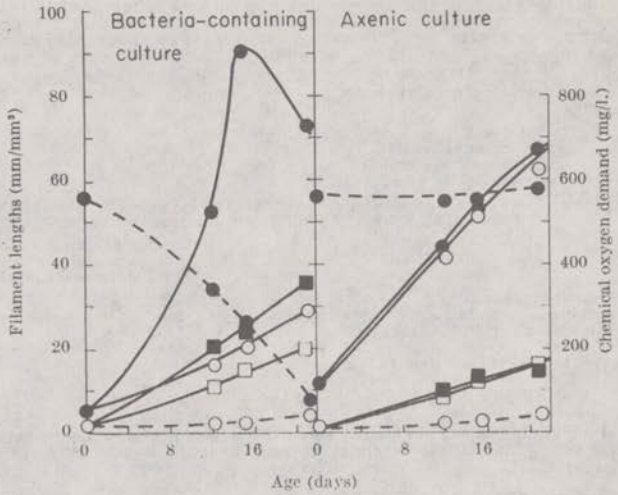

Fig. 2. Effect of added sucrose on cultures containing bacteria, EAWAG 18, Clone 51 (left) and on pure cultures of *Oscillatoria rubescens* DC. EAWAG 19, Clone 51 R (right). Starting concentrations: 5·3 mg of phosphorus/l., 80·6 mg of nitrogen/l., and 500 mg of sucrose/l. Light was 50 ft.-candles (540 lux) at 22° C. Total lengths of algal filaments and chemical oxygen demand of membrane filtrates and of biomass plotted versus age of cultures.

	Sucrose containing culture	Sucrose free control
Filament lengths	●——●	○——○
Chemical oxygen demand of filtrates	●- - -●	○- - -○
Chemical oxygen demand of biomass	■——■	□——□

The following observations suggest a protective function of the added source of carbon against bacterial degradation of the metal chelates. The membrane filtrate of declining control cultures still contained 1·0 mg of phosphorus/l. and 37 mg of nitrogen/l. The cultures could only be revived by the addition of a solution of ferric citrate, the minor elements, ethylenediamine tetraacetic acid (EDTA), and citric acid in the original concentrations, increasing the carbon content in the final culture by only 2·2 mg of carbon/l. The addition of the chelated metals slowly restored the blue-green colour of the algae, and growth resumed. Deterioration of the cultures soon started again, apparently as a result of bacterial assimilation of the insignificant amount of added organic chelating agents (Table 1). The large number of bacterial cells in deteriorating cultures fed sucrose prevented a revival because the added chelating agents were assimilated too rapidly. The blue-green colour was restored, but growth did not resume and the cultures started to deteriorate further 2 days later.

The effect of an added source of carbon on algal growth

Table 1. EFFECT OF THE ADDITION OF EQUAL VOLUMES OF DISTILLED WATER, POTASSIUM PHOSPHATE SOLUTIONS OR SOLUTIONS OF ORGANIC IRON–TRACE METAL COMPLEXES ON A DECLINING CONTROL CULTURE OF *Microcystis aeruginosa*

Equal volumes of solutions added	No. of viable cells ($\times 10^3$/mm^3) Days after addition		
	0	4	7
Distilled water	7·3	6·4	4·9
6·9 mg of phosphorus/l.	7·3	3·8	2·3
Iron–trace metal complexes	7·3	12·3	9·1

Table 2. EFFECT OF AN INCREASED CONCENTRATION OF CARBON DIOXIDE IN THE ATMOSPHERE UPON THE GROWTH OF *Microcystis aeruginosa*

	Cell No. ($\times 10^3$/mm^3)	*p*H	Chemical oxygen demand (mg/l.)		
			Total	Filtrate	Biomass
Starting culture	6·4	9·2	116	38	77
Control in normal air, after 7 days	10·0	9·1	206	45	161
Air with added 0·5% CO_2, after 7 days	22·9	8·8	403	55	348
Normal air, but addition of 250 mg of sucrose/l. to the culture, after 7 days	23·8	9·2			

Table 3. COMPARISON OF CELL COUNTS ($\times 10^3$/mm^3) AS THE GROWTH RESPONSE OF BLUE–GREEN ALGAE CONTAINING BACTERIA TO ADDED SUCROSE (500 mg/l.)

Species								
Nostoc muscorum Kütz. Wisc	Days	0	2	4	7	11	14	45
		0·5	0·5	0·8	1·6	6·0	9·4	13·0
		0·5	0·7	1·1	2·2	6·9	13·0	27·0
Anabaena circinalis Rab. Wisc. 1038	Days	0	19	26	34			
		0·1	0·3	1·2	3·8			
		0·1	2·6	5·2	10·8			
Phormidium faveolarum Gomont IU 427	Days	0	26	40				
		0·6	12·7	24·6				
		0·6	32·2	74·6				
Lyngbya sp. IU 487	Days	0	13	21	26			
Total lengths of filaments, mm/mm^3		5·3	29·4	67·0	94·2			
		5·3	52·4	145·7	191·8			
*p*H		9·4	10·3	10·2	10·4			
		9·2	10·1	9·9	10·9			
Chemical oxygen demand (mg/l.) Total		15	121	271	385			
		580	721	765	911			
Filtrate		14	19	49	69			
		576	475	119	151			
Biomass		1	102	222	316			
		4	246	646	760			

The upper value is the sucrose free control, the lower that of the sucrose culture.

was duplicated by raising the concentration of carbon dioxide in the atmosphere (Table 2). Table 3 gives the results for other alga–bacteria systems fed 500 mg of sucrose/l. in similar conditions.

Axenic cultures and cultures of *Oscillatoria rubescens* containing bacteria, a strict photolithoautotroph[12], were grown in the presence or absence of sucrose. Sucrose was of no value to the axenic alga, but it stimulated the growth of the association of bacteria and alga (Fig. 2).

Work in progress indicates that many sugars and polyhydric alcohols, glucuronate, citrate and starch give results similar to sucrose. Also, using closed containers at

decreasing ratios of enclosed air and algal culture volumes with proper illumination, *Microcystis* and its associated bacteria may grow in low concentrations of oxygen without an atmospheric source of carbon dioxide if enough organic matter is available.

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BACTERIA, CARBON DIOXIDE, AND ALGAL BLOOMS

L. E. Kuentzel

Bacteria and Blue-Green Algae—A Mutualistic Symbiosis?

College textbooks reveal that blue-green algae (phylum Cyanophyta) and bacteria (phylum Schizophyta) are descendents of the most ancient and primitive of living creatures. Yet, in spite of some two billion years of evolutionary history, they are still the simplest and least evolved of all living organisms. If "survival of the fittest" has any place in evolution, the biologist is attempting to deal with a very "fit" species in blue-green algae and should not be surprised if the task is a difficult one. Moreover, since there are reported to be 2,500 different species of Cyanophyta widely distributed in nature and capable of healthy growth under widely differing conditions, nuisance growths can be expected at any time conditions foster a "population explosion." Measures taken to eleminate one species may produce optimum conditions for encouraging a different species to take its place. Also, it is fundamental that aerobic bacteria require oxygen to degrade organic matter and produce carbon dioxide (CO_2), that algae require CO_2 to photosynthesize organic matter and produce oxygen, and that both aerobic bacteria and algae require similar environments of temperature and minor nutrient concentrations to grow properly. This is a nearly perfect mutualistic symbiosis that has been going on for millions of years. Once established in a given body of water, such a cycle would be difficult to break so long as temperatures approach optimum and the sun continues to shine. This must be nearly the situation in Lake Erie's western basin where, according to Harlow (1), algae produce nearly 10 bil lb (4.54 bil kg) of organic matter per year. This is some 18 times as much as contributed by all wastewater effluents to Lake Erie combined. Moreover, according to Harlow (2), Lake Erie now has excessive amounts of phosphorus in its waters and vast amounts stored in its sediments. Therefore, since P may be used and recycled many times in a growing season and "nutrients which accumulate in the bottom sediments constitute a vast reservoir apparently capable of supporting plant growth in the event all input is shut off" (3), the task of reducing algal growth via control of P in wastewater effluents could be long and very likely an impossible task. Compounding the task via P control are reports of healthy algal growths on amounts of P that are an order of magnitude less than the minimum found in Lake Erie (4) (5) (6). Ferguson (6) and a task group (7) indicate that sources of nutrients are so widespread that "control would be difficult if not impossible." Thus, consideration must be given to all aspects of algal growth and control if an effective means of reducing nuisance blooms is to be achieved. The role of biologically produced CO_2 has been neglected almost completely in the literature.

There is a tremendous volume of literature on the subject of lake eutrophication and algae. An excellent

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bibliography by Mackenthun and Ingram (8) lists over 400 references to material on algal growth factors other than N and P—but not one appears to concern itself with CO_2! Of several hundred papers, books, and reviews covered in this survey, only one paper reported laboratory work that demonstrated the bacteria-algae symbiosis and suggested that this relationship might be responsible for the rapid growths that resulted in blooms. Lange (9) (10) described experiments that strikingly demonstrated the beneficial effects of adding sucrose to *Microcystis aeruginosa* cultures which harbored bacteria while additions of organic matter to axenic algal cultures had no effect on growth. Additions of CO_2 to the cultures induced similar increases in algal growth while additions of P had no effect. Clearly, CO_2 was the limiting factor and bacterial action on sucrose or CO_2-enriched air provided the additional amounts necessary for continued growth. This should not come as a surprise as it long has been known that CO_2 is a major growth-limiting factor for all types of plant life. Quinn and Jones (11) report the successful increase in yields and growth for many plants resulting from enriching the atmosphere around them with CO_2. Thus, when other factors are optimum, nature limits all plant growth to the available CO_2. This operates no less effectively in natural waters where the dissolved CO_2 is normally in equilibrium with atmospheric CO_2.

Carbon Dioxide—A Limiting Nutrient

That an adequate supply of CO_2 is a key factor in healthy algal growth is indicated by a number of publications. Among several papers concerned with the photosynthetic process, West and Todd (12) detail the role played by CO_2 (not HCO_3^- or CO_3^{--}). Clement (13), in establishing optimum conditions for growing algae in synthetic media, reports that improvements in the cultures resulted from reductions in CO_3^{--} and HCO_3^- concentrations or by completely replacing them with CO_2. Optimum growth results when air enriched with one-percent CO_2 by volume is passed through at a rate of one liter/min/liter of culture. Soltero and Lee (14) describe automatic equipment to control pH in algal cultures so as to obtain maximum growth. Such apparatus controls the passing of CO_2-enriched air through the cultures. Several others report the need to aerate with CO_2-enriched air to achieve good growth rates, but the reasons given usually involve pH control rather than nutrient supply. A large scale example of the need for added CO_2 has been provided by Eliassen and Tchobanoglous (15). They describe extensive efforts to remove N and P from agricultural run-off waters in California by, among other methods, growing and harvesting algae in large artificial ponds. The water is relatively rich in N and P and inorganic salts, but low in organic matter. Preliminary experimentation revealed that algae would not grow satisfactorily without supplemental supplies of CO_2 although there was ample access to atmospheric CO_2. Blue-green algae require a slightly alkaline medium for optimum growth (16) (17). Therefore, under equilibrium conditions, relatively small amounts of free CO_2 exist (4) (18), and the removal of CO_2 by algal growth causes the pH to rise (5) (19) (20) until growth is retarded or stops. Gaseous CO_2 is practically insoluble at pH 9 and above.

The availability of CO_2 from natural inorganic sources is precisely stated by Hutchinson (4) as follows:

> At equilibrium, regardless of pH, the quantity of free CO_2 is a function of gaseous phase in contact with the water, its pressure and temperature, and the concentration of salts in solution. Both

> from theory and as far as can be ascertained empirically the quantity of free CO_2 present will ordinarily lie between 0.4 and 1.0 mg/l.

Also, quoting Hutchinson (4):

> At temperatures over 10°C, at no reasonable value of the atmospheric content of the gas will the free CO_2 in equilibrium be as great as 1 mg/l, even at sea level.

Moreover, the natural establishment of equilibria to restore the free CO_2 that is removed by algal growth takes time. Hutchinson (4) states that the movement of CO_2 in and out of a water interface is a slow process. Also, the replacement of free CO_2 by carbonate salts in slightly alkaline media is a relatively slow process. The wide variations of pH with depth that can exist in a given lake over extended periods of time indicate that restorations of equilibria via ionic processes in tranquil lakes are indeed slow. Thus, the available free CO_2 from natural inorganic sources (at pH of 7.5 to 9) probably never exceeds 1 mg/l, and it becomes available at a rather slow rate.

CO_2 Requirements for Massive Blooms

The massive algal blooms that result in floating mats of odorous organic matter involve tens and hundreds of thousands of cells per milliliter (21) to millions of cells per milliliter (22). Thus, in Mackenthun's (21) description of algal growth in Lake Sebasticook, Maine, the maximum bloom involved some 211,550 cells/ml, 56 mg/l dry weight,* most of which grew in a single August day. From algal mass data supplied above and the application of the $C_5H_7NO_2$ biological mass relationship (15) (18) it is calculated that some 110 mg/l of CO_2 must have been delivered to the algae during their growth period. If the stoichiometric relation reported by Stumm and Morgan (23) of C:N:P ratios of 106:16:1 were used, the CO_2 requirements for this growth would be even higher. Obviously, this could not have come from natural inorganic sources delivering a maximum of one mg/l over a period of several days. However, just 30 mg/l of organic carbon and bacterial action would suffice since ample quantities of oxygen would come from the fast-growing algae. It also might be noted here that at no time did the soluble P exceed 0.01 mg/l in the upper 20 ft (6.1 m) of the lake where the growth took place, except in midwinter when a value of 0.011 mg/l was reported. Sawyer (24) indicates that nuisance blooms may be expected when the soluble P exceeds 0.015 mg/l.

*Note: It has been confirmed by private communication with Mackenthun that on page R78 there is an error in the published derivation of phytoplankton volume (ml/l). The final factor should have been 10^{-9} rather than 10^{-6}. This makes the values for the wet weight of algae, Table III, to read milligrams per liter rather than grams per liter. This correction was made for calculations used in the present paper.

Bacteria—CO_2—Algae

The thesis of this paper is that bacterial action on decomposable organic matter in close proximity to the algae supplies the required CO_2 for massive algal blooms and that when such a massive CO_2 supply exists, very small amounts of P suffice. Close scrutiny of the literature provides considerable support for this thesis although no one states the proposition as clearly as does Lange (9). Also, there are statements in the literature that indicate an awareness of the situation such as those by Hutchinson (4) who, after discussing the well-known nutrient factors (not including CO_2), concludes:

> Some accessory substance derived from land drainage or sewage may promote the development of large populations (of algae) in nature. . . . It would seem likely, therefore, that unknown chemical or biological factors are involved.

Billaud (19) is quoted as follows:

> The role of bacteria in the algal cycle is unfortunately little known. . . . In Sanctuary Lake there is important inflow of sewage-laden water with varying nutrition concentrations, which seem to influence the algal periodicity. . . .

Also, Eberly (25) states:

> A second problem concerns the role of bacteria in the nutrition of blue-green algae. . . . Only a few workers have attempted axenic cultures of blue-green algae. . . . In some cases algal cultures grew poorly or not at all in axenic bacteria-free cultures. Whether any symbiotic dependency on bacteria exists in planktonic blue-green algae is not known yet.

Gorham (26) reports observations of the close association of bacteria and algae but without revealing any CO_2 connection. Safferman (27) tried to eliminate bacteria from algal cultures but could not. Holm-Hansen (17), in performing an experiment designed to test the possible heterotrophic growth of blue-green algae, added sucrose to half of a number of cultures then placed half of each of the two groups (with and without sucrose) in complete darkness and left the rest exposed to light. At the end of a month there was no sign of growth in any of the cultures stored in the dark. Of the rest, those having sucrose additions showed twice as much growth as the cultures without sucrose. He then concluded that heterotrophic growth was possible in the light but not in the dark. Since part of the experiment closely parallels Lange's work (9), it would seem reasonable to attribute the increased growth of the sucrose-fed cultures to bacterial generation of CO_2 and the lack of response in the dark to inhibited photosynthetic processes. Clesceri and Lee (28) demonstrated that algae with bacteria grow much faster than algae from which the bacteria substantially have been removed. Their cultures had ample supplies of orthophosphate and carbonates (pH of 8.3), yet bacteria-free cultures achieved normal growth only after an additional 100 hr as compared to the algae-bacteria cultures.

Wastewater (Organic) Pollution and Blue-Green Algae

There is much general agreement in the literature that wastewater pollution of lakes and excessive growth of algae go hand in hand, but such growths usually are attributed to the inorganic nutrients rather than to the decomposable organic matter that always accompanies it. However, Fogg (16) observes that "blue-green algae are of frequent occurrence in environments rich in organic matter and in freshwater lakes a distinct correlation exists between their abundance and the concentration of dissolved organic substances." Taylor (29) states that bacterial activity is related to the amount of decomposable carbohydrate present and that the activity of bacteria in a lake can be controlled by the amount of organic matter present. Sawyer (30) says:

> CO_2 feed-back from bottom deposits and the role of bacteria must be taken into close consideration when considering nutrients (for algae) and their sources.

Dean (31) observed decreasing algal growths at increasing distances from a hydraulically overloaded wastewater plant discharging into a lake. Sigh (32) reports India's lakes to be polluted badly and in constant bloom, and observes that *Microcystis aeruginosa* always is associated with the highest organic pollution. Fitzgerald (33) reports that blue-green algal blooms in reservoirs and lakes usually are associated with wastewater effluent. Torpey (34) makes effective use of the bacteria-algae symbiosis in explaining the effects of reducing pollution in the Thames estuary. He has diagrammed a normal situation showing the flow of organic carbon (pollution) to the bacteria to produce CO_2 which

then flows to the algae for the production of oxygen. The oxygen, with some dissolved from the air, then flows to the bacteria to complete the cycle. Omitted as having negligible influence on the cycle are CO_2 from the atmosphere and dissolved salts as well as the minor nutrients N and P, for the latter are always in adequate supply in the river water. However, of significance is the fact that CO_2 becomes a limiting growth factor under some circumstances. Such a situation occurs in the presence of autotrophic nitrifying bacteria where pollution contains considerable amounts of organic nitrogen. The diagrammed presentation shows the nitrifiers competing with the algae for available CO_2 with the result that diminished algal growth and oxygen generation cause a reduction of dissolved oxygen in that portion of the river. Schulze (35) describes an interesting "pilot plant" scale experiment to measure the effectiveness of a simple tertiary treatment for the removal of organic matter from the effluent of a secondary activated sludge plant. It simply consisted of a holding tank with screens on which slimes, protozoa, rotifera, etc., could develop and consume the residual organic matter. It worked so well that, at times, in excess of 99-percent organic matter was removed. He then set up a second experimental tank to receive the effluent from his efficient tertiary process, aerated it with air, and tested these waters for support of aquatic life. Fish thrived as did aquatic plants that had access to the surface. However, blue-green algae would not grow. He concluded that carbon (CO_2) in the water had become a limiting nutrient. It would have been interesting to test the effect of adding a little CO_2 to the aeration stream; however, this was not reported as having been done.

McIntire, however, does report (36) the effects of added CO_2 in experiments conducted over a six-year period. His procedure was to divert part of a natural stream through his laboratory in troughs where he could control flow rate, temperature, light intensity, and turbulence and measure their effects on algal growth. Natural concentrations of CO_2 were reported to be less than two mg/l, and McIntire states:

> If ionic forms of carbon dioxide diffuse through cell membranes much less readidly than do neutral carbon dioxide molecules, rates of photosynthesis of algae in the laboratory streams as well as in natural streams may be limited by low concentrations of available form of carbon dioxide.

The addition of CO_2 to the natural waters produced the following observation:

> An increase in molecular carbon dioxide markedly increased the photosynthetic rate of the light-adapted community at illumination intensities between 1,000 and 2,000 ft-c (10,764 and 21,528 lumens/sq m).

McIntire concludes:

> One important effect of community organization is the retardation of diffusion in the microspaces adjacent to the metabolizing cells. Apparently, the compact growth form of the community explains the susceptibility of these communities to effects of carbon dioxide deficiency.

From this information, it may be concluded that it is an intimate mixture of algal cells, bacteria, and organic matter that provides localized sources of CO_2 to support massive growths of algae in stagnant lakes without much need for diffusion.

Controlling Factor—Carbon Dioxide or Phosphorus?

Many papers reporting investigations and studies attempting to clarify the role of P in algal growth problems give evidence that CO_2 well may be an unrecognized factor. Thus, Sylvester and Anderson (37) report that Green Lake in Washington has offensive algal blooms, yet the concentration of P is seldom above 0.01 mg/l.

Measurements on dissolved organic matter and bacteria are not reported. Tucker (38) reports that in lakes he has examined he finds no evidence that P is a limiting factor in the growth or reproduction of phytoplankton since there always seems to be enough. He further states that some other nutrient is more important, but does not identify it. Wohlschlag (39) reported an observation on Lake Mendota, Wisconsin. He noted increased algal growth after strong winds in areas exposed to the winds but not in areas that were protected, i.e., coves, etc. He suggests that the winds stirred up nutrients from the sediments. It is also possible that the increased aeration dissolved sufficient additional CO_2 to make a contribution to this growth. Pennak (40) states:

> Adequate nutrients remain in the epilimnion during the summer months, therefore it is suspected that light, temperature and organic matter (bacteria) play important roles in plankton activity fluctuations.

Hamilton (41) observed of Cayauga Lake that despite the low levels naturally present, augmented phosphate concentrations were not stimulatory to photosynthesis and some evidence is presented for inhibition by phosphorus. Shapiro and Riberio (42) report the effects of adding secondary wastewater plant effluent to Potomac River water which already contained 0.23 to 1.09 mg/l of P. As the authors explained, they intended to show that the addition of more P via the secondary effluent would have no effect on algal growth in water that already was overloaded with P. However, marked increases in algal growth immediately followed such additions of effluent water whereas additions of soluble P alone resulted in growth increases only after considerable delays in time. It would seem logical to attribute the rapid initial growth with the added effluent water to a fresh supply of organic matter and bacteria, whereas increased growth on addition of soluble P alone had to depend on CO_2 generated by the slower physical-chemical processes.

Bacteria are Essential

The textbooks are clear on the importance of bacteria in aquatic processes. Kendeigh states (43):

> Basic to the food cycle (in lakes) are the bacteria. A few occur free-floating in the water. For the most part, however, they are attached to algae, to other plankton organisms, to submerged objects or occur in the bottom as part of the benthos.

Ward and Whipple (44) add emphasis:

> The food supply of the whole plankton of fresh-water streams and ponds is therefore dependent upon the activity of bacteria, and the share of these organisms in producing or modifying the conditions under which all aquatic life is possible can never be ignored.

Bacteria can supersaturate natural waters with more than 20 mg/l of free CO_2 (18). The large bloom described by Mackenthun *et al.* (21) would require CO_2 delivered at a rate in excess of 5 mg/l/hr during the final 10-hr growth period. This could be achieved only if a massive "bacterial bloom" preceded or accompanied the algal bloom. That such bacterial blooms do precede algal blooms has been shown by Silvey and Roach (45). Extensive population counts on bacteria and algae over a period of 10 yr provide data for a number of graphs showing the population variations plotted against time over 1-yr periods. Significant is the fact that in every case, large increases in the numbers of gram-negative bacilli always preceded explosive growths of blue-green algae. In a typical graph, gram-negative bacilli showed a steady growth in numbers beginning in April which reached a peak about August 25 to September 1, followed by a rapid decline through September. Blue-green algae in the same lake showed no in-

crease, just minor fluctuations, until August when an explosive growth developed to reach a peak about September 1 to 5 and then declined along with the bacteria through the rest of September. The authors make the following observations regarding this particular set of data:

> There appears to be some interdependent relationship between the two types of organisms (blue-green algae and gram-negative bacilli), . . . Even though the interdependence appears to exist, the authors have not been able to show its purpose in their laboratory investigations. . . . One notes, in careful observation, that the gelatinous covers of the blue-green filaments contain high concentrations of bacteria, most of which are gram-negative bacilli.

A logical explanation seems to be that the bacteria developed a condition of supersaturation in the surface waters with respect to CO_2 at a time when the algae, somewhat more sensitive to temperature and light conditions, found such conditions optimum in August and proceeded to grow explosively. This phenomenon continued as long as the bacteria were supplied with sufficient organic matter to maintain CO_2 production. When the supply of organic material finally failed, first the bacteria and then the algae, for lack of CO_2, terminated their explosive growths and then both declined to low levels for the winter months. These data were obtained from lakes in the southwest where temperatures were too high to cause winter stratification. Consequently, there was no fall turnover to bring nutrients from the sediments to the surface waters which some have indicated to be the cause of algal blooms. It should be pointed out that, while either aerobic or anaerobic bacteria degrade organic matter at the bottoms of lakes to produce high concentrations of CO_2 locally, because of thermal stratification this CO_2 is not readily accessible for rapid algal growth at the surface of the lake except at times of spring and/or fall turnovers.

Full-Scale Studies

Returning to the massive algal bloom described by Mackenthun *et al.* (21) in Lake Sebasticook, it must be concluded that massive bacterial activity must have preceded or accompanied the algal bloom. Although the authors report no measurements on the amounts of non-refractory organic matter in the lake, they went to some length to describe extreme organic pollution flowing into the lake from untreated municipal wastes, woolen mills, and a potato canning plant (21):

> Dye wastes colored the water purple and luxuriant growths of aquatic slimes, wool fiber mats and potato sprouts and rotting potatoes were visible in certain areas. Floating masses of wool dotted the surface waters and rising gas bubbles from decomposition pock-marked the stream reach.

This is what was discharging into the lake. It is obvious that, with the gross organic contamination reported, this lake would have little difficulty supporting the sizeable bacterial bloom necessary to provide ample CO_2 for the excessive algal bloom—even in the presence of minimal amounts of P. Yet, the authors concluded that "a reduction in the phosphorus contributed to the lake by industrial and municipal wastes is necessary to reduce the severe algal nuisances and to increase the lake's recreational use potential."

Another lake in the news is Minnesota's Lake Minnetonka. It has been under close observation since 1962. According to Orr (46), in June 1966 when the testing program was enlarged, "Symptoms of gross pollution are not present in the lake. . . . Swimming, boating, water skiing and fishing abound during the summer months." Yet, analysis for soluble P averaged 0.013 mg/l which is more than that found in the polluted waters of Lake

Sebasticook. Clearly, Lake Minnetonka was a fertile lake as far as N and P were concerned (0.56 mg/l N and 0.013 mg/l P). It needed only bacteria and organic matter to supply the necessary CO_2, and then massive algal blooms probably could be expected. Later, 1968 newspaper articles (47) (48) (49) revealed rapidly worsening conditions with some areas of the lake experiencing algal bloom problems. All agreed that pollution is the problem, but as one public official expressed it, "When we say pollution, the thing that all of us are worried about is nutrient pollution—nitrates and phosphates." This ignores the role of organic matter and bacteria. However, remedial activity recommended includes better control of septic tanks, lawn fertilizer, dead fish, boat toilets, etc., all of which also will effect reductions of organic matter reaching the lake. A recognition of the role played by organic pollution and bacteria in the production of algal blooms might prompt efforts to control sources of organic pollution not necessarily associated with gross amounts of P.

