

# U.S. ENVIRONMENTAL PROTECTION AGENCY



PACIFIC NORTHWEST ENVIRONMENTAL  
RESEARCH LABORATORY

QUARTERLY PROGRESS REPORT  
October 1 - December 31, 1973

**PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY**  
An Associate Laboratory of  
National Environmental Research Center—Corvallis

8 APR 1974

PACIFIC NORTHWEST ENVIRONMENTAL  
RESEARCH LABORATORY

QUARTERLY PROGRESS REPORT  
October 1 - December 31, 1973

N. A. Jaworski, Director  
L. P. Seyb, Deputy Director  
PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY  
NATIONAL ENVIRONMENTAL RESEARCH CENTER  
OFFICE OF RESEARCH AND DEVELOPMENT  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
200 S.W. 35th ST.  
CORVALLIS, OREGON 97330

FTS 503-752-4571  
503-752-4211

## INTRODUCTION

The purpose of this report is to present a quarterly view of the activities, both intramural and extramural, of the Pacific Northwest Environmental Research Laboratory (PNERL). The research branches at PNERL include:

- Coastal Pollution Branch (CPB), involving research on the behavior of pollutants in the marine environment.
- Eutrophication and Lake Restoration Branch (ELRB), involving research on the eutrophication (premature aging) process in polluted water and development of methods and technology for the control and restoration of eutrophic waters.
- Eutrophication Survey Branch (ESB), a study to identify and analyze approximately 800 bodies of water in the United States with potential or actual eutrophication problems brought on by the discharge of excessive amounts of nutrients into them.
- Thermal Pollution Branch (TPB), involving the study of causes, effects, controls, and prevention of thermal pollution in streams, lakes, reservoirs, estuaries, and coastal waters.
- Industrial Wastes Branch (IWB), involving research on treatment of wastes from the pulp and paper industry, wood products industry, forestry and logging, and the food processing industry.
- Laboratory Services Branch (LSB), a centralized laboratory providing analytical and computer services to the five branches of PNERL.

The reporting of the research activities focus around the Research Objective Achievement Plan (ROAP). Included in the presentation are the ROAP approach, intramural activities, and extramural activities.





# Coastal Pollution Research Highlights

---

Pacific Northwest Environmental Research Laboratory

200 S. W. 35th Street

Corvallis, Or. 97330

---

COASTAL POLLUTION BRANCH  
Program Element 1BA025

## I. INTRAMURAL ACTIVITIES

December 1973

### A. New York Bight

The fifth quarterly survey of the New York Bight experimental sewage sludge dump site was conducted in December. Specimens from the first four cruises have been identified and enumerated. The site is characterized by an apparently "healthy" assemblage of polychaete, amphipod and other macrobenthic species. The structure of this community should be a good indicator of the impact of sludges on the benthos.

The current meter stations established in May '73, have been maintained through December. One additional meter was positioned near the bottom using a tripod assembly. This meter has been recovered and is now being processed in concert with four others deployed during the summer months.

Two types of sediment traps have been tested within the site area. Large, 30-liter traps positioned in groupings of three per station have exhibited some problems attributable to inadequate vessel capability for deployment. A smaller metal cylinder has performed adequately and the latest retrieval in December shows significant amounts of materials including what appears to be a large fraction of sand. Tests are now underway to quantify and identify the material.

The mathematical model to be evaluated as part of this study is now operational and some preliminary parametric investigations have been performed. These basic studies have demonstrated the need for laboratory work to better characterize the waste parameters in terms of:

- (a) The percent solids by volume and type.
- (b) The settling velocity and specific gravity of identifiable solid types.
- (c) The bulk specific gravity of the composite waste.

(d) The porosity of sludge solids settled through marine waters.

The model's sensitivity to the ambient density structure has demonstrated the need for additional and more sensitive characterizations of the local salinity-temperature gradients and their seasonal variability. Horizontal and vertical coefficients of eddy diffusivity have been identified as important parameters to investigate seasonally at this particular site because of the time requirements to realize a 50+ percent settling of the solids.

Work on the analysis of Trace Metals in sludges from various sewage treatment plants considered as potential sources of experimental material for placing in the NB buoy area, and of sediments taken from the NB area, has continued.

Several sludges and sediments and water samples have been examined for PCB content. The results show that the levels in the sludges are significantly higher than in the sediments so that the proposed experimental study of the movement and chemical behavior of these chlorinated hydrocarbons may be feasible. Since the analytical procedures require a fairly large sludge sample, there may be difficulty in obtaining adequate sludge samples from the bottom after experimental placement in the N.Y. Bight. In addition, it is necessary to obtain some normalizing factors, too, if chemical changes are to be observed. This information will be available if a group of Trace Metal constituent traces can be successfully analyzed in actual experimentation.

## B. Simulated Ecosystems

An experiment on the effects of sewage sludge on benthic communities maintained under controlled laboratory conditions was initiated at the Newport Field Station in December. Several benthic crustaceans, polychaetes, mollusks, and a demersal fish are being exposed to different concentrations of sewage sludges in a continuous-flow aquarium system. This study complements our field study of the response of the macrobenthos to sludge dumping in the New York Bight.

## II. EXTRAMURAL RESEARCH

### A. Southern California Bight

The first year's work on DDT mass emission rates (MER) measurements from various point (pipeline) sources and some non-point sources

has been successfully completed including the establishment of analytical methodology. An annual report was issued by the Southern California Coastal Water Research Project (SCCRWP), Dr. David Young, Principal Investigator.

A second year's effort has been planned to continue work on such non-point source MER estimates as aeolian and net input from coastal current flux density. It is now intended to observe the modes of transport of the originally deposited DDT (the original manufacturing source having been brought under control) as the DDT moves from inventory points by various possible mechanisms. This substantial experimental effort is scheduled to commence in January 1974, taking advantage in this following work of the analytical capability developed during the first year's effort; a corollary utilization of the analytical capability will be to identify those constituents whose peaks continually show up, but whose identity is unknown. This, it will be recalled, was the case with PCB becoming recognized during original DDT analytical work.

Scientists at the Southern California Coastal Water Research Project are continuing their study of the effects of wastewater discharges on the population dynamics, disease incidence, species composition, and diversity of benthic invertebrates and fishes of the Southern California Bight.

#### B. Chlorinated Hydrocarbons Decay

A six months progress report was received from Dr. Phillips of the Stanford University Hopkins Marine Station laboratory on the work in progress on bacterial decay of DDT under various conditions of pH, Eh, and nutrients.

Radiorespirometry is the method of choice for following this rather difficult experimental problem. Because of the very low solubility of the DDT and its metabolic products and because of the low incidence in the regional muds of bacteria capable of its metabolism, it is difficult to assay the changes. However, analyses of the muds show DDT concentration changes, so there is a good possibility some of the laboratory cultures will give useful rate of decay measurements.

#### C. Phytoplankton Responses to PCB

The field observations in Puget Sound have been summarized in SYOPS, Data Report #54, from Department of Oceanography, University

Washington, December 1973. SYOPS is Synthetic Organics In Puget Sound. Principal Investigator is Dr. Spyros Pavlou.

The next year's effort in this program is to continue and expand the chemostat measurements already begun, on the basis of the field data summarized in the data report. Estimates of the influence of these levels (i.e., observed in waters and sediments) of PCB, of course, add to the utility and reality of the empirical laboratory measurements made in the chemostat for ultimate setting of acceptable levels or criteria for water quality.

#### D. Trace Metal Transport Mechanisms in Southeastern Coastal Currents

This project has evaluated Trace Metals in a variety of locations and along the coastal currents to the salt marshes. The investigator is now summarizing and constructing tentative models of these transport mechanisms.

In addition to the first annual report (Dr. Herbert Windom, Principal Investigator) which aroused considerable interest in EPA and in other laboratories, an interim report comprising the thesis of Daniel R. Bloomer has now been received. Dr. Windom also compiled for EPA some useful data showing actual data on Trace Metal resuspension and mobilization during dredging operations. This work, supported by the Corps of Engineers, has been summarized so that those analyses listed or recommended by the EPA, Corps of Engineers, Marine Technology Workshop (Chemistry Panel) at Montauk, November 1972, take on more meaning for regulatory and permit purposes.

The analytical procedures listed in November 1972, tell what ought to be done prior to dredging decisions, but this data compilation (available in limited quantities to those having a need for it) shows what kinds of results were obtained in some actual cases.

The Florida State University mercury study (Dr. Robert Harriss, Principal Investigator) in watersheds, river, and Eastern Gulf Coast waters continues with several journal publications after a very slow and delayed start due to administrative difficulties. One useful fact for ultimate use of the data on transport mechanisms from inputs on up through spartina to higher trophic levels of a significant Trace Metal is the estimation of stability constants for various ligands with the mercury. Another useful fact is that in all the areas in which ionic and methyl mercury measurements have been made, the methyl mercury has not been found to have more than .07 percent of the total mercury.

The California Institute of Technology project on Trace Element-Ligand Equilibria in Sewage Pipeline Discharges to the L.A. Bight (Dr. J. J. Morgan, Principal Investigator) has begun to make partial computation of some of the governing equilibria utilizing their elaborate computer methodology and assuming the amino acids (known to occur in sewage sludges) to be the principal ligands for a set of metals selected as of interest. These computations enable a model to be established of the probable influence of pH, Eh, and dilution on the distribution and destination of the Trace Elements in the effluent discharge area. Some measurements of particular metals are available and their relative concentrations and positions can be described.

