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DREDGED MATERIAL RESEARCH: NOTES, NEWS, REVIEWS, ETC.

Army Engineer Waterways Experiment Station
Vicksburg, Mississippi

February 1976

DREDGED MATERIAL RESEARCH

Miscellaneous Paper D-76-2
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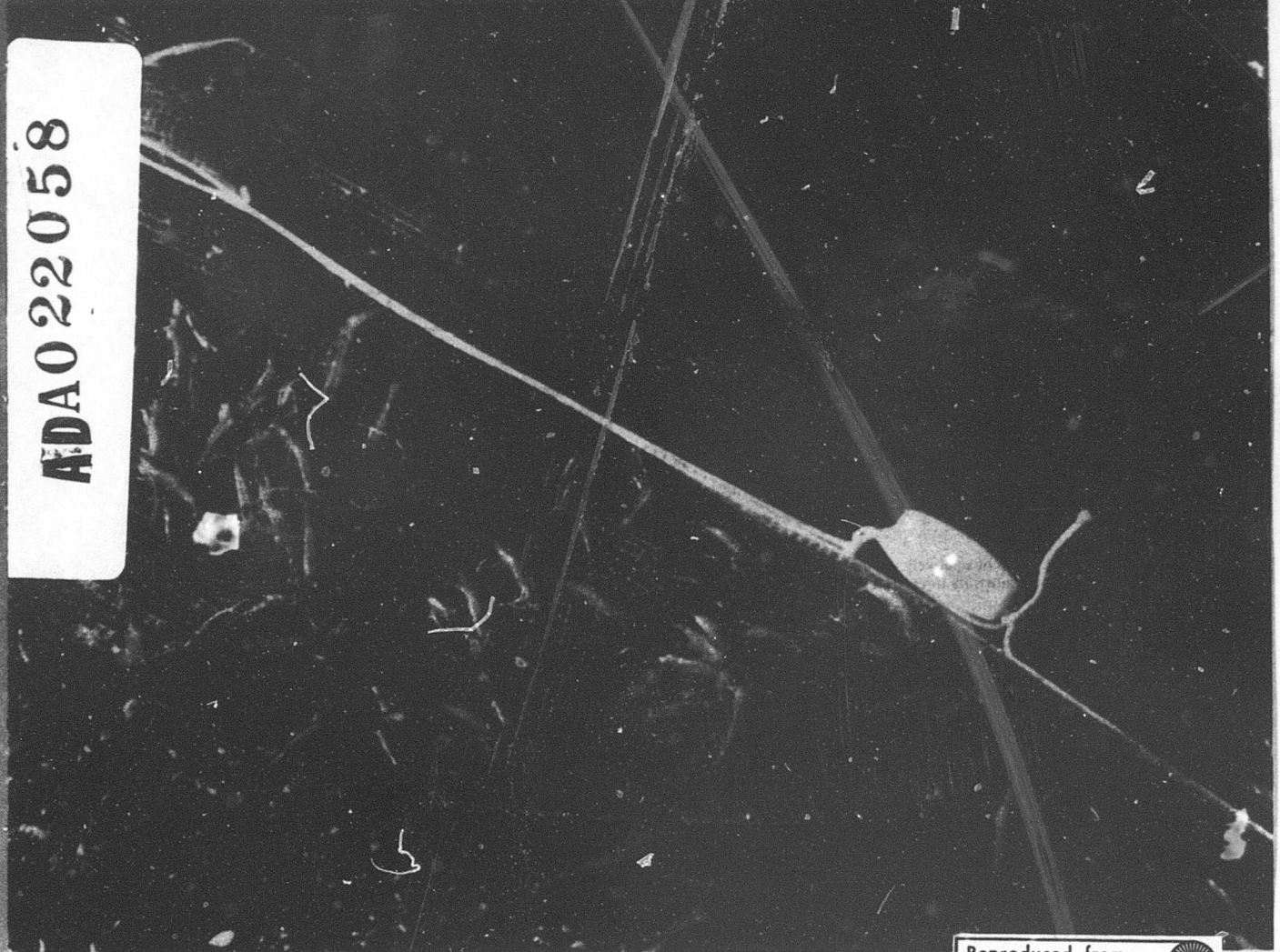
NOTES · NEWS · REVIEWS etc



"...in the eyes of the beholder." Dredged material, like other substances, is a different thing to different people. In some cases, it is perceived to be and indeed can be toxic or inhibiting to aquatic organisms while in other cases it can be a valuable source of nutrients. Under the Dredged Material Research Program (DMRP), both situations are being examined: the following article discusses initial results of a study of the mariculture of penaeid shrimp in dredged material disposal areas.

Contents;

PROGRESS REPORT—THE MARRIAGE OF MARICULTURE AND MATERIAL (DREDGED THAT IS!)

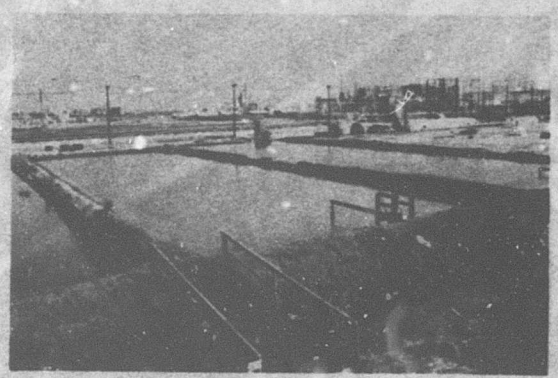
In August 1974 the Dow Chemical Company submitted an unsolicited proposal to the DMRP for an "Investigation of Mariculture as an Alternative Use of Dredged Material Containment Areas." Since the unique, innovative approach proposed was relevant to the Products Development Task of the Productive Uses Project, a 1-yr contract was awarded in February 1975. The work is being performed at Dow's Texas Division at Freeport under the direction of Mr. Joe Quick, who replaced Dr. Dorothea C. Mangum as principal investigator on 1 September 1975.