A final example comes from Wells (50) who reports detailed observations made on a 1,350-acre (547-ha) reservoir over a period of 5 yr. The water is used as condenser cooling water for a power plant and there is concern that algal growths might cause problems in the future. The voluminous records include periodic measurements of pH, phosphate, biological oxygen demand, coliform bacteria, and algae. While the pH consistently averages around 8.5 and there is ample access to Texas sunshine and air, there have not been excessive algal growths although the waters are well seeded with both algae and bacteria. Moreover, the phosphorus content of the water fluctuates between 0.30 mg/l and 0.07 mg/l—well above the minimum required for massive algal blooms. A reason for the low bacterial and algal activity lies in the low level of organic matter found in the waters—consistently two to four mg/l. Yet the author recommends that:

> . . . a close check should be maintained to see that there is neither a great increase (of phosphates) in the hypolimnion nor an increase in soluble phosphates in the upper portions of the lake. If conditions seem to be deteriorating with regard to phosphates and excessive biological growths, then immediate consideration should be given to some means of removal of the phosphate rich bottoms.

Conclusions

In summation, the following conclusions appear to be supported by the published literature:

1. In natural waters, blue-green algae and certain bacteria always are found in close association. Attempts to separate them in the laboratory prove detrimental to the algae.

2. Massive algal blooms always are associated with excessive amounts of decomposable organic matter. Much of the literature relates wastewater and organic pollution with blue-green algal blooms.

3. Carbon dioxide is the major nutrient required for algal growth. It takes about two grams of CO_2 to produce one gram of algae.

4. The large amounts of CO_2 required for fast-growing massive algal blooms of blue-green algae cannot come from the atmosphere and/or dissolved carbonate salts via the normal physical-chemical processes. At most, about one mg/l of free CO_2 accumulated over a period of many hours to days can be expected.

5. The action of bacteria on ample amounts of organic matter can supply as much as 20 mg/l of CO_2 in a supersaturated state. Explosive, logarithmic growth rates of bacteria under favorable conditions can deliver large amounts of CO_2 required for algal bloom development.

6. While phosphorus is a necessary element for algal growth, the amounts required to support massive blooms are quite low, about 0.01 mg/l (10 ppb) or less.

7. The widespread distribution of P in nature and its wide use by man will make reductions and limitations of soluble P in lakes to 0.01 mg/l extremely difficult. Even this would not prevent nuisance blooms in the presence of excessive amounts of decomposable organic matter and bacteria.

8. In well documented instances involving large lakes, the presence of decomposable organic matter and bacteria have produced massive algal blooms in waters containing not more than 0.01 mg/l soluble P. In other waters containing more than 0.01 mg/l soluble P but relatively free from organic pollution, there were no nuisance algal problems. Thus, the availability of adequate amounts of CO_2 via the action of bacteria on decomposable organic matter determines massive blue-green algal growth even in the presence of excessive amounts of soluble P.

These conclusions indicate that attempts to reduce massive algal blooms by limiting phosphorus in wastewater effluents will not be very effective unless equal emphasis is placed on removing biodegradable organic matter. Since a great number of lakes in this country already have in the neighborhood of 0.01 mg/l of soluble P in them, control of organic pollution is of prime importance. Fortunately, removal of phosphates usually is accompanied by more effective removal of organic matter from sewage effluents. However, the importance of the role played by organic matter and bacteria in the production of massive algal blooms should not be lost sight of in the rush to remove phosphorus. Although Fruh (51) has stated that "light and CO_2 as necessary ingredients for algal growth cannot be controlled," it is true that man has been largely responsible for the organic pollution that leads to and supports massive growths of blue-green algae. Such blooms present the most serious problem in the nation's eutrophic lakes, and certainly man can become more effective in reducing such organic pollution.

Finally, the bacteria-algae symbiosis opens up another possibility for reductions in algal growth via control of bacteria. It is easy to conceive that control of bacteria by means of a suitable bactericide would limit the availability of CO_2 for algal growth to produce massive blooms. This would result in sizeable reductions in lake-generated organic matter and would be followed by lower levels of bacteria-algae activity as long as levels of organic matter remained under control.

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Appendix 3.—Communications and Statements

U.S. Department of the Interior,
Federal Water Pollution Control Administration,
Washington, D.C., February 16, 1970.

Hon. Henry S. Reuss,
Chairman, Conservation and Natural Resources Subcommittee,
Committee on Government Operations,
House of Representatives, Washington, D.C.

Dear Mr. Reuss: Reference is made to your letter of January 20, 1970, requesting additional data and estimates on that part of the phosphorus content of detergents used in the United States during 1969 which entered surface waters. In response to your request, we are pleased to provide the following information:

(*a*) A yearly phosphorus excretion in pounds per capita is estimated to be 1.2 lbs/capita with a minimum of about 0.47 lbs/capita and maximum of 2.3 lbs/capita.

(*b*) Prior to the use of synthetic detergents, the amount of phosphorus in sewage agreed with the amount excreted by humans. Since 1950, the increase in phosphorus in sewage has reflected the acceptance and widespread use of detergents. For 1968, Eagle estimated between 2.0–4.5 pounds/capita of sewage phosphorus in treatment plants. Although data for 1969 are still not entirely available, the data for 1968 are at least representative and we estimate the same range of phosphorus with perhaps a mean of 3.5 pounds/capita/year.

(*c*) Considering the mean yearly excretion from humans of 1.2 lbs/capita, phosphorus from detergents is estimated at 65%.

$$\left(\frac{3.5-1.2}{3.5}\right)\times 100=65 \text{ percent}$$

(*d*) From non-sewered wastes, a comparable percentage is estimated.

(*e*) Based on the loadings of phosphorus to sewage treatment plants and the annual flows, the preceding figures are estimated to show:

1. 328 million pounds of phosphorus discharged from sewered population yearly.
2. 213 million pounds of phosphorus in sewered discharges are detergent in origin.

(f) In addition estimates on the unsewered population discharges indicate an additional 157 million pounds of phosphorus from detergents may have to be considered.

Detailed tables and references are enclosed with this letter to provide specific additional backup material.

We hope this information is of help to you and that we may of be assistance for other needs you have on this subject.

Sincerely,

Bryan F. LaPlante,
For David D. Dominick,
Commissioner.

The yearly per capita phosphorus contribution to sewage from human excretion varies with the diet, but 1.2 pounds appears to be the mean value. The range and sources of this information are given in table 1.

Data from several sources were examined to determine the per capita sewage phosphorus contribution. Table II shows clearly that the amount of phosphorus in sewage before the advent of synthetic detergents agrees fairly well with the amount excreted by human beings. The per capita sewage phosphorus loadings have increased greatly since 1950. It was about that time that synthetic detergents gained wide acceptance. Today it is reasonable to believe that the mean sewage phosphorus loading is 3.5 pounds per capita per year.

To obtain an estimate of the amount of phosphorus that enters the surface waters from sewage effluents, the amount discharged by each type of waste treat-

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ment process was calculated. Based on these calculations, 328×10^6 pounds of phosphorus are discharged from the sewered population. Of this total, 65 percent or 213×10^6 pounds would be from detergents. The percentage 65 is based on $\frac{3.5-1.2}{3.5}=.65$ which is the total phosphorus in sewage minus the contribution from feces and urine.

In addition to the above, there would be some from the unsewered populations of 69×10^6. Data are not available on the fate of this 242×10^6 pounds. Of this amount, 157×10^6 would have come from detergents.

TABLE I.—YEARLY PHOSPHORUS EXCRETION POUNDS PER CAPITA

Amount	Reference
0.47–2.3	1
1.4	2
0.7–1.6	3+4
.2–1.4	8
1.2	5

TABLE II.—YEARLY POUNDS PER CAPITA SEWAGE PHOSPHORUS

Year	Amount	Reference	Year—Continued	Amount	Reference
1872	1.4	6	1958	1.7 to 4.2	11
1936	2.7	7	1958	2.8 to 4.2	12
1938	0.86	8	1958	2.3	14
1947	0.8 to 1.2	9	1964	2.7	18
1953	1.9	15	1965	3.5	16
1954	2.0 to 4.0	13	1968	2.0 to 4.5	17
1958	1.1 to 1.4	10			

TABLE III.—PHOSPHORUS REMOVAL BY WASTEWATER TREATMENT PLANTS

Type	Percent removal
Primary-intermediate	5–15
Trickling filter	20–30
Activated sludge	30–50

TABLE IV.—ESTIMATE OF TOTAL POUNDS OF PHOSPHORUS DISCHARGED TO WATERWAYS [1]

[Per capita contribution of phosphorus is 3.5 pounds per year]

Type of discharge	Population served	Removal efficiency	Pounds discharged
Not sewered	69×10^6	([2])	([2])
Raw sewage	14×10^6	0.0	49×10^6
Primary-intermediate	43×10^6	.10	135×10^6
Activated sludge	33×10^6	.40	70×10^6
Trickling filters	23×10^6	.25	61×10^6
Miscellaneous	4×10^6	.10	13×10^6
Total	186×10^6		328×10^6

[1] Based on 1962 population and 1962 "Inventory Municipal Waste Facilities" U.S. PHS Publ. No. 1165 (1964).
[2] Unknown.

Note: Sample Calculation—activated sludge $33 \times 10^6 \times .60 \times 3.5 = 70 \times 10^6$.

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SELECTED PHOSPHATE CHEMICALS—TOTAL U.S. PRODUCTION AND CONSUMPTION BY SOAP AND DETERGENT MANUFACTURING INDUSTRY (SIC NO. 2841)

PREPARED BY CHEMICALS DIVISION, BUSINESS AND DEFENSE SERVICES ADMINISTRATION, DEPARTMENT OF COMMERCE—FEB. 2, 1970

[Expressed as short tons of product]

Year	Trisodium phosphate			Tetra sodium pyrophosphate			Sodium tripolyphosphate			Tetra potassium pyrophosphate		
	Total U.S. production	Consumed by SIC 2841	Col. 2 as percent of col. 1	Total U.S. production	Consumed by SIC 2841	Col. 5 as percent of col. 4	Total U.S. production	Consumed by SIC 2841	Col. 8 as percent of col. 7	Total U.S. production	Consumed by SIC 2841	Col. 11 as percent of col. 10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1947	88,568	(1)	(1)	56,641	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
1954	48,435	(1)	(1)	108,989	30,780	28	520,549	387,365	74	(1)	(1)	(1)
1958	45,533	30,767	68	101,307	56,470	56	632,577	476,274	75	(1)	(1)	(1)
1963	56,674	(2)	(1)	109,289	109,209	100	817,735	696,197	85	37,353	(2)	(1)
1967	61,683	76,800	125	108,850	69,200	64	1,048,079	848,600	81	54,877	(2)	(2)

[1] Not available.
[2] Withheld because the estimate did not meet publication standards, either on the basis of the associated standard error of estimate, or on the basis of a consistency review.
[3] withheld to avoid disclosing figures for individual companies.

Sources: U.S. production—U.S. Department of Commerce, Bureau of the Census: (a) "Facts for Industry—Inorganic Chemicals and Gases" series M-28A, years 1947, 1954, 1958; (b) "Current Industrial Reports—Inorganic Chemicals and Gases" series M-28A, years 1963, 1967. Consumed by SIC 2841: U.S. Department of Commerce, Bureau of the Census, "Census of Manufacturers," all years.

U.S. PHOSPHATE USE 1947–1967

PREPARED BY CHEMICALS DIVISION, BUSINESS AND DEFENSE SERVICES ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE—FEBRUARY 2, 1970.

[Expressed as P_2O_5]

Year	Column 1	Column 2		Column 3		Column 4	
	Apparent U.S. domestic consumption (thousands) short tons [1 2 3]	U.S. domestic consumption as fertilizers [4 5]		Phosphate consumed by manufacturers of soaps and detergents (SIC2841)		Other phosphate use [8]	
		(a) (Thousands) Short tons	(b) Percent of Col. 1	(a) (Thousands) Short tons [6]	(b) Percent of Col. 1	(a) (Thousands) Short tons	(b) Percent of Col. 1
1947	2,302	1,736	75	([9])	([9])	([9])	([9])
1954	3,857	2,364	61	[10] 251	7	1,242	32
1958	4,461	2,403	54	317	7	1,741	39
1963	5,392	3,073	57	[10] 482	9	1,837	34
1967	9,209	4,305	47	[11] 557	6	4,347	47

[1] "Apparent consumption" is defined as marketable U.S. domestic production, plus imports, minus exports, with adjustment for yearend inventory changes.

[2] Source: (a) U.S. Department of Interior, Bureau of Mines, "Minerals Yearbook" annual, 1954–67. (b) U.S. Department of Interior, Bureau of Mines, Knoxville, Tenn., verbal report 1947.

[3] Bureau of Mines does not report P_2O_5 content of imports of phosphate rock. However, Bureau of Mines has agreed that for purposes of these calculations it can be assumed that imported phosphate rock, contains 31.5 percent P_2O_5. These figures are, therefore, in part estimates. However, in each of the years under study, imports were less than one percent of domestic marketable production. Any error in estimating P_2O_5 content of imports would have an insignificant effect on final figures.

[4] These figures are reported on a fiscal year basis. In each case the year ends June 30 during the year reported.

[5] Source: (a) U.S. Department of Agriculture: "The Fertilizer Situation" (annual) for years 1947, 1954, 1958. (b) U.S. Department of Agriculture: "Consumption of Fertilizers in the U.S." (annual) 1963 and 1967.

[6] Source: U.S. Department of Commerce, Bureau of the Census: Census of Manufacturers SIC Code 2841, Soaps and other Detergents, years 1954, 1958, 1963 and 1967. From the Table "Materials Consumed, by Kind".

[7] The figures in Col. 3 are based on calculations assuming the P_2O_5 content of the 3 reported phosphate compounds as follows: trisodium phosphate—43.3 percent; sodium tetrapyrophosphate—53.4 percent; sodium tripolyphosphate—57.4 percent.

[8] Col. 4 represents the difference between Col. 1 and the sum of Col. 2 and 3.

[9] Not available.

[10] In 1954 and in 1963, Bureau of the Census reported only on tetrasodium pyrophsophate and sodium tripolyphosphate consumed. Since trisodium phosphate contributed about 5 percent of the P_2O_5 consumed by the industry in 1958 and 1967, an arbitrary amount equalling 5 percent of the total has been added to the figures for 1954 and 1963.

[11] Preliminary.

SOAP AND SYNTHETIC DETERGENTS: ESTIMATED SALES, TOTAL AND PER CAPITA 1947–68 [1]

[From "Fats and Oils Situation," FOS–248, June 1969, page 21; published by the Economic Research Service, U.S. Department of Agriculture]

Year	Estimated sales (million pounds)			Per capita (pounds)			Percentage distribution	
	Soap (non-liquid) [2]	Synthetic detergent [3]	Total	Soap [2]	Synthetic detergent [3]	Total	Soap	Synthetic detergent
1947	3,512	408	3,920	24.4	2.8	27.2	90	10
1948	3,088	636	3,724	21.1	4.3	25.4	83	17
1949	2,905	864	3,769	19.5	5.8	25.3	77	23
1950	2,882	1,443	4,325	18.9	9.5	28.4	67	33
1951	2,441	1,565	4,006	15.8	10.1	25.9	61	39
1952	2,210	1,856	4,066	14.0	11.8	25.8	54	46
1953	1,923	2,118	4,041	12.0	13.2	25.2	48	52
1954	1,692	2,468	4,160	10.4	15.1	25.5	41	59
1955	1,590	2,780	4,370	9.6	16.8	26.3	36	64
1956	1,540	3,230	4,770	9.1	19.1	28.2	32	68
1957	1,430	3,500	4,930	8.3	20.3	28.7	29	71
1958	1,370	3,550	4,920	7.8	20.3	28.1	28	72
1959	1,250	3,820	5,070	7.0	21.5	28.5	25	75
1960	1,230	3,940	5,170	6.8	21.8	28.6	24	76
1961	1,180	4,110	5,290	6.4	22.4	28.8	22	78
1962	1,210	4,420	5,630	6.5	23.7	30.2	22	78
1963	1,190	4,540	5,730	6.3	24.0	30.3	21	79
1964	1,140	4,730	5,870	5.9	24.6	30.6	19	81
1965	1,110	4,870	5,980	5.7	25.0	30.7	19	81
1966	1,100	5,000	6,100	5.6	25.4	31.0	18	82
1967	1,110	5,200	6,310	5.6	26.1	31.7	18	82
1968 [4]	1,110	5,350	6,460	5.5	26.6	32.1	17	83

[1] Estimates of the Soap and Detergent Association. 1964–68 estimates are subject to revision when 1967 Census of Manufactures becomes available. Data are on the built finished-weight basis.

[2] Excludes scouring cleansers, liquid soaps, and reported exports where possible.

[3] Includes only those solid and liquid with end uses and characteristics similar to soap, and excludes scouring cleaners and shampoos where possible. Liquids converted to pounds on the basis of 8 pounds per gallon.

[4] Preliminary.

THE PROCTER & GAMBLE CO.,
Cincinnati, Ohio., January 30, 1970.

Hon. HENRY S. REUSS,
Chairman, Conservation and Natural Resources Subcommmitttee,
Committee on Government Operations,
Rayburn Office Building,
Washington, D.C.

DEAR SIR: In response to your recent request, we are separately providing the specific information you asked for about the general subject of phosphates in detergents. In addition, I thought you and other members of your subcommittee should know the point of view of Procter & Gamble on this important matter.

In the soap and detergent field, it is our job, as we see it, to make available to housewives the best possible washing products that we know how to make, with full consideration of our responsibilities to society and to our environment. Such products must provide clean, sanitary washing results, with safety to those who use them and to the fabrics and surfaces they clean. They must provide these results at a reasonable cost to the user. All these considerations are recognized and weighed in formulating each of our products, and in searching for ways to improve existing product formulas.

Recently, questions have been raised about phosphates in detergents as one possible cause of eutrophication which is the growth of algae and other plant life in lakes and streams. The fact that the same question is being raised about phosphates in chemical fertilizers, and about other materials that find their way into lakes and streams, does not in any way diminish our very real concern.

In this connection, we emphasize that the company has no financial interest of any kind in phosphates as such. We own no phosphate deposits nor facilities to produce phosphates. Phosphates are included in washing products today, as they have been in one form or another, for over 40 years, because they contribute significantly to cleaning performance and are both economical and safe to use in the home.

An important and continuing part of our research activity is to search for new materials which will do a better job in detergents than present materials. During the past 20 years, we have studied hundreds of new materials which might replace phosphates in an effort to produce detergents to do a better job for the housewife at reasonable cost to her.

In view of the questions that have been raised about whether phosphates in detergents are contributing to eutrophication, in recent years this search for other materials has been accelerated. We are spending all the research money we know how to spend productively and every fruitful avenue of research exploration is being pursued.

One result of this overall effort is the fact that we are selling two brands nationally in the United States with low levels of nitrogen-containing material (NTA) as an adjunct to and partial replacement for phosphates. We expect to gain broader experience with this substitute material in the future.

In addition to its internal effort, the company has been cooperating and will continue to cooperate fully with the Department of the Interior in an effort to determine the causes of excessive algal growth in lakes and streams. There is still much that is unknown about this subject which must be determined before any prudent judgment can be made as to how to alleviate that problem.

Until more definite knowledge does develop, we regard it as an obligation to point out what we know about phosphates in detergents and their benefit to housewives. As of today, any general substitution for phosphates that has been suggested would entail considerable penalty to the ultimate consumer, either in terms of poorer cleaning performance or a higher price for the finished detergent product, or both. Furthermore, we must be certain that any substitute materials are not harmful to the environment.

If, as knowledge develops about the cause of excessive growth of algae in lakes and streams, it should be eventually concluded that the balance of advantages and disadvantages for both consumers and the environment is such that phosphates should be eliminated from detergents, we shall, of course, act on such a conclusion.

We appreciate this opportunity to present our company's views on this important subject.

Sincerely,

HOWARD MORGENS,
President.

STATEMENT, WITH ATTACHMENT, SUBMITTED BY MR. RAY D. LEARY, CHIEF ENGINEER & GENERAL MANAGER, AND MR. LAWRENCE A. ERNEST, DIRECTOR OF LABORATORY, MILWAUKEE SEWERAGE COMMISSION, MILWAUKEE, WIS, DECEMBER 8, 1969

Phosphorus has been singled out by many researchers as the nutrient most critical to the growth of algae in natural waters. The 1969 report to the International Joint Commission on the Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River (1), made public on October 8. 1969, contains one of the latest and most convincing arguments for reduction in the quantity of phosphorus discharged into surface waters. This report also points out that at the present time 70 percent of the phosphorus in municipal sewage in the United States arises from phosphate based detergents. The report's principal recommendation concerns itself with reduction of the quantity of phosphorus discharged and includes the following recommendation:

(*a*) immediate reduction to minimum practical levels of the phosphorous content of detergents and the amounts of phosphate-based detergents used; complete replacement of phosphorous compounds in detergents with environmentally less harmful substitutes as soon as possible, but not later than 1972.

The Milwaukee Sewerage Commission has operated an activated sludge type sewage treatment plant in Milwaukee since 1925 and has disposed of the waste solids produced as a fertilizer (commercially sold as Milorganite). While no annual records of the phosphorous content of the liquid effluent discharged to Lake Michigan are available, the fact that the sludge was processed and sold as a fertilizer makes it possible to accurately determine the quantity of phosphorus removed. Attached hereto is a table which shows the quantity of phosphorus removed per year from 1928 through 1965. The table also lists the annual quantity of Milorganite produced and the average phosphorous concentration found in the Milorganite.

When one compares the phosphorus concentrations found in the fertilizer, it can be seen that the concentration remained relatively constant until the mid-1940's and then increased rapidly with the advent of synthetic detergents. From 1949 to 1954 the concentration increased from 1.5 percent to 2.2 percent. Production of synthetic detergents in the United States was rapidly increasing during this period (1949–1954). "Chemical Week" in its September 20, 1969, issue estimates 1949 U.S. production of synthetic detergents at 700 million pounds and 1954 production as 2,000 million pounds.

In view of the rapid increase in fertilizer phosphorus content during this period, representative samples of plant effluent were submitted to the University of Wisconsin for determination of phosphorus content. The results of this determination, completed in April 1951, indicated an effluent phosphorus concentration of .07 mg/l. It must be concluded from this information that the quality of phosphorus in the plant effluent was extremely low and virtually all of the phosphorus received at the plant was therefore being removed with the fertilizer.

It should also be pointed out that Rudolfs (2) in 1947 reported phosphorus removals by American activated sludge processes ranging from 80 to 90 percent. Rudolfs high phosphorus removals are confirmed by the low effluent phosphorus concentrations found in the Milwaukee effluent in 1951.

It is interesting to note that in spite of the continued increase in synthetic detergent production in the United States, since 1954 there has been no corresponding increase in phosphorus concentration in Milorganite. One must therefore conclude that since 1954 the quantity of phosphorus in the plant effluent has been increasing due to the inability of the solids to retain the additional phosphorus contributed by detergents ("Chemical Week" reported 1968 U.S. production as 4,700 million pounds).

For the past 2½ years an intensive research program supported in part by the FWPCA has been underway at the Milwaukee Sewerage Commission Jones Island Plant to attempt to determine the factors that have enabled the Milwaukee plant to consistently remove large quantities of the phosphorus received in the raw sewage.

It was found that the phosphorus removal could not be related to any of the conventional parameters used to gage plant performance in removing suspended solids and biochemical oxygen demand. During 1969 (June 9–July 15) a major brewery strike occurred, and the brewery waste waters normally received at the plant were eliminated. Effluent phosphorus concentrations increased, and phosphorus removal was adversely affected as shown in the attached graphs. When the strike ended and brewery waste waters were again discharged to the

plant, phosphorus removal was enhanced, and effluent phosphorus concentrations returned to normal.

During the study period it became evident that while 70 to 90 percent phosphorus removal could be expected, control of the plant operations to maximize phosphorus removal at the 85 percent level could not be accomplished. We must therefore conclude that an activated sludge plant receiving a heavy brewery waste load and disposing of its waste solids without waste sludge digestion can remove large quantities of phosphorus but under present plant phosphorus loadings could not continuously achieve 85 percent phosphorus removal.

Since the phosphorus contributed by synthetic detergents and other cleaning compounds is 60 to 70 percent of the total phosphorus load received at the plant, we could expect much lower concentrations of phosphorus in the plant effluent if detergent phosphorus were eliminated. Indeed we would expect the Jones Island Plant to remove virtually all of the phosphorus as it did in 1951.

Phosphorus can also be removed from the plant effluent by the addition of chemicals such as lime, alum and iron salts. Alum coagulation and settling in conjunction with the activated sludge process has been proposed (1) and operating costs in the range of $30 to $50 per million gallons of sewage treated were projected. Based upon the $30 per mgd figure, annual costs at the Jones Island Plant for alum treatment would exceed $2 million per year. The 1968 net operating budget for the plant and collection system totaled $3,803,093.

Preliminary studies using ferrous iron to stabilize phosphorus removal were initiated at the Jones Island Plant during the summer and fall of 1969, as a part of the aforementioned research program. These studies indicate that chemical costs using ferrous sulfate may be as low as 5 dollars per million gallons. No estimate of *total* additional costs using iron salts have been made, but a year-long plant-scale study using iron has been proposed.

The Milwaukee Jones Island Sewage Treatment Plant receiving a large quantity of brewery waste water and designed to dispose of sludge as fertilizer cannot be considered a typical treatment facility. Therefore Milwaukee costs should not be applied to other plants. It should also be pointed out that production of fertilizer from waste activated sludge requires a large capital investment.

Elimination of detergent phosphorus could immediately effect a 70 percent reduction in the phosphorus content of raw sewage (1). Since a minimum amount of phosphorus is necessary to sustain biological activity in secondary treatment processes and consequently is removed in the waste sludge (either as fertilizer, raw or digested sludge) additional phosphorus removal could be expected at all secondary treatment plants.

During the past year the Milwaukee Sewerage Commission has obtained a commercial dishwasher detergent which is free of phosphorus. The material was purchased from the dishwasher manufacturer Heinicke Instruments Co. of Hollywood, Fla. at the same price previously paid for a formulation containing phosphorus (37 cents per pound in 100 pound lots). This material is used in laboratory dishwashers and is satisfactory.

Dr. S. K. Malhotra of Marquette University conducted a study to determine the effects of this phosphorus free detergent on aerobic sewage treatment processes (activated sludge). Dr. Malhotra's report (which is attached) indicates that the phosphate free detergent (B–5) in concentrations as high as 200 mg/l had no detrimental effects on the activated sludge process. A comparison with "Tide," a commercial synthetic detergent, indicated that both were biodegradable and had no toxic effects on *E. Coli*, a common sewage bacteria.