#### G. Floatables

The funded project to assess the significance of surface floatable materials of sewage origin is nearing completion: the field work was completed on schedule, and the final sample analyses and data interpretations are now in progress. The final report is scheduled for January 1974, and is, barring any last minute delays, on schedule.

The sampling procedures developed for surface slicks was presented at an EPA-sponsored symposium on marine monitoring methodologies as a candidate method for standardization by EPA's Quality Assurance Division. The field procedures were also demonstrated to personnel of the sponsoring agency and the L. A. County Sanitation District.

#### H. Microbial Predation of Enteric Organisms

Dr. Ralph Mitchell, Harvard University, has completed a preliminary model of coliform die-off in the sea. The model is based, in part, on his previous research on environmental factors affecting the predation of enteric organisms by the native marine microflora. After field verification, this model should provide a valuable predictive tool for outfall design and evaluation.

### III. MODELING

Considerable effort has been expended in developing models capable of simulating the circulation of continental shelf areas.



An Interagency Agreement with the U.S. Navy Environmental Prediction Research Facility at Monterey, California, (Dr. T. Laevastu, Principal Investigator) is nearing completion. One of the initial objectives of the Agreement was to "model" the New York Bight area (bounded, approximately, by the west,  $39^{\circ}30'N$ ,  $71^{\circ}30'W$ ). Additionally, two "inner-harbor" models were prepared.

Single-layer, vertically-integrated models of all three regions utilize the same algorithm for solution; differences in the models are mainly in the specified boundary conditions. Input consists of wind, tide, and runoff forcing from given initial conditions. Also, continuous or instantaneous pollutant sources may be specified at one or more grids. Output consists in tidal elevations, current vectors, and pollutant concentration versus time. The final report on this project should be completed in January.

The final report on a grant with California Institute of Technology (Dr. Norman H. Brooks, Principal Investigator) was published and is available for those interested by writing to us. The report summarizes the results of a five-year laboratory research project on various flow phenomena of importance to transport and dispersion of pollutants in hydrological and coastal environments.

The results for buoyant jets may be used for the design of wastewater outfalls in oceans, reservoirs, lakes, and large estuaries. Particular emphasis is given to line sources (or slot jets) which represent long multiple-outlet diffusers, which are necessary for all large discharges to get high dilutions.

For reservoirs which are density stratified, the results include formulations for prediction of selective withdrawal, and a simulation procedure for predicting reservoir mixing by systems which pump water from one level to another. For applications to rivers and estuaries, laboratory flume experiments were made to measure transverse mixing of buoyant or heavy tracer flows, as well as for neutral-density flows.

#### A. Fjords

The overall objective in our grant with the University of Washington (Dr. D. Winter, Principal Investigator) has been to develop techniques

for predicting pathways and retention times of pollutants introduced into fjords, with emphasis on the deep basins of Puget Sound. In pursuit of this objective during the first year, they have developed an approximate description of near-surface nontidal circulation in fjord segments, using similarity techniques, and have identified some of the basin subdivisions in Puget Sound where the conditions of similarity are reasonably well satisfied, having given priority to the main basin, portions east of Whidbey Island, and the main basin of Hood Canal. Historical oceanographic data are being used to check the self-consistency of this quantitative description of the circulation and density structure.

## B. Estuaries

The MIT grant, "Tidal Variations of Water Quality Parameters in Estuaries: Longitudinal and Vertical Distributions," Dr. D. R. F. Harleman, Principal Investigator, is continuing under prior year funding.

Current effort is devoted to the continued development of the transient, estuary water quality model for nutrient and algal distributions for the prediction of the effect of increasing levels of waste treatment on estuarine water quality. The parameters that govern the temporal variations in the concentrations of essential water quality parameters are strongly influenced by physical environmental conditions, of which temperature and salinity are the most important.

In the water quality model, two categories of substances will be handled by the proposed model.

### I. Conservative

- (a) Salinity
- (b) Dye concentrations
- (c) Biologically "inert" pollutants

### II. Non-Conservative

- (a) Temperature
- (b) Abiotic
  - $\text{NH}_3$ ,  $\text{NO}_2^-$ ,  $\text{NO}_3^-$ , particle organic matter, dissolved organic nitrogen
- (c) Biotic
  - (i) phytoplankton
  - (ii) zooplankton

Conceptually, the water quality part of the model is similar to the Chen and Orlob approach, but the formulation of the MIT model is different, in the following domains:

(a) Hydraulics: Instead of using node-stream approach and looking at nodes, the MIT model applies the continuity and momentum equations simultaneously for each element. Furthermore, density variations due to salinity intrusion and variations in the longitudinal dispersion coefficient are taken into account in the momentum and water quality equations. The Chen and Orlob model solves a set of motion equations written for links of the system and a set of continuity equations written for nodes.

(b) Reaction and/or process rate determinations.

(c) Level of sophistication in the description of nitrogen cycle. The goal here is not to model the whole ecosystem, but to investigate the variation in the structure and the composition of the aquatic environment (meaning nutrient and trophic levels) under varying hydrologic and meteorologic conditions.

#### The Use of the Proposed Model

1. The model will be a useful tool to describe and predict the temporal and spatial distribution of a set of variables which may influence the extent of eutrophication in an estuary. It is being applied to the upper reaches of the Potomac estuary.

2. The goal is to have a model which will specifically predict the relative location of algal blooms, and the expected duration of algal growth under transient meteorological conditions.

3. The model will aid in environmental planning by providing information necessary to anticipate the environmental impact of potential nutrient loadings from proposed new treatment plant designs.

The draft final report on a grant with Dr. David Bella, Oregon State University, on "Tidal Flats in Estuarine Water Quality Models" was completed. The initial phases of the study involved mixing processes and tidal hydraulics; however, the study emphasis shifted to estuarine benthic systems as the importance of these systems became more apparent. The sulfur cycle was given particular emphasis because:

(1) Sulfides, resulting from sulfate reduction within the benthic systems, can influence the benthic oxygen uptake rate;

(2) Free sulfides are highly toxic to a variety of organisms, and;

(3) The release of hydrogen sulfide may contribute to a deterioration of air quality.

#### IV. Technical Assistance

##### A. Operations Quicksilver and Fetch

Operation Quicksilver was an attempt to recover seven sediment traps deployed at Region III's interim sludge dumping site. EPA's Annapolis Field Office, The Coastal Pollution Branch and the U.S. Coast Guard pooled resources in this matter.

Operation Quicksilver was completed in the first quarter of FY-74 and is documented in EPA Report #903/9-73-001-A, September, 1973. Sediment traps deployed during the initial survey period were not recovered and two subsequent attempts were made. Each attempt followed documented buoy sitings by local research vessels.

The first attempt utilized the U.S. Coast Guard Cutter Sassafras supported by a search and rescue helicopter. A two and one-half day search produced no sitings.

Operation "Fetch" was the second recovery attempt and was a joint undertaking by Research and Regional personnel and served as a monitoring survey for the Philadelphia sludge disposal operation and the E. I. DuPont titanium waste discharge at sites some 50 miles off the Delaware coast.

Report(s) covering this last operation will be prepared by the Annapolis Field Station and Region III S & A personnel.

##### B. Near Field Dispersion Model for Barged Waste Discharges

Staff personnel have continued technical support of Regions IV and VI in the area of barged waste disposal. Sample computer simulations were run for Region IV for a sodium chloride brine permit application.

Region VI work has been more complicated in that the model responses for a deep water discharge of a three-phase waste, including immiscible droplets, was sought. Environmental parameters to describe the site have not been made available and only order of magnitude values for initial dilution have been provided. Work in this area is continuing, but at a slow "time available" rate.

## Ocean Dumping Legislation

Staff personnel respond on a regular basis to requests from Headquarters for review of draft sections of new proposed legislation.

The work assignment from the Office of Water Programs for the preparation of draft interim analytical and sampling methods for marine determinations has been completed and forwarded on schedule to the project coordinator Dr. Paul Lefcourt. One section dealing with biological sampling procedures was reassigned in late October and is progressing on schedule under the direction of Dr. Swartz.

### V. Presentations:

Messrs. Baumgartner, Callaway, Feldman, Rittall and Swartz participated in an Office of Monitoring Symposium in Seattle, October 16-18, 1973. The symposium dealt with methods of monitoring the marine environment. The Proceedings will be published.

Papers presented were:

"Comparison of Species Diversity and Faunal Homogeneity Indices as Criteria of Change in Biological Communities," Dr. Richard C. Swartz.

"Petrochemical Marine Monitoring Methods," by Dr. Milton H. Feldman.

"Surface Slicks and Films--A Need for Control," by Walter F. Rittall.

"Mathematical Modeling as a Framework for Coastal Monitoring," by Richard J. Callaway.

A report on "Techniques for Sampling and Analyzing the Marine Macrobenthos" has been completed by Dr. Swartz and submitted for inclusion in the EPA Ocean Dumping Analytical Methods Manual.

