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DREDGED MATERIAL RESEARCH

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US ARMY ENGINEER WATERWAYS EXPERIMENT STATION

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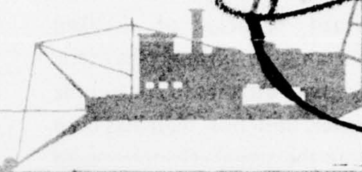

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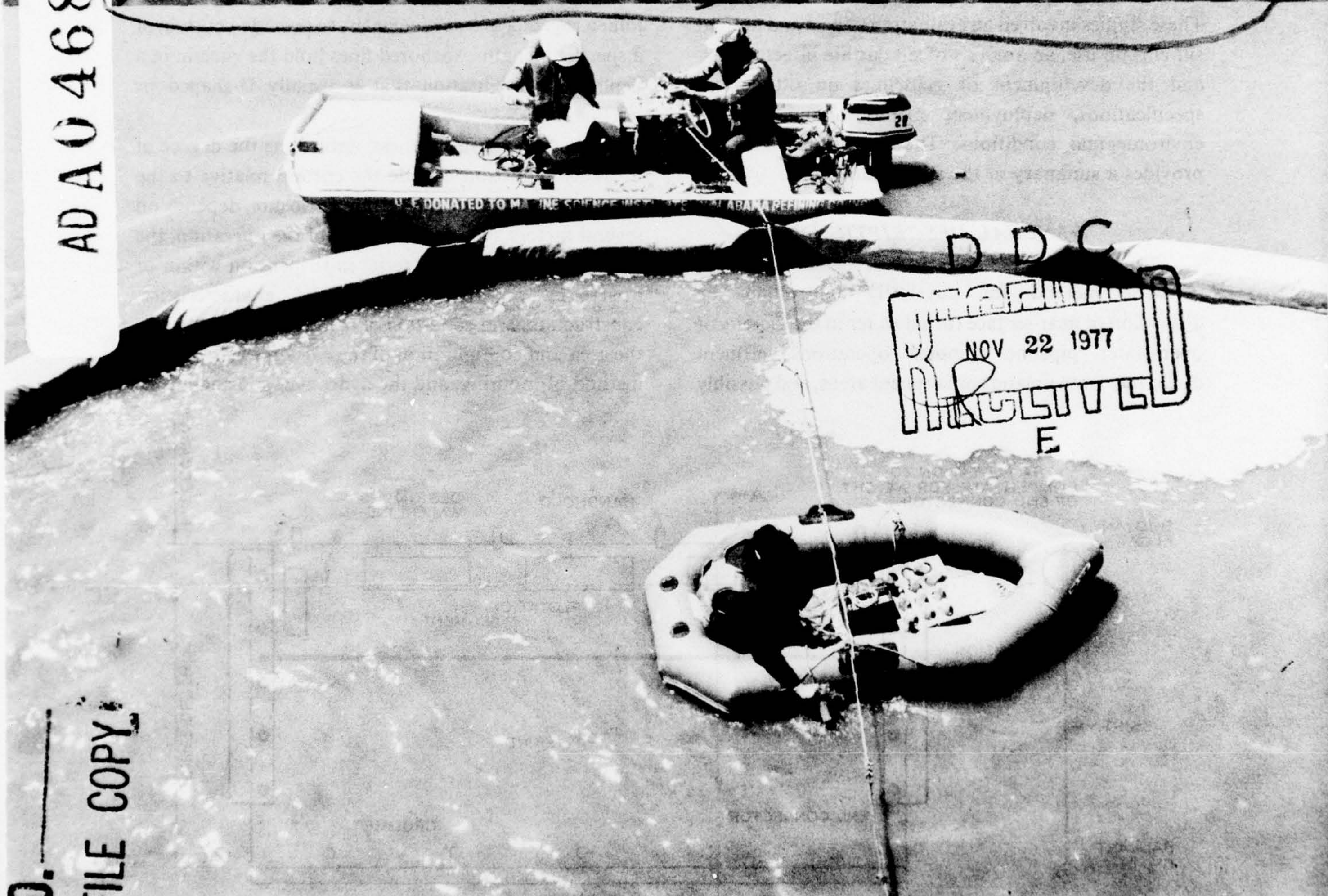

How effective are silt curtains in controlling the dispersion of turbidity generated by dredging and disposal operations? To answer this question, the field tests shown in the photo were performed in Heron Bay, Alabama, as part of the Dredged Material Research Program's (DMRP) study of the functional capabilities and performance of silt curtains. The results of this entire study are synthesized in the following article.

(11) Oct 77 (12p.) 038100

APPLICATION AND PERFORMANCE OF SILT CURTAINS

INTRODUCTION

Dredging and the disposal of dredged material in open water often generate turbidity in the water column by suspending fine-grained particles of dredged material. Although silt curtains, or turbidity barriers, have been used extensively in an attempt to control the dispersion of this turbid water, until now there has been very little information about the actual effectiveness of silt curtains. Field and analytical studies were conducted by JBF Scientific Corporation, Wilmington, Massachusetts, as part of the DMRP to evaluate the functional capabilities and performance of silt curtains. These studies involved an evaluation of past and present silt curtain use, an analysis of silt curtain effectiveness, and the development of guidelines on silt curtain specifications, deployment methods, and limiting environmental conditions. The following discussion provides a summary of the silt curtain study.

GENERAL DESCRIPTION

One method for physically controlling the dispersion of near-surface turbid water in the vicinity of open-water pipeline disposal operations, effluent discharges from upland containment areas, and possibly small (clamshell) dredging operations in quiescent environments involves placing a silt curtain or turbidity barrier either down-current from or around the operation.