This would lead us to believe that formulation of phosphorus free detergents, that would not adversely affect sewage treatment processes, is possible at this time.

A precedent for the removal of an undesirable compound from synthetic detergents was set in 1965 when the soap and detergent industry completed a changeover from nonbiodegradable to biodegradable surfactants. During the 1950's paralleling the widespread acceptance of synthetic detergents most plants employing activated sludge process noted increasing foaming problems.

In addition to the foam in treatment plants, foam upon watercourses at dams and other areas of turbulent flow made the nonbiodegradable surfactant evident to the public.

In 1963 the Wisconsin Legislature passed an act prohibiting sale of nondegradable detergents containing alkyl benzene sulfonate (copy attached) after December 31, 1965. The 1965 changeover from nonbiodegradable to biodegradable surfactant, to comply with this act as well as proposed Federal legislation, eliminated the foaming problem at the Milwaukee Jones Island Sewage Treatment Plant.

REFERENCES

1. Report to the International Joint Commission on the Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River by the International Lake Erie Water Pollution Board and the International Lake Ontario—St. Lawrence River Water Pollution Board 1969.

2. Rudolfs W., "Phosphates in Sewage and Sludge Treatment I Quantities of Phosphates" Sewage Works Journal 19, 1, 43 (Jan. 1947).

TOTAL AMOUNT OF PHOSPHORUS IN MILORGANITE PER YEAR

Year	Milorganite tons (dry)	Percent Phosphorus (dry)	Tons phosphorus	Pounds phosphorus
1928	31,103	1.21	376.3	752,693
1929	33,419	1.20	401.0	802,056
1930	34,509	1.31	452.1	904,136
1931	26,108	1.35	352.5	704,916
1932	26,698	1.35	360.4	720,846
1933	29,613	1.36	402.7	805,474
1934	31,297	1.39	435.0	870,057
1935	30.996	1.39	430.8	861,689
1936	43,838	1.39	609.3	1,218,696
1937	48,272	1.39	670.9	1,341,962
1938	41,496	1.41	585.1	1,170,187
1939	43,773	1.44	630.3	1,260,662
1940	45,960	1.48	680.2	1,360,416
1941	47,345	1.34	634.4	1,268,846
1942	52,049	1.42	739.1	1,478,192
1943	52,078	1.38	718.7	1,437,353
1944	50,966	1.45	739.0	1,478,014
1945	50,986	1.48	754.5	1,509,186
1946	52,585	1.45	762.5	1,524,965
1947	49,684	1.51	750.2	1,500,457
1948	54,909	1.55	851.1	1,702,179
1949	57,455	1.54	884.8	1,769,614
1950	61,679	1.74	1,073.2	2,146,429
1951	61,890	1.77	1,095.5	2,190,906
1952	61,699	1.97	1,215.5	2,430,941
1953	59,626	2.14	1,275.9	2,551,993
1954	60,788	2.21	1,343.4	2,686,830
1955	68,183	2.09	1,425.0	2,850.049
1956	70,592	2.11	1,489.5	2,978,982
1957	71,573	2.06	1,474.4	2,948,808
1958	65,812	2.00	1,316.2	2,632,480
1959	70,042	2.00	1,400.8	2,801,680
1960	66,031	2.11	1,393.3	2,786,508
1961	60,357	1.91	1,152.8	2,305 637
1962	66,947	1.76	1,178.3	2,356.534
1963	66,380	1.97	1,307.7	2,615,372
1964	73,258	1.89	1,384.6	2,769,152
1965	79,364	2.21	1,753.9	3,507,888

STATE OF WISCONSIN

No. 404, S. Published Dec. 27, 1963

CHAPTER 434, LAWS OF 1963

AN ACT

AN ACT to create 20.410 (6) and (49) and 144.14 of the statutes, relating to the regulation of detergents, requiring industry to report status of industrial conversion to biodegradable detergents, granting rulemaking and investigation authority, and making an appropriation.

The people of the State of Wisconsin, represented in senate and assembly, do enact as follows:

Section 1. 20.410 (6) of the statutes is created to read:

20.410 (6) Regulation of Detergents.—On January 1, 1964, and on July 1, 1964, and annually thereafter $10,000, for the accomplishment of s. 144.14.

Section 2. 144.14 of the statutes is created to read:

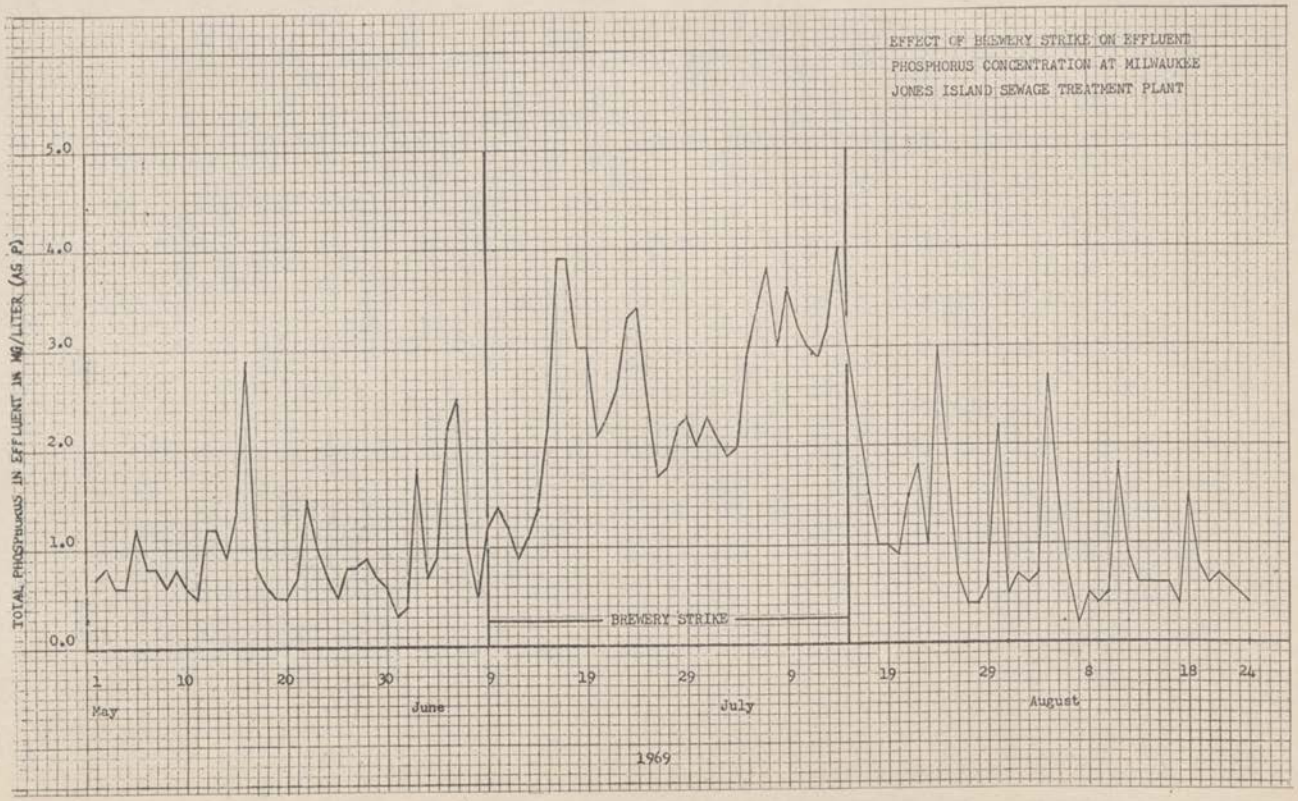
144.14 Degradable Detergents.—(1) Investigation and Standards.—The State board of health shall investigate and review industry progress in developing degradable detergents, and request that various raw material manufacturers make status reports to the State board of health every 4 months commencing December 15, 1963, until such time as the board feels such reports are no longer needed; review and investigate the disposition of synthetic detergents and other persistent chemical pollutants, as wastes, into sewage treatment facilities, rivers, ground and surface water supplies; determine what problems are thereby created; establish a standard and a method for determining synthetic detergent degradability in waste treatment systems, as a suggested guide to detergent manufacturers, such standard to be in keeping with the current level of scientific knowledge and technology; hold public hearings concerning the establishment of such standard, if any; and report its findings and recommendations to the 1965 legislature when it convenes.

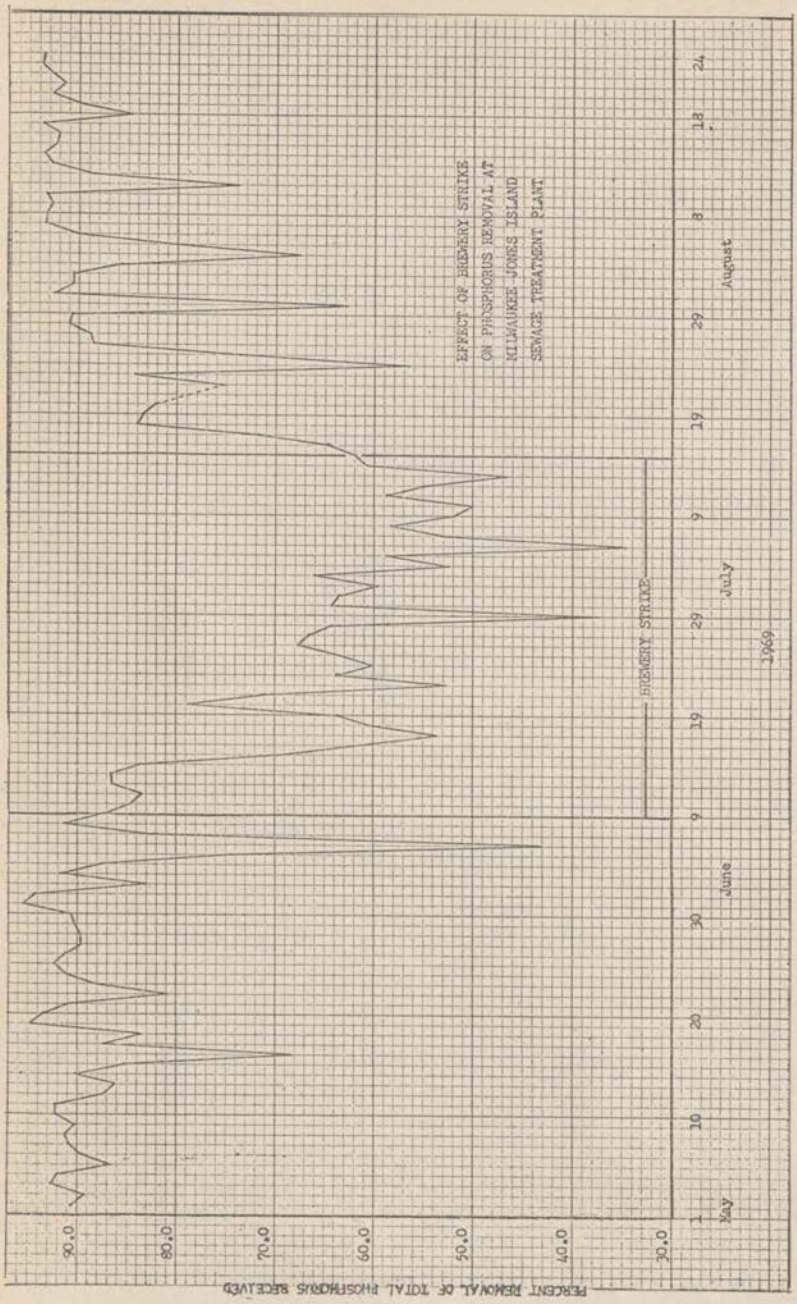
(2) Suppliers To Report to Board.—All suppliers of raw materials for the present surface active agent contained in detergents of the generally nondegrading type, whose materials either directly or indirectly are sold in this State, shall report to the State board of health every 4 months, commencing December 15, 1963, for such time the board deems necessary, the suppliers current progress towards the complete conversion of its facilities to the manufacture of degradable detergents for domestic sale and consumption.

(3) Sale Prohibited.—On and after December 31, 1965, the sale and use of nondegradable detergents containing alkyl benzene sulfonate is prohibited in this State.

Senate: Ayes 29; Noes 1.

Assembly: Ayes 88; Noes 3.


EFFECT OF BREWERY STRIKE ON EFFLUENT
PHOSPHORUS CONCENTRATION AT MILWAUKEE
JONES ISLAND SEWAGE TREATMENT PLANT
TOTAL PHOSPHORUS IN EFFLUENT IN MG/LITER (AS P)
5.0
4.0
3.0
2.0
1.0
0.0
BREWERY STRIKE
1
10
20
30
9
19
29
9
19
29
8
18
24
May
June
July
August
1969


EFFECT OF BREWERY STRIKE
ON PHOSPHORUS REMOVAL AT
MILWAUKEE JONES ISLAND
SEWAGE TREATMENT PLANT
BREWERY STRIKE
PERCENT REMOVAL OF TOTAL PHOSPHORUS RECEIVED
90.0
80.0
70.0
60.0
50.0
40.0
30.0
May
1
10
20
30
June
9
19
29
July
9
19
29
August
8
18
24
1969

MARQUETTE UNIVERSITY,
Milwaukee, Wisconsin, December 8, 1969.

Mr. RAYMOND D. LEARY,
General Manager and Chief Engineer,
Metropolitan Sewerage Commission,
Milwaukee, Wis.

DEAR MR. LEARY: With reference to the letter from Mr. Ernest dated November 20, 1969, Dr. Raymond J. Kipp, Dr. Alphonse E. Zanoni and I made the following evaluation of the sample of Heinicke No-Phosphate B–5 detergent with regard to its biodegradability and its toxicity to the activated sludge process and its effectiveness as a cleaning compound. In all aspects of the evaluation of the sample of B–5, the behavior of the B–5 sample was compared with that of a sample of Tide, which is a commercial detergent used for household laundry purposes.

Included herewith is a report with all the findings of our evaluation. Please feel free to contact me if you have any questions on the contents of this study.

Sincerely yours,

S. K. MALHOTRA,
Assistant Professor, College of Engineering, Department of Civil Engineering.

Outline of the Report

1. Introduction.
2. Activated Sludge Toxicity and Biodegradability Tests.
3. Toxicity to Bacteria (to Fecal Coliforms Only).
4. Biochemical Oxygen Demand and BOD/COD Ratios.
5. Detergency Tests.
6. Additional Observations.
7. Conclusion.
8. References.

Introduction

A concentration of 100 mg/l of Tide or B–5 in the feed to the laboratory activated sludge units was selected from the reported average levels of alkylbenzene sulfonate or linear alkylate sulfonate in domestic sewage. (This is based on an ABS or LAS concentration of less than 20 mg/l and commercial detergent containing less than 20 percent ABS or LAS).

Because the B–5 is methylene blue inactive and its composition is not known, it was not possible to use the standard biodegradability test as set forth by the Soap and Detergent Association in reference 3, and obtain the percent reduction of the B–5 in the activated sludge process directly.

Also because of the low foamability and poor stability of the foam produced by B–5, foam measurements such as given in reference 4, for determining the concentration of B–5 was thought to be a poor measure for use in the biodegradability tests.

The biodegradability of B–5 has also been indirectly evaluated by measuring the biochemical oxygen demand and BOD/COD ratios of B–5 as reported in reference 4. A simultaneous qualitative and quantitative evaluation of B–5 and Tide (a commercial household laundry detergent) has been made in all the observations for evaluating the biodegradability, toxicity to the activated sludge process and cleaning effectiveness of B–5.

Biodegradability and Toxicity to the Activated Sludge Process

Five laboratory aeration units were set up as shown on page 4 and the assembly of these units is shown in a photograph on page 23. Each unit contained 1 liter of return sludge and 2 liters of synthetic feed as recommended by the Soap and Detergent Association. The synthetic sewage feed contained the following quantities per liter.

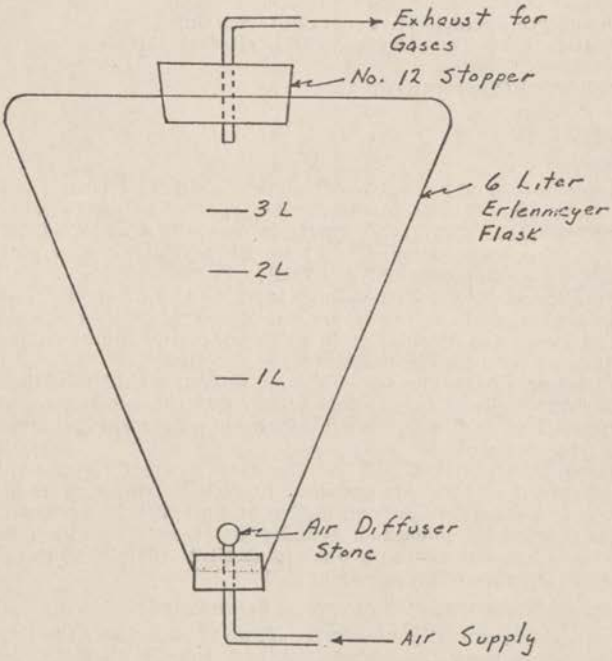
	Milligrams
Glucose	130
Nutrient Broth	130
Beef Extract	130
Dipotassium hydrogen phosphate	130
Ammonium sulfate	25

Tap water to make up to 1 liter.

Each unit was fed once a day and aerated for about 23 hours, allowed to settle for 1 hour and 2 liters of supernatant was siphoned off and replaced by feed and aerated again. One unit was kept as a control, one was fed with Tide and the remaining three were fed different concentrations of B-5. As recommended by the Soap and Detergent Association, the units were acclimated in 5 days to 100 mg/l of Tide in increments of 20 mg/l/day; to 100 mg/l of B-5 in increments of 20 mg/l/day; to 50 mg/l of B-5 in increments of 10 mg/l/day and to 200 mg/l of B-5 in increments of 40 mg/l/day. The feeding schedule is shown on page 5. After the acclimation period the operation of the units was continued for seven more days at a constant level operation.

During these seven days the reduction in COD in each of the units was observed and also occasional observations were made of the Mixed Liquor Suspended Solids, Mixed Liquor Volatile Suspended Solids, Sludge Density Index and the pH of the effluent. The results obtained are presented on pages 6 through 7 (printed hearing record p. 272). All the tests were conducted in accordance with *Standard Methods*.[1]

A concentration of 200 mg/l of B-5 and a concentration of 100 mg/l of Tide in the feed and the control resulted in almost the same average reduction of COD and almost the same value of the sludge density index. This indicates that not only B-5 and Tide are biodegradable but also the concentrations studied do not have any detrimental effect on the activated sludge process.



LABORATORY AERATION UNIT FOR ACTIVATED SLUDGE

OPERATIONAL PROCEDURE:

Aerate mixture for 23 hours.

Settle for 1 hour.

Remove supernatant to 1 liter level. (If solids are greater than 1 liter volume, remove excess solids also to 1 liter volume.

Add 2 liters of feed solution, bringing volume to 3 liters.

Begin aeration. Repeat procedure on daily basis.

FEED SCHEDULE

Date	Unit 1, control	Unit 2, tide, 100 mg/l	Unit 3, B5, 100 mg/l	Unit 4, B5, 50 mg/l	Unit 5, B5, 200 mg/l
Nov. 24	Synthetic sewage	Synthetic sewage plus 20 mg/l Tide.	Synthetic sewage plus 20 mg/l B5.	Synthetic sewage plus 10 mgl B5.	Synthetic sewage plus 40 mg/l B5.
Nov. 25	do	Synthetic sewage plus 40 mg/l Tide.	Synthetic sewage plus 40 mg/l B5.	Synthetic sewage plus 20 mg/l B5.	Synthetic sewage plus 80 mg/l B5.
Nov. 26	do	Synthetic sewage plus 60 mg/l Tide.	Synthetic sewage plus 60 mg/l B5.	Synthetic sewage plus 30 mg/l B5.	Synthetic sewage plus 120 mg/l B5.
Nov. 27	do	Synthetic sewage plus 80 mg/l Tide.	Synthetic sewage plus 80 mg/l B5.	Synthetic sewage plsu 40 mg/l B5.	Synthetic sewage plus 160 mg/l B5.
Nov. 28	do	Synthetic sewage plus 100 mg/l Tide.	Synthetic sewage plus 100 mg/l B5.	Synthetic sewage plus 50 mg/l B5.	Synthetic sewage plus 200 mg/l B5.

END OF ACCLIMATING PERIOD

Nov. 29 through Dec. 5	Synthetic sewage	Synthetic sewage plus 100 mg/l Tide.	Synthetic sewage plus 100 mg/l B5.	Synthetic sewage plus 50 mg/l B5.	Synthetic sewage plus 200 mg/l B5.

REDUCTION OF CHEMICAL OXYGEN DEMAND

Date	Unit 1 control		Unit 2 Tide		Unit 3 B5		Unit 4 B5		Unit 5 B5	
	Feed COD=360 mg/l effluent COD		Feed COD=410 mg/l effluent COD		Feed COD=368 mg/l effluent COD		Feed COD=376 mg/l effluent COD		Feed COD=381 mg/l effluent COD	
	Conc. mg/l	Percent reduction	Conc. mg/l	Percent reduction	Conc. mg/l	Percent reduction	Conc. mg/l	Percent reduction	Conc. mg/l	Percent reduction
November 29	55	85	59	86	55	85	43	89	67	82
November 30	(256)	(29)	84	80	28	92	(4)	(99)	(4)	(99)
December 1	52	86	52	87	52	86	56	85	68	82
December 2	65	82	69	83	110	70	82	78	86	76
December 3	54	85	60	85	56	85	60	84	52	86
December 4	92	74	75	82	71	81	74	80	89	77
December 5	78	78	80	80	82	78	68	82	62	84
Average reduction in COD		82		83		82		83		81

	Unit				
	1	2	3	4	5
pH:					
Nov. 29	7.25	7.7	7.35	7.45	7.5
Dec. 4	6.75	6.9	7.2	6.85	7.35
Dec. 5	7.0	7.15	7.4	7.1	7.5
Mixed liquor suspended solids:					
Nov. 30	2,338	2,514	2,656	2,553	2,706
Dec. 5	1,747	1,815	1,845	1,848	1,917
Percent volatile mixed liquor suspended solids:					
Nov. 30	68.9	69.3	70.2	69.5	69.2
Dec. 5	70.3	69.4	67.9	69.8	69.0
Settleable solids, 30 min. settling (ml./l.): Dec. 1	280	320	350	350	340
Sludge density index	0.84	0.79	0.76	0.73	0.80

Toxicity Test

To determine whether or not the detergent B–5 was toxic to bacteria, the following procedure was used. A pure culture of *Eschericia coli* was obtained by filtering raw sewage through a Millipore filter and placing the filter on MFC media. After 20 hours incubation at 44.5° C, typical fecal coliform colonies were transferred to nutrient broth and cultivated at 35° C. From the nutrient broth culture, further dilutions and filtrations were made to obtain a pure culture. The culture was transferred to nutrient broth and cultivated at 35° C for 24 hours before using as a test organism.

Since no previous work was available, an assumption was made that the B–5 detergent might be toxic. However the toxicity of other detergents was unknown so a control detergent, Tide, was selected for comparison. It was assured that a high concentration would be toxic, so a series of concentrations of Tide and B–5 were selected to measure the effect of concentration. Concentrations selected are shown on pages 9 through 11 (printed hearing record pp. 273–274).

Sterile dilution water was prepared. Stock solutions of Tide and B–5 were sterilized by Millipore Filter. At time zero, 1 ml of the 24 hour culture was added to the flask containing the detergent and dilution water. The first plates were poured 5 minutes after the culture was added. At least four dilutions were poured so that significant plate counts could be obtained. A second set of plates were poured 60 minutes after the culture was added. All plates and dilutions were made according to standard bacteriological procedures. Nutrient agar was used as a plate count medium.

After 24 hours incubation at 35° C, the plates were counted. Only those plates with a count between 30–300 were considered sufficient.

The results are shown on pages 9 through 11 (printed hearing record pp. 273–274).

Detergent	Concentration mg/l	Time after inoculation minutes	Dilution 1/10ⁿ ml	Plate count
Control		5	10^{-4}	(1)
			10^{-5}	95
			10^{-6}	12
			10^{-7}	(2)
Do		60	10^{-4}	(1)
			10^{-5}	144
			10^{-6}	14
			10^{-7}	(2)
Tide	1	5	10^{-4}	(1)
			10^{-5}	115
			10^{-6}	14
			10^{-7}	(2)
Do	1	60	10^{-4}	(1)
			10^{-5}	151
			10^{-6}	17
			10^{-7}	(2)
Do	5	5	10^{-4}	(1)
			10^{-5}	158
			10^{-6}	10
			10^{-7}	(2)
Do	5	60	10^{-4}	(1)
			10^{-5}	141
			10^{-6}	(2)
			10^{-7}	(2)
Do	10	5	10^{-4}	(1)
			10^{-5}	132
			10^{-6}	(2)
			10^{-7}	(2)
Do	10	60	10^{-4}	(1)
			10^{-5}	139
			10^{-6}	(2)
			10^{-7}	(2)
Do	50	5	10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	145
Do	50	60	10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	133
Do	100	5	10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	147
Do	100	60	10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	202
Do	200	5	10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	143
Do	200	60	10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	192
Do	1,000	5	10^{-0}	(1)
			10^{-1}	(1)
			10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	133
Do	1,000	60	10^{-0}	(1)
			10^{-1}	(1)
			10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	144
Control		5	10^{-4}	(1)
			10^{-5}	157
			10^{-6}	13
			10^{-7}	(2)
Do		60	10^{-4}	(1)
			10^{-5}	186
			10^{-6}	16
			10^{-7}	(2)

See footnotes at end of table.

Detergent	Concentration mg/l	Time after inoculation minutes	Dilution 1/10ˣ ml	Plate coun
B-5	1	5	10^{-4}	(1)
			10^{-5}	160
			10^{-6}	(2)
			10^{-7}	(2)
Do	1	60	10^{-4}	(1)
			10^{-5}	161
			10^{-6}	(2)
			10^{-7}	(2)
Do	5	5	10^{-4}	(1)
			10^{-5}	117
			10^{-6}	(2)
			10^{-7}	(2)
Do	5	60	10^{-4}	(1)
			10^{-5}	134
			10^{-6}	(2)
			10^{-7}	(2)
Do	10	5	10^{-4}	(1)
			10^{-5}	132
			10^{-6}	(2)
			10^{-7}	(2)
Do	50	5	10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	124
Do	50	60	10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	128
Do	100	5	10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	156
Do	100	60	10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	142
Do	200	5	10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	178
Do	200	60	10^{-0}	(1)
			10^{-1}	(1)
			10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	182
Do	1,000	5	10^{-0}	(1)
			10^{-1}	(1)
			10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	150
Do	1,000	60	10^{-0}	(1)
			10^{-1}	(1)
			10^{-2}	(1)
			10^{-3}	(1)
			10^{-4}	(1)
			10^{-5}	132

[1] Too numerous to count.
[2] Too few to be significant.