The objectives of the study are to (a) determine the suitability of dredged material as a substrate for penaeid shrimp; (b) investigate the advantages and disadvantages for the landowners and the Government of combining dredged material disposal with mariculture, and evaluate legal and institutional constraints associated with mariculture and marketing of the product; (c) simulate dredged material containment and simultaneous penaeid shrimp mariculture in existing ponds; (d) investigate the controlled growth of other fresh, brackish, and saltwater aquatic organisms in containment areas; and (e) perform an economic and engineering analysis of the conversion of existing containment areas to mariculture.

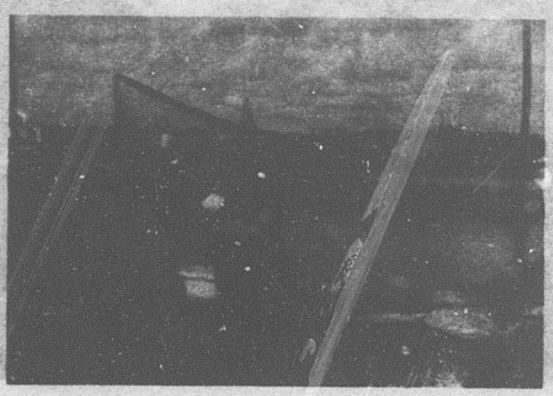
Although the project will not be completed until February 1976, an interim progress report is in order because of the intense interest generated by the work and the promising results of the small-scale pilot demonstration.

Four quarter-acre ponds were used for the pilot demonstration. Ponds 1 and 2 were control ponds; experimental ponds 3 and 4 each received a 1-ft layer of

One-foot thick layer of relatively uncontaminated dredged material was used as substrate in each of the experimental ponds



One foot of seawater completed the habitat and protected the shrimp from predatory birds



Harvesting with this 8-ft-square baited umbella net was less efficient than seining

The big one that didn't get away. At about 5 in. in length, this specimen was one of the largest captured

COLOR ILLUSTRATIONS REPRODUCED IN BLACK AND WHITE

fine-grained material (greater than 85 percent silt or clay by weight) dredged from a navigation channel in West Galveston Bay. On 16 May 1975, each pond was stocked with about 10,000 (±10 percent) juvenile brown shrimp (*Penaeus aztecus*) raised in the Dow hatchery to a relatively uniform length of 1.3 cm and weight of 0.1 gram. Each pond was fertilized with urea (nitrogen-to-phosphate ratio of 5:1) at a rate of 4 lb/acre/week to maintain plankton blooms in excess of 10,000 cells/ml. No other food sources were added to any of the ponds.

All ponds were harvested after 3 months. Results of the harvest are shown in the tabulation below.

Pond	Total Number Captured	Total Weight kg	Avg Weight per Shrimp gm	Growth per Shrimp per Week gm
1	7740	23.5	3.0	0.22
2	8455	21.1	2.5	0.19
3	5155	19.0	3.7	0.27
4	6498	27.3	4.2	0.32

Before comparing productivity of the various ponds harvesting efficiency should be considered. The primary harvesting technique employed was seining followed by complete drainage of ponds 1, 2, and 3 through a net bag with shrimp captures of 195, 182, and 916, respectively. Bag capture numbers are included in the respective totals shown above. The figures suggest that more shrimp evaded capture in the experimental ponds because of the opportunity to burrow in the softer substrate provided by the dredged material. After drainage, about 50 shrimp remained in ponds 1 and 2. An estimated 500 to 1000 shrimp remained in pond 3 (more than 250 by actual count). These estimates are not included in the totals shown in the tabulation. Since pond 4 was not drained, total shrimp survival had to be estimated. Based primarily on the results obtained from pond 3, it was estimated that 1000 to 2000 shrimp evaded capture in pond 4.

Data analysis is continuing to determine whether or not the harvest results substantiate the belief that the dredged material in the experimental ponds provided a valuable nutrient source. This is extremely important to the economic analysis since food costs reportedly account for 35 to 60 percent of total cost in most intensive mariculture operations. In the ultimate analysis, economics will be the key to the attractiveness of mariculture in dredged material disposal areas to private or corporate investors and, subsequently, to the increased availability of private or corporate lands for Corps dredged material disposal operations.

Persons interested in further details of this study should contact CPT Robert M. Meccia, Manager of the Productive Uses Project, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Mississippi 39180, or call 601/636-3111, ext. 3449.

NEWLY ORGANIZED COASTAL SOCIETY HOLDS FIRST ANNUAL CONFERENCE

With full cognizance of and obvious apprehension toward the many obstacles and frustrations facing anyone who would propose to form a new national society, a group of courageous individuals representing various professions and interests met early this year and did just that. Their commitment to organize a society, that was to be named THE COASTAL SOCIETY, was motivated by the realization that a critical specific need existed that was not being filled by any present organization, i.e., leadership in establishing and nurturing a holistic approach to coastal science, planning, decision making, and assessment. As a means to this end, the mission of the new society was defined as the promotion of knowledge, understanding, and wise use of coastal environments through education and communication.

The founders and directors of THE COASTAL SOCIETY view the objectives as threefold: (a) to foster improved interdisciplinary cooperation and communication among scientists, engineers, lawyers, other professionals, managers, government officials, public-interest groups, and individuals concerned with coastal environments; (b) to improve their effectiveness in the promotion of the wise use of coastal resources consistent with the dynamic natural processes of coastal environments; and (c) to improve public understanding and appreciation of the importance of and the need for science, effective management programs, and clear policy and law in all decisions affecting coastal environments.

Based on the success of the initial membership drive and the over 100 registered attendees at the First Annual Conference held on 24-26 November 1975 in Arlington, Virginia, there is apparent widespread acknowledgment

of the importance of the need recognized by the founders. To the attendees at the conference, there was a striking display of consistency in the themes of the keynote address by Aron R. Schwartz (Texas State Senator) and the 16 presentations by representatives of Federal agencies, State agencies, private industry, special interest groups, and the academic/research community. In essence, all spoke in support of a need for an interdisciplinary and interfunctional forum rather than just another scientific society.

Plans are moving ahead at this time to publicize the mission and objectives of THE COASTAL SOCIETY to increase membership. Preliminary plans also have been made for the second conference to be held in 1976 in the Gulf Coast area. Persons interested in more information on the society should contact: The Secretary, THE COASTAL SOCIETY, P. O. Box 34405, Bethesda, MD 20034.