Silt curtains (Figure 1) are impervious floating barriers that extend vertically from the water surface to a specified water depth. The flexible, nylon-reinforced polyvinyl chloride (PVC) or equivalent fabric forming the barrier is maintained in a vertical position by flotation segments at the top and a ballast chain along the bottom. A tension cable is often built into the curtain immediately above or just below the flotation segments (top tension) or approximately 0.5 m below the flotation segments (center tension) to absorb stress imposed by currents and other hydrodynamic forces. The curtains are usually manufactured in 30-m sections that can be joined together at a particular site to provide a curtain of a specified length. Anchored lines hold the curtain in a deployed configuration that is usually U-shaped or circular.

Silt curtain effectiveness, defined as the degree of turbidity reduction outside the curtain relative to the turbidity levels inside the curtain enclosure, depends on several factors such as the nature of the operation; the quantity and type of material in suspension within or upstream of the curtain; the characteristics, construction, and condition of the silt curtain as well as the area and configuration of the curtain enclosure; the method of mooring; and the hydrodynamic conditions

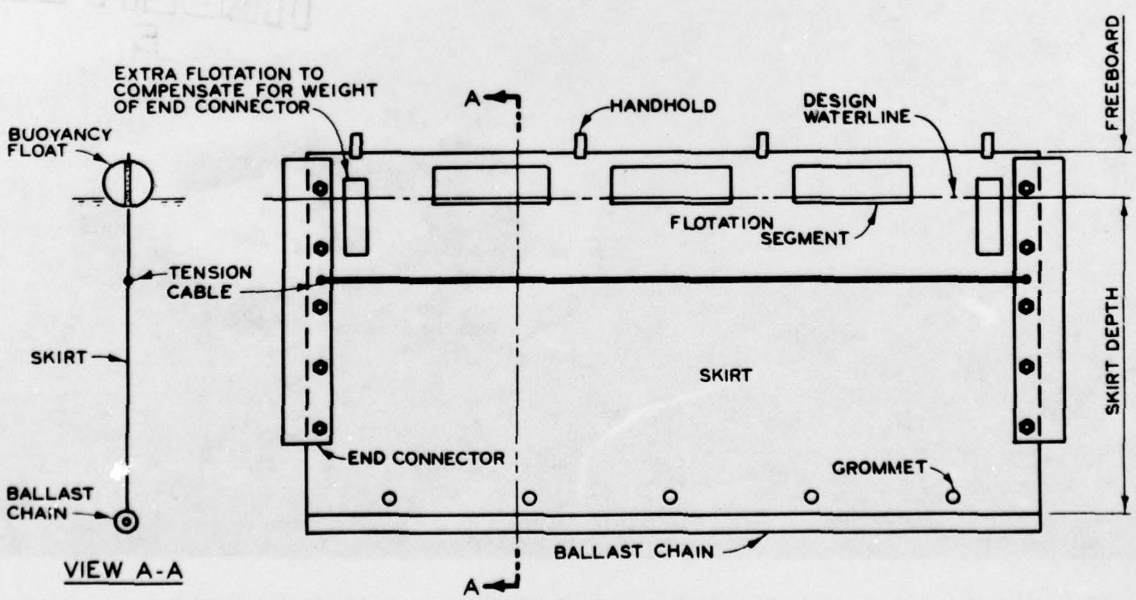

Figure 1. Typical center-tension silt curtain

(i.e., currents, tides, waves, etc.) at the site. Because of the high degree of variability in these factors, the effectiveness of different silt curtain operations is highly variable.

It should be emphasized here that silt curtains cannot effectively be used around all dredging or disposal operations; they are not recommended for operations in the open ocean, in currents exceeding 1 knot, in areas frequently exposed to high winds and large breaking waves, or around hopper or cutterhead dredges where frequent curtain movement would be necessary.

PROCESSES AFFECTING PERFORMANCE

In many cases where silt curtains are used, the concentration of fine-grained suspended solids inside the curtain enclosure may be relatively high (i.e., in excess of 1 g/ℓ) or the suspended material may be composed of relatively large, rapidly settling flocs. In the case of a typical pipeline disposal operation surrounded by a silt curtain (Figure 2) where suspended solids concentrations are high and material usually *flocculated, the vast majority (95 percent or more)* of the fine-grained material descends rapidly to the bottom where it forms a fluid mud layer that slopes away from the source of material at an approximate gradient of 1:200. The other 5 percent or less of the material remains suspended in the water column above the fluid mud layer and is responsible for the turbid appearance of the water inside the curtain.

While the curtain provides an enclosure where some of the fine-grained material may flocculate and/or settle, most of this fine-grained suspended material in

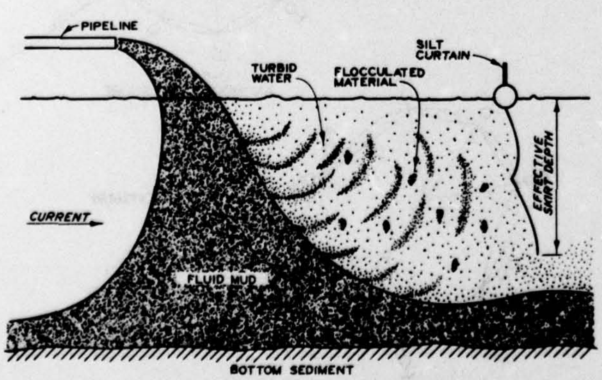

Figure 2. Processes affecting the performance of silt curtains in controlling dredged material dispersion

the water column escapes with the flow of water and fluid mud under the curtain. The silt curtain does not indefinitely contain turbid water but instead controls the dispersion of turbid water by causing it to flow under the curtain, thereby minimizing the turbidity in the upper water column outside the silt curtain.