The results of the toxicity tests are somewhat inconclusive. Certain observations can be made:

1. No toxic effects are noted from concentrations of Tide and B–5 up to and including 1000 mg/l. The plate counts indicate that within experimental error, no significant difference was noted at varying concentrations.

2. The effect of a contact time of 60 minutes, even at the highest concentration, is not detectable. The average plate count after a 60 minute contact period was not significantly different from the 5 minute contact period dilution plates.

3. The number of viable organisms, *E. coli*, in the original culture was approximately 3.5×10^9/ml.

4. Neither Tide nor B–5 shows any toxic effect on *E. coli* at a concentration of 1000 mg/l with a contact time of 60 minutes when conducted at room temperature.

Biochemical Oxygen Demand and BOB/COD Ratios

A very common method of evaluating the effect of any new waste discharge on biological waste water treatment and on its degradation under normal receiving water conditions, is to determine its BOD and compare this value with the BOD of a known substrate. The BOD also gives some indication of the biodegradability of the test substrate and also its possible bacteriocidal effect.

On November 26, a 5-day BOD test series was set-up using the detergents B–5 and Tide alone and each in combination with *Standard Methods* glucose-glutamic acid solution. Settled raw sewage from the Jones Island plant was used as the seed. Three different concentrations of detergent (10 percent of 0.05 mg/ml, 25 percent of 0.05 mg/ml, and 0.5 percent of 10 mg/ml) were employed to ascertain both the biodegradability and toxicity effects if any. The standard glucose-glutamic acid solution was used at a concentration of 0.6 percent for the tests in which it was added to the detergents.

Partly due to the lack of experience with detergents substrates, the BOD results were somewhat inconclusive. Some general observations can be made upon an examination of the 12 BOD set-ups which were made. Firstly, for similar concentration levels, Tide consistently exhibited a greater oxygen demand than B–5. Secondly, when both detergents were used at very high concentrations, complete depletion of the oxygen occurred in the incubated bottles indicating bottles biodegradability and lack of bacterial toxicity. And lastly, when both detergents were combined with the glucose-glutamic acid solution, the Tide combinations were consistently higher than the B–5 combinations, and the detergent in each case did not suppress the degradation of the glucose-glutamic acid solution.

It was decided to conduct a second biochemical oxygen demand test on December 3, the results of which are presented on page 16 (printed hearing record below). Because of limited time the 3-day BOD values were determined. The results of a standard glucose-glutamic acid solution test showed that the settled raw sewage used for the seed met the requirements of *Standard Methods*. When the glucose-glutamic acid solution was combined with each detergent, the expected oxygen depletion was obtained indicating again that the presence of either detergent did not inhibit the degradation of glucose-glutamic acid solution. The results demonstrate further that the BOD of the Tide solution is considerably higher than that of the B–5 probably as much as 5 to 6 times as high. Finally, though the actual kinetics were not established for each detergent, it is safe to conclude that the organic matter present in both detergents can be considered biodegradable.

3-DAY BIOCHEMICAL OXYGEN DEMAND TEST

Test substrate	Ml. per stand. BOD bottle	3-day BOD (mg./l)	Estimated 5-day BOD (mg./l)	Mg. 5-day BOD per mg. substrate	COD (mg./l)	Ratio 5 day BOD to COD
Standard methods glucose-glutamic acid solution (0.15 gms./l. each)	5	180	220	0.73	[1] 325	0.68
Tide (100 mg./l)	5	11				
Tide (100 mg./l)	10	15				
Tide (100 mg./l)	20	14	20	.20	38	.53
B–5 (100 mg./l)	10	3	([2])	([2])	4	
B–5 (100 mg./l)	20	([2])				

[1] Calculated.
[2] Negative.

Detergency Test

The evaluation of any detergent as a cleaning compound can only be made through a long series of comparative tests using waters of various hardness and temperature, using many types of fabrics, and considering numerous types of stains and soiling conditions. Furthermore the tests should be conducted under a rigid set of test conditions and employing both qualitative and quantitative measures of overall stain removal and cleanliness. Standard test procedures have been developed by the detergent manufactures for this purpose.

With the time available it was not possible to follow the rigid test conditions cited above for the comparative evaluation of B–5 and Tide as a cleansing compound. It was decided to use a simple qualitative test to compare the two detergents.

Four dozen new white cotton diapers were employed for the test. All except 3 diapers were soiled thoroughly with a water containing garden soil and dried. Just prior to washing, the corners of all the diapers were stained with a barbecue sauce and randomly divided into three piles of 14 diapers each. Three soiled diapers were set aside for comparative purposes. Each load of diapers was washed separately in a recent model automatic clothes washer using a hot water wash for 14 minutes and warm rinse. One load was washed in plain water (Milwaukee water hardness about 120 mg/l as $CaCO_3$), the other was washed with one cup of Tide (77 gms), and the third was washed with the same weight of B–5 (77 gms). After the washing cycle, the clothes were dried for 40 minutes in a gas dryer. The three loads were compared with the original new diapers, the soiled diapers and with each other. Photographs of different stages of the washing test are presented on pages 23 and 24.

(Note.—The photographs referred to in this study are in the subcommittee files.)

Admittedly it is difficult to come to any final conclusion on detergency on the basis of the limited data available. A visual comparison was made of the three loads in comparison to new diapers and the soiled diapers. Below are presented the relative results of six observers (3 men and 3 women) under daylight, incandescent and fluorescent lighting conditions. The lowest number indicates the best detergency conditions.

	Water	Tide	B-5
I. Whiteness (none matched whiteness of new fabric)	2	1	3
II. General cleanliness (removal of soiling)	1	1	1
III. Stain removal	1	3	2

Additional Observations

Additional analyses, pages 20 and 21 were made to determine the COD, and the phosphate concentration of Tide and B–5. One mg of Tide contributed about 0.378 mg of COD whereas 1 mg of B–5 contributed only 0.04 mg of COD. Also Tide was about 3.33 percent P by weight whereas B–5 contained about 0.055 percent P. (See hearing record pp. 276–277.)

The COD of the synthetic sewage used in the biodegradability studies is presented on page 20. (See hearing record immediately below.)

Some additional observations as determined during the investigation are summarized on page 22 (printed hearing record, p. 277).

Chemical oxygen demand

[COD concentration of synthetic sewage: (Feed to unit No. 1)]

Nov. 29	369 mg/1
Dec. 3	360 mg/1
Dec. 4	350 mg/1
Dec. 5	366 mg/1
Total	1, 445

NOTE.—1,445 over 4 equals 361 mg/1.

[COD concentration of Tide]

Dec. 4 ..... 0.378 mg/1 COD per mg/1 Tide.

[COD of Feed to unit No. 2. Unit No. 2 was fed 100 mg/1 Tide, therefore the Tide added 38 mg/1 of COD to the feed solution]

Nov 29	425 mg/1
Dec. 3	419 mg/1
Dec. 4	386 mg/1
Total	1, 230

NOTE.—1,230 over 3 equals 410 mg/1 COD in Unit No. 2.

[COD concentration of B-5]

Dec. 4 ..... 0.04 mg/1 COD per mg/1 B-5.

COD of Feed to	Unit 3 100 mg/l B-5	Unit 4 50 mg/l B-5	Unit 5 200 mg/l B-5
Nov. 29	N.G.	N.G.	N.G.
Dec. 3	387	376	376.
Dec. 4	350	N.G.	386.
	737/2=368 mg/l.	376 mg/l.	381 mg/l.

[For calculative purposes use the following COD concentrations for the feed]

Unit No. 1 ..... 360 mg/l
Unit No. 2 ..... 410 mg/l
Unit No. 3 ..... 368 mg/l
Unit No. 4 ..... 376 mg/l
Unit No. 5 ..... 381 mg/l

PHOSPHORUS ANALYSES OF TIDE AND B-5

[As percent P by weight]

	Tide	B-5
Orthophosphate (analysis):		
1	0.094	0.00218
2	.104	.00243
3	.099	.00228
Average	.099	.00229
Ortho and polyphosphate (analysis):		
1	3.00	.0218
2	3.20	.0240
3	3.10	.0228
Average	3.10	.0228
Total phosphates (analysis):		
1	3.20	.0490
2	3.46	.0555
3	3.33	.0620
Average	3.33	.0555

GENERAL COMPARATIVE OBSERVATIONS

	B-5	Tide
Color	Pure white	Cream white.
Odor	Inert, dusty	Strong perfume.
Texture	Powdery	Granular.
Approximate unit weight (gms/liter)	1,150	325.
Solubility in cold water (10,000 mg/1)	Very soluble	Good solubility (some amount insoluble).
Appearance of 10,000 mg/1 solution	Completely colorless	Milky white.
Filterability of 10,000 mg/1 solution through membrane filter (0.45 micron).	Excellent—very little residue in approximately 400 ml.	Poor—creamy textured emulsion plugs filter after 50 ml.
Sudsing ability	Very poor	Very good.
Stability of suds	Disappear very quickly	Long lasting.
pH of .05 percent solution	8.70	8.05.
pH of 1 percent solution	12.03	9.69.

Conclusions

1. No detrimental effects were observed in the concentrations as high as 200 mg/1 for B-5 on the activated sludge process.

2. COD reductions indicated no significant differences in activated sludge units fed Tide detergent and B-5 detergent as compared to the control.

3. Neither Tide or B–5 had any discernible toxic effect on the biochemical oxygen demand of a standard glucose-glutamic acid solution. Both detergents in very high concentration exhibited biodegradability.

4. No toxic effects on *E. coli* were observed with concentrations of 1000 mg/l Tide or 1000 mg/l B–5 at contact times of 1 hour.

5. Because of the low COD and BOD per unit weight of B–5, no conclusion can be reached regarding its rate of biodegradability with the limited tests performed using the activated sludge units.

6. The limited qualitative laundry test indicated that B–5 did not equal Tide in whitening ability, but was equally effective in general cleansing.

7. Because of the limited time available to us, it is recommended that these conclusions not be widely disseminated until further long-term studies are made as initiated herein. Other studies should be conducted on additional effects from B–5.

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3. A Procedure and Standards for the Determination of the Biodegradability of Alkyl Benzene Sulfonate and Linear Alkyl Sulfonate. Jour. of Am. Oil Chemists' Soc. Vol. 42, No. 11. 1965.

4. A Report on the Status of Biodegradability Testing of Nonionic Surfactants by M. Mausner and others.

NEW YORK, N.Y.
December 15, 1969.

Representative HENRY REUSS,
Conservation and Natural Resources, Subcommittee of Government Operations Committee, Washington, D.C.

Many housewives like myself will gladly forego spotless laundry if this will in any measure help save our rivers and lakes from premature aging.

ELIZABETH ROGERS.

FRESNO STATE COLLEGE,
Fresno, Calif., January 7, 1970.

Hon. HENRY REUSS,
House of Representatives,
Washington, D.C.

DEAR SIR: In the December 26, 1969, issue of Time magazine you are quoted as an active participant in the House Subcommittee on Conservation and Natural Resources hearing on eutrophication of our native waters. You are quoted, in that article, as correctly singling out the phosphate contribution of detergents as being largely responsible for much of the damage that has already occurred to our native waters.

It is my understanding that most of the phosphate is added to detergents, as sodium hexametaphosphate—as in "Calgon"—and is added as a water softener. The effective chemical element is then sodium. If a water softening agent is required, then the easiest alternative for the detergent industry is to turn to a commercially available product such as sodium borate—"Borax".

Both boron and phosphorus are essential to the growth of green plants. However, at very low concentration, boron becomes toxic to plant growth. It seems to me that the subsitution of the borate softener for the phosphates will be going from one problem to another even more difficult to handle.

The chemistry of most phosphates is such that they will be held in a soil system, either alkaline or acid. On the other hand, most boron compounds are quite soluble and will not be held by a simple filtering through soil or sand beds. Processing of sewage to remove phosphates should then be relatively easy, as compared to the borates.

As an alterative, a new type of product should be developed—biodegradable, into basic elements that are neither nutrients nor toxins, possibly a carbon or silicate compound—to act as a carrier for the water softening cation sodium

without constituting a threat to the environment; if water softeners are necessary with present day detergents. In the early days of the detergent take-over from soap, the advertising claimed that they were equally effective in soft or hard water. Possibly, we should all get used to shirts that aren't whiter than the neighbor's.

I hope that this is not redundant to testimony already submitted in the hearings of the subcommittee, but it has bothered me since I read the article, and I wanted to be certain that you were informed of this possible problem.

Sincerely,

JAMES R. BROWNELL,
Associated Professor of Soil Science.

MALIBU PRODUCTS CO.,
Long Beach, Calif., January 12, 1970.

STATEMENT OF CONRAD J. GAISER ON "HYDRATED, AMORPHOUS SODIUM SILICATE FOR USE AS A DETERGENT BUILDER"

A newly discovered form of sodium silicate, and the process for its manufacture are the subjects of a current patent. This material has several applications. Its use as a builder in home laundering compounds is the one of interest here.

Historically, home laundering compounds have depended on the polyphosphates for (a) water hardness control by their threshold effect on calcium soap precipitation, and (b) soil suspension by an "electrostatic" or ionic dispersion effect. In commercial laundering the highly alkaline sodium silicates have been used. Here, the high alkalinity promotes the dispersion of the silicate agglomerates as colloids. Since this high alkalinity could not be used in home laundering, silicates of the usual crystalline nature failed to disperse as colloids which could be useful soil suspending agents, and so have been used in home laundering compounds only for their protecting effect against corrosion of soft metal parts of the machinery. There are commercial laundries presently using mixtures of high silica ratio sodium silicates in water solution ("N"-brand) mixed with liquid caustic soda as detergent builders. In these cases, the original, highly colloidal nature of the sodium silicate solution is preserved by maintaining a suitable alkalinity.

The newly discovered, amorphous, hydrated sodium silicates go into solution readily, with the SiO_2 portion forming low molecular weight, negatively charged agglomerates (small colloidal particles). These offer great surface area, highly negatively charged, which surfaces then suspend soil by absorbing it in competition with the negatively charged fabric fibers being laundered. Tests by independent test laboratories, and more recently by a large manufacturer of household laundering compounds in his own laboratory, demonstrate the value of these amorphous, hydrated granular sodium silicates in replacing the polyphosphates as far as soil suspending is concerned. Where hard water is being used to wash greasy soil from cotton, the insoluble soaps formed are adsorbed by the colloidal silica, consuming its capacity to suspend other soils. In this case, calcium and magnesium ion chelates are needed.

The present concern over the prevention of phosphates from becoming pollutants in surface waters is directing attention to either their removal from effluent waters, or discontinuance of their use in home laundering compounds. So far, published discussions of this problem have indicated that efforts are being directed at the partial replacement of phosphates with chelates, but no low cost, highly active, biologically inert soil suspending agent has been recognized. This is exactly the role which the granular, hydrated, amorphous sodium silicates can fill. Furthermore, they cost less than do the polyphosphates.

In the course of manufacture by the process which is part of the current patent, the amorphous, hydrated granular sodium silicates may be produced in a wide range of bulk densities and granular sizes.

By the same process, products may be produced in which all or part of the several other ingredients of a good home laundering compound are incorporated, with the wide granular size and bulk density option still available. The granular, amorphous, hydrated sodium silicate best suited for a home laundering compound builder has been found to be one with a ratio of Na_2O to SiO_2 of 1 to 2.6 which product, made in fairly large granules has the very great advantage of acting as a good binder for laundering tablets. Tablets so made are rugged and

tough, yet dissolve quickly in hot or cold water. Areas which need further work are those of maintaining moisture content and protecting from the action of carbon dioxide, both packaging problems about which some suggestions are available.

These sodium silicates are covered by U.S. patent No. 3,450,494 issued to Conrad T. Gaiser of No. 24 on 66th Place, Long Beach, Calif., June 17, 1969. Their use in compounding home laundering detergents could eliminate polyphosphates completely at no cost increase to the detergent user or to the processing of domestic sewage.

Re, Household detergents.

CAROL A. PIETRYKOWSKI,
Toledo, Ohio, February 11, 1970.

Hon. HENRY S. REUSS,
Chairman, Conservation & Natural Resources Subcommittee,
House Committee on Government Operations,
U.S. House of Representatives, Washington, D.C.

DEAR CONGRESSMAN REUSS: I have followed with interest the hearings your subcommittee held in the latter part of 1969 concerning the effect of detergents on the pollution and degradation of our streams and lakes. Because of Lake Erie's advanced stage of eutrophication, we here in Toledo are vitally interested in this matter.

As pointed out in the Department of Interior's report on Lake Erie (August, 1968) the injection of phosphorus into the lake is one of the major factors contributing to the foreseeable demise of this body of water. As the report points out, 137,000 pounds of phosphorus are deposited each day into Lake Erie; that 72 percent of this amount is contained in municipal waste; and that 66 percent of this latter amount comes directly from detergents.

Obviously, if we are going to save Lake Erie, we must substantially stop the dumping of phosphorus into the lake.

Thus far the $4½ billion detergent industry has effectively lobbied against any measure introduced in Congress which would regulate the industry in this respect. Charles Bueltman, vice president and technical director of the Soap & Detergent Association, testified before your committee and reiterated the industry's traditional view that: (1) the industry is not the prime source of phosphorus injected into our waters, and (2) the industry is doing everything possible to remedy the situation.

Mr. Bueltman's testimony before your committee was essentially the same as his testimony before the House Public Works Committee on March 6, 1969.

Until now, the detergent industry has not itself remedied the situation. Neither Congress nor the administration has found an immediate solution. However, some action particularly with reference to Lake Erie must be initiated now.

It is for this reason that I write.

Can you list for use the detergents that have the least deleterious effect upon our waters? I have tried numerous sources (including Mrs. Virginia Knauer, Assistant to the President for Consumer Affairs) but have been unsuccessful in obtaining this information.

Frankly, if we housewives have this information I am sure that we will act accordingly.

At the present time, it is the opinion of the administration as reflected by Carl L. Klein, Assistant Secretary of the Interior for Water Quality and Research, that the removal of the phosphates from sewage should be accomplished at the sewage treatment facility. This is not a workable solution. First of all, here in Toledo it will cost us (even after the construction of a new $18 million sewage treatment facility plant in 1972) 1.8 million dollars per year to effectively remove phosphates from municipal sewage. Secondly, most municipalities do not at this time, nor will they have in the next several years, treatment facilities to adequately remove phosphates no matter what the cost may be. However, if the consumer is aware of which soaps or detergents to use, I am sure that much of the problem will be solved.

Thank you in advance for your consideration.

Yours very truly,

CAROL A. PIETRYKOWSKI,
Chairman City Council's Pollution
Control and Public Utilities Committees.

STATEMENT BY FRANCIS T. MAYO, REGIONAL DIRECTOR, GREAT LAKES BASIN REGION, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, CHICAGO, ILL., AT HEARINGS BY THE INTERNATIONAL JOINT COMMISSION ON THE POLLUTION OF LAKE ERIE, LAKE ONTARIO AND THE INTERNATIONAL SECTION OF THE ST. LAWRENCE RIVER, ROCHESTER N.Y., FEBRUARY 4, 1970

Mr. Chairman, Members of the International Joint Commission, ladies and gentlemen.

The Federal Water Pollution Control Administration appreciates the opportunity to comment on the report of the Lake Erie and Lake Ontario Water Pollution Advisory Boards to the International Joint Commission on the pollution of Lake Erie, Lake Ontario and the international section of the St. Lawrence River.

It is not my intention today to expound on the generalities of water pollution. We—all of us here at this hearing—are well aware of the pollution that plagues our lakes and fouls our streams.

President Nixon in his State of the Union message on January 22 set the priorities and defined the environmental goals for the United States in the 1970's.

I would like to commend the Commission for its leadership in bringing together the technological expertise of the Governments of the United States and Canada, including the States and Provinces, to deal with the pollution problems of the lower lakes and the St. Lawrence River. In addition, we in FWPCA have appreciated the opportunity to participate in this effort. The preparation and writing of this report represents a significant and unique achievement in international relations.

We believe the United States is well on its way toward accomplishing most, if not all, of our common objectives for the Great Lakes.

The Federal Water Pollution Control Administration has been conducting a broad program in the Great Lakes Region since 1964. At that time basic technical studies were initiated and data gathered to identify the problems in the lakes.

In response to a request of the Governors of the Lake Erie States an enforcement conference on Lake Erie was called in August 1965 in accordance with the provisions of the Federal Water Pollution Control Act.

As a result the respective Great Lakes States have agreed to a clean-up program and a time schedule for its implementation and completion.

The Water Quality Act of 1965 provides for the adoption of water quality standards for all interstate waters; probably the most forceful single program yet devised to protect and enhance the quality of the Nation's waters. All of the contiguous Great Lakes States now have approved water quality standards with limited exceptions.

The Standards make it possible for municipalities, industries and other water users to know in advance what their responsibilities are for keeping waters clean, and for restoring polluted waters to an accepted degree of purity. The standards also give the States and Federal Government authority to prevent pollution before it occurs, instead of instituting enforcement action after health and welfare are proven endangered.

As a result of the Enforcement Conference and the establishment of water quality standard by the States in the U.S. Portion of Lake Erie and Lake Ontario, many of the recommendations of the Advisory Board have been and are being implemented.

The Federal Water Pollution Control Administration is pleased that the findings and recommendations of the Advisory Board's report is in agreement with those contained in our reports on Lake Erie and Lake Ontario which were made public in 1968. Lakes Erie and Ontario are polluted, as is the international section of the St. Lawrence River. Most of the pollutants which degrade Lake Erie and the Niagara River have their sources in the United States, a fact of which no U.S. citizen should be proud.

The findings of the report as to the types and levels of pollutants that are causing international problems; that industries and municipalities contribute the largest amount of pollution, and that the immediate institution of redemial measures is absolutely necessary if we are to save Lakes Erie and Ontario, are commensurate with our 1968 reports.

I am pleased to say that we in FWPCA are in general agreement with the recommendations which have been made by the Advisory Boards for correcting

the pollution problems of the two lakes, and for the preventive measures which have been suggested.

The Boards have considered and made recommendations on several special problems on which I would like to comment at this time.

We agree with the Board's recommendations that existing laws related to reporting and controlling spills of oil and hazardous material should be strengthened, and a preventive program developed. Since the Torrey Canyon affair off the south coast of England and the Santa Barbara incident off our west coast, the world has become extremely sensitive about oil pollution from any source. It is an altogether unpleasant fact that human beings tend to wait until tragedy occurs before they take steps to correct a problem. We are now recognizing, however, the necessity of anticipating these problems and the need to develop effective preventive programs and this is especially true in the case of oil and other hazardous materials. They are extremely complex pollutants with which to deal after they get into the water.

We are recognizing with growing concern the potential dangers associated with the transfer and transport of toxic and other hazardous materials. The Board is to be commended for calling attention to this serious situation in its report. I would remind the Commission that this subject was also given particular attention in the Board's report of September 1969 entitled "Potential Oil Pollution Incidents from Oil and Gas Well Activities in Lake Erie."

You will recall that at the hearings which the Commission conducted on that report FWPCA testified as to its concern for off-shore drilling in Lake Erie and its potential as a source of serious pollution.

We reiterate that position now.

Because existing State and provincial rules and regulations need to be strengthened, because the "state of the art" in technology for containment and cleanup of massive oil spills is yet inadequate, and because the international aspects of contingency plans have not been completed and fully coordinated, we recommend that there be a mortorium on oil production from Lake Erie.

Because of the increasing awareness of the number of oil spills since the Torrey Canyon disaster we found it necessary recently to establish within FWPCA the Office of Oil and Hazardous Materials. This new office will be the focal point for FWPCA's responsibilities and activities in oil pollution and bring to bear our full expertise in contingency planning and in dealing with spills of oil and other hazardous materials in interstate waters.

Recommendations in the Board's report deal with the pollution problems associated with solid waste disposal practices. We agree with the need to eliminate solid wastes, including sediments, as a source of pollution to the Great Lakes. FWPCA has on-going programs developing techniques to deal with solid wastes which result from such activities as dredging, municipal sewage treatment, combined sewer overflows, urban runoff, and erosion related to agricultural activities, urban development, and highway and road construction.

Major water pollution control legislation has passed both Houses of Congress and is now in conference committee. Provisions of the legislation would regulate pollution from federally licensed activities, such as power plant construction and dredging. This has been referred to as a "new dimension" in water pollution control in that it would seek to prevent pollution, rather than waiting until operations which cause pollution are undertaken and then trying to undo the damage.

This legislation would require anyone applying for Federal license or permit to build or operate any kind of facility which might discharge a pollutant into navigable water, to certify "reasonable assurance" that such a facility will be in compliance with water quality standards. Such certification would have to be obtained from the appropriate State agency or regulatory Federal agency, whichever the case may be. The Secretary of the Interior would also be authorized to set performance standards for marine sanitation devices to prevent the discharge of untreated or inadequately treated sewage into navigable water. Thereupon the Coast Guard would promulgate—and enforce—regulations based on these standards, as well as regulations governing the design, construction, installation and operation of these devices on vessels. In other words this legislation seeks to achieve across the country uniformity in the approach to vessel pollution control. Other provisions of the regulation provide for time schedules for compliance, and penalties for non-compliance. Explicit in the legislation is the development of a "reasonable program" based on current technology.

The new legislation would provide for the repeal of the old Oil Pollution Act of 1924 and provide new controls in its place.

Of particular interest to the Commission are the provisions of this legislation which authorizes the appropriation of $20 million for projects demonstrating new methods and techniques for eliminating or controlling pollution within the Great Lakes watershed. The Secretary of the Interior would also be authorized to make grants or contracts for developing or demonstrating new or improved methods for prevention and control of natural or man made pollution in lakes, including the undesirable effects of nutrients and vegetation. Furthermore, our fiscal year 1970 appropriation language directs us to accelerate our research effort in the Great Lakes by $3 million. Since there is a Senate and House version of this legislation and a conference committee is currently attempting to reach agreement on their differences, I would like to suggest that rather than going into any further details at this time, that FWPCA prepare for the Commission a discussion of the act and its implications in the Great Lakes after it is signed into law by the President.

Now I would like to comment briefly on the Board's recommendation No. 2, dealing with the role of nutrients in the pollution problems of the lakes, particularly Lake Erie. The Board's assessment of the role of nutrients, particularly phosphorus, has developed some new and better insights on what is occurring and why. The recommendations on what needs to be done to reverse the rapid aging trends in the lakes are stringent and far reaching.

A subcommittee of the House of Representatives held hearings in December on the matter of phosphates in detergents. Then, as you know, FWPCA and several Canadian agencies sent a joint team of scientists to Sweden to learn first hand what progress has been made in combatting problems of lake eutrophication by product control.

On the basis of our assessment of the information brought back by the joint team and the accumulated data on the impact of phosphates on nutrient growths in the lakes, the Federal Water Pollution Control Administration is in agreement with the recommendations of the Board calling for an immediate reduction of phosphate levels in detergent formulations to minimum practical levels, and the complete replacement of phosphorous compounds in detergents with environmentally less harmful substitutes as soon as possible.