DMR NEWSLETTER DISTRIBUTION

Many wise men have noted that nothing makes time pass more quickly than hard work and an intellectual challenge. Once again we are convinced the DMRP fits this description since it seems like only several months ago we began publication of this newsletter. But simple addition confirms that this is the 31st issue to be published in a 34-month period. This in itself has been a challenge but apparently one that has proven to be quite worthwhile.

Distribution of the first newsletter issue numbered about 550 copies and was mainly to a previously prepared list of Corps offices and a few other Federal agencies. Since then, the list has been expanded on the basis of written and oral requests and now monthly distribution totals nearly 2000 copies. An additional 500 or so copies of each issue are printed to fulfill subsequent requests and calls for back issues.

The organizational and geographic breakdown of the distribution is interesting and indicative to the DMRP staff of the nature of the problem and the information users. Copies of the newsletter are distributed to readers in 48 of the 50 states, Puerto Rico, the Canal Zone, and 9 foreign countries. The largest number of copies goes to various Corps District and Division offices and Laboratories (23%), followed closely by the number distributed to private industry (22%). In the latter category are included the dredging industry and numerous architect/engineer firms, including many of the DMRP contractors.

Other governmental agencies at the Federal and State level receive 26 percent of the total distribution. These include 29 separate Federal agencies (mainly the Environmental Protection Agency, the Fish and Wildlife Service, the National Marine Fisheries Service, the Navy, and the National Oceanic and Atmospheric Administration) and nearly 100 State agencies, bureaus, and commissions in 31 states. About 15 percent of the distribution is to individuals in university departments and institutes and 2 percent is to conservation/preservation organizations and environmental action groups. The remainder of the distribution is to interested individuals in all walks of life.

We are pleased that we are able to disseminate research results and news to such a large audience and once again extend the offer to all interested persons to have their names added to our distribution list. Communications regarding distribution should be to Ms. D. P. Booth at the address on the outside of the newsletter or by calling (commercial) AC 601, 636-3111, Ext. 3584, or (FTS) 542-3584.

FIELD DEMONSTRATION OF IN-LINE OXYGENATION OF DREDGED MATERIAL

The JBF Scientific Corp., under contract to the DMRP, recently conducted a field investigation and demonstration of in-line oxygenation as a means of satisfying the oxygen demand of dredged material slurry being discharged in open water. The demonstration was sponsored under Task 6B (Treatment of Contaminated Dredged Material) of the DMRP Disposal Operations Project and was located in the Gulf Intracoastal Waterway near Apalachicola, Florida. The task objectives include the determination of oxygen uptake rates for various dredged material slurries, the relationship between oxygen demand and dredged material composition, and the effect of oxygenation on the chemical constituents in the dredged material.

The DMRP profited from the outstanding cooperation and assistance provided to the contractor by the Mobile District of the Corps and in particular the Panama City Area Office. The study was conducted between 1-4 December 1975 using the Corps' 16-in. cutterhead Dredge *William L. Guthrie*. The assistance

provided by CPT John Hutto and his crew was invaluable.

Before the demonstration, sediment and water-column samples were taken in the area to be dredged and water-column samples were taken in the disposal area to establish baseline conditions. Four experimental 20-minute injections of oxygen were made during the demonstration: two close to the discharge and two near the dredge in order to vary the residence time of the oxygenated slurry within the discharge pipe (Photo 1). The pipeline slurry was sampled with and without oxygenation (Photo 2). Water samples were taken from the discharge plume while operating with and without oxygenation (Photos 3 and 4).

Other measurements made in the field during the baseline and oxygenation tests included dissolved oxygen and transmissivity profiles across the discharge plume, vertical salinity profiles in the discharge area, and immediate oxygen demand of slurry samples from the dredge pipe upstream of the injection point and after traversing the dredge pipe with oxygenation. Some samples were preserved and returned to the JBF Scientific Corp. laboratory to be characterized in terms of particle size, chemical analysis, oxygen demand factors, etc.

Preliminary results based on observations made during the demonstration indicate that the method was successful in enhancing dissolved oxygen levels in the discharge area. More detailed results from the laboratory analyses and data interpretations will be published in the final report, which will be prepared when the contract study is completed in May 1976.

The operations at Apalachicola were coordinated by the manager of Task 6B, Mr. T. K. Moore. Mr. C. C. Calhoun, Jr., is the Disposal Operations Project Manager.