Whereas properly deployed and maintained silt curtains can effectively control the flow of turbid water, they are not designed to contain or control fluid mud. In fact, when the accumulation of fluid mud reaches the depth of the ballast chain along the lower edge of the skirt, the curtain must be moved away from the discharge; otherwise sediment accumulation on the lower edge of the skirt will pull the curtain underwater and eventually bury it. Consequently, the rate of fluid mud accumulation relative to changes in water depth due to tides must be considered during a silt curtain operation.

SILT CURTAIN EFFECTIVENESS

In some cases where relatively quiescent current conditions (0.1 knot or less) are present, turbidity levels in the water column outside the curtain can be as great as 80 to 90 percent lower than the levels inside or upcurrent of the curtain. While there may be a turbid layer flowing under the curtain, the amount of suspended material in the upper part of the water column, as a whole, is substantially reduced.

The effectiveness of silt curtains can be significantly reduced in high energy regimes characterized by currents and turbulence. High currents cause silt curtains to flare, thus reducing the curtain's effective depth; in fact, in a current of 1 knot, the effective skirt depth of a 1.5-m curtain is approximately 0.9 m. Increased water turbulence around the curtain also tends to resuspend the fluid mud layer and may cause the turbid layer flowing under the curtain to resurface just beyond the curtain.

Even under moderate currents (up to 0.5 knots), a properly deployed and maintained center tension curtain can effectively control the flow of turbid water from under the curtain. In cases where anchoring is inadequate and particularly at sites where tidal currents dominate the hydrodynamic regime and may cause resuspension of the fluid mud as the curtain sweeps back and forth over the fluid mud with changes in the direction of the current, the turbidity levels outside the curtain can be substantially higher than the levels inside the curtain.

With respect to overall effectiveness and deployment considerations, a current velocity of approximately 1 knot appears to be a practical limiting condition for silt curtain use.

GUIDELINES FOR SELECTION AND USE

Site Survey

Prior to specifying or selecting a curtain for a particular project, it is necessary to characterize the deployment site with respect to current velocity, water depth (relative to tidal range), bottom sediment types, and possibly background levels of turbidity. Maximum surface currents over a tidal cycle (12 or 24 hr) should be established first. In addition, information on current direction and water turbulence may also indicate potential deployment problems and/or the best configuration to use.

If the hydrodynamic regime appears to be conducive to silt curtain deployment (i.e., current velocities are less than 1 knot), a survey of the water depths over the entire site and surrounding areas is required so that a curtain with a proper skirt depth can be selected and its initial and future placement geometries be determined. The minimum depths at the lowest low tide are used to determine necessary skirt depth allowing about 0.5-m clearance between the lower edge of the skirt and the existing bottom in the disposal area at the lowest low tide during the operation (the gap between the skirt and the bottom may be difficult to maintain in very shallow water). The effect of fluid mud accumulation on water depth as well as the proposed schedule for moving the silt curtain to prevent burial should also be considered in selecting the curtain skirt depth.

The character of the bottom sediment/vegetation at the proposed deployment site must be established to determine the type of anchors to use. Convenient anchor points on the outer limits of the deployment site should also be noted. The potential effect of boat traffic and boat-generated waves on the proposed deployment configuration and mooring system should be considered. Since launching and retrieving the silt curtain will require the use of a large truck and a boat(s), a launching ramp, crane service, etc., should be located as near the site as possible.

If an evaluation of silt curtain effectiveness relative to preoperation background conditions is desired, background turbidity levels must be determined preferably under a variety of current and wave conditions. Samples may be taken with a conventional water sampler at the surface, middepth, and near the bottom.

Deployment Configurations

After the deployment site has been surveyed, the geometry of the deployed curtain should be determined based on the type of silt curtain application, the hydrodynamic regime at the deployment site, and factors such as boat traffic. Any environmental policies regulating allowable turbidity levels as a function of distance from the operation should also be considered. Four typical deployment geometries are shown in Figure 3. Typical curtain lengths might be 150 to 450 m for the U-shaped or semicircular configurations and 300 to 900 m for the circular/elliptical case.

In some cases, the curtain may be deployed in an open-water environment in the form of a maze, a semicircle or U, or a circle or ellipse. The maze