I do have an additional comment on recommendation 2(b) in the Board's report as it relates to the recommended time schedules. We have checked the compatibility of the Board's recommended schedules with those recommended in th Lake Erie Enforcement Conference.

Our Lake Erie Enforcement Conference schedules will require phosphorous removal facilities for all sources on tributaries to Lake Erie to be completed by 1973. The Board's report recommends this to be accomplished by 1975. While we recognize that 1975 is a negotiated date between representatives of the two countries serving as members of the Board, it is our strong recommendation that the Commission's report to the two governments contain the 1973 date.

There is one final point which we in FWPCA believe is important to the final realization of our goals in the Great Lakes and which is not specifically mentioned in the report.

In the United States it is a matter of national policy in regard to the establishment of water quality standards, that secondary treatment be required as a minimum treatment level for all significant municipal wastes and equivalent treatment as a minimum for industrial wastes and we would strongly urge our Canadian neighbors to do likewise.

Not as an afterthought, but as a means of emphasizing the magnitude of the effort and the course that has been set by President Nixon for the people of the United States, I call attention to the release last week of $800 million to the Federal Water Pollution Control Administration to fight water pollution during the current fiscal year. Most of this money will be used to construct municipal water pollution control facilities necessary to meet our water quality standards.

While it is not possible at this time to indicate precisely the amounts which will be made available within the Lake Erie and Lake Ontario Basins, we can indicate the amounts which will be available to the States, under a prescribed formula, as follows:

Michigan	$33, 033, 000
Ohio	40, 850, 400
Pennsylvania	47, 524, 200
New York	69, 938, 200
Total	191, 345, 800

Again, Mr. Chairman, I commend the Advisory Boards for their excellent report and strong recommendations and the Commission for these public hearings.

Our studies now have given us a clear path to follow. Let's get on with the job. I can assure the Commission that I, as Regional Director of FWPCA's Great Lakes Region, intend to move ahead quickly and strongly with the fullest cooperation of the States to carry out the common mission of protecting and enhancing water quality in the United States.

And we look forward to a continuance of the cooperation and good will which we have established with our Canadian neighbors through the International Joint Commission, in order that we might jointly deal with boundary water problems for which we all share major responsibility.

STATEMENT OF JOSEPH SHAPIRO TO THE INTERNATIONAL JOINT COMMISSION, FEBRUARY 4, 1970

During the past 20 years a good deal of understanding has been obtained on the role and behavior of phosphorus in lakes and a formidable case has developed for the belief that increasing eutrophication of lakes is frequently caused by increasing supplies of phosphorus. Those holding this belief do not claim that phosphorus is the sole cause of eutrophication or that it is always the cause. They do claim, and have substantiating evidence, that it frequently is the so called "key element" in eutrophication, by virtue of the fact that of all the elements required by freshwater algae, phosphorus is generally present in least amount relative to need. Therefore an increase in phosphorus allows use of other, already present, nutrients for growth. This situation is peculiar to fresh waters and is not necessarily true for the sea. It is in fact believed that the algal productivity of the North Pacific is controlled by the availability of nitrogen compounds, phosphorus being present in excess.

With regard to lake eutrophication, those concerned with the problem are heartened by two circumstances. Firstly, the high concentrations of phosphorus in domestic and certain industrial wastes are of our own making through use of phosphate-rich detergents, and therefore are available to control and reduction. Secondly, phosphate is a highly reactive material and can be readily precipitated, absorbed or adsorbed in a variety of highly efficient processes so that the phosphate inevitably left in wastes even without detergents can be removed to tolerable levels. These facts along with the knowledge of the behavior of lakes afforded us by limnologists suggests that, through phosphorus control, lake eutrophication is preventable and in most cases reversible. I will not attempt here to further substantiate this idea but I will say I agree with it.

Recently certain investigators, notably Dr. L. E. Kuentzel of the Wyandotte Chemical Corp., have challenged this view, and have attempted to show that phosphorus removal by itself will be of doubtful value in controlling eutrophication. Due to the costs of tertiary treatment and the necessity of soon making decisions on types and extents of treatment, this has caused a certain degree of consternation among administrators and those charged with pollution control. In fact I have personally received several communications from persons around the country concerned with this matter.

Because I believe that the arguments used in challenging the efficacy of phosphorus removal are based on false premises and on unwarranted extrapolation and misinterpretation of data, I would like at this time to analyze certain of these arguments, taking as typical certain points made by Dr. Kuentzel in his recent paper in the Journal of the Water Pollution Control Federation (Vol. 41, pp. 1737–47, Oct. 1969). These are as follows:

(1) *Since phosphorus may be used and recycled many times in a growing season reducing algal growth via control of phosphorus in waste water effluent could be impossible.*

Superficially, this argument has appeal. Phosphorus is in fact recycled within the open waters of lakes by virtue of its release from phytoplankton by bacteria and by the grazing activities of zooplankton. This released phosphorus is then available for more algal growth. But, phosphorus is not a catalytic material. It is an essential component of algal substance and it follows that a fixed quantity of algae requires a fixed minimum quantity of phosphorus. No amount of open water recycling *per se* can result in a greater quantity of algae than is permitted by the quantity of phosphorus present in the open water system. There-

fore, the abundance of algae in a system is fixed, other things being present in excess, by the quantity of phosphorus. What recycling does, is permit algae to be produced over a longer period of time. It does not permit a larger standing crop.

Another argument against recycling being too formidable an obstacle to lake renovation, lies in its inefficiency. Thus only part of the phosphorus originally taken up by the algae is released again. In Lake Minnetonka near Minneapolis, for example, a lake mentioned in his article by Dr. Kuentzel, work now underway by my associate, Dr. Robert Megard shows that the total phosphorus content of the lake is remaining constant, despite an annual contribution to the lake, by sewage, of an equal amount of phosphorus, and despite negligible losses through the outlet. Thus most of the phosphorus is being precipitated to the lake bottom and recycling does not seem to be contributing very much to the maintenance of the high levels.

(2) *Phosphorus accumulated in the bottom sediments of lakes constitutes a vast reservoir apparently capable of supporting plant growth in the event all input is shut off.*

This point has frequently been made but it is in general not valid. The phosphorus of the sediments does not act as a source of phosphorus for algae rather it is the other way around. Lake sediments are, except under extraordinary conditions, formed by the remains of phyto-and zooplankton produced within the lake, that is, they are autochthonous. Thus the net flow of phosphorus is into the sediments. To be sure, a portion of this phosphorus, as yet unevaluated, must recirculate, and this may be of some importance in shallow wind-blown lakes, but the very fact of sediment phosphorus even in the most non-productive of lakes attests to the sediments as a sink for phosphorus. In fact because of this phenomenon the concept has developed, especially in regard to phosphorus, that a lake is a self-regulating system. That is, if disturbed and then left alone it will seek to regain its former status. For example it is known from the early work in Austria by Einsele, in fertilizing lakes with super-phosphates, as well as from the work by Nelson and Edmondson on Bare lake, Alaska, that "single-shot" fertilization of lakes is ineffectual. That is the results last only for that year and do not carry over to any extent the next year unless the fertilization is repeated. The massive growths of algae persisting in lakes year after year are dependent on the persistent influx of phosphorus from outside the lake.

(3) *Massive algal blooms can occur when the concentration of soluble phosphorus is extremely low.*

This statement, or variations on it, is repeated several times in Dr. Kuentzel's article, both directly and as a quotation. For example, Kuentzel describes production of a very dense algal bloom in Lake Sebasticook, Maine, and says "It also might be noted here that at no time did the soluble P exceed 0.01 mg/liter." Further, he quotes Ferguson, from a recent article in *Environmental Science and Technology*, ". . . excessive growths can occur in waters containing less than 0.001 ppm inorganic phosphorus."

Clearly, such statements are without meaning. When algae grow they take up phosphorus. When they do not grow they do not take up phosphorus. Therefore if any relationship at all exists between the abundance of algae and the concentration of soluble phosphorus at the same moment, it will be an *inverse* relationship. We have many lakes in Minnesota in which algal growth is very abundant in Spring and Summer. Most of these lakes have practically undetectable soluble phosphorus concentrations at that time. We would not expect otherwise!

Another reason for not using such an argument as Kuentzel's is that algae have been shown to be able to store phosphate internally and use it for continuing growth in the absence of external supplies. This internal pool can be very effective. For example, I have been able to maintain in my laboratory *Microcystis aeruginosa*, a common nuisance blue-gree alga, in active growth for several weeks in phosphorus-free medium, simply by first allowing the cells to absorb large quantities of phosphate before innoculating them into the phosphorus-free medium.

This is not to say that the growth of algae is not proportional to the amount of phosphorus available to them. In fact this is just what I do wish to emphasize—growth is proportional to supply—not to the phosphorus left in solution after growth! To draw an analogy, a person's buying power can better be measured by his income rather than by the amount of money he has left after a buying spree.

(4) "* * * *bacterial action on decomposable organic matter in close proximity to the algae supplies the required CO_2 for massive algal blooms, and—when such a massive CO_2 supply exists, very small amounts of P suffice.*"

This quotation from Dr. Kuentzel's paper refers to the fact that one of the major nutrients required by algae is carbon dioxide. This of course is eminently true and no ecologist would even think of denying it. Thus the first part of Dr. Kuentzel's statement can be accepted in the sense that under conditions where organic matter is decomposing and carbon dioxide being liberated the carbon dioxide can be and probably is used by algae. In fact this is the only reason that a sewage oxidation pond can work. That is, in such a situation the exceedingly high concentrations of algae and bacteria require high concentrations of carbon dioxide and oxygen respectively, and by their respective activities each supplies the other with its needs. However on the other hand it should be pointed out that in sewage oxidation ponds large amounts of phosphorus are continually available and thus sufficient phosphorus is available for algal growth. Now my contention is that while the first half of Dr. Kuentzel's statement is partly correct the second half is completely wrong, and is based on misinterpretation. No matter what the availability of carbon dioxide, a sufficient supply of phosphorus must also be available if massive algal blooms are to develop.

In order to explain the above further, let me describe a case cited by Dr. Kuentzel. In his paper he uses data developed by Mackenthun on Lake Sebasticook and takes a situation where, allegedly, a massive algal bloom occurred—a growth of about 56 mg/liter dry weight of algae in about one and a half days. From this data in Mackenthun's paper Dr. Kuentzel calculates correctly that for a bloom of such magnitude 110 mg/liter of carbon dioxide must have been delivered, and that such a delivery could come from bacterial action on just 30 mg/liter of organic carbon. (This is approximately though not exactly true.) Then as noted earlier Dr. Kuentzel states, "It also might be noted here that at no time did the soluble P exceed 0.01 mg/liter in the upper twenty feet of the lake where the growth took place * * *" BUT—if we ask how much phosphorus was necessary to grow these algae, and if to answer this question we look at the P/C ratio of the algae —, as cited by Dr. Kuentzel, as 1 atom of P per 106 atoms of C, we find that in order to utilize 30 mg/liter of organic carbon, the algae, *at a minimum*, would require 0.731 mg/liter of P or approximately 73 times the maximum external concentration at the time of the algal bloom. In other words this "massive bloom" required not very small amounts of P but *very large amounts.*

Finally a reference to some of my own work as cited by Dr. Kuentzel in support of this thesis as to the relatively insignificant role of P versus carbon. In doing a study on the Potomac River (J. WPCF *37:* 1034–1043) Ribeiro and I determined that addition of sewage effluent to the river water resulted in rapid and abundant growth of a test alga. Addition of an amount of phosphorus equivalent to that in the effluent had the same effect but with a short time lag before growth began. Dr. Kuentzel, to quote him, says of this, "It would seem logical to attribute the rapid initial growth with the added effluent water to a fresh supply of organic matter and bacteria, whereas increased growth on addition of soluble P alone had to depend on CO_2 generated by the slower physical-chemical process." (That is, by diffusion in from the air). This is clearly incorrect. We showed by subsequent experiments in the same paper that the time lag was the result of our omitting nitrogen from the medium which under the high phosphorus concentrations thus became limiting. Therefore the algae, which were blue green algae, required the several days lag to initiate the enzymes necessary for them to fix and use atmospheric nitrogen. We also showed that if we treated sewage effluent with ferric sulphate to remove approximately 98 percent of the phosphorus, the growth of the algae supported by this effluent was reduced to essentially nil.

On the basis of the foregoing I respectfully submit that the conclusion reached by most investigators, that reduction of phosphorus in effluents through curtailed use of detergents, or through tertiary treatment, will significantly delay further eutrophication of our lakes, and will allow those already severely affected to begin their recovery through natural processes is correct.

QUALIFICATIONS OF DR. SHAPIRO

Dr. Joseph Shapiro who has degrees from McGill University, the University of Saskatchewan, and Yale University, is currently Professor of Ecology of

Associate Director of the Limnological Research Center at the University of Minnesota. He has held academic appointments at the University of Washington and at the Johns Hopkins University, where he was a member of the Department of Sanitary Engineering and Water Resources. He has worked extensively on eutrophication problems on the Potomac estuary, on lakes in Minnesota and on Lake Washington near Seattle. He has worked on phosphorus-related problems under grants from the National Science Foundation, the Public Health Service, and the Federal Water Pollution Control Administration, and has developed a biological system for removing phosphorus from sewage effluents. He is currently involved in furthering his studies on the physiologic relationships of algae to phosphorus. Dr. Shapiro has consulted to various private firms and to the government of Israel on lake problems, is an adviser to several American Water Works Association Committees, and was one of the scientists who devised the Provisional Algal Assay Procedures.

STATEMENT TO THE INTERNATIONAL JOINT COMMISSION CONCERNING THE POLLUTION OF LAKES ERIE, ONTARIO AND THE INTERNATIONAL WATERS OF THE ST. LAWRENCE RIVER—BY DR. P. H. JONES, ASSOCIATE DIRECTOR OF THE GREAT LAKES INSTITUTE, ASSOCIATE PROFESSOR OF CIVIL ENGINEERING, ASSOCIATE PROFESSOR OF MICROBIOLOGY, VICE CHAIRMAN OF THE ENVIRONMENTAL SCIENCES AND ENGINEERING PROGRAMME, UNIVERSITY OF TORONTO, FEBRUARY 6, 1970

GENTLEMEN: It has been fairly well established now that phosphate is the critical nutrient in the fertilization of the Great Lakes and in fact other fresh water bodies in the U.S.A., Canada, and the rest of the world. Even the Soap and Detergent Industry have now come to accept this fact. This fact is particularly comforting since the industry has for the past several years devoted a major part of its substantial financial and scientific effort to proving otherwise.

The entire argument has had the trappings of a Laurel and Hardy movie. In the first act an attempt was made to show that the fault was not entirely with the detergent. When that argument was agreed by everyone as attempt was made to show that detergents were not even a significant source of phosphates. This was proven otherwise so an attempt was made to prove that phosphate was not the critical nutrient. Since that has failed the new argument has been that it is not physically possible to produce a detergent which does not contain phosphates.

Truly, gentlemen, if the same degree of vigour and resourcefulness was shown by the Industry in trying to develop this impossible miracle material the problem might not exist today. In the matter of a heavy duty detergent which does not contain phosphates and does not pollute the environment, it is my intention today to demonstrate that such a miracle material has been conceived, tested, manufactured and will soon be marketed.

It is now quite a number of years since it became apparent to many researchers that phosphates were of such great significance in the eutrophication of the lakes and rivers, that some drastic measures were warranted to remove them. A great deal of research was conducted by men in my field of waste treatment to determine if a relatively simple solution lay there. Some three of four years ago I concluded that no ready and simple solution was imminent, the problem was compounding annually and that we did not have the time to proceed at the rate we were. It is a fairly self evident fact that if you do not want something in the waste water that you cannot easily remove, the first and simplest solution is to not put it in in the first place. At least not to put in any more than you literally have to. It was also apparent from engineering research literature since the late 1940's that detergents contributed between one-half and two-thirds of the phosphates reaching waste treatment plants. It was further obvious that a very considerable amount of waste was still not being treated by any waste treatment facility.

At this time, I began to give some serious thought to the idea of replacing phosphate in the commercially available detergent. Naturally, since my expertise lay in the area of waste treatment my first approach had to be to the major manufacturers. I was promptly told that they were working on the matter and had been for some years. I got the distinct feeling that my observations on the subject were not wanted and that they had the matter well in hand. Two years ago I decided that perhaps they needed some help and I gave the matter further

thought. The result of this was that eighteen months ago we at the University of Toronto commenced laboratory studies which resulted in a material which we now believe is well within the acceptable range of heavy duty products presently being marketed. This material has no phosphates in it whatsoever, launders well, is economical to the housewife and offers no short term or detectable long term ecological effect which might create a pollution problem.

The patents are now applied for in several countries and for the first time we are in a position to offer the evidence to substantiate the claims laid for this material. We should first of all clear up any misunderstanding concerning the nature of this material. It is not a new exotic organic chemical which can be popped into the box in place of phosphates and thus not upset the present range of products available. This material is simply a new formulation representing a complete product. For any companies to consider marketing this material it would represent a new product line. There is no doubt that further research and development will improve and diversify this line into many alternative products but our contribution to this problem is simply "A heavy duty laundry detergent which contains no phosphates and does not contain anything which might be considered to upset the natural cycle or create nuisance pollution conditions".

It is not intended at this time to publicly give a precise recipe for its manufacture because such a move would give an opportunity for any person or company to divert their activities to discredit the material if such was their wish. The precise details will be made available to anyone who is properly motivated and is willing to take the necessary steps to manufacture and/or market this material as widely and quickly as possible. Details of components will also be provided in confidence to health authorities and water resources authorities anywhere in Canada, U.S.A. or any patent convention country.

In the meantime, we are providing in the balance of this brief the evidence to support our claims that a successful product has been produced.

Laundering Tests

This material was compounded initially in solution form an order to ensure proper mixing and precise concentrations. A range of mixtures were tested using a launderometer. Such a device ensures reproducible and scientifically comparable washes. It consists of a shaft with pint size glass mason jars each containing a number of glass balls to increase agitation.

Initially, tests were conducted on 4″ x 4″ swatches of Dacron/cotton (65/35) shirting produced by Testfabrics Inc. In each case a standard soiled piece of fabric was washed with a similar swatch of clean fabric. The intention here was to measure not only washing abilities but also the redeposition effect on the unsoiled sample.

The following conditions prevailed during most of the washing trials.

Launderometer bath	160° F.
Washing bath	160° F.
Washing bath size	400 ml.
Bath ratio (wt bath/wt fabric)	62/1.
Swatch size	4 by 4 inches.
Swatches per bath	4 soiled, 4 unsoiled.
Detergent concentration	2 g/1.
Water bath hardness	0,100 and 650 mg/l as $CaCO_3$.
Wash cycle	10-minute wash, 2-minute rinse.

Rinse in water of same hardness and temperature.
Squeeze dry by hand.
Iron dry.

Following these tests the samples were compared for whiteness using a Zeiss Elrepho reflectometer. This is an extremely precise method of comparison and far more critical than is normally used by the industry to the best of our knowledge. The standard used for calibration of the instrument was magnesium oxide dry powder (MgO). The instrument was set in the following manner:

Zeiss Elprepho $-\lambda=461\mu\pm34\mu$

Setting for no ultraviolet light to eliminate optical brightness (illusion aids).

After washing trials, reflectance readings were taken and recorded. Comparisons were made with commercially available detergents. As a standard background 12 folds of soiled cloth and 12 folds of unsoiled cloth were used.

For any given roll of material used for testing, reflectance readings were taken at random and averaged to yield the unwashed reflectances. The reflectance readings indicated that our formulation was well within the range of products currently available. With this encouraging start we proceeded with further development which was expected to improve the performance.

Manufacture

When the formulation was manufactured on a limited run under commercial conditions an improvement was achieved which raised the reflectance readings up to equal the level of the second best of all the twelve commercial products tested.

Manufacturing conditions did not call for any special equipment although it is felt that some minor improvements in handling could be accomplished by some changes in the manufacturing procedures. Thus we had now proved that the product was acceptable as a heavy duty laundry detergent and could be manufactured under commercially available conditions. An analysis of the costs of the components indicated that under present market conditions this product would cost perhaps 5¢ per pound more than the current prices. It was, however, established that in the event that the new detergent captured a considerable fraction of the market the raw material price of certain of the components would drop appreciably and that it could then be marketed at a price no higher than the present norm.

Environmental Consequences

Although a careful watch had been kept on the ingredients to ensure that little harmful effect could be anticipated it was of course necessary to undergo some exhaustive tests to ensure that the final product was not going to cause a problem greater than or even equal to the one which it solved.

Thus a series of tests were undertaken some of which are now completed and some are underway. The tests planned were all:

1. Biodegradibility tests—To determine how the new product compares in performance in waste treatment plants. These are now completed in laboratory scale tests. These tests were conducted under a series of temperatures.

2. Fish toxicity studies—These are now underway and some results are now in. These tests caused us to reconsider certain ingredients in the formulation.

4. Algae studies—The relative crop of algae (of various species) is being measured under laboratory identical conditions using a commercial detergent and our new formulation.

5. Corrosion tests—Tests on the corrosive effect of the new formulation are underway on copper, iron, aluminum alloy and Buna-N "rubber". These being the most probable components which are likely to make contact with the new product.

6. Shrinkage—Further testing for shrinkage is underway at a water hardness of 650 mg/l (as $CaCO_3$). Comparisons are being made with commercially available products after 5 washes in a domestic machine.

7. Tensile strength—Using a standard test procedure GGSB4GP2 method 9A2 the force required to break certain fabrics is being determined under specified test conditions. A comparison is being made against the leading commercial product after washes in 650 mg/l hardness water.

8. Colour fastness—Using Canadian Government Specification Board Standard 4GP2, test 19.1 and substituting the leading commercial product and our new product for the soap solution specified colour loss is being measured. The test is conducted using the high temperature (160° F.) distilled water and losses and staining of other fabrics will be determined after 5 washes.

9. Fabric Hand—A panel test procedure to compare the feel of fabric after washing in hard (650 mg/l) water.

10. Soil removal tests—Further tests are underway using a broad range of fabrics to determine soil removal efficiency.

Fabrics tested:

100 percent cotton sheeting.
65/35 percent cotton/fortrel shirting.
100 percent Nylon.
100 percent Rayon lingerie.
100 percent Nylon lingerie.
Permanent Press fabric.

Tests being run at various temperatures:

70° F cold.
100° F hand wash.
120° F warm automatic wash.
160° F hot automatic wash.

These tests are being run at two water hardnesses:

100 mg/l as $CaCO_3$.
650 mg/l as $CaCO_3$.

Comparisons are being made against the leading commercial brand and evaluated on the basis of (i) Gray scale—Industry method (ii) Reflectance—Precise method.

11. Respiration studies.—The rate at which a polluting substance is oxidised and stabilized in the aquatic environment is related directly to its biological availability to the natural microbial flora. This rate may be measured by the rate of respiration exhibited by bacteria when they are fed the substance. Studies are underway which will confirm the relative biological availability of our new product with a leading commercial product. These tests are being conducted over a range of temperatures.

Domestic Evaluation

Since the real final test of the acceptability of a laundry detergent is the housewife's evaluation, the new product has been used by a small number of housewives under different conditions for the period October to the present. Many useful comments have resulted from this trial period which have resulted in improvements. On no occasion, however, has a real criticism been made which might lead us to believe that the product was not acceptable.

In the near future, it is proposed to send small samples in confidence to all agencies in Canada and U.S.A. who may have an interest in the properties of this material. These samples must be provided confidentially because we do not wish the material to reach the hands of commercial interests until we are satisfied with their motives. These must be to ensure that this product or a legitimately improved version of the same thing is rapidly produced and marketed as widely as possible to control the rate of eutrophication of the natural fresh water bodies of North America.

Appendices

1. *Biodegradibility study:*

Tests conducted in triplicate on a batch basis.
Using 4 litre aspirator bottles.
Airflow 1000 cc/min/bottle.
Synthetic "sewage" concentrate:

Dextrose	13.0 gm.
Nutrient broth	13.0 gm.
$(NH_3)_2SO_4$	2.5 gm.
Beef extract	13.0 gm.
Total	41.5 gm/litre tapwater.

Commercial heavy duty detergent 5 gm/litre tapwater.
Formula N 4.65 gm/litre tapwater.

FEED WASTE WATER COMPOSITION

I. 200 ml of concentrate, 193.5 ml of Formula N.
II. 200 ml of concentrate, 180 ml of commercial.
Both batches diluted to 4.5 litres with tapwater.

To simulate a wastewater treatment plant the waste described above is mixed with 4.5 litres of activated sludge taken from the Humber sewage treatment plant at Toronto. These two 9 litre mixes were then split into triplicate 3 litre batches and placed in two series of aspirator jars. The 6 batches were then aerated and samples withdrawn at zero, 2, 5, 17 and 22 hours. The samples were allowed to settle to simulate the final stage of a sewage treatment plant and the supernatant (simulated final effluent) was sampled for C.O.D. (an indirect measure of organic carbon), NH_3 (Ammonia nitrogen) and total phosphate. The results are shown on the following curves. (Appended.)

2. *Range of variation of components*

In order to test the optimality of the concentration of components used, a series of tests were conducted by alternately doubling and halving the concentration of each component. The resulting variations were then tested for laundering properties. The materials included in the formulation are not listed by name but will be made available confidentially to members of the Commission and any government agency with public service interest. Our reasons for not publishing the precise recipe for this product has been made clear elsewhere in this brief.

General content of formulation:

1. Surface active agent (biodegradable).
2. Chelating agent (sodium nitrilotriacetate).
3. Anti redeposition agent.
4. Alkalinity.
5. Inert matter.
6. Bleach.
7. Optical brightener.
8. Ultramarine.

Having tested our formulation initially against twelve well known commercial brands, we found that one of them, "Tide XK", seemed to give the best results of the twelve, from a laundering viewpoint. Subsequent comparisons, therefore, were made only with this detergent. "Tide XK" it is claimed contains enzymes. It is hard for me to understand how enzymes could provide any significant advantage in the conditions that would apply in this case but this possibility exists. Then it follows that the proposed formulation should outperform all the commercially available products.

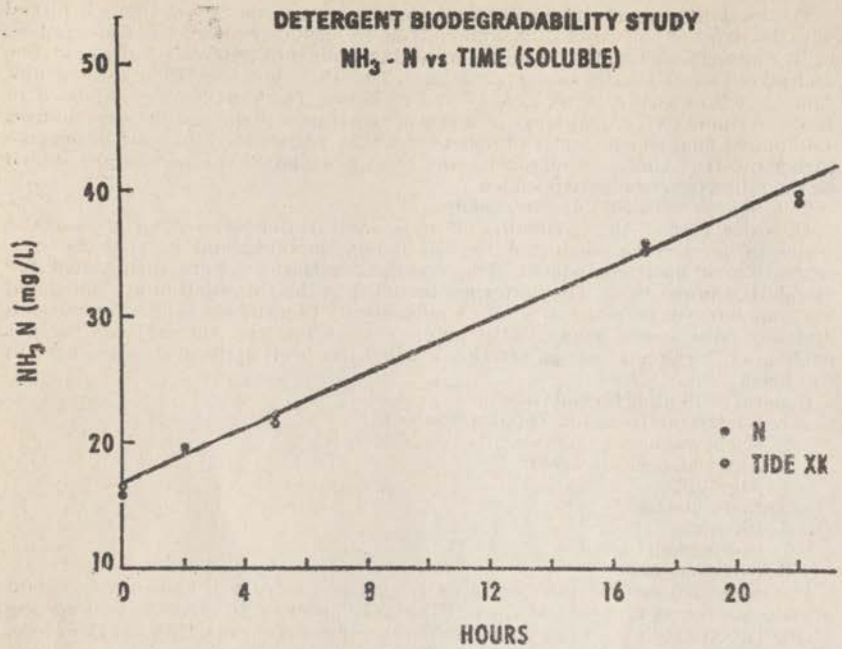
This matter will ultimately be decided by the housewives of the world.