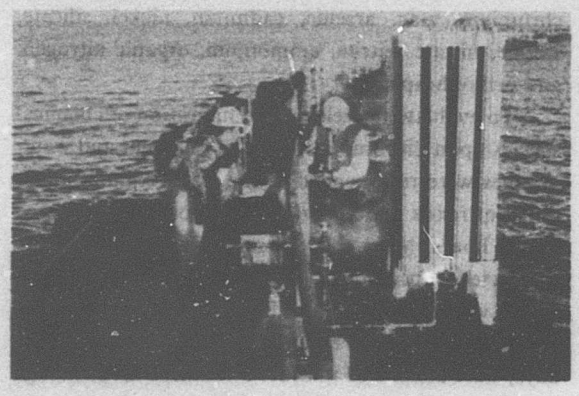


Photo 1. Injection of oxygen into pipeline

Photo 2. Sampling slurry from pipeline discharge

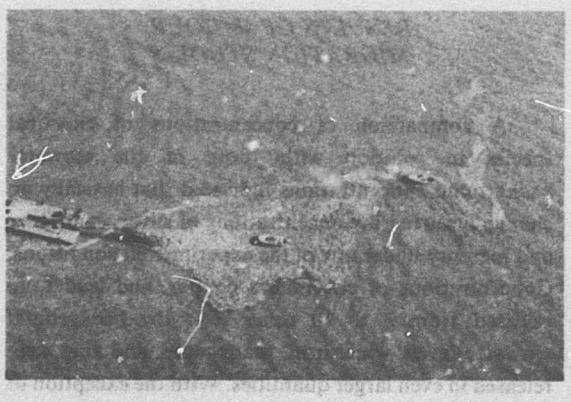


Photo 3. Boats in position to take water samples from discharge plume

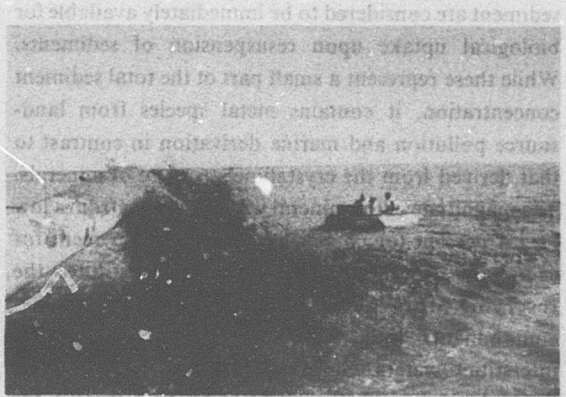


Photo 4. Closeup of water-sampling operation

CHEMICAL CONSTITUENT MIGRATION STUDY COMPLETED

The final report of an extensive study on the effect of dispersion, settling, and resedimentation on the migration of chemical constituents during open-water disposal of dredged material is being prepared for publication. The study, DMRP Work Unit No. 1C06, was conducted by Dr. Kenneth Y. Chen at the University of Southern California through laboratory experiments that simulated the impact of open-water disposal on water quality. An effort was made to quantify the migration of trace contaminants and nutrients under various conditions during the resuspension resettling and long-term migration from redeposited material of both freshwater and marine sediments. The chemistry of chlorinated hydrocarbons and organo-metallic complexes as related to their mobility or environmental stability was also investigated.

PHASES OF METAL SPECIES

Most metal cations and nutrients exist in sediments in several forms of differing toxicity and availability. The behavior of sediment contaminants during aquatic disposal and after redeposition largely governs the distribution of chemical constituents among various available and nonavailable forms.

Among the metal species in various geochemical fractions of sediment, the fractions of the interstitial waters and water-soluble phase of metal species in the sediment are considered to be immediately available for biological uptake upon resuspension of sediments. While these represent a small part of the total sediment concentration, it contains metal species from land-source pollution and marine derivation in contrast to that derived from the crystalline structure of minerals. The magnitude of the mineral fraction ranges from a low of 1.4 percent for copper to a high of 98 percent for cadmium. The nonresidual fraction constitutes the reservoir for potential subsequent release of contaminants into water columns and into new interstitial waters. Since the residual or crystalline mineral phase is not considered to be available for biological uptake, total concentrations of constituents in sediments are not deemed to be the proper criteria for determining the acceptability of dredged sediments for disposal. The availability for biological uptake should be the determining factor for establishing criteria.

METHODOLOGY

Water and sediment samples were obtained from a variety of marine and freshwater environments. Sediment samples of silty sand, sandy silt, and clay were characterized with respect to physicochemical properties, including particle-size distribution, and were analyzed for total concentrations of metal species in sediments, nonresidual fraction, lithogenous fractions, and attachment of trace metals and chlorinated hydrocarbons to macromolecular organic complexes.

The chemical constituents studied were those that usually respond to changes in biological, electrochemical, and physicochemical conditions in sediments: iron, manganese mercury, copper, lead, chromium, zinc, arsenic, cadmium, nickel, silicate, sulfide, nitrate, nitrite, ammonium, organic nitrogen, and orthophosphate.

To evaluate the release and migration of chemical species upon disposal, mixtures of sediment and water samples were resuspended in the water column under different redox and agitation conditions and observed for 48 hours. More than 24 sets of experiments were conducted. Additional, long-term experiments (in which water samples in sediment-water interfaces of redeposited dredged material were analyzed for 120 days) were conducted in order to observe the exchange phenomena in the sediment-water interface under rigorously controlled conditions.

RESULTS OF 48-HOUR MIGRATION STUDIES

A comparison of concentrations of chemical species in solution with those of the seawater background concentrations indicated that basically no change occurred in concentrations of silver, cadmium, and mercury under any of the experimental conditions. Concentrations of chromium, copper, and lead were released from 3 to 10 times over the background seawater levels while iron, manganese, and zinc were released in even larger quantities. With the exception of manganese, the metals released were in the low to sub-parts per billion (ppb) levels. In a seawater environment,

trace metals were released in somewhat greater quantities from freshwater sediment than from marine sediment.

Nitrogen and phosphorous compounds were released in the sub-parts per million (ppm) range in the water column, while the concentration of soluble silicate increased to 10-20 ppm. Of the three types of sediment tested, the silty clay released in higher concentrations of nutrients and lower concentrations of trace metals and at levels that could greatly increase autotrophic activity. The released chlorinated hydrocarbons could not be detected.

RESULTS OF LONG-TERM EXCHANGE STUDIES

With the exception of iron and manganese, most of the metals were released in the low to sub-ppb range under slightly oxidizing conditions, and with little increase or an actual decrease under reducing conditions. Iron and manganese were released several hundred times over the seawater background levels under reducing conditions, with iron in the range of 0.1-1.0 ppm and manganese from 0.01-0.1 ppm.

Nitrogenous compounds were released in substantial quantities from clayey sediments. Ammonia nitrogen and organic nitrogen were released in levels as great as 10 ppm under anaerobic conditions while nitrate and nitrite increased to the same range under aerobic conditions. Silty and sandy sediments released at levels 2 to 10 times lower than did clayey sediments. Release of chlorinated hydrocarbons was not observed even after 3 months of experimentation.

After long-term exposure to different environmental conditions, the characteristics of the resettled sediments changed relative to the conditions. Under oxidizing conditions, the concentrations of most trace metals in the interstitial water and water-soluble phase, as well as easily and moderately fractions, were found to be increased; while concentrations of the sulfide and organic fractions were found to be decreased. Even the concentrations of iron, manganese, nickel, and lead in the mineral residue fraction were converted to other more readily available fractions.

Total concentrations of chlorinated hydrocarbons were observed to be correlated with concentrations of macromolecular organic compounds and to be closely related to particles of 8 μm or smaller.