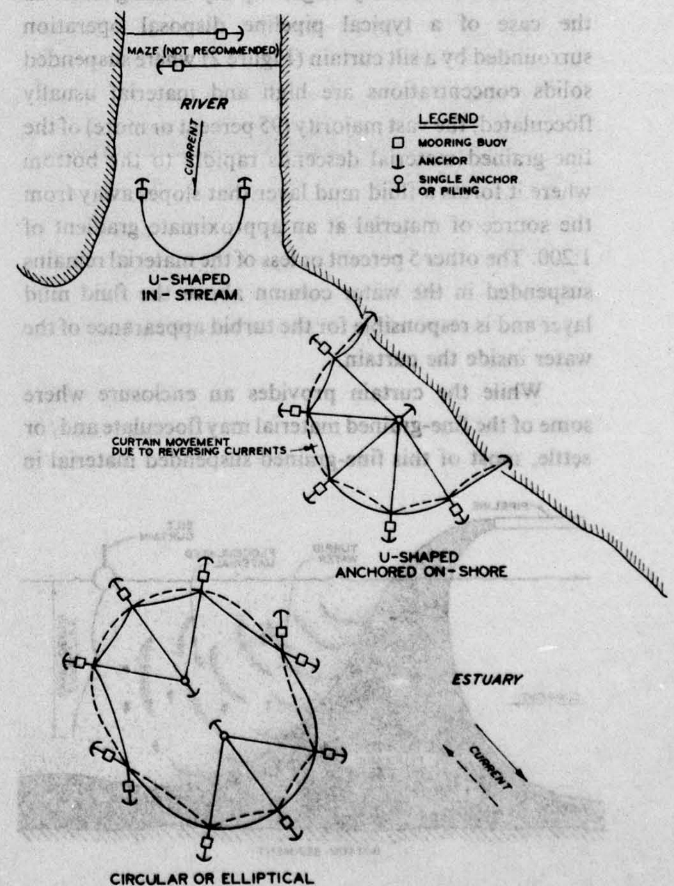

Figure 3. Typical silt curtain deployment configurations

configuration has been used on rivers where boat traffic is present, but appears to be relatively ineffective due to direct flow through the gap between the two separate curtain sections.

On a river where the current does not reverse, an in-stream U-shaped configuration is acceptable, but the distance between the anchored ends of the curtain (i.e., across the gap) should be large enough to prevent leakage of turbid water around the ends of the curtain. Where the turbid water is being generated by effluent from a containment area or a pipeline disposal operation close to the shoreline, the curtain can be anchored in a semicircular or U-shaped configuration with the ends of the curtain anchored onshore approximately equidistant from the discharge point. The required radius of the configuration is determined by the type and volume of material being disposed inside the curtained areas as well as the water depth. (Procedures for calculating the necessary radius and/or schedule for moving the curtain to prevent burial are given later.)

In a tidal situation with reversing currents, a circular or elliptical configuration is necessary. Unfortunately, this configuration requires an extensive mooring system.

Silt Curtain Specifications

The silt curtain can now be selected based on the appropriate deployment geometry and the characteristics of the deployment site. The following recommendations are made from an evaluation of silt curtain performance under various field conditions. In 1977 a 30-m section of silt curtain with these specifications and a skirt depth of 1.5 m could be purchased at an approximate cost of $700 (no tension member) to $1300 (center tension).

The silt curtain should have a skirt depth such that the lower edge is about 0.5 m from the bottom at lower water; however, the skirt depth should not exceed 3 m unless the current velocities at the site are negligible. The fabric should be a nylon-reinforced PVC material (or equivalent) with a tensile strength of 525 N/m ; a fabric weight of 610 g/sq m for low current conditions, 746 g/sq m for high current conditions; a tear strength of 445 or 890 N for 610- or 746-g fabric, respectively; and a tensile strength after abrasion of greater than 350 N/m.* The fabric surface should be easily cleaned and resistant to marine growth, ultraviolet light, and mildew. All fabric seams should be heat sealed.

Sections of solid, closed-cell, plastic foam flotation material should be sealed into a fabric pocket and provide a buoyancy ratio (buoyant force/curtain weight) of greater than 5. Each flotation segment should have a maximum length of 3 m so the curtain may be easily folded for storage or transport.

In low current situations (where velocities are less than 0.1 knot), most available connectors for joining 30-m sections probably maintain adequate physical contact along the entire skirt joint. If current velocities exceed 0.1 knot, aluminum extrusion (or equivalent) load-transfer connectors are recommended (Figure 4). The noncorrosive ballast chain should have a weight ranging from approximately 1.5 kg/m for a 1.5-m skirt depth up to 3.0 kg/m for a 3-m skirt depth.

When current velocities are negligible, no tension member (other than the fabric itself) is necessary. For current velocities between 0.1 and 1.0 knot, a galvanized or stainless steel wire rope should be used as a top or center tension member; the center tension curtain provides a somewhat greater effective skirt depth, but requires stronger tension members as well as more effective anchor systems.

* The fabric should be a nylon-reinforced PVC material (or equivalent) with a tensile strength of 300 lb/in.; a fabric weight of 18 oz/sq yd for low current conditions; 22 oz/sq yd for high current conditions; a tear strength of 100 lb or 200 lb for 18-oz or 22-oz fabric, respectively; and a tensile strength after abrasion of greater than 200 lb/in.

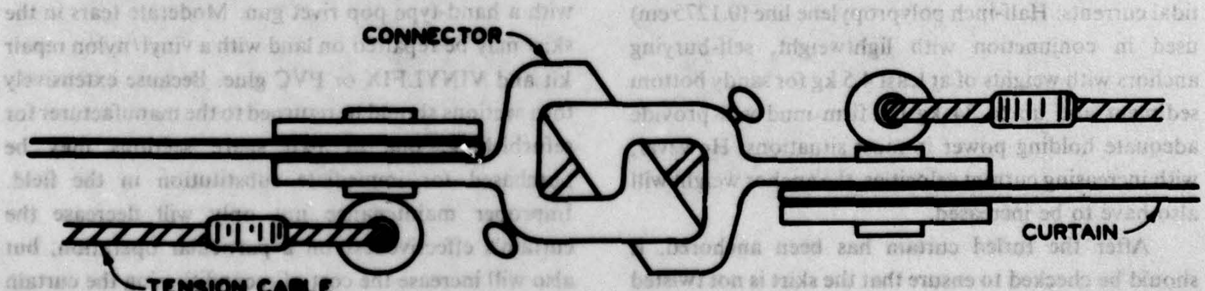

Figure 4. Aluminum extrusion connectors recommended for joining silt curtain sections

Handholds should be located along the top of the curtain between the flotation segments for ease in handling. Repair kits, included with a section of silt curtains, are necessary for patching minor tears in the fabric.