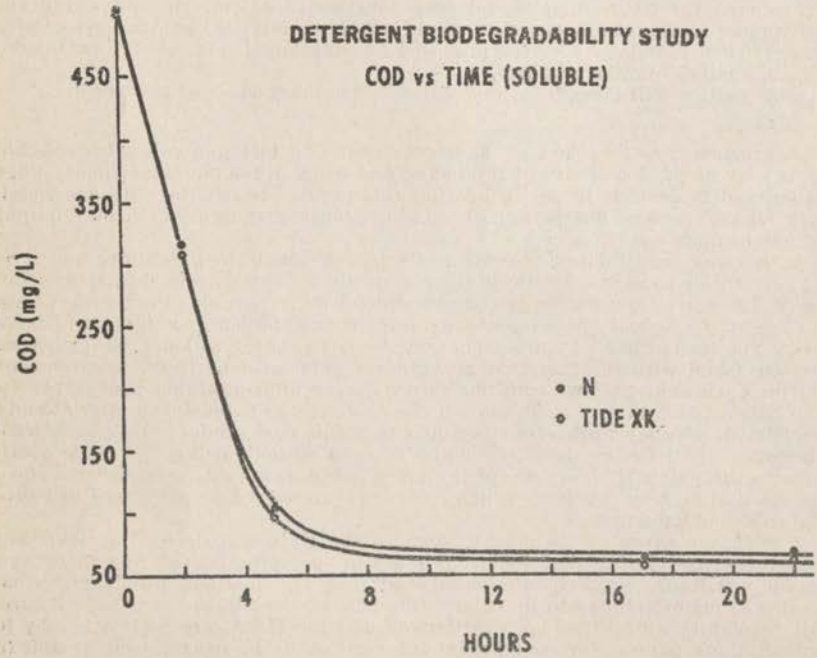
Conclusion

Gentlemen, I believe that we have presented as complete a case as is possible in favour of the feasibility of producing and using a non-phosphate heavy duty laundry detergent. It is our belief that this product is not the only one which will be satisfactory but perhaps is now the most advanced which may be put into immediate use.

It is clear that further improvements may be made in the future and it is our intention to strive for these improvements by more research and development. Insofar as the testing is concerned, we believe that this product has been tested for ecological consequences as few other detergents in the world have been. The testing has, of course, not ended—maybe never will end. Nevertheless, we are faced with the fact that grave harm is being done to our environment during each hour that we continue to use detergents containing phosphates. In the light of this urgent need, and on the basis of the extensive studies already completed, it is my professional opinion that this new product and others with similar characteristics should be manufactured without delay and made available to the public. It has none of the offensive properties associated with phosphates and no new problems which have been uncovered by the broad test procedures conducted to date.

I wish, therefore, gentlemen, to dismiss the claims made by the Soap and Detergent Association that such a product is "not practical at this time" and intend to license properly motivated and properly qualified people and companies to manufacture and distribute this new product in the very near future. All regulatory authorities both in Canada and the U.S.A. are invited hereby to submit their request for confidential information as to specific content and to receive samples for their own examination.


DETERGENT BIODEGRADABILITY STUDY
NH3 - N vs TIME (SOLUBLE)
NH3 N (mg/L)
50
40
30
20
10
0
4
8
12
16
20
HOURS
N
TIDE XK


DETERGENT BIODEGRADABILITY STUDY
COD vs TIME (SOLUBLE)
COD (mg/L)
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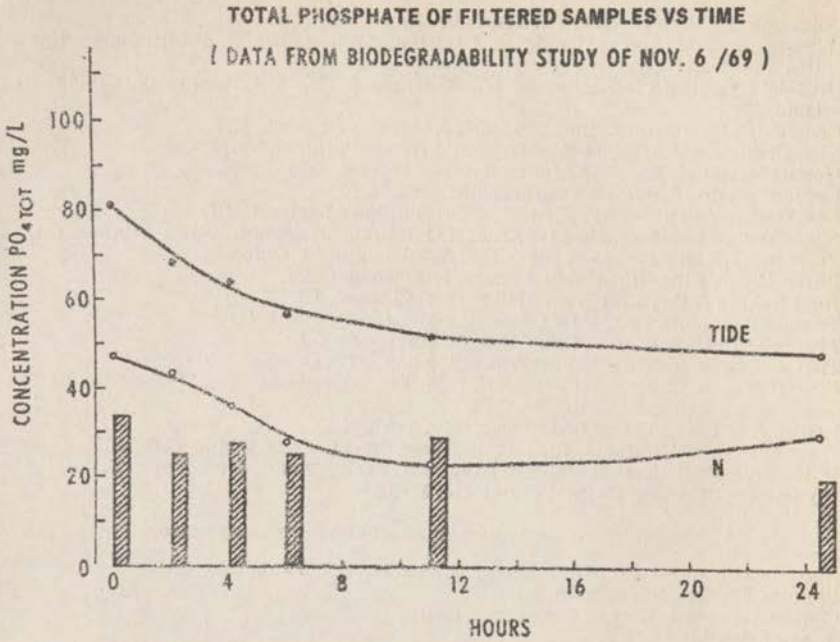
350
250
150
50
0
4
8
12
16
20
HOURS
N
TIDE XK



HOUSE OF REPRESENTATIVES,
CONSERVATION AND NATURAL RESOURCES SUBCOMMITTEE
OF THE COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D.C., January 9, 1970.

DEAR SIR: This subcommittee is studying phosphate enrichment of America's waters. In connection with this study we are trying to learn how much of this phosphate enrichment comes from soaps and detergents.

We intend to tabulate the percentage of phosphate in the various soap and detergent products now marketed in the United States. To avoid possible inaccuracies, we are asking each of the manufacturers of detergents, whose names have been supplied to us by the Soap & Detergent Association, to provide that information to us.

We would therefore appreciate your sending us a list of your soap and detergent products currently on the market, showing the kind of phosphorous compound and the percentage, by weight, of phosphorus (as P) in each.

We would also appreciate receiving from you, for each of your soap and detergent products, a copy of any instructions on the label advising the consumer about varying the amount, or method of use, of the product in accordance with the hardness or softness of the available wash water.

We would also appreciate your sending to us a statement of your company's total expenditures during 1969 for (1) research to find a phosphorus-free builder for your detergent products, and (2) advertising your detergent products.

Thank you for your cooperation.

Sincerely,

HENRY S. REUSS, *Chairman.*

(Above letter sent to the following:)

THE SOAP AND DETERGENT ASSOCIATION MEMBERS

Amway Corp., 7575 East Fulton Road, Ada, Mich.
Calgon Corp., Post Office Box 1346, Pittsburgh, Pa.
Chemical Service Division of Imoco-Gateway Corp., Howard and West Streets, Baltimore, Md.

Colgate-Palmolive Co., 300 Park Avenue, New York, N.Y.
DeSoto, Inc., Chemical Products Division, 1700 South Mount Prospect Road, Des Plaines, Ill.
DuBois Chemicals, Division of W. R. Grace & Co., 634 Broadway, Cincinnati, Ohio.
Economics Laboratory, Inc., 250 Park Avenue, New York, N.Y.
Alex C. Fergusson Co., 44 East Oregon Avenue, Philadelphia, Pa.
Hewitt Soap Co., Inc., 333 Linden Avenue, Dayton, Ohio.
Lever Bros Co., 390 Park Avenue, New York, N.Y.
Los Angeles Soap Co., 617 East First Street, Los Angeles, Calif.
New South Manufacturing Co., Inc., 711 Bankhead Avenue, NW., Atlanta, Ga.
Procter & Gamble Co., Post Office Box 599, Cincinnati, Ohio.
Purex Corp., Ltd., 5101 Clark Avenue, Lakewood, Calif.
John Sexton & Co., 4501 West 47th Street, Chicago, Ill.
Texize Chemicals, Inc., Post Office Box 368, Greenville, S.C.
Theobald Industres, Post Office Box 72, Harrison, N.J.
Tidy House Products Co., Post Office Box 489 DTS, Omaha, Neb.
U.S. Borax & Chemical Corp., 20 Mule Team Products, Post Office Box 75128, Sanford Station, Los Angeles, Calif.
Utility Co., Inc., 10 West 33d Street, New York, N.Y.
West Chemical Products, Inc., 42–16 West Street, Long Island City, N.Y.
Witco Chemical Corp., Ultra Division, 277 Park Avenue, New York, N.Y.
Wyandotte Chemical Corp., Wyandotte, Mich.

NOT MEMBERS OF THE SOAP AND DETERGENT ASSOCIATION

Newport Products Co., 1501 Mariposa Street, San Francisco, Calif.
Popular Market, Springfield, Mass.
Coast Detergents, City of Commerce, Calif.
A. & P., Brockport, N.Y.
Grand Union Co., East Paterson, N.J.
Stanson, Bogota, N.J.
Curley Co., Jefferson and Master Street, Camden, N.J.
President, Willex Products, Inc.,* 8446 Madison, Omaha, Nebr.
President, Heinicke Instruments Co.,* 3000 Taft Street, Hollywood, Fla.

ALEX C. FERGUSSON CO.,
Philadelphia, Pa., February 24, 1970.

CONSERVATION AND NATURAL RESOURCES SUBCOMMITTEE,
COMMITTEE ON GOVERNMENT OPERATIONS,
Rayburn House Office Building, Washington, D.C.
(Attention Mr. Henry S. Reuss, chairman).

DEAR MR. REUSS: In answering your letter of January 9, 1970, I would like to give you the answers in a more meaningful way than that which you ask.

We are in the specialty cleaning business which involves a great many products for a great many specific end uses. The volume on each varies, so in order to give you a better picture on the percentage of P in a given product would require over 400 calculations, and would produce nothing satisfactory.

The easiest way would be to divide total pounds produced of product into total pounds of phosphates used times 100 times the percent of P in the phosphate used. The answer is 6.97 percent.

In answering your request for direction labels, we have very few directions because of the varied conditions of soil load and method of cleaning. From your wording of your letter I take it your survey points more toward the household market. This field we do not enter in any meaningful way. Our budget for advertising is unbelievably low—less than $2,000. Most of our sales are made through personal contact and recommendations. How much money was spent on research time for phosphate substitutes is very hard to say. Partial substitution has been accomplished in several products with an estimated research cost of $6,000.

Inasmuch as the ultimate in industry is to reduce costs to as low a level as feasible our recommended quantities for concentration of cleaning solutions

*Letter sent on Jan. 14, 1970.

also dip as low as possible with a reuse of the solution in a great many cases. This has been done in car wash, metal cleaning, mold cleaning, et cetera. Use concentrations can vary, for example, in cold milk line as low as one-quarter ounce per gallon to a metal cleaning bath of 12 ounces per gallon.

Trusting this is the information you desire, we remain,

Very truly yours,

CHARLES W. SCHWARTZ,
Chief Chemist and Vice President.

CALGON CORP.,
Pittsburgh, Pa., March 12, 1970.

Re Phosphate detergents.

HON. HENRY S. REUSS,
Rayburn House Office Building,
Washington, D.C.

DEAR MR. REUSS: This is in response to your letter of January 9, 1970, to Mr. T. M. Welton, the president of Calgon Corp., in connection with your study of the amount of phosphate enrichment which comes from soaps and detergents.

Of our five divisions, only our consumer products division and our commercial division make and sell soap and detergent cleaning products which contain "phosphorus compounds."

I.

Our consumer products division markets Calgonite, an electric dishwasher compound which contains both trisodium phosphate and sodium tripolyphosphate. The total percent by weight, as phosphorus, is 12.4. This product is sold through retail stores for home use.

II.

Our commercial division markets 85 soap and detergent cleaning products. A list showing the products, the type of phosphate, and percent by weight, as phosphorus, for each product is attached. These products are not sold through retail channels but through distributors or direct to institutional, commercial, and industrial users. Labels carrying instructions for varying the amount of product depending upon water hardness are enclosed as requested.

Since Calgon Corp. is not a basic manufacturer of chemicals and relies on its suppliers to a great extend for research and development in basic areas, our expenditures to develop phosphate-free detergents have not been significant up to the present time.

We trust that the information presented will be kept in confidence since it represents much data we normally would not reveal outside the company.

Sincerely,

JAMES K. EVERHART, Jr.,
Secretary and General Counsel.

CALGON COMMERCIAL DIVISION—SOAP AND DETERGENT PRODUCTS SOLD IN 1969—KEY TO PHOSPHATE TYPES

Symbol	Phosphate type	Factor
A	Orthophosphate:	
	TSP-(anhy)	X.1889=P
	TSP-12H_2O	X.0815=P
	$Na_2HPO_4 2H_2O$	X.1740=P
	NaH_2PO_4	X.2575=P
	TKP-(Anhy)	X.1418=P
B	Pyrophosphate:	
	TSPP	X.2330=P
	$Na_2H_2P_2O_7$	X.2771=P
	TKPP	X.1875=P
C	Polyphosphate:	
	STPP (Anhy)	X.2526=P
	KTPP (Anhy)	X.2072=P
D	Phosphoric acid: 75-percent grade	X.2370=P
E	Dequest	X.3107=P
F	Hexametaphosphate (all Calgons)	X.2911=P
G	Chlorinated TSP	X.0813=P
H	Spray dried LAS beads with 10-percent STPP	X.0252=P

CALGON COMMERCIAL DIVISION—SOAP AND DETERGENT PRODUCTS SOLD IN 1969

[Proprietary sales data deleted at request of Calgon Corp.]

Product IBM No.	Product name	Phosphate Type	Phosphate Percent	Total percent P in product
1184	Powr Wash	C	73.33	22.50
		F	13.67	
1847	Heavy Duty, regular	B	9.90	
		C	3.30	3.14
1846	Heavy duty, fine	B	9.90	
		C	3.30	
1420	Calgonite (commercial)	F	39.90	11.61
1017	Dishmate	C	54.50	13.77
1048	Spray-Off	C	45.00	14.28
		F	10.00	
1016	XL-100	C	30.00	13.27
		G	70.00	
1480	Clor-Ade	G	31.67	8.88
		C	25.00	
1836	Lotion toilet soap	C	4.00	1.01
1190	Sparkleen	F	45.66	13.54
		H	9.79	
1073	S-44	C	39.25	11.51
		A	19.63	
1130	Pot-n-Pan	F	20.00	8.15
		B	10.00	
1110	Maxade	F	29.85	11.20
		C	9.95	
1879	M5B-227A (Ford)	C	40.00	13.08
		F	10.00	
1076	S-88	C	25.00	6.40
		H	3.00	
1010	Aura	A	30.00	13.27
		E	70.00	
1113	Vantage	C	19.12	8.17
		B	14.34	
1047	S-125	C	29.02	7.49
		H	6.45	
1063	Formula CK	C	24.80	7.19
		H	36.90	
1040	Calgolac	F	30.00	10.91
		A	10.00	
1460	Soak-eze	C	24.50	6.32
		H	5.00	
1007	Scale-gon	D	35.73	8.47
1030	Calade	F	15.00	4.75
		H	15.00	
1003	Hi-Suds	C	7.92	2.52
		H	20.60	
1650	Hel-Cat	C	3.32	.98
		B	1.84	
1006	Hi-Lo	C	29.00	7.33
1885	Liquid Car Wash Concentrate	C	12.00	4.78
		F	6.00	
1129	Disperse	C	54.50	13.70
1055	Surf-kleen	B	9.67	8.54
		C	24.17	
		H	7.25	
1054	Super-kleen	C	30.00	9.40
		A	20.00	
1833	Hyspeed	B	8.27	1.93
1037	Brite	D	36.10	8.56
1874	Follow Charlie Car Wash	C	45.00	14.27
		F	10.00	
1872	Stock-285	B	5.02	1.17
1023	Clarion XIV	F	39.00	11.60
		H	9.95	
1871	Stock 235	B	5.04	1.17
1654	Payload	C	2.85	.72
1117	Phos-kleen	A	80.00	24.32
		D	4.00	
		B	10.00	
1827	Crusader	B	5.02	1.17
1004	Powr-Jet	F	19.95	5.81
1862	Stock 117	B	3.33	.78
1972	GM-2256M	B	3.32	.77
1916	P-2010	C	29.43	7.58
		H	5.89	
1832	GED-19A-1B	B	3.23	.75
1090	Hi-Level	C	14.72	3.72
1122	Sofspray	C	60.39	15.50
		H	10.00	
1851	JES-3-Fine	B	3.31	.77
1032	Instant-Rinse	D	13.87	3.29

REMAINDER OF THE PRODUCTS ARE LISTED ALPHABETICALLY

Product IBM No.	Product name	Phosphate Type	Phosphate Percent	Total percent P in product
1884	Approve	C	2.00	0.51
1410	Bactergent	D	3.20	.76
1801	Bell System Powder	A	1.67	.92
		B	3.34	
1803	Bo-Peep	H	2.55	.06
1806	Borapax-Regular	H	2.55	.06
1807	Borapax-Supreme	C	5.00	1.26
1161	Compound A	A	10.00	4.22
		B	10.00	
1809	Corntex-Regular	B	3.23	.75
1808	Corntex-Emollienated	B	5.03	1.17
1026	Dairymate	C	54.50	13.77
1829	F-54	A	12.31	2.33
1042	Fantastic	A	2.13	.46
1653	General Cleaner Concentrate	A	2.00	.67
		C	2.00	
1116	IRM	E	20.00	8.84
		D	11.10	
1155	J1001	C	5.45	1.37
1187	J-Wash	C	2.81	1.20
		F	.96	
		B	.89	
1979	No. 25 with Color Control	C	39.25	13.48
		A	19.63	
1651	P-1512	B	9.00	1.69
1840	Pax Special	B	3.32	.77
1864	Stock 119	B	3.23	.77
1865	Stock 134	B	1.66	.39
1867	Stock 187	C	5.00	1.26
1150	Pinnacle	F	9.43	2.84
		H	3.92	
1450	Powr-Clor	A	17.00	5.89
		B	2.50	
		C	13.00	
1158	S-106	D	65.00	15.41
1082	S-505	C	10.00	2.53
1154	Soiltex Improved	C	.50	.13
1984	Sudsless	C	39.25	11.51
		A	19.63	
1013	Sumtotil	C	6.00	1.34
1093	Super-Dip	C	18.25	8.07
		A	20.55	
1843	Super-X	B	3.39	.79

Product IBM No.	Product name	Phosphate Type	Phosphate Percent	Total percent phosphorus in product
1099	Syn Dek	C	13.28	3.52
		H	6.64	
1056	Syn Kote	C	.75	.27
		A	1.00	
1121	Syn Sol	G	99.97	8.13
1057	Syn Tex	A	12.30	1.00
1009	Totil	C	4.00	.83

COAST DETERGENTS, INC.,
Los Angeles, Calif., February 5, 1970.

Hon. HENRY S. REUSS,
Chairman, Conservation for Natural Resources Subcommittee, Rayburn House Office Building, Washington, D.C.

DEAR SIR: We are making and selling the following private label detergents containing phosphates: Lucky, Vons, Shopping Bag, Stater Bros., Market Basket, Food Giant, O-So-Kleen. These products contain sodium tripolyphosphates. By weight these products contain 30 percent of tripolyphosphates, translating this into phosphorus (as P) equals 7½ percent. Our instructions call for one-half cup of detergent per washer load varying this according to hardness of water and amount of soil.

We use the facilities of Food Machinery & Chemical Corp., Monsanto Corp., and Stauffer Chemical Co. who provide us with their research laboratories as we have been excellent customers of these large chemical companies. We do not advertise our detergent products.

If we can be of any further assistance, kindly call on us.

Very truly yours,

JAMES GERBER, *General Manager.*

DESOTO, INC.,
Des Plaines, Ill., February 11, 1970.

Hon HENRY S. REUSS.
House of Representatives, Washington, D.C.

DEAR SIR: Mr. Malm has asked me to reply to your letter of January 9, 1970, requesting information on the use of phosphates in our detergent products. We are basic manufacturers of detergent products for a number of corporations, however, we do not market any of these products under our own labels. Therefore we spend no money on advertising or promoting these products. In 1969 we spent approximately $50,000 in research on the replacement of phosphates in our detergent products.

Listed below are the detergent products we manufacture with the percent of phosphorus in their formulations. We would like to point out that the products containing the higher percentage of phosphorus are the best performers. We have also enclosed several cartons with directions for your inspection.

Product:	*Percent phosphorus in formulation*
Sears enzyme presoak	15.3
Sears enzyme laundry detergent	11.4
Sears laundry detergent	11.4
Whirlpool laundry detergent	10.3
Farm Service laundry detergent	14.8
Sears automatic dishwash detergent	12.0
Hudso laundry detergent	7.6
Service soft laundry detergent	7.6

Very truly yours,

JOSEPH KOSCHAK,
General Manager, Chemical Products Division.

THE GREAT ATLANTIC & PACIFIC TEA CO., INC.,
Brockport, N.Y., February 10, 1970.

Congressman HENRY S. REUSS,
Rayburn House Office Building, Washington, D.C.

DEAR CONGRESSMAN: Your letter of January 9, 1970, concerning the subcommittee investigation into the phosphate enrichment of America's waters has been referred to this office for reply.

We are pleased to assist you in this study and for your ready reference we have tabulated the information you have requested below.

Product	Phosphorus-containing chemical	Percent in product	Percent phosphorus in phosphorus-containing chemical	Percent phosphorus in product (as percent P)
White Sail	Sodium tripolyphosphate	50.00	25.26	12.63
Blue Sail	do	50.00	25.26	12.63

We are attaching herewith photostats for your review of the detergent products we manufacture which will give you the instructions on consumer usage. We trust that this information will be of assistance to you and you may be assured of our cooperation.

Very truly yours,

C. J. HENSLEY,
General Manager.

THE PROCTER & GAMBLE CO.,
Cincinnati, Ohio, February 17, 1970.

Hon. HENRY S. REUSS,
Chairman, Conservation and Natural Resources Subcommittee of the Committee on Government Operations, Rayburn Office Building, Washington, D.C.

DEAR SIR: This is in response to the letter concerning phosphate usage in our brands, which you gave me during our visit of January 30. As I mentioned during our discussion, the Hewitt Soap Co. which received a copy of this letter in the mail is a wholly owned subsidiary of the Procter & Gamble Co., and therefore, I am answering the questions raised in the letter for the Procter & Gamble Co. in the United States including the Hewitt Soap Co.

1. Exhbit I designates all of the products manufactured and sold by the Procter & Gamble Co. or its subsidiaries in the United States that include phosphate. The information has been broken down in accord with the categories outlined in your letter.

2. The usage directions on Procter & Gamble's detergent packages are intended to aid the consumer in determining the proper amount of product to use. A great deal of consumer research over many years has shown that the proper amount of product necessary to get clothes satisfactorily clean under most typical soil and water hardness conditions is 1¼ cups of a normal sudsing detergent, in top-loading automatic washing machines.

The usage instructions on our packages are, therefore, basically uniform. For instance, Tide XK instructions state, "start with 1¼ cups of Tide XK. Use more Tide XK in hard water, for large loads or for heavily soiled clothes. A good layer of hard-working suds throughout the washing cycle is the best indication you are using the right amount of Tide XK."

Our packages do not advise the consumer concerning variations in usage in relation to the hardness or softness of available wash water. There are two reasons why it is not possible to do this in any effective way:

a. Clothes bring their own varying amounts of hardness to the wash water due to the soil on the clothes being washed. Our studies indicate that this ranges from 10 p.p.m. to 300 p.p.m., and that this variation exists in soft water cities as well as in cities with hard water.

b. There are extreme variations in minerals in the water supplies within a single geographic area.

There are different degrees of hardness within the water supplied to a single metropolitan area, because many such areas draw on more than one basic source for water. In New York City, for instance, the Catskill Reservoir has a typical hardness of 19 p.p.m. while the Jamaica Wells have 300 p.p.m. In Los Angeles, hardness will vary from 81 p.p.m. from the San Fernando Reservoir to 200 p.p.m. from the Weymouth Treatment Plant, to 323 p.p.m. from the Colorado River.

In addition to this wide range of water hardness within single metropolitan areas, it should also be noted that rural areas within a geographic area will averagely have water 40 percent harder than metropolitan homes in the same area—principally as a reflection of the well water source common for rural homes.

Finally, there can be a significant effect on hardness based upon the season of the year. Here in Cincinnati, for instance, high river levels in the spring of the year reduces water hardness to 100 p.p.m. whereas in the fall, hardness will increase to above 200 p.p.m.

The result of this degree of hardness variation in any particular washing situation has prompted housewives to vary the amount of product they use—either more or less—depending upon the particular conditions that they face at any particular time with the combination of soil load on clothes and water hardness.

Accompanying this letter are packages of our major laundry detergent brands which will provide you with the specific instructions used on each brand.

3. During the 5 year period 1965–1969, the Procter & Gamble Co. spent an estimated $11 million in research effort directed at the development of non-phosphate detergent builders. This effort has been on an accelerating basis. In 1969, for instance, our expenditure in this area is estimated at approximately $3,200,000. This, incidentally, represents the single largest research project on our phosphate containing brands.

I don't know how meaningful these research figures will be to you. I want to reiterate the assurance we have previously given you that our efforts in achieving the objective of developing a non-phosphate builder have not been limited in any way by money. We have been, and we will be, pursuing all of the avenues of technical investigation that we judge to have any opportunity of being successful.

4. We respectfully submit that the expenditures involved in advertising our detergent products to the consumer are not germane to what we understand to be the intent of your inquiry. Funds spent in advertising our products are a necessary cost of conducting our business, just as important, for example, as sales costs or manufacturing costs. I can assure you that these expenditures, such as advertising, sales, and manufacturing, have no relationship to the effort being placed against the research objective outlined above. Further, you should know that these matters are confidential and therefore their publication would be potentially injurious to the interest of our company.

We are pleased to continue to cooperate in the subcommittee's investigation of this matter.