CONCLUSIONS

The results show that concerns regarding the release of any significant quantity of toxic materials into solution phase during dredging and disposal operations are unfounded. While some trace metals may be released in the ppb range, others show essentially no release pattern. Most of the concentrations in the soluble phase are well below the allowable concentration levels of the ocean water discharge standards. However, trace metals and chlorinated hydrocarbons associated with macromolecular organics and suspended particles released to the water column as a result of dredging may present some unknown effect (for example, the availability of these organic compounds as a food source for filter-feeders and algae may present some potential problems).

The report of the study was prepared by Kenneth Y. Chen, Shailendra K. Gupta, Amancio Z. Sycip, James C. S. Lu, Miroslav Knezeric, and Won-Wook Choi of the Environmental Engineering Program at the University of Southern California, Los Angeles, as part of the Environmental Impacts and Criteria Development Project of the DMRP (Dr. Robert M. Engler, Manager). Mr. James D. Westhoff managed the contract.

TASK AREA 5A PLANNING SEMINAR II

Task 5A of the DMRP, concerned with development and evaluation of promising techniques for dewatering or densifying fine-grained dredged material, was the subject of the Planning Seminar II held at the Waterways Experiment Station (WES) on 13-14 January 1976. The first planning seminar, held in October 1974 and attended by noted technical experts in soils engineering and soil science, gave assistance to the DMRP staff in planning research to obtain task goals from discussion centered upon Phase I—Feasibility Studies. (See November 1974 newsletter for report on Planning Seminar I.)

The second seminar was convened by Mr. C. C. Calhoun, Jr., manager of the DMRP's Disposal Operations Research Project, and was moderated by Dr. T. A. Haliburton, geotechnical engineering consultant. In addition to DMRP staff members, the seminar was attended by work unit contractors and

invited consultants. They were Mr. Michael R. Bartos, Environmental Effects Laboratory, WES; Dr. Kirk W. Brown, Soil and Crop Science Department, Texas A&M University; Mr. Harry R. Cedergren, Private Consultant; Mr. Ed Chamberlain, USAE Cold Regions Research and Engineering Laboratory; Mr. Robert Chamlee, USAE District, Mobile; Mr. Patrick Douglas, USAE District, Mobile (Engineering Division Liaison); Mr. Gary N. Durham, Mobility and Environmental Systems Laboratory, WES; Dr. Anthony J. Gaudy, EEC, Inc.; Mr. Stanley J. Johnson, Soils and Pavements Laboratory, WES; Mr. Robert Kaufman, USAE Division, Lower Mississippi Valley (Engineering Division); Dr. Suzanne Lacasse MIT; Dr. Charles E. O'Bannon, KMA Research, Inc.; Mr. Michael R. Palermo, Environmental Effects Laboratory, WES; Dr. William H. Patrick, Agronomy Department, Louisiana State University; Mr. Walter C. Sherman, Jr., Soils and Pavements Laboratory, WES; Dr. James W. Spotts, Soils and Pavements Laboratory, WES, Dr. Frank C. Townsend, Soils and Pavements Laboratory, WES; and Mr. Jim Washington, Western Division, Naval Facilities Engineering Command, USN.

Each contractor gave a brief presentation of the research accomplished under the work units of the Phase I—Feasibility Studies as shown in the tabulation below.

Work Unit	Title	Presentation Made by
5A02	Mechanical Slurry Agitation	Mr. Durham
5A03	Survey of Conventional Dewatering Techniques	Mr. Johnson
5A04	Electro-Osmotic Dewatering Feasibility	Dr. O'Bannon
5A05	Aeration Dewatering Feasibility	Dr. Gaudy
5A06	Crust Management	Dr. Brown
5A07	Freeze-Thaw Dewatering Feasibility	Mr. Chamberlain
5A08	Trench Dewatering	Mr. Palermo
5A09	Vacuum Well Point Dewatering	Mr. Chamlee
5A10	Capillary Wick Dewatering	Dr. Spotts
5A13	Containment Area Management	Mr. Bartos
4A16A	Containment Area Sizing	Dr. Lacasse

The various research efforts were then discussed in detail and promising concepts for potential field evaluation (Phase II) were identified.

The success of the first two planning seminars indicates that, if at all possible, a third seminar should be held during 1977 to advise the DMRP staff in the planning of Phase III—Design Alternatives Development

IJC WORKING GROUP REPORT PUBLISHED

On April 15, 1972, the President of the United States and the Prime Minister of Canada signed the "Agreement between Canada and the United States of America on Great Lakes Water Quality." On November 15, 1972, on the advice of the International Joint Commission (IJC), the International Working Group on the Abatement and Control of Pollution from Dredging Activities was established in compliance with Article V, Section (f) of the Agreement.

The Working Group was a 14-member body representing navigational, environmental, and fish and wildlife interests selected from several Canadian departments and ministries and several United States Federal and State agencies, including the Environmental Protection Agency and the Corps of Engineers. The Working Group was charged with undertaking a review of existing dredging practices, programs, laws, and regulations with the objective of developing compatible criteria for the characterization of polluted dredged material and recommending compatible programs governing the disposal of dredged material in open water.

The final report of the International Working Group on its studies, investigations, conclusions, and recommendations has just been published (dated May 1975). Although the report summary is considerably longer than those normally included in this newsletter for new items of literature, it is presented below verbatim because of its significance and the fact that it reflects certain of the results of research conducted as part of the DMRP. It should be kept in mind that the report is a submission of recommendations of the Working Group that has not been officially endorsed by the U. S. State Department or the participating agencies.

By its terms of reference the Working Group has been directed to review dredging practices and programs in the Great Lakes as well as the relevant laws and regulations governing dredging for the purposes of developing compatible criteria for the characterization of dredged material and making recommendations for compatible programs governing disposal of polluted spoil in open water.

Prior to the 1970's no special concern regarding the environmental aspects of dredging had been identified and, as a consequence, very little information can be gleaned from the experience record which would indicate the effects which may have been imposed. Indeed, even today, after several years of intensive study into lake processes, it is difficult to separate the chemical and biologic impacts of a dredging or open-water disposal operation from similar influences occurring as a consequence of introductions of pollutants from other sources.