Transportation

When transporting silt curtains from a storage facility to an unloading site, they should be furled (Figure 5), tied with lightweight straps or rope every 1 to 1.5 m, compactly folded accordion style, packaged into large bundles, and carefully lifted into the transport vehicles. At the unloading dock, the curtain can be unloaded and maneuvered into the water by backing the truck down the ramp so that the tailgate is as close as possible to the water and then carefully pulling the curtain out of the truck (like a string of sausages); the 30-m sections are joined as they are played out. After all the sections have been joined, the curtain can be towed to the site by a boat travelling at 2 to 3 knots. Curtains over 600-m long have been towed in this way. The curtain should remain furled except near the end connectors until it has been deployed at the operation site.

An alternative method involves maneuvering the curtain onto an open-decked workboat or barge, transporting the curtain to the site, and finally off-loading the curtain in sections. The sections are then joined and the curtain deployed.

Mooring

Improper and/or inadequate mooring systems have often contributed to silt curtain ineffectiveness and failure. The recommended mooring system (Figure 6) consists of an anchor, a chain, an anchor rode (line or cable), and mooring and crown buoys. It is recommended that the curtain be anchored from the section joints every 30 m in a radial pattern (Figure 3) and on both sides if the curtain is exposed to reversing tidal currents. Half-inch polypropylene line (0.1275 cm) used in conjunction with lightweight, self-burying anchors with weights of at least 4.5 kg for sandy bottom sediment and up to 34 kg for firm mud will provide adequate holding power in most situations. However, with increasing current velocities, the anchor weight will also have to be increased.

After the furled curtain has been anchored, it should be checked to ensure that the skirt is not twisted around the flotation. If this is the case, the curtain should be separated at the nearest connector, untwisted, and rejoined. The curtain in its deployed, untwisted configuration can now be unfurled by simply cutting the furling lines or straps. If the barrier needs to be repositioned during the operation, any curtain with a long skirt depth relative to the ambient current conditions should be refurled before it is moved.

Deployment Model

The length of time that a silt curtain can remain deployed in its initial configuration before the enclosed area must be enlarged or the curtain moved to a new location to prevent siltation along the lower edge of the curtain depends on the accumulation of fluid mud inside the curtain relative to the deployment geometry, the discharge rate, and the initial bottom gap (i.e., the distance between the lower skirt edge and the bottom sediment at the beginning of the operation) as shown in Figure 7. The size of the enclosure is limited by the total length of the curtain available for the project. As the area of the enclosure increases, the length of time before the curtain must be moved also increases. In addition, as the gap between the lower skirt edge and the bottom sediment increases, the frequency of curtain movement decreases. Since it may be necessary to move a silt curtain during an operation, a procedure has been developed to calculate a schedule for curtain movement and redeployment and will be presented in the report on the study scheduled for publication early in 1978.

Maintenance

To maximize the effectiveness of a silt curtain operation, maintenance is extremely important. This entails moving the curtain away from the turbidity source just before the fluid mud layer reaches the lower edge of the skirt, replacing worn or broken anchor lines, and maintaining the integrity of the curtain by repairing leaking connectors and/or tears in the curtain fabric. Tears in the flotation pocket can be repaired in the water with a hand-type pop rivet gun. Moderate tears in the skirt may be repaired on land with a vinyl/nylon repair kit and VINYLFIX or PVC glue. Because extensively torn sections should be returned to the manufacturer for refurbishing, one or two spare sections may be purchased for immediate substitution in the field. Improper maintenance not only will decrease the curtain's effectiveness on a particular operation, but also will increase the cost of reconditioning the curtain for reuse.

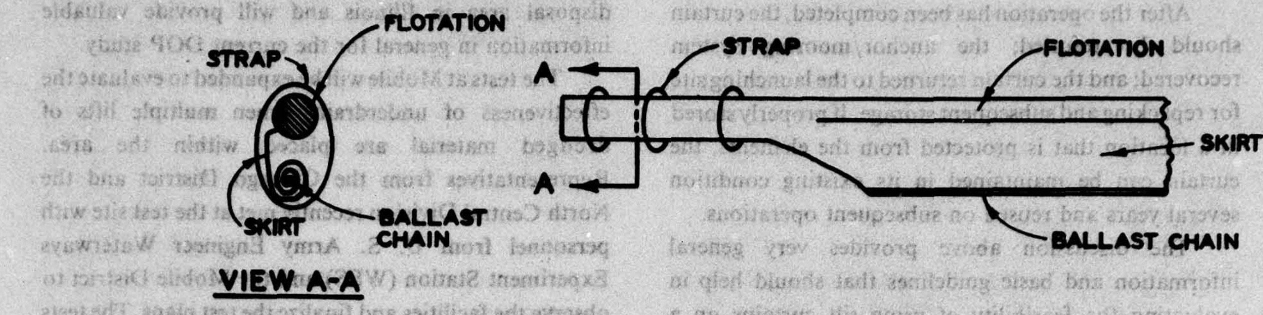

Figure 5. Furling of the curtain skirt for deployment and/or recovery of silt curtains