Very truly yours,

J. G. SMALE,
Vice President, Packaged Soap and Detergent Division.

PROCTER & GAMBLE EXHIBIT I

Item	Phosphate type	Parts P in product
Consumer brands:		
American Family Detergent	STPP	12.4
Bold	STPP	11.5
Bonus	STPP	9.8
Cascade	STPP	11.3
	ClTSP	1.8
Cheer	STPP	9.6
Dash	STPP	14.7
Dreft	STPP	10.1
Duz Detergent	STPP	9.8
Gain	STPP	10.5
Oxydol	STPP	11.8
Salvo	STPP	15.0
Tag	TKPP	3.8
Thrill	TKPP	2.3
Tide	STPP	12.4
Biz	STPP	17.5
	Octadecene	.009
Spic and Span	STPP	5.0
	TSP	3.8
Comet	ClTSP	1.3
	STPP	1.7
Mr. Clean	TKPP	2.4
Top Job	TKPP	2.4
Cinch	TSP-12H_2O	.18
Brands sold in laundromats:		
Bold Coin Vend	STPP	11.5
Dash Coin Vend	STPP	14.7
Gain Coin Vend	STPP	10.5
Tide Coin Vend	STPP	12.4
Industrial products:		
Pierce	STPP	3.2
Orvus Hytemp	STPP	12.4
Orvus Extra	STPP	12.6
P&G Blue	STPP	12.1
Launette Special	STPP	14.7
Ozonite	TSP	.7
Cold Water Ozonite	TSP	.7
Launette	STPP	5.7
BreakThrough	STPP	5.0
	DSP	3.3
BreakThrough HD	STPP	5.0
	DSP	3.3
Detergent 90	STPP	6.3
Orvus AB Granules	TSPP	0.12
Clean Quick	TKPP	2.4
Cream Suds	STPP	11.2
Institution X	STPP	12.4
Lo Range	STPP	14.7
Car Wash Detergent No. 28	STPP	18.1
Power Spray No. 99	STPP	18.1
Detergent No. 87	STPP	6.6
Polo	STPP	6.6
Detergent No. 40	TKPP	3.8
Burnishing Compound No. 100	TKPP	0.6
RW Compound	STPP	12.4
Drilling Lubricant No. 77	STPP	12.4
Institution Comet	ClTSP	1.3
	STPP	1.7

KEY TO PHOSPHATE ABBREVIATIONS

STPP—Pentasodium tripolyphosphate—$Na_5P_3O_{10}$.
TSPP—Tetrasodium pyrophosphate—$Na_4P_2O_7$.
TSP—Trisodium orthophosphate—Na_3PO_4.
DSP—Disodium monohydrogen orthophosphate—Na_2HPO_4.
TKPP—Tetrapotassium pyrophosphate—$K_4P_2O_7$.
ClTSP—Chlorinated trisodium orthophosphate hydrate.
Octadecene—Phosphonated octadecene.

THE PROCTER & GAMBLE CO.,
Cincinnati, Ohio, March 23, 1970.

Mr. LAURENCE DAVIS,
Assistant Counsel, Conservation and Natural Resources Subcommittee, House Government Operations Committee, Rayburn House Office Building, Washington, D.C.

DEAR MR. DAVIS: This is in response to your request on Friday for additional information about Procter & Gamble's home laundry products which do not contain phosphate.

They are as follows:

Laundry products	*Dishwashing products*
Ivory Snow	Joy
Ivory Flakes	Ivory Liquid
Duz Soap	

If we can be helpful in discussing these matters further, please let me know.

Very truly yours,

J. A. BRUCK,
Associate Director, Product Development Division.

PUREX CORP., LTD.,
Lakewood, Calif., February 9, 1970.

Hon. HENRY S. REUSS,
Chairman, Conservation and Natural Resources Subcommittee of the Committee on Government Operations, Rayburn House Office Building, Washington, D.C.

DEAR MR. REUSS: This is in reply to your letter of January 9, 1970, concerning the phosphate enrichment of America's waters. You state that you intend to tabulate the percentage of phosphates in the various soap and detergent products now marketed in the United States. We are not a major manufacturer of soap and detergent products. However, you will note that our Trend is last on the list of the percentage of phosphates in detergents as compiled in a study of Limnetics, Inc., as set forth in a New York Times news story which is as follows:

> WASHINGTON, December 14.—Following is a list of the percentages of phosphates in major detergents, as compiled in a study by Limnetics, Inc., a Milwaukee consulting concern:

Detergent	Manufacturer	Percent phosphate
Axion	Colgate-Palmolive	43.7
Biz	Procter & Gamble	40.4
Bio-Ad	Colgate-Palmolive	35.5
Salvo	Procter & Gamble	35.3
Oxydol	do	30.7
Tide	do	30.6
Bold	do	30.2
Ajax Laundry	Colgate-Palmolive	28.2
Punch	do	25.8
Drive	Lever Bros	25.3
Dreft	Procter & Gamble	24.5
Gain	do	24.4
Duz	do	23.1
Bonus	do	22.3
Breeze	Lever Bros	22.2
Cheer	Procter & Gamble	22.0
Fab	Colgate-Palmolive	21.6
Cold Power	do	19.9
Cold Water All	Lever Bros	9.8
Wisk	do	7.6
Diaper Pure	Boyle-Midwest, Inc	5.0
Trend	Purex Corp	1.4

You also ask for both soap and detergent products currently on the market. Purex Corp., Ltd., manufactures many products, some contain phosphate, but the majority do not. The products containing no phosphate generally are soap bars for personal cleanliness and light-duty detergent products for dishwashing or fine fabrics. Many of our products are for regional markets or manufactured for others to be marketed under their labels. Products may be marketed under various labels but are usually similar to each other in each particular category. A list of all products or brands would prove quite burdensome. Below is a list of products representing our national products and the stronger regional products.

Bar soaps for personal care containing no phosphate are represented by: Sweet-Heart soap, SweatHeart deodorant soap, Surex bar soap, Sing deodorant soap, Protex deodorant soap, Cuticura soap, and Gay Bouquet bag soap.

In addition, Purex Corp., manufactures a laundry bar soap by the name of Fels Naptha bar which contains no phosphate.

A representative list of liquid detergents containing no phosphates consists of: Liquid Trend (both clear and pink), SweetHeart Dishwashing Liquid, and Gentle Fels (both clear and pink).

Representative abrasive products manufactured by Purex may contain some phosphate. Following is a list showing some of these products and their phosphorous level: Brillo Soap Pads (no phosphate), Cameo Stainless Steel and Aluminum Cleaner (no phosphate), Cameo Copper Cleaner (less than 0.5 percent phosphorus), and Dutch Cleanser (1.5 percent phosphorus).

Most of our spray dried products contain some level of phosphate. The inclusion of phosphate is to soften water and increase the performance of the particular product for its intended use. Following is a representative list of these products:

	Percent phosphorous (P)
Trend	1.5
Blu-White	1.5
Bubble Club	<1.0
Instant Fels Naptha Soap Granules	3.0
Beads O'Bleach	8.0
Brillo Detergent	9.0
News Detergent (regional brand)	9.0
Brion Pre-Soak	16.0

We are enclosing copies of the label panels from the packages that contain special use instructions for a change in water conditions.

Although some of the Purex products contain moderate levels of phosphorus, many of our products contain no phosphorus. Even more significant is our usage level of phosphate which, based on what we know about the industry, is less than 1 percent of the total phosphate used in the industry. This obviously means our contribution to phosphate quantity is minor.

We are well aware of and agree with the desire to reduce phosphate usage levels and the emphasis being placed by both Government and private industry on the need to reduce pollution. As a result and in response to your final question, we are spending about 10 percent of our total research effort in the grocery products group in search of a phosphorus-free builder or a significant reduction in phosphorous content. Considering the number of products and projects we are working on, this level of activity for phosphate replacement receives more attention than any single new development project. Although this effort is sizable within our own company, I am sure it is minuscule in relation to the larger companies in our business area.

We wish you well in your studies. No doubt you have been furnished by the Soap and Detergent Association a bibliography relative to the problem. It seems that the elimination of detergent phosphate could not possibly stop excessive algae growth. We of course desire to find an effective substitute for phosphate for a number of reasons, one of which is that we would then have a tremendous competitive advantage. Such effective substitute is not available at this time. Such substitute would no doubt involve new environmental problems although it would seem the phosphate enrichment of America's waters would not be involved. The changeover to biodegradable detergents was a momentous task but its worthwhile results cannot be disputed. Eutrophication is a problem equally as great and we commend you for your work.

Very truly yours,

MERLE ASPER,
Director, Corporate Legal Office.

STANSON CHEMICALS,
Bogota, N.J., March 3, 1970.

Mr. HENRY S. REUSS,
Conservation and Natural Resources Subcommittee of the Committee on Government Operations, Rayburn House Office Building, Washington, D.C.

DEAR MR. REUSS: We are primarily a packer of private label detergents. A representative list of our accounts is enclosed. We do have three additional controlled labels, Stanzal, Supa-Safe and Our Own. We use sodium tripolyphosphate with an 11 percent P_2O_5 value.

Until recently, our products contained 25 percent tripoly. We have altered our concentration so that now the phosphate content is reduced to 15 percent.

We are experimenting with NTA. We find it a costly chemical and difficult to work with in our present equipment. We have no defined research budget.

The wording of our directions varies with the private label, but basically we recommend the same usage as "All."

We do not advertise our products. We work on too small a margin to permit advertising expenditure.

Very truly yours,

STANLEY J. HOLUBA, Jr.

STANSON DETERGENTS, INC., TEANECK, N.J.—LIST OF OUR BETTER KNOWN ACCOUNTS

Aimcee Wholesale Corp., New York City.
Albany Public Markets, Albany, N.Y.
Associated Dry Goods, New York City.
Bargaintown, Long Island.
Barker's.
Brillo.
Caldor.
Chatham Supermarkets, Detroit, Mich.
Consolidated Laundries, New York City.
Dade Wholesale Products, Miami, Fla.
Dairymen's League Cooperative Assoc.
Daitch Crystal Dairies, New York City (Shopwell)
Dart Drug Corp., Landover, Md.
Farm Bureau Cooperative Assoc., Columbus, Ohio.
Farmers Pantry, New York.
Federated Commodity Service, New York City.
Fernandes Super Markets, Norton, Mass.
M. H. Fishman Co.
Food Fair Stores.
Fortunoffs, Long Island.
Gamble-Skogmo.
General Electric Co.
G E X Stores.
Golub Corp., Schenectady, N.Y.
Good Deal Super Markets, New Jersey.
Grand Union.
Gristede Bros., New York.
Growers Outlet, Springfield, Mass.
Harold's Super Markets, Omaha, Nebr.
Hess's, Allentown, Pa.
Hillman's, Chicago, Ill.
Thalheimer's, Richmond, Va.
H. P. Hood, Boston, Mass.
Woodward & Lothrop, Washington, D.C.
Hotpoint.
Strawbridge & Clothier, Philadelphia, Pa.
Jordan Marsh, Boston, Mass.
Rike Kumler, Dayton, Ohio
Jumbo Food Stores, Washington, D.C.
Milwaukee Boston Store, Milwaukee, Wis.
Rich's, Atlanta, Ga.
Key Food Stores, Brooklyn, N.Y.
F. & R. Lazarus, Columbus, Ohio.
King Kullen Grocery, New York.
Joseph Horne, Pittsburgh, Pa.
Key Stores, Mass.
Hutzler Bros., Baltimore, Md.
Little Falls Laundry, New Jersey.
J. L. Hudson, Detroit, Mich.
Loblaw's, Buffalo, N.Y.
Loveman's, Birmingham, Ala.
Masters
May's Dept. Store, Brooklyn, N.Y.
Met Food Corp., Syosset, N.Y.
Metro Wholesale Corp., New York City.
Mid-Eastern Cooperatives, New Jersey.
National Bellas Hess Stores.
Navy Commissary Stores, Virginia.
New England Cooperatives, Framingham, Mass.
Packer Bros., Brooklyn, N.Y.
Park View Markets, Cincinnati, Ohio.
Pet Milk Co.
Pioneer Food Stores, New York.
Post Commissaries, Fort Hamilton, Brooklyn, N.Y., Fort Meade, Md.
Higbee's, Cleveland, Ohio.
Harvey Co., Nashville, Tenn.
Carson Pirie Scott, Chicago, Ill.
Burdine's, Miami, Fla.
Blass Co., Little Rock, Ark.
Sanger Harris, Dallas, Tex.
Shillito's, Cincinnati, Ohio.
Goldsmith's, Memphis, Tenn.
Read Drug & Chemical Co., Baltimore, Md.

Rockefeller Center, New York City.
Roger Williams Grocery Co., Cumberland, R.I.
Seaway Foodtown, Maumee, Ohio.
Servisoft Water Conditioning Services, New Jersey and New York.
Stix-Baer Fuller, St. Louis, Mo.
Erie Dry Goods, Erie, Pa.
The May Co., Stores
Famous Barr, St. Louis, Mo.
Kaufman's, Pittsburgh, Pa.
Dayton's, Minneapolis, Minn.
Abraham & Straus, Brooklyn, N.Y.
Pure Ice Cream & Dairy Co., Ohio
P. G. S. Stores
Jamesway Stores
Topps Discount Stores
Springfield Sugar, Windsor Locks, Conn.
Staff Supermarkets
Stop & Shop, Mass.
Thriftway Foods, King of Prussia, Pa.
Wakefern Food Corp., N.J. (ShopRite)
Waldbaum's Supermarkets, N.Y.
Weis Markets, Sunbury, Pa.
Washington Wholesale Grocery, Landover, Md.
Walgreen's
Topps Discount Stores
Charley Brothers, Pittsburgh, Pa.
Cooperative Feed Dealers, Binghamton, N.Y.
Petelinz Dist., Newburgh, N.Y.
Murry's Steaks, Alexandria, Va.
Mars Super Markets, Baltimore, Md.
Giant Food, Washington, D.C.
Great A & P Tea Co., New York
Food Center Wholesale Grocers, Boston

THE THEOBOLD INDUSTRIES,
Kearney, N.J., February 19, 1970.

MR. HENRY S. REUSS,
Chairman, Conservation and Natural Resources Subcommittee of the Committee of Government Operations, Rayburn House Office Building, Washington, D.C.

DEAR MR. REUSS: Answering your February 11 letter, we would like to list below those products which we are currently manufacturing and the type phosphorus compound used and the percentage, by weight, of phosphorus (as P) in each.

Product name	Type of phosphorus compound	Percent by weight of phosphorus, explain as "P"
Sage Safety Bleach	Sodium tripoly	5.1
Shop Rite Safety Bleach	do	7.8
Pathmark Safety Bleach	do	7.6
Miracle White Safety Bleach	do	1.3
Shop Rite Cold Water Detergent	do	7.6
Pathmark Cold Water Detergent	do	7.6
Shop Rite All Purpose Detergent	do	6.8
Pathmark All Purpose Detergent	do	6.8
Fyne Tex All Purpose Detergent	do	6.8
Grand All Purpose Detergent	do	6.8
Jet Power All Purpose Detergent	do	6.8
Key Food All Purpose Detergent	do	6.8
Easy Bright All Purpose Detergent	do	6.8
Staff All Purpose Detergent	do	6.8

If we can be of any further assistance, please do not hesitate to call upon us.
Very truly yours,

S. R. Crosby,
Vice President.

UNITED STATES BORAX,
February 25, 1970.

Re United States Borax & Chemical Corp.; study of phosphate-containing detergents.

CONSERVATION AND NATURAL RESOURCES SUBCOMMITTEE OF THE COMMITTEE ON GOVERNMENT OPERATION,
House of Representatives, Rayburn House Office Building,
Washington D.C.
(Attention of Mr. Henry S. Reuss, Chairman).

DEAR MR. REUSS: As Assistant General Counsel of United States Borax & Chemical Corporation, a Nevada corporation with principal offices within the State of California being situated at 3075 Wilshire Boulevard, Los Angeles, Calif., I should like to respond on behalf of such corporation to your letter of January 9, 1970, concerning your current study of phosphate enrichment of America's waters.

Since your letter and other available publications concerning this subject apparently concentrate upon the issue as to the percentage of phosphate in the various soap and detergent products now marketed within the United States, this response will therefore be confined to the consumer-product or household-marketing phases of our business operations as distinguished from industrial sales or distribution, and I do not believe that your investigation would be actually interested in the latter marketing activities of the company.

Responding directly to your inquiry then, in light of the foregoing comments, the following is a list of our soap and detergent products currently on the market, showing the use of each product as well as the kind and percentage of phosphorous compound contained in each such product:

Brand name	Use	Percent phosphorus (as P)
Borateem (R)	Laundry additive	None.
20 Mule Team (R) Borax	do	None.
Boraxo (R) powdered hand soap	Hand cleaner	None.
Boraxo (R) creme hand cleaner	do	None.
20 Mule Team (R) household cleaner	Powdered cleaner	2.02.
Luron (R) with lanolin	Hand cleaner	None.
Luron (R) lotion soap	do	None.
Boraxo (R) heavy-duty powdered hand soap	do	None.
PCB-100 (R) powdered hand soap	do	None.
Boraxo (R) waterless hand cleaner	do	None.
MD-7 (R) lotion soap	do	None.

You will observe that the only product containing phosphate is 20 Mule Team (R) Household Cleaner; the phosphate used in this product is pentasodium tripoly phosphate and introduces 2.02 percent phosphorous.

We do not include on our labeling any instructions advising the consumer how to vary the amount or method or use of the product in accordance with the hardness or softness of the available wash water; however, we should add that all our labeling is prepared with the utmost caution, following intensive investigation and study of pertinent legal and technical phases and, in addition, the language is also specifically designed to comply with applicable Federal and State statutes.

I doubt very much whether we could, even after the most intensive review of the subject, prepare any statement which would satisfactorily answer the inquiries posed in the final paragraph of your communication and, I am confident, any data we might offer in this area would hardly be advantageous to the purposes of your present program. To illustrate, by way of example only, you will note that we have only one consumer-product on the market containing phosphate, and any information we might be able to supply concerning the possibility of discovering a phosphorus-free builder for that particular product can hardly be of any significance to your project. In this same vein, we would like to emphasize that our products are essentially free from the hazards under study by your group and, accordingly, we sincerely believe that our household products truthfully pose no real problem within the scope of your investigation.

Sincerely,

EDWIN A. MCDONALD, Jr.,
Assistant General Counsel.

THE UTILITY CO., INC.,
New York, N.Y., February 5, 1970.

Re Letter January 9, 1970.

Hon. HENRY S. REUSS,
Chairman, Conservation and Natural Resources Subcommittee, Committee on Government Operations, Rayburn House Office Building, Washington, D.C.

DEAR SIR:

[Proprietary sales data deleted]

P by weight:

Formula A—5 percent (tetrasodium pyrophosphate), and 2 percent (trisodium phosphate).

Formula B—5 percent (tetrasodium pyrophosphate).

The above are combined with soap and inert fillers in hand cleansers sold in bulk to industrial plants for use by their workers and mechanics.

Very truly yours,

D. C. STRAUSS, V.p.

WILLEX PRODUCTS, INC.,
Omaha, Nebr., February 3, 1970.

Mr. HENRY S. REUSS,
Conservation and Natural Resources Subcommittee,
Rayburn House Office Building,
Washington, D.C.

DEAR MR. REUSS: Concerning your letter of January 9, 1970, the only product which we sell that contains phosphorus is our Willex cleaner-degreaser. By calculation the amount of phosphorus (as P) is less than 1 percent (actually .7584 percent).

Based on the above figure, we do not feel our product would really be significant for your study. If you still feel it is, please let us know and we will send you any other information you desire on the product.

Sincerely,

JOSEPH H. MURPHY,
General Manager.

WITCO CHEMICAL CORP.,
Paterson, N.J., January 26, 1970.

HON. HENRY S. REUSS,
Chairman, Conservation and Natural Resources Subcommittee of the Committee on Government Operations, Rayburn House Office Building, Washington, D.C.

DEAR MR. REUSS: Your letter of January 9, 1970, requesting percent by weight of phosphorus in each of our soap and detergent products has been forwarded to me.

We manufacture private label products under a great many names. I am, therefore, giving you below the total pounds produced in 1969 for each type of product:

Product	Pounds	Percent phosphorus
Sulframin HD Beads White	1,589,959	7.2
Sulframin HD Beads Blue	1,497,069	7.2
Sulframin RSE Beads (enzyme detergent)	2,745,395	8.2

I would respectfully suggest that information such as this be obtained only from basic producers. If such information is supplied by other than basic producers there will be a duplication.

We depend upon our raw material suppliers to provide us with any potential phosphate replacements. The only research we are able to do is directed toward learning how to handle these materials in our production systems, and to evaluate their performance. Our research expenditures are not sufficiently structured to be able to apply a dollar value to this work. There is however work going on, right now, directed toward a partial replacement.

With respect to your question about advertising, there is no expenditure since our detergent products are all private label.

Sincerely,

Dr. Marvin Mausner,
Director of Research, Ultra Division.

Wyandotte, Chemicals Corp.,
Wyandotte, Mich., February 2, 1970.

Hon. Henry S. Reuss,
House of Representatives, Conservation and Natural Resources Subcommittee of the Committee on Government Operations, Rayburn House Office Building, Washington, D.C.

Dear Sir: Your letter of January 9 is a difficult one for Wyandotte Chemicals to respond to in a meaningful way.

Wyandotte manufactures about 250 various chemical specialties used in industrial and institutional establishments, but markets no products intended for household consumption. The usual definition of soap and detergents would be those items containing soap and/or organic synthetic detergent for dishwashing, laundering, or building maintenance cleaning.

Using this definition, the attached table gives the information requested.

Since our products are not used in the household, instructions are not included on the label.

We cannot give a definitive figure for research expenditures in development of nonphosphated products. Our research accounting includes this work under a general category of "Improvement of Existing Products." We can assure you that research has been and will continue to be performed on nonphosphated products. To date, we have concentrated on metal finishing chemical specialties, where substitution of other hard water controlling agents has the least effect on detergency.

Our advertising budget, likewise, covers a specialized trade journal type of activity, which bears no relationship to the large soap and detergent type of advertising, and we cannot separate our soap and detergent advertising from that of our total product line.

We would respectfully submit that the phosphate contribution from various sources could be more accurately estimated by the phosphate manufacturers than by the accumulation of data from the many thousands of soap and detergent manufacturers and compounders in the country.

Sincerely yours,

Donald E. Anderson,
Director, Technical Service, J. B. Ford Division.

Wyandotte Chemical Products

	Percent phosphate
Laundry soaps and detergents:	
Ker-Cell—sodium tripolyphosphate	1.3
Clarene—sodium tripolyphosphate	1.3
Laud—tetrasodium pyrophosphate	4.4
Pardet—tetrasodium pyrophosphate	5.3
Skortex—tetrasodium pyrophosphate	1.2
Maintenance cleaning:	
Ammosene—sodium tripolyphosphate	.8
El-Bee—tetrasodium pyrophosphate	2.3
F-100—trisodium phosphate	5.1
Grime-Go—sodium tripolyphosphate	1.6
Kalso—sodium tripolyphosphate	.5
Preview—tetrasodium pyrophosphate	.7
Profound—	0
Dishwashing, hand and machine:	
Fame—sodium tripolyphosphate	1.4
Preferred—orthophosphates	.12
Kromet—sodium hexametaphosphate	2.4
Melmor—sodium hexametaphosphate	1.4
Observe—sodium tripolyphosphate	9.4
—trisodium phosphate	-----
Salute—sodium tripolyphosphate	10.2
—trisodium phosphate chlorinated	-----
Clenzit—sodium tripolyphosphate	4.6
Armada—sodium tripolyphosphate	7.7
Rotate—sodium tripolyphosphate	2.6
Volley—	0
U.L.C.—	0
Tradition—sodium tripolyphosphate	7.3

A/BENNETT ADVERTISING

[Press Release]

Hadco Corp., Cleveland, Ohio, announces that all of their manufactured commercial/industrial detergents, shipped from all of their plants in the United States and Canada, are now phosphate free and completely biodegradeable.

This discovery of the Hadco scientific staff, after many months of intensive research, has resulted in the development of KLM 0001 PF, a phosphate free polyelectrolite builder system which is now being used in all Hadco detergents, and which can be successfully broken down in disposal plants, the manufacturer states.

"Throughout the years, contamination in our waterways has built up to the critical point," states R. H. Albers, president of Hadco, "and it is time that our industry takes positive steps toward the arresting of this condition."

The manufacturer further states that henceforth all containers of Hadco detergents will be plainly marked as being phosphate free, and completely biodegradeable.

PAR CHEMICAL CORP.,
Columbus, Ohio, January 30, 1970.

Congressman HENRY S. REUSS,
Member of the U.S. Congress,
Washington, D.C.

DEAR CONGRESSMAN REUSS: We are manufacturers of cleaning detergents here in Columbus, Ohio.

I was reading your article concerning detergents made with phosphates in the Chemical Marketing newspaper on December 23, 1969. This article is quite interesting since it is directed toward our product line.

Our product. PAR All Purpose Cleaner, is manufactured completely "phosphate free." In addition to this, it is biodegradeable and nontoxic. It is also highly concentrated which enables us to use less concentration than the average all-purpose cleaner on the market today. Also, with its phosphate free char-

acteristic, the cleaner leaves no white residue whatsoever. Our product has also been approved by the USDA for use in meat and poultry processing plants. We have found that PAR All Purpose Cleaner can replace as high as 12 other cleaners. Ours is a product of high quality and economy.

In your article you mentioned NTA (sodium salt of nitrolitriacetic acid) as a possible substitute. We are quite familiar with this chemical and have had some fine results with our tests of it. I would be more than happy to discuss these with you.

I am enclosing some literature regarding our product and a sample will follow under separate cover. After you have had an opportunity to read the material and test PAR All Purpose Cleaner, I would greatly appreciate hearing from you and receiving your comments and evaluation of our product. Thank you.

Very truly yours,

VICTOR J. BELLISARI,
Vice President, Industrial Sales Division.

PAR CHEMICAL CORP.,
Columbus, Ohio, February 12, 1970.

Mr. PHINEAS INDRITZ,
Chief Staff Counsel, Conservation and Natural Resources Subcommittee, House of Representatives, Rayburn House Office Building, Washington, D.C.

DEAR MR. INDRITZ: Reference is made to our telephone conversation of February 11 concerning PAR PLUS All Purpose Cleaner. As per that conversation please find enclosed a copy of the Detroit Testing Laboratory's report on PAR PLUS All Purpose Cleaner.

To further acquaint you with our product, may I submit the following information: In addition to being a phosphate-free cleaner, PAR also leaves a residue-free surface after its use. PAR is so highly concentrated that only a very small amount is needed to clean any surface. For example, a 480-to-1 ratio (1¼ teaspoon of PAR to 1 gallon of water) is all that one needs to make the best window wash solution, stainless steel cleaner, or wood and formica paneling cleaner on the market today. For general cleaning a 50-to-1 ratio (one-fourth cup of PAR to 1 gallon of water) is all that is needed for mopping all types of floors as well as washing walls. For heavy cleaning a 20-to-1 ratio (one cup of PAR to a gallon of water) is all that is needed to strip wax from a floor, degrease a motor, clean range hoods, white sidewall tires, wash an automobile, marble walls, a greasy garage floor, to clean a printing machine or shampoo a carpet (it emulsifies chewing gum from a carpet and reduces static electricity).