The ROAP for the study of oil pollution, 21AIV "Scientific Criteria for Oil Discharges" was active in 1973, in the planning stages only, and has now been discontinued entirely, but two items



of interest have resulted. One was the participation of a staff member on the NAS Ocean Affairs Committee Workshop on Oil Pollution in May 1973. The NAS publication Oil Pollution is in press. The EPA publication Ecological Research Series, 660/3-73-013, "Petroleum Weathering: Some Pathways, Fate and Disposition on Marine Waters" by Milton H. Feldman was issued. This document considers the trace material phenomena occurring in the surface layers of the ocean as a result of oil pollution, and their ecological significance.

The second item was the experimental examination of some tar ball specimens from the Atlantic and from the Bermuda Biological Station environs. This work showed that the trace elements content of the tar balls can readily be studied by neutron activation analysis methods and represents a significant addition to the long list of methods in use to study petroleum pollution of the sea. A publication of this work is being written.

Personnel to Contact for Further Information:

D. J. Baumgartner, Chief, Coastal Pollution Branch, (503) 752-4211, Ext. 368.

R. J. Callaway, Physical Oceanography and Modeling, (503) 752-4211, Ext. 369.

M. H. Feldman, Chemistry, (503) 752-4211, Ext. 370

R. C. Swartz, Biological Oceanography (503) 867-4031.

W. F. Rittall, Technical Assistance and Ocean Dumping (503) 752-4211 Ext. 365

United States  
Environmental Protection Agency  
PACIFIC NW ENVIRONMENTAL RESEARCH LABORATORY  
200 S W 35th Street  
Corvallis, Oregon 97330

OFFICIAL BUSINESS  
PENALTY FOR PRIVATE USE \$300  
AN EQUAL OPPORTUNITY EMPLOYER

POSTAGE AND FEES PAID  
U.S. ENVIRONMENTAL PROTECTION AGENCY  
EPA-335



Return this sheet if you do NOT wish to receive this material ☐, or if change of address is needed ☐ (indicate change, including zip code)

NERCC-26



# *Eutrophication Research Highlights*

Pacific Northwest Environmental Research Laboratory

200 S. W. 35th Street

Corvallis, Or. 97330

December 1973

## Nutrient Inactivation Research

Laboratory screening of lanthanum, zirconium, aluminum, tungsten, and titanium compounds as possible phosphorus inactivants has shown lanthanum to be the most efficient complexer of phosphate, followed by zirconium and aluminum. Zirconium and lanthanum exhibited optimum performance with pH ranges commonly encountered in eutrophic lakes, whereas the optimum pH for aluminum was lower, rendering it less appropriate for field situations. Algal assays conducted on algal growth medium and in natural lake water treated with lanthanum, zirconium and aluminum showed that algal growth was depressed and the decrease in algal growth was caused by the removal of phosphorus. Toxicity studies utilizing salmonid fish and *Daphnia magna* revealed severe detrimental effects only with lanthanum rare earth chloride, and in that case it is believed that the mortalities result from a component of the compound other than lanthanum. Laboratory tests have been designed and implemented to test the longevity of inactivation and the effect of inactivant-phosphorus precipitates on sediment-water nutrient interchange. These experiments, which utilize phosphorus isotopes as tracers, have not proceeded sufficiently far for conclusions to be made.

## Diamond Lake Nutrient Diversion Study

Three years data have now been accumulated on the limnology of Diamond Lake, Oregon, where interception of campground septic tank wastes has been completed by the U.S. Forest Service. Waste discharge from a lodge-motel complex has not yet been incorporated into the system. The data now on hand on lake limnology, nutrient-hydrologic budget, and lake use are the basis for a forthcoming report which will constitute the baseline against which future changes in the lake will be evaluated.

## Algal Assay Application

Algal assays were conducted on 18 Snake River and tributary sites to determine the impact of domestic, industrial and agricultural waste effluent upon algal growth within a multiple use river system. Information received from EPA's Region X Surveillance and Analysis Branch identified nutrient-bearing (nitrogen and phosphorus) effluents that could be stimulatory to algal growth.

The goals of this assay were to: (1) determine if algal growth obtained in the assay was consistent with results predicted from review of chemical analysis for ortho-phosphorus and total soluble inorganic nitrogen ( $\text{NO}_2 + \text{NO}_3 + \text{NH}_3$ ); (2) determine if algal yields were limited by phosphorus, nitrogen or some other nutrient essential for algal growth; and (3) predict the effects of nitrogen and phosphorus additions on algal productivity.

Phosphorus was the algal growth-limiting nutrient in 45 percent of the 18 river waters assayed. Nitrogen was growth-limiting in 33 percent of the waters and nutrients other than nitrogen and phosphorus were growth-limiting in 11 percent of the river water samples.

Studies to determine the nitrogen and phosphorus requirements of the green alga, Selenastrum capricornutum indicate that, in the presence of other essential nutrients, in the absence of toxicants and not less than  $10 \mu\text{g}$  ortho-phosphorus per liter, each microgram of ortho-phosphorus per liter will yield 0.43 mg dry weight of the alga. Similarly, under the same conditions, 0.001 mg of total soluble inorganic nitrogen per liter will yield 0.038 mg dry weight of the alga. Actual yield is considered statistically significant within  $\pm 20$  percent of the predicted yield.

A high correlation ( $r = 0.98$ ) between the predicted and actual yields were found in the Snake River samples limited for algal growth by either phosphorus or nitrogen. Failure of some of the samples to meet predicted yields indicated that these waters may contain toxicants. Inhibition of daily maximum yields during the logarithmic phase of algal growth (usually one to seven days) further indicated that some constituent, other than nitrogen and phosphorus, limited growth in the samples. Inadequately treated toxic wastes and commercial poisons have been identified as causing intermittent water quality problems in the Snake River Basin. Further research is necessary to adequately define the effect of these toxicants upon algal growth.

#### Shagawa Lake Demonstration Project

The advanced wastewater treatment plant at Ely, Minnesota, which commenced operation in April 1973, continues to operate successfully in removing phosphorus from municipal wastewater that discharges to Shagawa Lake. During the nine month period of operation, the average concentration of phosphorus in the final effluent has been 0.043 mg/liter, a reduction of about 99 percent. The total phosphorus load to the lake has been reduced to about 70 percent of the average for the same interval for the previous three years. Total and ortho-phosphate concentrations in the lake are somewhat lower than they have been the previous three years. The coming year will provide critical information concerning the expected supply of phosphorus from the sediments.

### Modeling Workshop

The Utah Water Research Laboratory, the Division of Environmental Engineering, College of Engineering of Utah State University and the Eutrophication and Lake Restoration Branch of EPA sponsored a Workshop entitled "Modeling the Eutrophication Process" which was held at Logan, Utah, September 5-7, 1973. Fourteen papers were presented including one entitled "Modeling Algal Growth Dynamics in Shagawa Lake, Minnesota, with Comments Concerning Projected Restoration of the Lake" by D. Phillip Larsen of the Eutrophication and Lake Restoration Branch. The Proceedings of the Workshop have been published.

### Recently Completed Reports

Brezonik, Patrick L. Nitrogen Sources and Cycling in Natural Waters. Environmental Protection Agency Ecological Series, EPA-660/3-73-002, July 1973.

Megard, Robert O. Rates of Photosynthesis and Phytoplankton Growth in Shagawa Lake, Minnesota. Environmental Protection Agency Ecological Series, EPA-R3-73-039, July 1973.

Neel, Joe K., Peterson, Spencer A., and Smith, Wintfred L. Weed Harvest and Lake Nutrient Dynamics. Environmental Protection Agency Ecological Series, EPA-660/3-73-001.

Prows, Bernard L. and McIlhenny, William F. Development of a Selective Algaecide to Control Nuisance Algal Growth. Environmental Protection Agency Ecological Series, EPA-660/3-73-006, August 1973.

Baumann, Paul C., Hasler, Arthur D., Koonce, Joseph F., and Teraguchi, Mitsuo. Biological Investigations of Lake Wingra. Environmental Protection Agency Ecological Series, EPA-R3-73-044, August 1973.

Maloney, Thomas E. Use of Algal Assays in Studying Eutrophication Problems (Presented at the 6th Intl. Water Pollution Res. Conf., June 18-23, 1972). Pergamon Press, Oxford & New York, 1973.

Clesceri, Nicholas L. Organic Nutrient Factors Effecting Algal Growths. Environmental Protection Agency Ecological Series, EPA-660/3-73-003, July 1973.

Workshop Proceedings, Modeling the Eutrophication Process. Edited by E. J. Middlebrooks, D. H. Falkenberg and T. E. Maloney, 1973.



Need More Information

Consultation and advice on the subjects of this research are available by calling or writing to:

Thomas E. Maloney  
Chief, Eutrophication & Lake Restoration  
Branch  
Commercial - 503 752-4211, Extension 353  
FTS - 8-503 752-4353



## Highlights

# *National Lake Survey Program*

---

Pacific Northwest Environmental Research Laboratory

200 S. W. 35th Street

Corvallis, Or. 97330

---

January, 1974

### Status of Sampling Programs

In the summer and fall of 1973, the one-year stream sampling program was completed in the states of Vermont, Connecticut, Rhode Island, New Hampshire, Massachusetts, Maine, Wisconsin, Minnesota, Michigan, and New York. The stream nutrient, the lake and the sewage treatment plant effluent data are now being evaluated to determine (1) trophic condition of each surveyed lake, (2) nutrient (nitrogen and phosphorus) loadings to each surveyed lake, (3) the limiting nutrient in each water body, (4) the percentage of the total nutrient load originating from municipal sewage treatment plants and (5) nutrient loadings from non-point sources within the drainage basin for each lake.