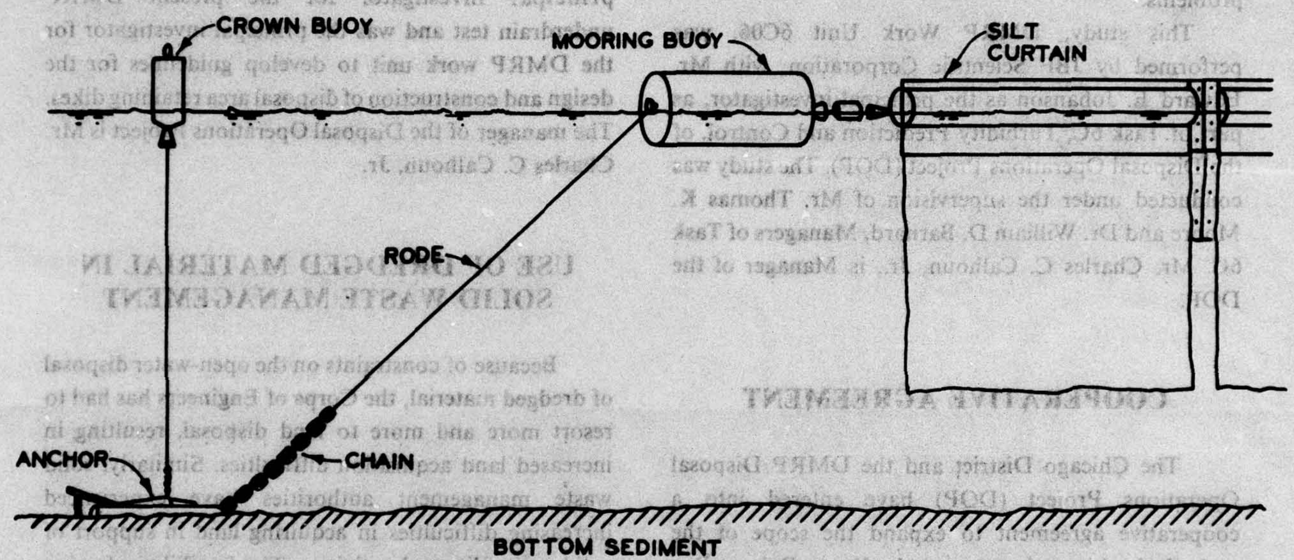

Figure 6. Recommended silt curtain mooring system

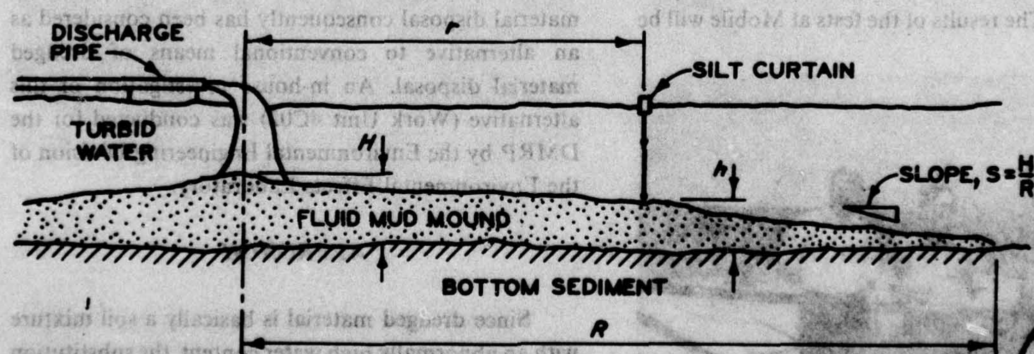

Figure 7. Parameters affecting the schedule for moving and redeploying silt curtains

Recovery

After the operation has been completed, the curtain should be refurled; the anchor/mooring system recovered; and the curtain returned to the launching site for repacking and subsequent storage. If properly stored in a location that is protected from the elements, the curtain can be maintained in its existing condition several years and reused on subsequent operations.

The discussion above provides very general information and basic guidelines that should help in evaluating the feasibility of using silt curtains on a particular operation. Many manufacturers provide advisory services to assist customers with site-specific problems.

This study, DMRP Work Unit 6C06, was performed by JBF Scientific Corporation, with Mr. Edward E. Johanson as the principal investigator, as part of Task 6C, Turbidity Prediction and Control, of the Disposal Operations Project (DOP). The study was conducted under the supervision of Mr. Thomas K. Moore and Dr. William D. Barnard, Managers of Task 6C. Mr. Charles C. Calhoun, Jr., is Manager of the DOP.

COOPERATIVE AGREEMENT

The Chicago District and the DMRP Disposal Operations Project (DOP) have entered into a cooperative agreement to expand the scope of the underdrain dewatering tests at the Upper Polecat Bay Disposal Area Field Test Site in Mobile, Alabama. The Chicago District is considering the use of underdrains in connection with a potential disposal area within an abandoned pit. The results of the tests at Mobile will be applicable to the site-specific conditions at the proposed disposal area in Illinois and will provide valuable information in general for the current DOP study.

The tests at Mobile will be expanded to evaluate the effectiveness of underdrains when multiple lifts of dredged material are placed within the area. Representatives from the Chicago District and the North Central Division recently met at the test site with personnel from U. S. Army Engineer Waterways Experiment Station (WES) and the Mobile District to observe the facilities and finalize the test plans. The tests will be conducted by Mr. David P. Hammer of the WES Soils and Pavements Laboratory. Mr. Hammer is principal investigator for the present DMRP underdrain test and was the principal investigator for the DMRP work unit to develop guidelines for the design and construction of disposal area retaining dikes. The manager of the Disposal Operations Project is Mr. Charles C. Calhoun, Jr.