Insights derived from recent research into the chemistry of the Lake waters indicate considerable variability in the geochemical and biochemical processes which is not predictable on the basis of routine analyses. Nevertheless, there is ample evidence to show that water quality has been influenced by man's activities within the basin of the Great Lakes since settlement began about the beginning of the 19th century. The decline and virtual extinction of the indigenous oligotrophic fish species, which were once widely distributed throughout the Lakes, as well as succession changes in the planktonic and benthic populations evidence the impact of cultural pollution upon the aquatic environment and its ecosystems. Recent sedimentologic studies have demonstrated the widespread distribution in the bottom sediments of the Lakes and connecting channels of heavy metals and of unnatural products of technologic society, as well as indicating increases in the rates of accumulation of sediments and leached chemicals above those levels which prevailed prior to settlement.

There is evidence from laboratory studies that the levels of toxicants and oxygen demands, which occur in the sediments that accumulate in harbours and channels, can impose lethal stresses on organisms of the ecosystem, while high concentrations of nutrients can trigger instability in the biomass. The occurrences of blue-green algal blooms in Lake Erie, as well as parts of Lakes Ontario and Michigan, have been related to high levels of nutrient supply, particularly phosphates, being added to the waters. Fish and wildlife studies have demonstrated their capacity for biochemical uptake and concentration of heavy metals and pesticides. Even after point-source control of such contaminants has been achieved it is apparent from studies of diffuse sources of pollutants that contamination of sediment accumulations at the mouths of rivers and drainageways is likely to continue, despite efforts being made to reduce such sources through improved management practices.

The criteria currently being applied by the U. S. Environmental Protection Agency and the Ontario Ministry of Environment for the categorization of pollutants in dredged materials provide somewhat limited indications of potential hazards. The selected parameter values, as determined by traditional laboratory processes, provide only information on the total concentration of various substances. No satisfactory correlations have been established between such total concentration values and the levels of their availability under natural environmental processes. Geochemical and biochemical reactions differ under oxic and anoxic conditions; many reactions are interdependent, some synergistic. There is, moreover, a wide range in the natural background levels of various chemical constituents from one location to another within lakes and between lakes, which, particularly in the littoral zone, exhibit seasonal variations.

It is the conclusion of the Working Group that there are no single parameter values which could be adopted as universal criteria applicable throughout the Great Lakes. Thus, it is recommended that environmental protection will be more meaningfully achieved through a site-specific assessment of the hazards and potential benefits of each project within its particular environment. The basic criteria for all dredging activities should be the preservation of designated water uses, including viable aquatic and terrestrial ecosystems, and the optimization of net socio-economic benefits to society. In project evaluation, a selection of indicator parameters should be made from baseline information of water and sediment quality and known sources of potential contaminants. In the evaluation of hazards, bioassays and other tests which more closely relate to the availability of contaminants to the ecosystem should be adopted. Attention must also be given to the design of sampling programs, and test procedures to ensure that they adequately assess the actual conditions.

Many of the potentially adverse impacts from disposal operations could be avoided through enlarging the

scope of dredging projects to encompass activities for the beneficial use of dredged materials. Much of the material dredged from the Great Lakes and connecting channels is not so heavily contaminated as to require deposition in special containment sites. Indeed, the high cost of confined disposal provides an incentive for finding alternative uses for the dredged material. Multipurpose design of dredging projects can take advantage of opportunities to create facilities and amenities which will avoid the more-serious environmental impacts likely to arise from open-water disposal and at the same time provide supplemental benefits which will offset the added costs of dredging under environmental constraint.

The existing legislation and regulations concerning dredging activities as well as the agency responsibilities and administrative procedures with respect to the assessment and design of dredging projects have been reviewed in some detail. It is concluded that there are adequate laws to ensure that dredging activities are carried out in compliance with requirements for environmental protection. The Working Group considers that the introduction of the recommended guidelines should be accomplished by administrative action to allow some flexibility to meet changing responsibilities of different agencies and jurisdictions. Moreover, it is recommended that administrative procedures be adapted to provide a longer lead time between identification of projects and programs and their execution to facilitate the proper investigation and assessment of alternatives. Although subsequently some legislative modifications may be appropriate, it appears premature at this time to suggest specific changes.

The majority of dredging is undertaken directly by government agencies in support of navigation interests and for the improvement of marinas and harbours for fisheries and recreational activities. Dredge mining of sands and gravels for materials recovery and creation of landfills is often undertaken by private enterprise. Such activities are, however, subject to licensing by provincial or state jurisdiction. Therefore, although a situation could arise which would not be covered by existing regulations requiring prior assessment of environmental concerns, in such event, the project proponent would be advised to comply with acceptable environmental practices, under notice of possible prosecution under a variety of acts which prohibit any actions which cause a deterioration of water quality. Even though such an approach is punitive rather than preventative, it seems unlikely that any private dredging would proceed without regard to the concerns identified by the regulatory agencies for environmental protection.

The attention focussed upon the environmental aspects of dredging during recent years has led to intensive programs of research and investigations. At this time the state of knowledge of many aspects of the Lake environments, ecology and complex water chemistry processes is being rapidly extended. Most of the specific research needs have been identified and projects initiated to investigate a broad spectrum of interrelated aspects.

In parallel with the specific research into various aspects of dredging activities there is a continuing program of investigations into the morphology and morphometry of Lake sediments and of the spatial and time variations in water quality and aquatic ecosystems. During the past five years a great deal of data has been collected, much of which remains to be fully analyzed and interpreted. Thus this report is written at a time when the general conclusions and recommendations presented herein are supported by the preliminary findings and interpretations of the research and investigation programs. However, many specific aspects will be developed and confirmed only during the next few years. The Working Group recommends that the research programs be encouraged to define more rigorously the specific nature of impacts relating to nutrients and potentially toxic substances as well as to support further advances in dredging technology

The effects of individual dredging projects are seen primarily as short-term impacts, although it is recognized that the redistribution of polluted materials in thin layers on the bottom of the lakes may make additional contaminants available for uptake through the ecosystem. Even though the specific long-term contributions to degradation of water quality by individual dredging projects may be impossible to establish, it is important to recognize the aggregate effort of dredging programs, by lake, which will continue into the foreseeable future. Thus the Working Group finds it appropriate to recommend the appointment of a Standing Committee to audit dredging activities in the Great Lakes and to review assessments of individual projects to ensure compliance with recommended guidelines. Moreover, such a committee would provide a logical focus for encouraging the exchange of information from continuing research activities and accumulated experience and to recommend changes in criteria and guidelines as may be appropriate in the light of advances in the technology relating to dredging and environmental problems.