The data relevant to each lake are being summarized and evaluated in individual reports. These reports are reviewed by the appropriate state environmental agency before they are finalized and available for public distribution. To date preliminary reports have been prepared for thirty-five lakes or reservoirs.

In November, 1973, the NERC-Las Vegas field teams concluded lake sampling in the remaining seventeen states east of the Mississippi River which involved about 250 lakes, each sampled three times. Simultaneous stream and sewage treatment plant sampling in the same seventeen states will begin phasing out this month.

### Survey Authorized for Western States

After a six month delay, the Survey was authorized to extend sampling activities into the states west of the Mississippi River during calendar years 1974 and 1975. Initial contacts will be made with involved EPA Regional Offices and State Water Pollution Agencies starting in February. The emphasis in the western states will be on nutrients contributed to lakes and reservoirs from non-point sources rather than from municipal sewage treatment facilities.

### Nutrient Criteria for Lakes: Based on Loading or Concentrations

One of the objectives of the Survey is to estimate, for each study lake, the total annual nitrogen and phosphorus inputs and to determine the percentage of the total inputs originating from non-point sources, e.g., land runoff, versus the percentage originating from more easily controlled point sources such as municipal sewage treatment effluents. In addition, data on nutrient concentrations within each lake are also being obtained. Both the loading and concentration data will be useful for assessing the need for phosphorus control measures for a specific lake situation and predicting whether control measures could be expected to have any impact on the rate of eutrophication.

Within the past year, there has been considerable controversy concerning the establishment of lake water quality criteria for phosphorus and whether the criteria should be based on phosphorus concentrations within a lake or on phosphorus loading rates to a lake. The question of a single nation-wide phosphorus criterion versus individually tailored criteria for specific areas or some compromise between the two has also been discussed.

The idea of the concentration criteria is the older of the two concepts, dating back primarily to Sawyer (1947) who suggested that

concentrations of 0.010 mg/l of inorganic phosphorus and 0.300 mg/l of inorganic nitrogen were critical levels in the development of algal blooms.

The concept of loading rate criteria stems largely from the work of Vollenweider (1968) who developed a relationship between annual nutrient loading rates and mean depth from which "permissible" and "dangerous" loading rates could be estimated for a lake with a given mean depth. Vollenweider's theory is subject to further verification, meanwhile, he has continued to refine it, adding most recently considerations of volume and retention time.

From the standpoint of enforcement, a loading rate criteria would be easier to work with than a lake concentration criteria because it is one step closer to the source of nutrient supply; therefore, once a desirable loading rate to a given water body is established it would be relatively easy to determine the extent of nutrient reduction from point sources and non-point sources that would be necessary to achieve the desired loading.

On the other hand, if a concentration criterion alone were applied to a water body, the back calculation necessary to determine the nutrient reduction necessary to meet that concentration level would be much more difficult because the relationship between concentration in a lake and nutrient input to a lake is not a simple one. Factors such as volume, detention time, mixing patterns, biological activity, sedimentation rates and resolubilization of nutrients from the sediments all play a role in determining the concentration that will result from a given loading rate.

A single loading rate criterion for a lake also has its disadvantages because it is applied with the assumption that the loading is equally distributed to all parts of the lake. This assumption is often invalid particularly in larger lakes or reservoirs with several tributary streams

carrying different nutrient loads. While the average loading rate to the entire lake may appear acceptable, nutrient loads in some embayments may be excessively high resulting in localized nuisance problems while other areas may receive very light nutrient loads and have no problems.

The questions of what kind of nutrient criteria to apply to lakes and reservoirs and more specifically the level at which to set the criteria are difficult to answer. The data being collected and evaluated by the National Eutrophication Survey will assist in answering these difficult questions.

#### Literature Cited

Sawyer, C. N. 1947. Fertilization of Lakes by Agricultural and Urban Drainage. J. New England Water Works Association. 61:109-127.

Vollenweider, R. A. 1968. Scientific Fundamentals of the Eutrophication of Lakes and Flowing Waters, with Particular Reference to Nitrogen and Phosphorus as Factors in Eutrophication. OECD, DAS/CSI/68-27. 159 p.

#### NEED MORE INFORMATION

Additional information about the Lake Survey Program is available from the following persons:

Mr. Robert Payne  
Coordinator, National Eutrophication Survey, EPA  
Waterside Mall - Room 3801  
410 M Street, S. W.  
Washington, D. C. 20460  
Commercial #202-426-4453  
FTS #8-202-426-4453



Mr. Donald Wruble  
National Eutrophication Survey, EPA  
P. O. Box 15027  
Las Vegas, Nevada 89114  
Commercial #702-736-2969  
FTS #8-702-736-2969

Dr. Jack H. Gakstatter  
National Eutrophication Survey, EPA  
200 S. W. 35th Street  
Corvallis, Oregon 97330  
Commercial #502-752-4211, Extension 575  
FTS #8-503-752-4575

United States  
Environmental Protection Agency  
PACIFIC NW ENVIRONMENTAL RESEARCH LABORATORY  
200 S W 35th Street  
Corvallis, Oregon 97330

OFFICIAL BUSINESS  
PENALTY FOR PRIVATE USE \$300  
AN EQUAL OPPORTUNITY EMPLOYER

POSTAGE AND FEES PAID  
U. S. ENVIRONMENTAL PROTECTION AGENCY  
EPA-335



Return this sheet if you do NOT wish to receive this material ☐, or if change of address is needed ☐ (indicate change, including zip code)

NERCC-26



# *Thermal Pollution Research Highlights*

---

Pacific Northwest Environmental Research Laboratory

200 S. W. 35th Street

Corvallis, Or. 97330

---

January 1974

## Reviewing Environmental Impact Statements

The approach and technical base that have been used by EPA's Thermal Pollution Branch for reviewing those portions of Environmental Impact Statements relative to cooling water systems of thermal power plants are described in a new report (see item 2 in New EPA Publications). This report (completed in June but still with the printer) provides information and discussions on cooling system configurations, operations, environmental effects and costs. Methods of assessing alternative selections and benefit-cost analyses are also presented.

Primary responsibility for EPA review of these topics was transferred from the Thermal Pollution Branch to the Regional Offices in July.

## EPA Thermal Report to Congress is Available

The 11-chapter report "Effects and Methods of Control of Thermal Discharges" [See Thermal Pollution Research Highlights, July 1973] has been published by the Senate Committee on Public Works. The report is available in three volumes (See New EPA Publications). Volume 1 contains Chapters 1-2, Volume 2--Chapters 3-7, and Volume 3--Chapters 8-11.

## Modeling Aquatic Thermal Pollution

Research to develop a stochastic temperature prediction model was conducted by ESL, Inc., of Sunnyvale, California under EPA research contract No. 68-01-0167. The final report "Statistical Prediction of Equilibrium Temperature from Standard Meteorological Data Bases" (EPA 660/2-73-003) contains analyses and associated computer software pertaining to this research effort. Meteorological data from standard ESSA weather tapes for three cities and several time periods were used in a computer program developed to calculate equilibrium temperatures. The stochastic nature of the variation in meteorological parameters and their relation to equilibrium temperature were investigated. In general, the correlations between meteorological variables are not consistent from place to place or between time periods. This lack of statistical uniformity among variables precluded the development of a general model suitable for providing a distribution function for equilibrium temperature. However, this research effort shed considerable light on the stochastic nature of meteorological parameters and their relation to equilibrium temperature.

Fluid dynamic research culminated in several reports and papers. See New EPA publications.

## Power Plant Effluent Control Technology

No effluent limits for steam electric power generation promulgated by EPA yet (1-15-74), but keep your eyes and ears open.

Two extramural final reports are being readied for publication and distribution in early 1974. They are: 1. "A Demonstration of Thermal

Water Utilization in Agriculture" by the Eugene, Oregon, Water and Electric Board. This report describes a five-year project using warm water for irrigation, frost protection, and underoil heating.

2. "A Review of Engineering Aspects of the Control of Power Plant Discharges" by S. J. Daugard and T. R. Sundaram of Hydronautics, Inc. This report describes a comprehensive inventory of discharges and treatment techniques of fifteen power plants in the Maryland region. Control trade-offs are discussed.

Contract "Request for Proposals" were announced for two projects-- one on detailed economics of backfitting cooling devices and one on engineering and economic aspects of once-through discharge modifications. Sorry if you missed this one; closure date is passed.

Some potential environmental concerns with coal gasification are identified in Jim Chasse's "Staff Report on Coal Gasification: Processes and Effects." Efforts will continue in gathering information in this area to enable proper assessment of water and discharge effluent requirements for this developing technology.

An inhouse effort is currently in progress to assess the potential for power plant water recycle/reuse. Economics are emphasized in the assessment. The approach interprets each "water requiring" process as an integral part of the total plant water use system. Important factors for the assessment include: 1) process water quality requirements-- including makeup, blowdown, and recirculating water; 2) process water quantity requirements; and 3) plant operating and site conditions that affect water requirements. This recycle/reuse information is planned to be released via the EPA reporting system.