USE OF DREDGED MATERIAL IN SOLID WASTE MANAGEMENT

Because of constraints on the open-water disposal of dredged material, the Corps of Engineers has had to resort more and more to land disposal, resulting in increased land acquisition difficulties. Similarly, solid waste management authorities have experienced increasing difficulties in acquiring land in support of solid waste disposal activities. The feasibility of using dredged material in solid waste management and thereby satisfying the solid waste disposal material needs and creating additional space for future dredged material disposal consequently has been considered as an alternative to conventional means of dredged material disposal. An in-house investigation of this alternative (Work Unit 4C02) was conducted for the DMRP by the Environmental Engineering Division of the Environmental Effects Laboratory.

APPROACH

Since dredged material is basically a soil mixture with an abnormally high water content, the substitution of dewatered dredged material for soil should be feasible. The types of dredged material suitable for use in conjunction with solid waste management have been determined. The properties of dewatered dredged material were compared with those of similar soils, and the suitability of dewatered dredging material to fulfill the requirements of soil at solid waste disposal operations have been evaluated. In addition, the characteristics of dredged material disposal operations were investigated to devise innovative concepts for using dredged material in solid waste management.

FINDINGS

Dredged material that has been dried to the point that it has a water content comparable to that of natural soil of similar grain size generally has the physical and engineering properties required to be suitable for several uses in a sanitary landfill. Use of the material in construction of cover, liners, and gas barriers is technically feasible, based on a comparison of the properties of suitable natural soils with the properties of dewatered dredged material.

The use of dredged material in slurry or semisolid form is not practical in a conventional sanitary landfilling operation. However, the use of slurry injected into existing sanitary landfills to fill voids or to control underground fires appears feasible but limited in application. The use of semisolid dredged material to cover lifts of shredded solid waste is acceptable when trafficability in the area is not immediately necessary.

Since coarse-grained dredged material (sand and gravel) is free-draining and does not require dewatering, such material is ready for use as it exists in most containment areas. This coarse-grained material can be used to construct drainage blankets for collecting leachate and can be used to vent decomposition gases to the atmosphere.

The area method of sanitary landfilling is the most adaptable to the use of dredged material as cover, although the trench method is applicable when proper planning, design, construction, and operation are included in the plans and specifications. In such cases a filled dredged material containment area could serve as a sanitary landfill.

The procedural guidelines for selecting materials for use as solid waste disposal sites indicate that most dewatered dredged material could be used in some way at most of these sites. If composting becomes a more widely used solid waste management operation in the United States, then dredged material may be used to cover compost landfills or as an admixture to improve the physical properties.

RECOMMENDATIONS

Corps of Engineers Districts and others facing disposal problems should make all practical efforts to consider the feasibility of dewatering at least portions of the dredged material in containment areas so that the dewatered material could be more attractive to and readily available to solid waste management authorities and other potential users.

The use of inactive dredged material containment areas as sanitary landfills should be considered by solid waste management authorities in order to find use for otherwise unused land.

This solid waste management study was conducted as part of the Productive Uses Project, Mr. Thomas R. Patin, Manager. Mr. Michael Bartos was principal investigator and wrote the report, which is Technical Report (TR) D-77-11.

FREEZE-THAW ENHANCEMENT OF FINE-GRAINED DREDGED MATERIAL IN CONFINED DISPOSAL AREAS

Past laboratory studies have indicated that the densities of certain soils can be increased by freeze-thaw cycling. A DMRP study (Work Unit 5A07) was therefore initiated in May 1975 to determine the feasibility of using natural frost action to accelerate and enhance the consolidation and densification of fine-grained dredged material and to improve its engineering properties.

Fine-grained dredged material obtained from disposal sites in the Great Lakes region was subjected to controlled freeze-thaw cycling in a special laboratory consolidometer. Volume changes and permeabilities were observed after full consolidation and freeze-thaw cycling for applied pressures in the range of 0.93 to 30.73 kPa.

It was observed that as much as 20 percent or more volume reduction resulted when dredged material with liquid limits in the range of 60 to 90 percent was subjected to one cycle of freezing and thawing. The degree of overconsolidation by freezing and thawing appeared to decrease with increasing amounts of coarse materials and with increasing plasticity. The vertical permeability of all materials examined was increased as much as two orders of magnitude for the materials examined, the greatest increase in permeability occurring for the fine-grained materials at the lowest stress levels.

The application of the phenomenon of overconsolidation by freezing and thawing to disposal sites is discussed and site management procedures are suggested in the final report. The process appears to be particularly adaptable to regions of severe winters where material frost penetrations of more than 1 m can be obtained, but it can be applied seasonally to regions of more moderate winters (such as in the Great Lakes region) by sequentially depositing relatively thin layers of dredged material and allowing each layer to freeze before more dredged material is discharged.

The study was conducted by E. L. Chamberlain and S. E. Blouin of the U. S. Army Cold Regions Research and Engineering Laboratory as part of the Disposal Operations Project, Charles C. Calhoun, Jr., Manager. The contract was monitored by Michael R. Palermo, Environmental Engineering Division of the Environmental Effects Laboratory. The report is in press and will be available in the near future as TR D-77-16.

AVAILABILITY OF SEDIMENT-ADSORBED PESTICIDES TO DEPOSIT-FEEDING ANIMALS

A laboratory study to determine the availability of sediment-adsorbed DDT and its metabolites to several species of deposit-feeding benthic infauna that may form a link for the entry of DDT into aquatic food webs has recently been completed. This study (Work Unit 1D07) was part of Task 1D, Effects of Dredging and Disposal on Aquatic Organisms, in the Environmental Impacts and Criteria Development Project (EICDP), Dr. Robert M. Engler, Manager. Principal investigator for this research was Dr. Marcel Nathans of LFE Corporation, Richmond, California.