In view of the above, we have found that our PAR PLUS will replace 16 of the leading chemical cleaners on the market today. Therefore, with our one phosphate-free chemical we can eliminate any of these 16 phosphate based cleaners that, according to Congressman Reuss and other conservation minded individuals, are polluting our rivers and streams.

I would also like to point out that we are introducing, in the near future, a phosphate-free laundry detergent as well as a phosphate-free nontoxic germicidal cleaner. We most certainly will notify you of this as we near the final production stage.

If you have been notified by any other company that has a phosphate-free cleaner, it would be most appreciated if you would advise us so that we might discuss the phosphate/pollution problems with them.

After you have had an opportunity to test the sample of PAR PLUS and read the enclosed literature, please call me at (area code 614) 486-5936. Thank you.

Very truly yours,

VICTOR J. BELLISARI,
Director of Industrial Sales.

THE PROCTER & GAMBLE CO.,
Cincinnati, Ohio, January 30, 1970.

HON. HENRY S. REUSS,
Chairman, Conservation and Natural Resources Subcommittee,
Committee on Government Operations,
Rayburn Office Building,
Washington, D.C.

DEAR SIR: In response to your recent request, we are separately providing the specific information you asked for about the general subject of phosphates in

detergents. In addition, I thought you and other members of your subcommittee should know the point of view of Procter & Gamble on this important matter.

In the soap and detergent field, it is our job, as we see it, to make available to housewives the best possible washing products that we know how to make, with full consideration of our responsibilities to society and to our environment. Such products must provide clean, sanitary washing results, with safety to those who use them and to the fabrics and surfaces they clean. They must provide these results at a reasonable cost to the user. All these considerations are recognized and weighed in formulating each of our products, and in searching for ways to improve existing product formulas.

Recently, questions have been raised about phosphates in detergents as one possible cause of eutrophication which is the growth of algae and other plant life in lakes and streams. The fact that the same question is being raised about phosphates in chemical fertilizers, and about other materials that find their way into lakes and streams, does not any way diminish our very real concern.

In this connection, we emphasize that the company has no financial interest of any kind in phosphates as such. We own no phosphate deposits nor facilities to produce phosphates. Phosphates are included in washing products today, as they have been in one form or another, for over 40 years, because they contribute significantly to cleaning performance and are both economical and safe to use in the home.

An important and continuing part of our research activity is to search for new materials which will do a better job in detergents than present materials. During the past 20 years, we have studied hundreds of new materials which might replace phosphates in an effort to produce detergents to do a better job for the housewife at reasonable cost to her.

In view of the questions that have been raised about whether phosphates in detergents are contributing to eutrophication, in recent years this search for other materials has been accelerated. We are spending all the research money we know how to spend productively and every fruitful avenue of research exploration is being pursued.

One result of this overall effort is the fact that we are selling two brands nationally in the United States with low levels of nitrogen-containing material (NTA) as an adjunct to and partial replacement for phosphates. We expect to gain broader experience with this substitute material in the future.

In addition to its internal effort, the company has been cooperating and will continue to cooperate fully with the Department of the Interior in an effort to determine the causes of excessive algal growth in lakes and streams. There is still much that is unknown about this subject which must be determined before any prudent judgment can be made as to how to alleviate that problem.

Until more definite knowledge does develop, we regard it as an obligation to point out what we know about phosphates in detergents and their benefit to housewives. As of today, any general substitution for phosphates that has been suggested would entail considerable penalty to the ultimate consumer, either in terms of poorer cleaning performance or a higher price for the finished detergent product, or both. Furthermore, we must be certain that any substitute materials are not harmful to the environment.

If, as knowledge develops about the causes of excessive growth of algae in lakes and streams, it should be eventually concluded that the balance of advantages and disadvantages for both consumers and the environment is such that phosphates should be eliminated from detergents, we shall, of course, act on such a conclusion.

We appreciate this opportunity to present our company's views on this important subject.

Sincerely,

HOWARD MORGENS, *President.*

THE PROCTER & GAMBLE CO.,
Cincinnati, Ohio, February 24, 1970.

MR. PHINEAS INDRITZ, ESQ.,
House Committee on Government Operations,
Conservation and Natural Resources Subcommittee,
Rayburn House Office Building, Washington, D.C.

DEAR MR. INDRITZ: We were grateful for the opportunity to meet with you on January 30 and to respond to your suggestion that we outline P. & G.'s

research program to develop fundamental understanding of the process of eutrophication.

I am responding separately to your request for information concerning our program to evaluate the environmental effects of new detergent ingredients because both these areas are broad and complex and I believe separate letters will present the information to you in more useful form.

Our work to develop fundamental scientific information about eutrophication falls in several distinct areas as follows:

PROVISIONAL ALGAL ASSAY PROCEDURE—JOINT TASK FORCE

P. & G. has actively participated in the Joint Industry/Government Task Force on Eutrophication since its inception in the fall of 1967. In meetings of this task force, the environmental effects of detergent phosphates and potential substitutes for them have been discussed. The problem of defining the effects of phosphate and predicting the potential effects of possible substitutes on the process of eutrophication came clearly into focus in the early discussions and agreement was reached to proceed with the development of a laboratory test which would help in this predictive work. Thus the concept of the provisional algal assay procedure (PAAP) was born and subsequently programed for earliest possible completion in Government, university and industry laboratories studies and in subsequent field studies (1972).

I must point out here that the development and field validation of a biological laboratory test is indeed a complicated matter and will take time. However, until it is available, neither we nor Government scientists can realistically estimate the effects of potential phosphate substitutes on eutrophication. And this is not the opinion of one company: it is the consensus of 17 of the world's academic and Government experts in this area who met in early 1968 under the auspices of the joint task force.

I must also point out that any laboratory test is only representative of the laboratory conditions under which the test is conducted. Thus, unless the scientists who are at work on this procedure can realistically reproduce the natural conditions of our surface waters, the test will never preclude the need for confirmatory field tests of the effects of some phosphate substitute.

The time schedule required for this kind of development is a little overwhelming and in recognition of this fact P. & G. has taken the following steps to demonstrate, in very practical terms, its concern and its dedication to the earliest possible completion of this vital procedure.

1. P. & G. began a substantial program in support of the PAAP development in the early summer of 1968 as a part of the company's broader technical program concerning the environmental safety of our detergent product ingredients. P. & G.'s program began nearly 8 months before FWPCA contracted with three universities to begin work on the development and has proceeded apace since the university programs were started.

2. The first presentation of our work to the Joint Industry/Government Task Force on Eutrophication was made in March 1969.

3. Subsequently we have initiated and actively participated in PAAP development review meetings held in Cincinnati by FWPCA in May and subsequently October of 1969. These meetings were attended by FWPCA scientists and university scientists involved (via FWPCA contracts) in the development of the PAAP.

4. One of our scientists has chaired a subcommittee of this group which was given the major responsibility for development of an appropriate nutrient medium to be used in the PAAP.

5. P. & G. has prompted better communication and cooperation between Government, university and industry laboratories in order to help minimize the time required to develop this test.

Thus, P. & G. has not only been active in the forefront of knowledge in this area but has developed fundamental new information and actively shared it with Government, university and other industry people.

STUDIES OF EFFECTS OF NUTRIENT LOADINGS ON NATURAL LAKE WATER

We have pioneered with the application of the preliminary PAAP to natural waters of interest. For example, in 1968 we used the test to study the effects of nutrient loadings from municipal sewage effluents on Lake Erie water samples

taken from the Maumee River outfall, the Toledo water intake and the Cleveland water intake. This information has also been shared with the FWPCA.

We have been particularly interested in PAAP studies of water samples from Lake Shagawa near Ely, Minnesota, where the FWPCA has a pilot waste treatment plant capable of producing very high grade effluents. These studies have been directed toward measuring the effects of effluents from various waste water treatment processes, available from the pilot plant, on Shagawa Lake water. This information has also been shared with the FWPCA.

While most of this work has been directed to the development of a reliable PAAP, we believe that we have contributed to the basic understanding of the effects of nutrient loadings in municipal waste effluents on algal growth. It certainly has contributed to the progress of the development toward real lake validation and we have repeatedly urged that those requisite tests be started on the earliest schedule possible.

NUTRIENT SOURCE STUDIES

Procter & Gamble's Sanitary Engineering Research Laboratory has conducted basic work to determine the availability of nutrients to algal growth from various sources. We have presented the results of one project (copy attached) which demonstrated that phosphorus is available to algae in a biological system from naturally occurring materials which are normally considered "insoluble." This work was performed in 1968 and, we believe, was influential in directing the attention of scientists in the field to the problem of phosphorus availability from bottom muds.

SOAP AND DETERGENT ASSOCIATION STUDIES

Procter & Gamble has participated actively in projects sponsored through the Soap & Detergent Association. I must emphasize that this work is actively supported by many companies of the association. Details of the complete program are available from SDA if desired. Specifically this work has included:

(*a*) Studies of the physical and chemical processes in waste treatment operations designed for the removal of phosphate. The objective of this program has been to investigate the most efficient methods of phosphate removal. The work has been conducted at the University of California at Berkeley, at Penn State, and at the University of Texas.

(*b*) Basic studies at the University of Cincinnati of blue-green algae nutrition including the importance of carbonaceous materials, natural chelating agents such as humic and fulvic acid, elemental nutrients (including phosphorus) and trace metals. This work is continuing and is contributing significantly to the understanding of blue-green algae nutrition.

(*c*) Studies at Stanford Research Institute to review existing information and develop new information concerning phosphate inputs into surface waters.

(*d*) Studies at the University of California, at Davis, to determine nutrient availability from bottom sediments in Clear Lake, Calif.

(*e*) Assistance in the collection and critical review of the scientific literature in eutrophication at the University of Wisconsin.

We at Procter & Gamble believe that we must understand the basic chemical and biological systems of the aquatic environment well enough to conduct intelligent dialog with experts in the field (sanitary engineers, limnologists, biologists, toxicologists, et cetera) and to be able to develop realistic estimates of the effects or potential effects of current and proposed detergent ingredients on these complex systems.

I can assure you we shall continue this effort and we shall continue to share our knowledge with appropriate Government agencies.

Very truly yours,

J. A. BRUCK,
Associate Director, Product Development Division.

THE PROCTER & GAMBLE CO.,
Cincinnati, Ohio, February 25, 1970.

Mr. PHINEAS INDRITZ., Esq.
House Committee on Government Operations, Conservation and Natural Resources Subcommittee, Rayburn House Office Building, Washington, D.C.

DEAR MR. INDRITZ. As I indicated to you in my letter of February 24, I would like to outline here the programs we undertake to establish the performance, safety during use, and environmental safety of a new detergent ingredient.

Once a new ingredient is physically in hand, such as a proposed substitute for phosphates, our work can be described in five steps:

1. Determine in laboratory work programs that the ingredient performs the intended cleaning task properly.
2. Assure ourselves that the ingredient is safe for people to use and to have in their homes.
3. Assure ourselves that the ingredient is safe for the environment.
4. Determine that the new ingredient can be incorporated in a satisfactory manufacturing operation and that a satisfactory product can be delivered to the consumer.
5. Develop sufficient consumer information to be sure that the product satisfies a consumer need and is acceptable to her.

While points 1, 4, and 5 require extended effort and the application of complicated technical knowledge, I will not attempt here to elaborate on these programs. Instead, I shall concentrate on the work we do in the areas to prove safety for people and safety for the environment.

SAFETY FOR PEOPLE

In this phase of our work four general areas are considered:

1. Acute studies,
2. Subacute studies,
3. Long term studies,
4. Special studies.

In the area of acute studies the following specific programs are normally deemed necessary:

1. Acute oral toxicity conducted over a 6-week period. The test animals are normally rats and the purpose of the test is to determine relative ingestion hazard of the new material. This test alone disqualifies many new materials.
2. Acute oral toxicity over an 8-week period in dogs to determine relative ingestion hazard of a large dose in a vomiting species. This study is always conducted subsequent to the rat studies.
3. Studies performed in dogs over an 8-week period to determine the comparative emetic potency of the material. This is a very important aspect of the total investigation.
4. Skin irritation tests are conducted on rabbits over a 4-week period to determine the potential irritancy of the new material under exaggerated conditions. Obviously this work is always done prior to tests on human skin.
5. Mildness tests are conducted on humans over a 6-week period. This is done in such a way that comparative mildness of the new material to human skin under exaggerated conditions is established relative to some material which is known to be safe, such as phosphate.
6. Eye irritation studies are done in rabbits over an 8-week period to determine the relative hazard to the eye compared to some safe material such as phosphate.
7. Eye irritation studies are also done in monkeys over a 3-week period in order to determine relative eye hazards of a new material with a species with eyes more similar to those of man.

While this program may sound precise and routine, it usually is not. Scientific analysis of the results from the test program as it proceeds almost always calls for more elaborate work to clarify some aspect of the results. Not infrequently,

evidence from the established procedures indicates the need for development of new procedures to answer questions which have arisen. It is a viable program which must respond to the scientific needs of the specific material being investigated.

Subacute studies are usually conducted after preliminary acute studies have indicated that the new material is relatively safe. This kind of study is used to determine the effects, if any, of long term exposure of the material to test animals and to humans. The program usually consists of the following steps:

1. Feeding studies on rats are conducted for 30-day and 5-month periods to determine the effect of repeated ingestions of small amounts of the new material and to set appropriate dose levels for long term feeding studies.

2. Percutaneous toxicity studies are conducted over a 28-day and 6-month test period to detect any toxic effect due to the penetration of the new material through abraded skin. Here the test animal is repeatedly exposed to relatively high concentrations of the new material over the test period and examined pathologically for evidence of effects of the ingredient.

3. Percutaneous toxicity studies are also performed on rabbits over 91-day and 10-month test periods. Once again the objective of these studies is to determine any toxic effect on the animal due to penetration of the test material through abraded skin upon repeated application throughout the test period.

4. Sensitization tests are conducted on guinea pigs over a 2½-month period to determine allergenic potential of the material upon repeated, exaggerated exposure. This test is usually subsequent to the rabbit skin irritation test.

5. When the above studies have indicated a new material to be safe, sensitization tests on humans are conducted over a 3-month period to detect any allergenic potential in humans due to repeated exposure to the new material. Obviously this test cannot be run until the guinea pig test has shown the new material not to be a sensitizer.

6. When all of this work has been completed and indicates that the material is safe for humans, then a clinical mildness test of the new material in a finished product formulation is conducted with humans over at least a 2-month test period. This test is used to determine relative mildness of the finished product formulation containing the new ingredient under actual home usage conditions.

This work program is vitally important in establishing the overall safety of a new detergent ingredient. It must be conducted essentially sequentially as each step of the program is dependent upon obtaining a "safe" result from the previous test work.

Long term studies are conducted after results from preliminary acute and subacute studies indicate that a new material has no problems.

Feeding studies, usually using rats over a 2½-year period, are conducted to determine any long term effects of the new material. Small amounts of the new material are repeatedly ingested over the entire test priod.

After successful acute studies, it is necessary to determine the fate of ingested materials. In order to do this, metabolism studies are conducted on rats and possibly other species over a period of at least 8 months and possibly 1 year.

Other studies may be indicated when the results of the test work above show the need for more information. For example,

> Teratological tests may need to be conducted to determine the effects of the new material on litter size and the presence of abnormality of fetuses due to incorporation of material in feed or as a result of oral dosing of pregnant does.
>
> The chemical and biological nature of some new materials require test work to determine carcinogenic potential. This is usually done with mice by repeatedly painting the material on the skin over about a 2½-year period.

This is obviously a very complicated and extensive program. I must emphasize again that it is only an outline of the kind of studies which are required to qualify a new material from the point of view of human safety. The program might be much longer than this, depending upon scientific interpretation of test results as the program progresses, but it might also not include some of the items listed above—again because scientific interpretation of the data indicate that certain steps are not necessary.

The evaluation of potential new detergent materials for effects on water quality also requires a long and complex program. Here again, I shall simply outline the basic studies which usually are required.

In phase 1 of this evaluation, preliminary biodegradability of the new material is established. This program requires about 3 months and includes studies of, for example—

The disappearance due to biological activity of the new material in laboratory test media.

The oxygen demand on the media for biodegradation.

The production of carbon dioxide as a result of biodegradation.

A determination of whether or not the new material is toxic to sewage plant bacteria.

In phase 2 the new material is studied in laboratory waste treatment systems and initial studies of aquatic toxicity are started. Phase 2, of course, does not start unless positive answers are acquired in phase 1. In addition, it is necessary to develop preliminary analytical methods for the new material in order that it can be identified and accurately measured at the extremely low concentrations encountered in waste treatment and surface water situations. Phase 2 usually requires 6–12 months for completion and includes the following steps:

Application of the newly developed analytical method to dilute natural waters and to sewage systems. Studies of the removability or ultimate fate of the new material in the environment. For example, if the material is not totally degraded in a waste treatment system its fate via precipitation, absorption, adsorption, or photolytic degradation must be determined. This phase must also include studies of the fate of the new material when injected directly to surface or ground waters.

The new material must be studied to determine its effects, in laboratory simulated processes, upon activated sludge waste treatment systems, septic tank systems, sludge digestion, and primary settling. In addition, it is necessary for us to be alert to the development of new waste treatment systems such as the physical-chemical process now being discussed and recommended by FWPCA. This new system has no biological stage, and materials which would normally be degraded biologically might not be removed in such a new process. In this case, much more intensive studies must be made of the fate of the material in the surface waters which receive the effluent from the plant.

In addition to studies of the effects on waste treatment operations, we must also determine the effect of the new material on water supply and waste treatment operations. We must be concerned with odor, color and taste as well as the fate of the material in the water treatment process.

We must also make some estimate of the effect of the new material on algal growth. It is well known that there is no reliable laboratory method for determining precise potential stimulatory effects. However, we are able to determine whether the new material is toxic to algae.

This phase of the work also includes studies of aquatic toxicity. Screening studies must be performed on sensitive species of fish and then extended to other vital species of the aquatic environment.

Phase 3 includes extended studies of various aspects of potential aquatic effects and requires a minimum of 18 months and usually is extended through 3 years. These studies which would be run on materials to be used in large quantities such as a phosphate replacement, include such things as:

Full scale testing in sewage treatment plants. As pointed out above, this must not only include established waste treatment processes such as primary, and activated sludge, but it must also include estimates of the effects of the new material in newly proposed waste treatment systems, and of course, we must study the fate of the new ingredient in anaerobic systems such as septic tanks and cesspools.

Practical studies of potential effects on eutrophication must be undertaken in this phase. The work includes laboratory aquarium studies but must ultimately be extended to field studies. While no field studies have yet been conducted on any new material, we believe a minimum program would require at least 2 years.

The long term effects of a new ingredient on the aquatic environment must also be studied. Potential effects on reproduction of the various representative organisms in the ecological cycle must be studied. This is an area which is not well defined technologically at this point and it therefore represents an area where cooperation between scientists in industry, Government and the academic area is fundamental to establishing meaningful investigative programs.

I am aware that this is a long and complicated letter. I repeat that I have touched only briefly on the more important aspects of the program we must undertake to establish that a new material is safe for humans and safe for the environment. I have not touched at all on the areas of product performance, manufacturing feasibility or consumer acceptability. I shall simply assure you that these facets of new ingredient investigations are just as complicated, just as important to the total program and usually as time consuming as those for which I have given some detail here.

Naturally we shall be very glad to discuss this program in any further detail that you might wish. We are especially anxious that you understand the deep significance this work has in considering, for example, a replacement for phosphates in our laundry products.

Very truly yours,

J. A. BRUCK,
Associate Director, Product Development Division.

WASTE WATER TREATMENT CORP.,
New York, N.Y., December 18, 1969.

Hon. HENRY S. REUSS,
U.S. Congressman,
House Office Building,
Washington, D.C.

DEAR MR. REUSS: I learned of your chairmanship of the Conservation and Natural Resources Subcommittee of the Government Operations Committee from the recent article in the New York Times and believe that you are performing a valuable public service by examining into the detergent and phosphate question.

The article in the Times is not completely accurate, but I am sure your committee will elicit the correct scientific evidence. True, phosphates are a problem, but so are the linear alkyl sulfonates (LAS) in the detergent mixes.

Our company believes it has solved this problem in one important area. We have equipment, described in the attached brochure, for treatment by biological oxidation for removal of LAS and ancillary treatment for the removal of phosphates. This equipment is in successful operation, and we are prepared to furnish the equipment to any coin-op laundry requiring treatment.

Will you kindly put me on your mailing list to receive releases by your committee on this subject, and I would like to have a copy of the record when it is printed.

Sincerely,

KENNETH B. RAY, *President.*

(The brochure submitted by Mr. Ray is in the subcommittee files.)

ARMANDO ASSOCIATES,
Freeport, N.Y., December 14, 1969.

Re water pollution.

Congress HENRY S. REUSS,
Natural Resources Subcommittee of the Government Operations Committee,
Washington, D.C.

DEAR MR. CHAIRMAN: I must congratulate you on your efforts in stemming the tide of water pollution: ref: article in New York Times, December 13th.

I have championed this cause for over 15 years and I have not made a dent in this paradoxical problem. It took me 5 years to develop a practical and economical method of cleaning without soaps or detergents. As early as 10 years ago I demonstrated this system to the R.C.A. Corp. and had test performed by independent testing labs. This patented electronic device was attached to the incoming water supply hoses of the machine and a clean wash was obtained every time without the use of chemical additives.

As you can surmise the interest has been negative but I even went beyond the soap companies and manufactures to the extent of having Columbia University test this system. The results were very favorable and I received a congratulating letter from the dean of engineering, Dr. John R. Dunning, on my concept and the effectiveness of the device tested.

I am not trying to solicit nor interest you in this product for I know it would

be a conflict of interest, I only want to inform both you and your committee that an answer has been around for about 10 years. I would be only too glad to give a demonstration in cleaning all the dirty linen of the soap industry.

Sincerely.

ARMANDO A. ARAUJO, Jr., *President.*

HOUSE OF REPRESENTATIVES,
CONSERVATION AND NATURAL RESOURCES SUBCOMMITTEE,
OF THE COMMITTEE ON GOVERNMENT OPERATIONS,
RAYBURN HOUSE OFFICE BUILDING,
Washington, D.C., February 16, 1970.

ECONOMICS LABORATORY, INC.,
New York, N.Y.

DEAR SIR: As you are probably aware this subcommittee is making a study of phosphates in detergents and held hearings on the subject last December.

One of the suggestions made at our hearings for reducing the total detergent phosphorus contribution to America's waste waters was to vary the amount of phosphate in particular products to match the hardness of the water in the areas where they are to be marketed.

We have purchased a box of your product "Finish" in a Washington grocery store. The label states, "Special formula for water in this area." What do these words mean? Do you vary the amount of sodium tripolyphosphate in "Finish" according to hardness of the water where particular shipments are to be used? How do you do this?

Please let us have a full explanation of the words "Special formula for water in this area."

Do you use these words on any product beside "Finish"? If so, do they have the same meaning as with "Finish?"

Sincerely,

HENRY S. REUSS,
Chairman, Conservation and Natural Resources Subcommittee.

[Telegram]

RESEARCH ECONOMICS LABORATORY,
St. Paul, Minnn., March 19, 1970.

Hon. HENRY S. REUSS,
Chairman, Conservation and Natural Resources Subcommittee of the Committee on Government Operations, Rayburn House Office Building, Washington, D.C.:

We have your letter of February 16, 1970, where you inquire about the claim "Special formula for water in this area" on our "Finish" product. This will be the reply to give you information and background on this product and claim.

We have formulated the "Finish" product to handle the general or prevailing water hardness in a given market area. We have three formulas: One to accommodate soft water, one for medium hard, and a third for hard water conditions. Actually these formulas contain different levels of phosphate as sodium tripolyphosphate. In softer water areas the formula for "Finish" contains less phosphate than the one for hard water areas. This is the basis for the claim, "Special formula for water in this area."

The basis for the selection of the phosphate content in a particular formula is derived from our best numbers of the water conditions not only in the city itself but in the surrounding suburbs. The distribution of a particular formula is made on a market basis through warehouse control serving these markets.

In some cases, of course, there is an overlap of hard and soft water areas, but I am sure you understand that product distribution through retail outlets makes it impossible to cover each and every specific water condition. Although we do not make this type of claim on the Electrasol package, we do distribute two different Electrasol formulas, again designed to accommodate the varying water conditions throughout the country. In softer water areas, we distribute an Elec-

trasol formula which has lower phosphate content than does the one for hard water areas.

In summary, we do have three different Finish formulas with varying percentages of phosphates distributed through the United States to support the claim, "Special formula for water in this area." The formulas for softer water have less phosphate content than the ones for hard water areas; the same is true of different formulas for our automatic dishwashing detergent, Electrasol.

The above information should answer your inquiry of February 16. If you desire further information we will attempt to amplify the above.

Cordially

WILLIAM M. PODAS,
Vice President.

[Telegram]

RESEARCH ECONOMICS LABORATORY,
St. Paul, Minn., March 23, 1970.

Hon. HENRY S. REUSS,
Chairman, Conservation and Natural Resources Subcommittee of the Committee on Government Operations, Rayburn House Office Building, Washington, D.C.

CONGRESSMAN REUSS: As a followup on our letter of March 19, 1970, I am giving more detailed information on our different formulations of Finish and Electrasol. As explained in that letter one of the differences in our various formulas is the phosphate content.

The phosphate content of our three Finish formulations is as follows:

(*a*) soft water area formula 18.00–0/0 sodium tripolyphosphate 4.53–0/0 p

(*b*) medium hard water area formula 28.80–0/0 sodium tripolyphosphate 7.26–0/0 p

(*c*) hard water area formula 43.20–0/0 sodium tripolyphosphate 10.89–0/0 p

The phosphate content of our two Electrasol formulations is as follows:

(*a*) soft water area formula 22.00–0/0 sodium tripolyphosphate 5.54–0/0 p

(*b*) hard water area formula 35.40–0/0 sodium tripolyphosphate 8.92–0/0 p

Thank you for giving us the opportunity to explain our formulas to you.

Cordially.

WILLIAM PODAS,
Vice president.

MICRO PROCESSING LICENSOR,
Minneapolis, Minn., November 1, 1969.

Hon. HENRY REUSS,
House of Representatives,
Subcommittee on Conservation,
Washington, D.C.

DEAR MR. REUSS: The enclosed newsletter in "Chemical Week" of October 29 states that a conference has been slated by you for December 15.

You can see from my telegram to the Wisconsin Legislature's Resources Conservation Council that phosphates are no longer necessary in home laundry products, providing a "suds controlled" washing machine is employed.

I am scheduling demonstrations of my prototype machine in November and December for nine washing machine manufacturers, as well as for the Department of the Interior's and Duluth's water quality lab representatives.

A representative of your committee could come to Minneapolis and see firsthand why soap-surfactant combinations could replace phosphates.

I thought this would help you in your deliberations.

Sincerely,

DONALD E. MARSHALL.

Enclosure: Market newsletters, September 6 and October 29, soap-surfactant combinations.

(Enclosures are in subcommittee files.)

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