A report by Ron Manabe, "Accurately Measuring Residual Chlorine Levels in Cooling Water--Amperometric Method" is to be released soon. The report discusses several techniques to improve the accuracy of residual chlorine measurement in cooling water--especially water with metal ion interference.

#### Demonstration Grant Money Available

EPA remains interested in cooperative projects with industry to demonstrate recycle/reuse and other effluent control technology.

### NEW GRANTS AND CONTRACTS

Aerospace Corporation, "Study of Power Plant Desulfurization Waste Waters for Reuse and Discharge," Grant No. R802853-01.

The Aerospace Corporation will conduct a program of experimentation and data analysis to determine the technical and economic potential for an allowable discharge of power plant desulfurization system water effluent or for its recycle/reuse in scrubbing and non-scrubbing applications. The program will consider the consequence of effluent water discharge to navigable waters as may be required. An assessment of water treatment technology will be made to determine the technical and economic basis of water reuse or discharge requirements.

University of Colorado, "Simulation of Two Power Plants' Thermal Discharges into the Atmosphere," Grant No. R802893-01.

An experimental and analytical investigation of environmental modifications due to heat and moisture rejection from a power plant

cooling tower and cooling pond is proposed. Field studies at the Fort St. Vrain and Valmont plants of the Public Service Company of Colorado, utilizing a low-altitude sounding rocket, will produce data on plume rise and dispersion from an induced draft evaporative cooling tower and from a cooling pond, respectively. These data from operating plants will be unique in that a moisture concentration profile check on the validity of analytical models has never before been rigorously attempted. The development of experimentally tested models will allow for the optimal location of cooling towers and cooling ponds.

#### NEW EPA PUBLICATIONS

1. Effects and Methods of Control of Thermal Discharges, U.S. Environmental Protection Agency. Committee Report, Committee on Public Works, United States Senate, Serial No. 93-14, Nov. 1973. Government Printing Office, in three volumes at \$3.70 each.
2. Reviewing Environmental Impact Statements - Power Plant Cooling Systems, Engineering Aspects. Thermal Pollution Branch Staff. Environmental Protection Technology Series, EPA 660/2-73-016, June 1973.
3. Coal Gasification: Process and Effects, by James P. Chasse, Staff Report, Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon, October 1973.
4. A Demonstration of Waste Heat Use in Agriculture, by A. G. Christianson, J. W. Berry, and H. H. Miller, Jr. Paper presented

at First World Congress on Water Resources, Chicago, Illinois.  
September 24-28, 1973. To be published in proceedings.

5. Some Results from Experimental Data in Surface Jet Discharge of Heated Water, by Mostafa Shirazi. Paper presented at First World Congress on Water Resources, Chicago, Illinois, September 24-28, 1973. To be published in proceeding.
6. An Evaluation of Ambient Turbulence Effects on a Buoyant Plume Model by M. A. Shirazi, L. R. Davis, and K. V. Byram. Paper presented at 1973 Summer Computer Simulation, Montreal, Canada, July 1973. published in proceedings.
7. Heated Water Jet in a Coflowing Turbulent Stream, by M. A. Shirazi, R. S. McQuivey, and T. N. Keefer. To be published in American Society of Civil Engineers, Hydraulic Division Journal. 1974.
8. Thermal Pollution Research Highlights. July 1973.
9. Explicit Calibration of the PILLS II System, Environmental Systems Corporation, Environmental Protection Technology Series EPA-660/2-73-011. September, 1973.
10. Nomographs for Thermal Pollution Control Systems, Hittman Associates, Inc., Environmental Protection Technology Series, EPA-660/2-73-004, September, 1973.

11. Numerical Thermal Plume Model for Vertical Outfalls in Shallow Waters, Oregon State University, Environmental Protection Technology Series, EPA-R2-73-162, March 1973.
12. Statistical Prediction of Equilibrium Temperature from Standard Meteorological Data Bases. Environmental Systems Laboratory. Environmental Protection Technology Series, EPA-660/2-73-003, August, 1973.
13. Technical and Economic Evaluations of Cooling System Blowdown Control Techniques, Wapora, Inc., Environmental Protection Technology Series, EPA-660/2-73-026, October 1973.
14. Dispersion in Hydrologic and Coastal Environments, by Norman H. Brooks, California Institute of Technology, Ecological Research Series, EPA-660/3-73-010, August 1973. [Developed as part of the Coastal Pollution Branch Program].

Note: Since we are using a new mailing list for the Research Highlights, we append a complete list of our publications, with a key to sources and addresses where publications are available.

#### Other Significant Publications

1. Waldrop, W. R., and R. C. Farmer. Three-dimensional Flow and Sediment Transport at River Mouths. Coastal Studies Institute, Louisiana State University, Technical Report No. 150. September 1973. 137 p.

2. Draley, J. E. Chlorination Experiments at the John E. Amos Plant of the Appalachian Power Company. April 9-10, 1973. Argonne National Laboratory Report #ANL/ES/23. June 1973. 26p.
3. Complete Watereuse, Cecil, L. K. (ed). New York, N. Y., American Institute of Chemical Engineers, April 1973. 728 p.
4. Margetts, M. J. and F. N. Shofner. Characterization of the Drift Emissions of a Natural Draft Cooling Tower and Examination of Sensitivity to Operational Parameter Variations. Babcock and Wilcox Technical Paper. Presented to Joint Power Generation Conference, New Orleans, L.A. Sept. 1973.

#### ADDITIONAL INFORMATION

More detailed information on EPA's Thermal Research may be obtained by contacting:

Mr. Frank H. Rainwater, Chief  
Thermal Pollution Branch  
Pacific Northwest Environmental Research Lab  
200 SW 35th St.  
Corvallis, Oregon 97330

Phone numbers:

Commercial: (503) 752-4211, ext. 349,350  
FTS: 8-503-752-4349 or 4350

## PUBLICATIONS

Thermal Pollution Branch  
Pacific Northwest Environmental Research Laboratory  
National Environmental Research Center, EPA  
200 Southwest 35th Street  
Corvallis, Oregon 97330  
December 1973

### KEY TO SOURCES

- \* Library, NERC, Corvallis, as long as supply lasts.
- GPO & Price Purchase through GPO.
- NTIS National Technical Information Service. Use PB order number.  
Microfiche - \$1.45. Price listed is for paper copy.
- OP Out of Print. Available through Library, NERC, Corvallis, and many other EPA and University libraries with an interlibrary loan form.
- Journal,  
Proceedings,  
etc. No reprints available. See published article.
- IP In press. Name kept on file for notification when available.
- @ Transcripts of conferences are on file in many EPA libraries, federal depository libraries, and other university collections. You may also contact the appropriate regional EPA offices for copies of transcripts.

### ADDRESSES WHERE PUBLICATIONS ARE AVAILABLE

- NERC - Library  
National Environmental Research Center  
U.S. Environmental Protection Agency  
200 S.W. 35th St.  
Corvallis, OR 97330
- NTIS - National Technical Information Service  
Department of Commerce  
Springfield, VA 22151
- GPO Superintendent of Documents  
U.S. Government Printing Office  
Washington, DC 20402

## INTRAMURAL OUTPUTS

	<u>Title of Publication</u>	<u>Source</u>
Chasse, James P. 1973	Staff Report on Coal Gasification: Processes and Effects. Pacific Northwest Environmental Research Laboratory, Corvallis, OR.	*
Christianson, Alden G., and Bruce A. Tichenor 1969	Economic aspects of thermal pollution control in the electric power industry, Working Paper No. 67. Pacific Northwest Water Laboratory, Corvallis, OR. 13 pp.	NTIS PB 208-434 \$3.00
Christianson, Alden G. 1969	Thermal Pollution. Paper presented at the Missouri Water Pollution Control Association, Annual Meeting. February 25. Kansas City, Missouri. Unpublished.	*
Christianson, A. G. 1972	Pollutional aspects of geothermal resources development.* Staff report. 8 p. Unpublished.	
Christianson, A. G., J. W. Berry, and H. H. Miller, Jr. 1973	A demonstration of waste heat use in agriculture. Paper presented at First World Congress on Water Resources; Chicago, Illinois, September 24-28.	* (To be published in proceedings)
Garton, Ronald R., and Alden G. Christianson 1970	Beneficial uses of waste heat -- an evaluation. Washington, D.C. Government Printing Office. Water Pollution Control Research Series 16130--04770. 7 pp.	NTIS PB 201-724 \$3.00
Garton, Ronald R. and Ralph D. Harkins 1970	Guidelines: Biological surveys at proposed heat discharge sites. Washington, D.C. Government Printing Office. Water Pollution Control Research Series 16130--04/70.	NTIS PB 206-815 \$3.00
Garton, Ronald R. 1972	Biological effects of cooling tower blowdown. Presented at 71st National Meeting, American Institute of Chemical Engineers, February 20-23, Dallas, Texas. 25 pp. Published in the American Institute of Chemical Engineer's Annual, entitled: Water--1972, Vol. 69, 1973. (AIChE Symposium Series No. 129) p. 284-292.	* JOURNAL