REPORTS BY DREDGED MATERIAL RESEARCH PROGRAM

REPORTS PUBLISHED

*Boyd, M. B. et al., "Disposal of Dredge Spoil-Problem Identification and Assessment and Research Program Development," Technical Report H-72-8, November 1972, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. NTIS number AD-757599.

*Tiederman, W. G. and Reischman, M. M., "Feasibility Study of Hydrocyclone Systems for Dredge Operations," Contract Report D-73-1, July 1973, prepared by the Office of Engineering Research, Oklahoma State University, under contract to the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. NTIS number AD-766212.

Keeley, J. W. and Engler, R. M., "Discussion of Regulatory Criteria for Ocean Disposal of Dredged Materials: Elutriate Test Rationale and Implementation Guidelines," Miscellaneous Paper D-74-14, March 1974, Office of Dredged Material Research, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. NTIS number AD-775826.

*Johnson, B. H., "Investigation of Mathematical Models for the Physical Fate Prediction of Dredged Material," Technical Report D-74-1, March 1974, Hydraulics Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Work Unit 1B01). NTIS number AD-" 3368.

*Murphy, W. L. and Zeigler, T. W., "Practices and Problems in the Confinement of Dredged Material in Corps of Engineers Projects," Technical Report D-74-2, May 1974, Soils and Pavements Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. NTIS number AD-780 753 0GA.

Bastian, D. F., "Effects of Open-Water Disposal of Dredged Material on Bottom Topography Along Texas Gulf Coast," Miscellaneous Paper D-74-13, November 1974, Hydraulics Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. NTIS number ADA-002659.

*Lee, G. F. and Plumb, R. H., "Literature Review on Research Study for the Development of Dredged Material Disposal Criteria," Contract Report D-74-1, June 1974, prepared by the Institute for Environmental Studies, University of Texas-Dallas, under contract to the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Work Unit 1E03). NTIS number AD-780 755 5GA.

*Reikenis, R., Elias, V., and Drabkowski, E. F., "Regional Landfill and Construction Material Needs in Terms of Dredged Material Characteristics and Availability," Contract Report D-74-2, Volumes I and II, May 1974, prepared by Green Associates, Inc., under contract to the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Work Unit 5C04). NTIS number AD-780 750 6GA.

Harrison, J. F. and Chisholm, I. C., "Identification of Objectionable Environmental Conditions and Issues Associated with Confined Disposal Areas," Contract Report D-74-4, September 1974, prepared by Arthur D. Little, Inc., under contract to the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Work Unit 2C06). NTIS number ADA-000895.

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Mallory, C. W. and Nawrocki, M. A., "Containment Area Facility Concepts for Dredged Material Separation, Drying, and Rehandling," Contract Report D-74-6, October 1974, prepared by Hittman Associates, Inc., under contract to the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Work Unit 5C01). NTIS number ADA-002605.

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Kadlec, J. A. and Wentz, W. A., Jr., "State-of-the-Art Survey and Evaluation of Marsh Plant Establishment Techniques: Induced and Natural. Volume I: Report of Research," Contract Report D-74-9, December 1974, prepared by the School of Natural Resources, University of Michigan – Ann Arbor, under contract to the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Work Unit 4A03). NTIS number A012 837.

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Saucier, R. T., "Fourth Semiannual Interagency Briefing," Miscellaneous Paper D-75-14, October 1975, Environmental Effects Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

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*Hornberger, G. M. and Kelly, M. G., "Methods of Dissolved Oxygen Budget Analysis for Assessing Effects of Dredged Material Disposal on Biological Community Metabolism," Contract Report D-75-3, November 1975, prepared by the Department of Environmental Sciences, University of Virginia, Charlottesville, under contract to the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Work Unit 1D04).

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Fulk, R., Gruber, D., and Wullschleger, R., "Laboratory Study of the Release of Pesticide and PCB Materials to the Water Column During Dredging and Disposal Operations," Contract Report D-75-6, December 1975, prepared by Envirex, Inc., Milwaukee, Wisconsin, under contract to the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Work Unit 1C04).

*REPORTS IN PRESS ON 1 FEBRUARY 1976***

Hall, P. W., Westerdahl, H. E., and Eley, R. L., "Application of Ecosystem Modeling Methodologies to Dredged Material Research," Technical Report, Environmental Effects Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Work Unit 1D04).

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Coastal Zone Resources Corporation (CZRC), "Identification of Relevant Criteria and Survey of Potential Application Sites for Artificial Habitat Creation. Volume I: Relevant Criteria for Marsh-Island Site Selection and Their Application," Contract Report prepared by CZRC under contract to the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Work Unit 4A01).

, "Identification of Relevant Criteria and Survey of Potential Application Sites for Artificial Habitat Creation. Volume II: Survey of Potential Application Situations and Selection and Description of Optimum Project Areas," Contract Report prepared by CZRC under contract to the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. (Work Unit 4A01).

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* Report is out of print, but can be purchased from NTIS (address: National Technical Information Service, 5205 Port Royal Road, Springfield, VA 22151). In requesting copies from NTIS, the NTIS number should be included, if given.

** Because of the administrative difficulties involved in handling advance requests, readers are urged to wait until newsletter announcement of publication to order the reports in press. The announcements will be prominently displayed, and requests will be processed on a first-come, first-serve basis.

NEW DMRP PUBLICATIONS

Lee, G. Fred, et al., "Research Study for the Development of Dredged Material Disposal Criteria," Contract Report D-75-4, Nov 1975, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Misssissippi. (Final report on Work Unit 1E03.)

Mann, Roy, et al., "Landscape Concept Development for Confined Dredged Material Sites," Contract Report D-75-5, Dec 1975, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Mississippi. (Final report on Work Unit 5E01.)