<u>Title of Publication</u>	<u>Source</u>
National Thermal Pollution Research Program, Staff 1968 Industrial waste guide on thermal pollution Pacific Northwest Water Laboratory, Corvallis, OR. 112 pp.	NTIS PB 197-262 \$3.00
National Thermal Pollution Research Program, Pacific Northwest Water Laboratory, and Great Lakes Regional Office 1970 Feasibility of alternative means of cooling for thermal power plants near Lake Michigan. Washington, D.C. Government Printing Office. 122 pp. (This is also printed in the Proceedings of the conference on pollution of Lake Michigan and its tributary basin, 3rd session reconvened in workshop sessions, September 28-30, October 1-2. Chicago, Ill. pp. 163-283).	@ Proceedings
National Thermal Pollution Research Program, Staff State of the art newsletter. Pacific Northwest Water Laboratory, Corvallis, OR. Issues published 1-6.	*
Nelson, Guy R. 1973 Predicting and controlling residual chlorine in cooling tower blowdown. PNERL Working Paper #9 Pacific Northwest Environmental Research Laboratory, Corvallis. 49 p. Also printed in the Environmental Protection Technology Series, EPA-R2-73-273.	*
Rainwater, Frank H. 1968 Research in thermal pollution control. In Proceedings, 4th American Water Resources Conference, held in New York, N. Y., November 18-22. American Water Resources Association, Urbana, Illinois. pp. 140-145.	Proceedings NTIS
Rainwater, Frank H. 1970 Thermal waste treatment and control. In Proceedings, Joint Conference of Atomic Industrial Forum, Inc., and Electric Power Council on Environment, on Thermal Considerations in the Production of Electric Power, June, Washington, D. C. Gordon & Breach Science Publishers, Inc., New York. pp. 189-212.	Proceedings NTIS
Rainwater, Frank H.. 1971 Recent developments in thermal waste control. In Intersociety Energy Conversion Engineering Conference p. 38, Proceedings of a meeting held August 3-6, in Boston, Mass. Society of Automotive Engineers. Pub- lished by The Institute of Electrical and Electronics Engineers, N. Y. pp. 728-730. Reprint No. 719099.	Proceedings NTIS

<u>Title of Publication</u>		<u>Source</u>
Rainwater, Frank H. 1971	Statement Before the State Water Resources Control Board of California. Water Temperature Standards. September 16, 1971, Los Angeles, CA.	*
Rainwater, Frank H. 1973	Statement Before New York State Department of Environmental Conservation. Water Temperature Standards. August 8, 1973. Albany, N.Y.	*
Shirazi, Mostafa A. 1970	Thermoelectric generators powered by thermal waste from electric power plants. Water Pollution Control Research Series 16130---10/70.	NTIS PB 207-870
Shirazi, Mostafa A., R. S. McQuivey and T. N. Keefer 1971	Basic data report on the turbulent spread on heat and matter. United States Dept. of Interior Geological Survey, Water Resources Div., in cooperation with U.S. Environmental Protection Agency National Thermal Pollution Research Program, open-file report.	OP
Shirazi, Mostafa A. 1972	Dry Cooling Towers for steam electric power plants in arid regions. Water Research, 6:1309-1319.	Journal
Shirazi, Mostafa A., L. R. Davis, and K. V. Byram 1972	Effects of ambient turbulence on buoyant jets discharged into a flowing environment. PNERL Working Paper #2. Pacific Northwest Environmental Research Laboratory, Corvallis, OR. 14 p.	*
Shirazi, Mostafa, A., and L. R. Davis 1972	Workbook of thermal plume prediction, Vol. 1: Submerged Discharges. Environmental Protection Technology Series EPA-R2-72-005a.	*
Shirazi, Mostafa A. 1973	A critical review of laboratory and some field experimental data on surface jet discharge of heated water. PNERL Working Paper #4. Pacific Northwest Environmental Research Laboratory, Corvallis, OR. 46 p.	OP

	<u>Title of Publication</u>	<u>Source</u>
Shirazi, M. A. 1973	Some results from experimental data in surface jet discharge of heated water. Paper presented at First World Congress on Water Resources, Chicago Illinois, September 24-28.	* (To be published in proceedings)
Shirazi, M. A., L. R. Davis, and K. V. Byram 1973	An evaluation of ambient turbulence effects on a buoyant plume model. Paper presented at 1973 Summer Computer Simulation Conference. Montreal, Canada.	* Proceedings
Shirazi, M. A., R. S. McQuivey and T. N. Keefer 1974	Heated water jet in a coflowing turbulent stream. To be published in American Society of Civil Engineers, Hydraulic Division Journal.	IP
Tichenor, Bruce A. 1968	FWPCA's role in thermal pollution control. Presented at the Cooling Tower Institute Meeting, Water Conservation Symposium, June 25, Los Angeles, CA. Pacific Northwest Water Laboratory, Corvallis, OR. 13 pp. Unpublished.	NTIS
Tichenor, Bruce A. 1968	Thermal pollution (A Seminar Paper). Pacific Northwest Water Laboratory, Corvallis, OR. 10pp. Unpublished.	*
Tichenor, Bruce A., and William A. Cawley 1969	Research needs for thermal pollution control. In Frank L. Parker and Peter A. Krenkel, eds., Engineering Aspects of Thermal Pollution. Proceedings, National Symposium on Thermal Pollution, sponsored by Federal Water Pollution Control Administration and Vanderbilt University, August 14-16. Vanderbilt University Press, Nashville, Tennessee. pp. 329-339.	Proceedings
Tichenor, Bruce A. 1970	Statement before the conference on pollution of Lake Michigan and its tributary basin, 3rd session (reconvened in working sessions), Sept. 28-30, Oct. 1-2, Chicago. pp. 162-311.	Proceedings @
Tichenor, Bruce A., Alden G. Christianson 1971	Cooling and temperature vs size and water loss. Journal of the Power Division, ASCE, 97(P03):589-596. Closure printed in Journal of the Power Division, ASCE, 99(P01):252, 1973.	Journal NTIS

	<u>Title of Publication</u>	<u>Source</u>
Tichenor, Bruce A. 1971	Statement. In Conference in the matter of pollution of Lake Michigan and its tributary basin, 3rd session (Reconvened), March 24-25, 1971, in Chicago. pp 157-173.	Proceedings @
Tichenor, Bruce A. 1973	Evaluating thermal pollution control alternative. Paper presented to the Second Institute of River Mechanics Colorado State University, August 2, 1972. In Environmental Impact on Rivers (River Mechanics III), edited and published by Hsieh Wen Shen, Fort Collins, Colorado. pp. 7-1 through 7-22.	Proceedings
Tichenor, Bruce A. 1973	EPA's view of waste heat control. Paper presented at the 72nd National Meeting, American Institute of Chemical Engineers, March 1973, in New Orleans, LA. To be published in their Annual entitled: Water-1973.	* Proceedings
Thermal Pollution Branch Staff 1973	Reviewing Environmental Impact Statements--Power Plant Cooling Systems, Engineering Aspects. Environmental Protection Technology Series, EPA 660/2-73-016.	IP
Thermal Pollution Branch Staff 1973	Research Highlights, Issues January, July, December.	*
Winiarski, Lawrence D., Bruce A. Tichenor, and Kenneth V. Byram 1970	A method for predicting the performance of natural draft cooling towers. Water Pollution Control Research Series 16130GKF12/70.	NTIS
Winiarski, Lawrence D., and Bruce A. Tichenor 1970	Model of natural draft cooling tower performance. Journal of the Sanitary Engineering Division, ASCE 96(S4): pp. 927-943. (This is a shorter version of the above-published report.)	Journal NTIS
Winiarski, Lawrence D., and Kenneth V. Byram 1970	Reflective cooling ponds. Presented at ASME Winter Annual Meeting, November 29- December 3, 1970, New York, N. Y. American Society Mechanical Engineers Paper #70-WA/PWR-4. 8 pp.	NTIS

<u>Title of Publication</u>	<u>Source</u>
Winiarski, Lawrence D., and James P. Chasse 1973 Plume temperature measurements of shallow submerged model discharges with current. Environmental Protection Technology Series. EPA-660/2-73-001.	NTIS PB 223-014
<u>MAJOR GRANT AND CONTRACT REPORTS</u>	
Advanced nonthermally polluting gas turbines in utility 1971 applications. United Aircraft Research Laboratories, Water Pollution Control Research Series 16130DNE03/71.	NTIS PB 211-283
Analysis of engineering alternatives for environmental protection 1973 from thermal discharges. State of Washington Water Research Center, University of Washington/ Washington State University, Environmental Protection Technology Series, EPA-R2-73-161.	*
An analytical and experimental investigation of surface discharge 1971 of heated water. Massachusetts Inst. of Technology, Water Pollution Control Research Series 16130DJU02/71. February 1971.	NTIS PB 210-134
Biological aspects of thermal pollution. Edited by Peter A. 1969 Krenkel and Frank L. Parker, Proceedings of the National Symposium on Thermal Pollution, sponsored by the Federal Water Pollution Control Administration and Vanderbilt University, June 3-5, 1968.	Vanderbilt U. Press Nashville, Tennessee \$7.95
Controlling thermal pollution in small streams. Oregon State 1972 University, Environmental Protection Technology Series EPA-R2-72-083. October 1972.	NTIS PB 213 901/9
Development and demonstration of low-level drift instrumentation. 1971 Environmental Systems Corporation, Water Pollution Control Research Series 16130GNK 10/71. October 1971.	NTIS PB 210-759
Effect of geographical location on cooling pond requirements and 1971 performance. Vanderbilt University, Water Pollution Control Research Series 16130FDQ03/71.	NTIS PB 208-031
Engineering aspects of thermal pollution. Edited by Frank L. 1969 Parker and Peter A. Krenkel, Proceedings of the National Symposium on Thermal Pollution, Sponsored by the Federal Water Pollution Control Administration and Vanderbilt University, August 14-16, 1968.	Vanderbilt U. Press Nashville, Tennessee \$7.95

<u>Title of Publication</u>	<u>Source</u>
An engineering-economic study of cooling pond performance. 1970 Littleton Research and Engineering Corporation, Water Pollution Control Research Series 16130DFX05/70. May 1970.	NTIS PB 206-817
Explicit Calibration of the PILLS II System. Environmental Systems 1973 Corporation, Environmental Protection Technology Series EPA-660/2-73-011.	*
Heat and water vapor exchange between water surface and atmosphere 1973 Wilfred Brutsaert, Cornell University, Environmental Protection Technology Series, EPA-R2-73-259. May 1973.	*
Heated surface jet discharge into a flowing ambient stream. 1971 Louis H. Motz and Barry A. Benedict, Vanderbilt University, Water Pollution Control Research Series 16130FDQ03/71.	NTIS PB 211-284
Initial mixing of thermal discharges into a uniform current. John 1969 Eric Edinger and Edward M. Polk, Jr., Vanderbilt University, Report No. 1, October 1969.	*
Mathematical models for prediction of temperature distributions 1970 resulting from the discharge of heated water into large bodies of water. Tetra Tech, Inc., Water pollution control Research Series 16130DW006/70, June 1970.	NTIS PB 208-034
Mathematical models for the prediction of thermal energy changes 1969 in impoundments. Water Resources Engineers, Water Pollution Control Research Series 16130DHS07/60, July 21, 1969.	NTIS PB 210-126
Nomographs for thermal pollution control systems. Hittman 1973 Associates, Inc. Environmental Protection Technology Series, EPA-660/2-73-004.	*
Numerical thermal plume model for vertical outfalls in shallow 1973 waters. Oregon State University, Environmental Protection Technology Series, EPA-R2-73-162, March 1973.	*
Potential Environmental Effects of an offshore submerged nuclear 1971 power plant. Volume I. General Dynamics, Electric Boat Division. Water Pollution Control Research Series 16130GFI06/71, June 1971	NTIS PB 208-281

<u>Title of Publication</u>	<u>Source</u>
Potential Environmental effects of an offshore submerged nuclear 1971 power plant. Volume II. General Dynamics, Electric Boat Division. Water Pollution Control Research Series 16130GFI06/71, June 1971.	NTIS PB 208-282
Potential environmental modifications produced by large evaporative 1971 cooling towers. EG&G, Inc., Water Pollution Control Research Series 16130DJH01/71, January 1971.	NTIS PB 210-702
A predictive model for thermal stratification and water quality 1971 in reservoirs. Massachusetts Institute of Technology Water Pollution Control Research Series 16130DJH01/71, January 1971.	NTIS PB 211-621
Project for concentrated research and training in the hydraulic 1969 and hydrologic aspects of water pollution control. Progress Report, August 1 to September 1, 1969, Vanderbilt University, Report No. 2, October 1969.	*
Report on Cooling Towers and Weather to FWPCA. Oregon State University. 1969	*
Research on dry-type cooling towers for thermal electric generation. 1970 R. w. Beck and Associates, Water Pollution Control Research Series 16130EES11/70, November 1970.	NTIS PB 206-954 (Part I) PB 210-778 (Part II)
Research on the physical aspects of thermal pollution. Cornell 1971 Aeronautical Laboratory, Water pollution Control Research Series 16130DPU02/71, February 1971.	NTIS PB 210-124
Statistical prediction of equilibrium temperature from standard 1973 meteorological data bases. Environmental Systems Laboratory, Environmental Protection Technology EPA-660/2-73-003.	*
Surface Discharge of Heated water. 1971 University of Minnesota, St. Anthony Falls. Hydraulic Laboratory, Water Pollution Control Research Series 16130FSU12/71, December 1971.	NTIS PB 211-285
A survey of alternate methods for cooling condenser discharge water - 1969 large scale heat rejection equipment. Dynatech R/D Company, Phase I - Task I Report, Water Pollution Control Research Series 16130DHS07/60, July 21, 1969	NTIS PB 208-035



<u>Title of Publication</u>	<u>Source</u>
A survey of alternate methods for cooling condenser discharge water - 1971 operating characteristics and design criteria. Dynatech R/D Company, Water Pollution Control Research Series 16130DHS08/70, August 1970.	NTIS PB 208-035
A survey of alternate methods for cooling condenser discharge 1971 water - system selection, design and optimization. Dynatech R/D Company, Water Pollution Control Research Series 16130DHS01/71, January 1971.	NTIS PB 212-392
A survey of alternate methods for cooling condenser discharge water - 1970 total community considerations in the utilization of rejected heat. Dynatech R/D Company, Water Pollution Control Research Series 16130DHS11/70, November 1970.	NTIS PB 206-816
Technical and economic evaluation of cooling system blowdown control 1973 techniques. Wapora, Inc., Environmental Protection Technology Series EPA 660/2-73-026.	IP
Temperature prediction in stratified water: Mathematical modeling 1971 user's manual. Supplement to Water Pollution Control Research Series 16130DHS01/71.	NTIS PB 210-701
Thermal pollution: Status of the art. Frank L. Parker and Peter 1969 Krenkel, Vanderbilt University, Report No. 3, December 1969.	* NTIS PB 216-716 \$23.75
A user's manual for three dimensional heated surface discharge 1973 computations. Massachusetts Institute of Technology, Environmental Protection Technology Series, EPA-R2-73- 133, January 1973.	*



# Waste Treatment Research Highlights

---

Pacific Northwest Environmental Research Laboratory

200 S. W. 35th Street

Corvallis, Or. 97330

---

January 1974

## FIFTH NATIONAL SYMPOSIUM ON FOOD PROCESSING WASTES

The program of the Fifth National Symposium on Food Processing Wastes to be held April 17-19, 1974, in Monterey, California at the Holiday Inn has been finalized. Current research and demonstration projects for the treatment of wastes and waste reduction methods for food processing operations will be reported. The meeting will be co-sponsored by the Environmental Protection Agency, Industrial Wastes Branch, Corvallis, Oregon, National Cannery Association, Berkeley, California, and the Cannery League of California.

For those arriving the evening of Tuesday, April 16, 1974, there will be an evening ice-breaker party at the Holiday Inn and a registration desk will be open. A no-host buffet luncheon will be held each day of the meeting. If you plan to attend we urge you to return the registration form attached to this newsletter together with your registration fee of \$15.00. Checks should be made payable to "Food Wastes Symposium".

Please indicate on the registration form if you are planning to bring your wife. If response is great enough some formal program will be established for the wives. The Monterey Peninsula offers many opportunities for golf and sight seeing. For further information, write to Jim Boydston or call 503-752-4211 ext. 312.

FIFTH NATIONAL SYMPOSIUM ON FOOD PROCESSING WASTES  
PROGRAM

WEDNESDAY, April 17, 1974

Moderator - J. L. Witherow

- 9:30 Welcome - J. R. Boydston and W. A. Mercer
- 10:00 Keynote Presentation - (To be announced)
- 10:40 Coffee
- 10:55 "Experience with Land Treatment of Food Processing Wastewater" - R. W. Crites and C. E. Pound
- 11:35 "Use of a Municipal Permit Program for Establishing Fair Wastewater Service Charges" - R. T. Williams
- 12:15 Lunch

Moderator - M. W. Cochrane

- 1:45 "Frozen Corn Processing Wastes: Use of Ferric Chloride to Improve Secondary Solids Settling Characteristics" - T. Jaffe
- 2:25 "Paunch Manure as a Feed Supplement in Channel Catfish Farming" - R. C. Summerfelt and S. C. Yin
- 3:05 Coffee
- 3:20 "Removal of Protein and Fat from Meat Slaughtering and Packing Wastes Using Lignosulfonic Acid" - T. R. Foltz, Jr., R. M. Ries, and J. W. Lee, Jr.
- 4:00 "Feasibility of Treating Meatpacking Plant Wastewater by Land Application" - A. Tarquin

THURSDAY, April 18, 1974

Moderator - H. W. Thompson

- 9:00 "Cleaning and Lye Peeling of Tomatoes Using Rotating Rubber Discs" - R. P. Graham
- 9:45 "Combining Blanching and Cooling to Reduce Effluent" - J. L. Bomben, G. E. Brown, W. C. Dietrich and D. F. Farkes
- 10:30 Coffee
- 10:45 "Recovery of Activated Sludge for Poultry Feed" "Engineering Aspects" - R. H. Jones  
"Feeding Studies" - B. L. Dameron
- 12:00 Lunch

Moderator - A. M. Katsuyama

- 1:30 "Investigation of Rum Distillery Slops Treatment by Anaerobic Contact Process" - T. G. Shea and G. Dorion
- 2:15 "Gulf Shrimp Canning Plant Wastewater Processing" - A. F. Mauldin and A. J. Szabo
- 3:00 Coffee
- 3:15 "Wastewater Characterization for the Specialty Food Industry" - C. J. Schmidt and J. W. Farquhar
- 4:00 "Industrial Wastewater Reuse" - J. D. Clise