Fulk, Richard, Gruber, David, and Wullschleger, Richard, "Laboratory Study of the Release of Pesticide and PCB Materials to the Water Column During Dredging and Disposal Operations," Contract Report D-75-6, Dec 1975, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Mississippi. (Final report on Work Unit 1E03.)

NOTE: Copies of the above reports will be furnished to individual requestors as long as supplies last. Since it is only feasible to print a limited number of copies, requests for single rather than multiple copies by a single office will be appreciated. Please address all requests to the Waterways Experiment Station, ATTN: Ms. D. P. Booth. When supplies are exhausted, copies will be obtainable from the National Technical Information Service, 5205 Port Royal Road, Springfield, VA 22151.

MARINE ECOLOGY AND DREDGING

The above theme was the subject of the entire November 1975 issue of *World Dredging and Marine Construction* (Vol 11, No. 12). Nine separate articles were included in this issue as listed below:

"From Dust to Ducks—Dredge Creates Habitat," by E. P. Denson. (Describes a project of the U. S. Bureau of Reclamation to improve the wildlife value of Canyon Ferry Reservoir (Montana) through water level control achieved by dredging and dike construction.)

"Dredge Overflow System Solves Turbidity Problem," by I. Ofuji and N. Ishimatsu. (Describes generally a mechanism for preventing the generation of air bubbles in hopper dredge overflow that cause suspended solids to swell to the surface creating a turbidity plume.)

"Estuarine Pollution—Reality or Fantasy," by J. F. Gustafson. (Calls attention to problems and conflicts associated with developing technically and operationally realistic pollution criteria.)

"Lead Enters Food Web of Estuarine Organisms," by J. E. Drifmeyer. (Discusses the uptake of lead by marsh plants and aquatic organisms from contaminated dredged material in two Virginia disposal areas.)

"Sands Protect Sea Walls of Bournemouth Resort," by M. Carter. (Describes the operational aspects of a 655,000 cu m beach replenishment project in southern Britain.)

"Disposal Operations Research Accents Turbidity, Dewatering," by C. C. Calhoun, Jr. (An overview of progress being made in the Disposal Operations Project of the DMRP.)

"Pneuma Pump System Reduces Chances of Secondary Pollution." (Discusses operation of the Italian dredge plant that is capable of producing high-solids-content output with minimal bottom disturbance.)

"Landscaping Enhances Looks of Confined Disposal Sites," by Roy Mann. (A summary of a project sponsored by the DMRP to develop concepts and evaluate methods of improving the appearance and public acceptance of confined disposal sites.)

"Dredge Makes Marsh Homey for Migratory Waterfowl," by W. O. Deason and F. P. Sharpe. (Describes a dredging project of the U. S. Bureau of Reclamation to enhance the wildlife habitat value of the Topock Marsh (Arizona) through water level control, water circulation regulation, and habitat construction.)

DREDGING AND RECLAMATION FEATURED IN CIVIL ENGINEERING

The November 1975 issue of *Civil Engineering* magazine (Morgan-Grampian Ltd., Calderwood Street, London, SE18 6QH) is devoted largely to the subjects of dredging and reclamation. Specific short articles discuss latest developments in dredge plant (dredgers), portable dredges, future dredging needs, positioning systems, highlights of the 1st International Symposium on Dredging Technology (University of Kent), predredging surveys and site investigations, and dredging research and development. While the emphasis in all articles is on the United Kingdom, developments and practices elsewhere are mentioned.

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NEW LITERATURE

Cammen, L. M., et al., "Animal Colonization of Salt Marshes Artificially Established on Dredge Spoil," Report No. UNC-SG-74-15, Oct 1974, North Carolina State University, Raleigh, North Carolina.

Research to determine whether dredged material covered with smooth cord-grass will function similarly to natural marsh with regard to animal colonization is reported. Selected areas were sampled for 9 months. Sediment particle size and temperature, organic carbon, and *Spartina* biomass were analyzed. Faunal concentration was measured.

Slotta, L. S. and Williamson, K. J., "Monitoring Dredge Spoils," *Proceedings of Seminar on Methodology for Monitoring the Marine Environment, Seattle, Washington, Oct 1973,* U. S. Environmental Protection Agency, Environmental Monitoring Series, EPA-600/4-74-004, Oct 1974, Washington, D. C.

An interdisciplinary team has been conducting research on the environmental effects of dredging in estuarine waters. The potential acute and chronic environmental impacts of dredging examined as part of this study were reported. Present monitoring technology is available to measure many parameters in relation to dredging projects. More research is necessary to elucidate cause-and-effect relationships especially in relation to chronic impacts. Proposed guidelines to minimize the acute impacts and identification of research needs to effectively monitor dredging projects were also presented.

NOTE: The DMRP regrets it cannot be a distributing agent for the new items of literature listed in this newsletter. All items presented are available at the time of listing from the publishing or issuing agency and requests for copies should be addressed to them. In many instances, only limited copies are available and the use of Interlibrary Loan or related services is encouraged.

This publication has been prepared and distributed as one of the information dissemination functions of the Environmental Effects Laboratory of the Waterways Experiment Station. It is principally intended to be a forum whereby information pertaining to and resulting from the Corps of Engineers' nationwide Dredged Material Research Program (DMRP) can be rapidly and widely disseminated to Corps District and Division offices as well as other Federal agencies, State agencies, universities, research institutes, corporations, and individuals. Contributions of notes, news, reviews, or any other types of information are solicited from all sources and will be considered for publication as long as they are relevant to the theme of the DMRP, i.e., to provide through research definitive information on the environmental impact of dredging and dredged material disposal operations and to develop technically satisfactory, environmentally compatible, and economically feasible dredging and disposal alternatives, including consideration of dredged material as a manageable resource. This publication will be issued on an irregular basis as dictated by the quantity and importance of information to be disseminated. Communications are welcomed and should be addressed to the Environmental Effects Laboratory, ATTN: R. T. Saucier, U. S. Army Engineer Waterways Experiment Station, P. O. Box 631, Vicksburg, Mississippi 39180, or call AC 601, 636-3111, Ext. 3233.

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