FRIDAY, April 19, 1974

Moderator - W. W. Rose

- 9:00 "Investigations of Fishery Byproducts Utilization: Ruminant Feeding and Fly Larvae Protein Production" - J. H. Green, S. L. Cuppett and H. J. Eby
- 9:40 "Pretreatment of Vegetable Oil Refining Wastewater" - A. Grinkevich
- 10:20 Coffee
- 10:35 "Biodegradability of Fatty Oils: A Case Study" - T. K. Nedued and C. F. Gurnham
- 11:15 "Economic Effects of Treating Fruit and Vegetable Processing Liquid Waste" - N. A. Olson, A. M. Katsuyama and W. W. Rose
- 11:55 Closure - J. R. Boydston

GENERAL CHAIRMAN: James R. Boydston  
Environmental Protection Agency  
Corvallis, Oregon

PROGRAM COMMITTEE: Kenneth A. Dostal  
Environmental Protection Agency  
Corvallis, Oregon

Jack W. Ralls  
National Cannery Association  
Berkeley, California

Larry Taber  
Canners League of California  
Sacramento, California

## LIST OF PARTICIPANTS

J. L. Bomben  
Western Regional Research Center  
USDA  
Albany, California

J. R. Boydston  
Industrial Wastes Branch  
Environmental Protection Agency  
Corvallis, Oregon

G. E. Brown  
Western Regional Research Center  
USDA  
Albany, California

J. D. Clise  
Department of Health and Mental Hygiene  
State of Maryland  
Baltimore, Maryland

M. W. Cochrane  
Industrial Wastes Branch  
Environmental Protection Agency  
Corvallis, Oregon

R. W. Crites  
Metcalf & Eddy, Inc.  
Palo Alto, California

S. L. Cuppett  
Department of Animal Husbandry  
Michigan State University  
East Lansing, Michigan

B. L. Dameron  
Poultry Science Department  
University of Florida  
Gainesville, Florida

W. C. Dietrich  
Western Regional Research Center  
USDA  
Albany, California

K. A. Dostal  
Industrial Wastes Branch  
Environmental Protection Agency  
Corvallis, Oregon

H. J. Eby  
Biological Waste Management Laboratory  
USDA  
Beltsville, Maryland

D. F. Farkas  
Western Regional Research Center  
USDA  
Albany, California

John W. Farquhar  
American Frozen Food Institute  
Washington, D.C.

T. R. Foltz, Jr.  
Armour Food Company  
Phoenix, Arizona

R. P. Graham  
Western Regional Research Center  
USDA  
Albany, California

J. H. Green  
National Marine Fisheries Service  
NOAA  
College Park, Maryland

A. Grinkevich  
Hunt-Wesson Foods, Inc.  
Fullerton, California

C. F. Gurnham  
Gurnham and Associates, Inc.  
Chicago, Illinois

T. Jaffe  
National Field Investigations Center  
Cincinnati, Ohio

R. H. Jones  
Environmental Science and Engineering, Inc.  
Gainesville, Florida

A. M. Katsuyama  
Western Research Laboratory  
NCA  
Berkeley, California

J. W. Lee, Jr.  
Cornell, Howland, Hayes and Merryfield  
Corvallis, Oregon

A. F. Mauldin  
Domingue, Szabo & Associates, Inc.  
Lafayette, Louisiana

W. A. Mercer  
Western Research Laboratory  
NCA  
Berkeley, California

T. K. Nedued  
Gurnham and Associates, Inc.  
Chicago, Illinois

N. A. Olson  
Western Research Laboratory  
NCA  
Berkeley, California

C. E. Pound  
Metcalf & Eddy, Inc.  
Palo Alto, California

J. W. Ralls  
Western Research Laboratory  
NCA  
Berkeley, California

K. M. Ries  
The Greyhound Corporation  
Phoenix, Arizona

W. W. Rose  
Western Research Laboratory  
NCA  
Berkeley, California

C. J. Schmidt  
SCS Engineers  
Long Beach, California

Timothy G. Shea  
W. E. Gates & Associates, Inc.  
Fairfax, Virginia

R. C. Summerfelt  
Department of Zoology  
Oklahoma State University  
Ada, Oklahoma

A. J. Szabo  
Domingue, Szabo & Associates, Inc.  
Lafayette, Louisiana

A. Tarquin  
Civil Engineering Department  
University of Texas at El Paso  
El Paso, Texas

H. W. Thompson  
Industrial Wastes Branch  
Environmental Protection Agency  
Corvallis, Oregon

R. T. Williams  
East Bay Municipal Utility District  
Oakland, California

J. L. Witherow  
Industrial Wastes Branch  
Environmental Protection Agency  
Corvallis, Oregon

S. C. Yin  
Treatment and Control Branch  
Environmental Protection Agency  
Ada, Oklahoma





## Program Highlights

# *Consolidated Laboratory Services*

---

Pacific Northwest Environmental Research Laboratory

200 S. W. 35th Street

Corvallis, Or. 97330

---

January 1974

### QUALITY CONTROL

The Laboratory Services Branch, formerly the Consolidated Laboratory Services, in its continuing effort to provide valid data, has completed a number of studies: loss of orthophosphate in marine water, preservation of nutrients in wastewater samples, use of powder reagents for dissolved oxygen measurements, and the determination of organic carbon using the direct injection technique.

In seawater, losses of orthophosphate phosphorus were noted after a sixteen day period in polyethylene bottles. If mercuric chloride is added to seawater, polyethylene bottles can be used for holding samples for orthophosphate analysis without any pretreatment (e.g. acid washing, washing and rinsing). Polyvinyl chloride bottles can be used as seawater sample storage containers as received from the supplier without any pretreatment.

The wastewater preservation study indicated that wastewater samples can be stored at room temperature after preservation with 400 mg/l of mercuric chloride for periods of up to 100 days with only minimal changes in the forms of nitrogen and phosphorus.

In the study that compared powdered reagents with liquid reagents for dissolved oxygen determinations the differences were within  $\pm 0.1$  mg/l at the 4.3, 8.8, and 11.7 mg/l levels and  $\pm 0.5$  mg/l at the 53.6 mg/l level.

The ampoule technique was compared with the direct injection technique for determining total organic carbon. The sources of the samples were raw municipal wastewater, and primary and trickling filter effluents. The samples were analyzed in duplicate and triplicate except on three occasions. On two samplings, four replicates were run and on one sampling, ten replicates were analyzed. A summary of the pooled standard deviation of the methods is presented below.

Estimate of Standard Deviation for Total Organic Carbon  
by  
the Direct Injection and Ampoule Techniques

<u>Technique</u>	<u>Pooled Standard Deviation mg/l</u>	<u>Number of Sets</u>
Low-range (18-146 mg/l C)		
Direct Injection	5.2	35
Ampoule	3.7	34
Mid-Range (161-297 mg/l C)		
Direct Injection	6.4	33
Ampoule	6.9	26
High-Range (303-509 mg/l C)		
Direct Injection	13.0	11
Ampoule	18.0	18

A COD analysis was also performed on the samples and BOD data were obtained from the wastewater treatment plant. The ratios of COD to TOC and TOC to BOD are presented below.

COD/TOC and the TOC/BOD Ratio  
in  
Wastewater Samples for the Direct Injection and Ampoule Techniques

<u>Sample Technique</u>	<u>Mean Ratio COD/TOC</u>	<u>S.D.*</u>	<u>n**</u>	<u>Mean Ratio TOC/BOD</u>	<u>S.D.*</u>	<u>n**</u>
Raw Direct Inject.	3.18	.46	27	.57	.11	26
Raw Ampoule	2.81	.43	27	.66	.13	25
Primary Direct Inj.	3.08	.53	26	.56	.19	26
Primary Ampoule	2.60	.32	25	.65	.08	22
Effluent Direct Inj.	2.88	.37	26	1.01	.24	25
Effluent Ampoule	2.80	.35	26	1.02	.31	26

\*S.D. = Standard Deviation

\*\*n = Number of samples

As a result of the evaluation the direct injection technique can be substituted for the ampoule technique in wastewater samples.

The following reprints are now available.

1. Krawczyk, D. F. "Preservation of Wastewater Effluent Samples for Forms of Nitrogen and Phosphorus." Presented at the Chemical Institute of Canada/Canada Centre for Inland Waters Symposium on Water Parameters - Selection, Measurement and Monitoring, Burlington, Ontario, Canada, (Nov. 1973).
2. Krawczyk, D. F., and Allen, M. W. "Adsorption of Orthophosphate on Borosilicate and Citrate of Magnesia Bottles, Polyethylene and Polyvinyl Surfaces in a Distilled Water and Seawater Matrix". Presented at the EPA Seminar on Methodology for Monitoring the Marine Environment, Seattle, Washington (Oct. 1973).

The following are in the review and draft stage:

1. Krawczyk, D. F. and Allen, M. W. "Dissolved Oxygen Determination: The Powder Pillow Technique Compared to the Winkler Azide Liquid Reagents Technique."
2. Krawczyk, D. F. and Griffis, W. L. "Evaluation of the Direct Injection Technique for the Determination of Total Organic Carbon."