DESCRIPTION OF STUDY

The objective was to determine the ability of selective and nonselective deposit feeders to take up DDT and its degradation products DDD and DDE from sediment interstitial water and from ingested detritus or clay particles. Another objective was to determine if excretion of the pesticides and/or their degradation products would keep the levels in the organisms low or if pesticide levels in the organisms would increase gradually.

Sediments were artificially compounded from sand, clay, and detritus (organic matter), with clay and detritus separately tagged with radioactively labeled pesticide. Organisms were introduced into these sediments and sampled for analysis in accordance with a predetermined time schedule.

Coastal and freshwater species were selected that were representative of organisms common to the United States. The species studied were *Capitella capitata,* a nonselective-feeding marine polychaete; *Nephtys californiaensis,* a selective-feeding marine polychaete; and *Tubifex tubifex,* a nonselective-feeding freshwater oligochaete.

TEST RESULTS

DDT was found to accumulate in *Capitella* and in *Tubifex*. This indicates that at least some of the DDT is available when adsorbed on clay and on organic matter. Accumulation was also found in *Nephtys*, but most of the DDT originated from clay as suggested by the low organic carbon content of the sediment (0.06%) and by the results of a separate experiment in which only clay was tagged.

Total levels of DDT and metabolites reached a steady state in *Capitella* and *Tubifex* after about 30 days and in *Nephtys* after about 70 to 80 days, indicating that some type of control of internal concentration occurs. The bioaccumulation factors found for uptake from the sediments were about 2 for *Tubifex*, about 50 to 70 for *Capitella*, and about 8 for *Nephtys*. These factors are much lower than those found where uptake is directly from water. There was also some indication from *Tubifex* experiments that the bioaccumulation factors are not sensitive to changes in the DDT concentration of the sediment.

The degradation of DDT, to the extent that it occurred, was almost entirely to DDD. Only in *Tubifex* was there some evidence of degradation to DDE. The DDT/DDD ratios in the organisms were about the same as in the sediment in the samples analyzed.

LIMITATIONS

Results of this study demonstrated that a small fraction of radio-labeled DDT freshly adsorbed to artificial sediments was available for uptake by deposit-feeding annelids. However, DMRP personnel feel several factors should be kept in mind by those desiring to use the findings of this study to estimate potential effects in the field.

First among these is the general caution that no laboratory study can exactly duplicate field conditions; therefore, the best-designed laboratory studies usually permit only the extrapolation of trends, rather than precise response, to the field. The entire study was conducted with artificially prepared sediments labeled with radioisotopes rather than with contaminated natural sediments. An artificial organic substrate was used as substitute detritus with no attempt to verify its suitability.

There was no measurement of initial DDT body burdens in the test animals collected, although this could affect regulation or uptake processes, nor was there any measurement of total body burden after the experimental exposure period.

The possible loss of DDT from the sediment to the water column was dismissed by the investigators even though the concentration that would be required to produce the observed apparent loss in the flow-through system used would only be less than the detection limit in the study. This point is important because it will affect the calculated accumulation ratios and calculated degradation rates and may even influence the observed DDT uptake since material in the water column is generally more available than the same material in a particulate phase.

The reader is also cautioned that the observed body burden levels were combinations of DDT actually incorporated in the body tissue and DDT passively being transported through the gut still tightly adsorbed to sediment particles. Therefore, results from the so-called "tissue analyses" are artificially high by an unknown amount and the actual extent of DDT accumulation in organism tissue was not determined.

The study demonstrated that a viable pathway exists for the movement of radio-labeled DDT from freshly tagged artificial sediments to benthic organisms. However, in view of the above comments, the reader is urged to consider carefully the appropriateness of this study to his needs before the results are used to assess the significance of such movement.

The report of the study is in press and will be available about November 1977.

A COMPREHENSIVE STUDY OF SUCCESSIONAL PATTERNS OF PLANTS AND ANIMALS AT UPLAND DISPOSAL AREAS

A field research project performed in 1974 and 1975 under DMRP Work Unit 5B03 by Coastal Zone Resources Corporation of Wilmington, North Carolina, resulted in the biological description of five upland disposal sites. The study was initiated to examine upland disposal sites for the relationships between dredged material and plant and animal patterns. Information of this nature is necessary for planning habitat development and management activities.

Five sites were selected across the country:

- Nott Island, Connecticut, in the lower portion of the Connecticut River.
- Six islands in Hillsborough Bay, Tampa, Florida.
- A disposal area for the Whiskey Bay Pilot Channel in the Atchafalaya River Basin, Louisiana.
- A disposal area for the Gulf Intracoastal Waterway between Port Arthur and Galveston, Texas.
- Mott Island in the lower Columbia River near Astoria, Oregon.

These sites were selected for their geographic distribution, their relation to planned Habitat Development Project fieldwork, and their service as historic disposal sites.

Another feature that they share is their isolation. Three of the sites are true islands. The other two sites, by nature of the placement of dredged material, have resulted in functional islands; i.e., they have caused an abrupt change in the topography and soil structure of the area.

The study areas were approached by an analysis of the history of disposal, a description of the setting, field studies for botany and wildlife, and analysis of historical air photos.

Through use of the air photos, it was possible to trace the development of vegetation succession at the sites over a period as long as 40 years. Due to multiple periods of dredged material disposal, the successional patterns of each site were not clear cut. They did in general follow the pattern expected for that geographic region.

Plant succession in general starts with grasses or herbs. As these plants modify the dredged material substrate by trapping sediments and by dying and decomposing, the way is prepared for further succession. Unless disposal or another disturbance such as fire interrupts this process, shrubs and trees can be expected to invade most sites.

Animal succession patterns closely follow those of vegetation, since a major determinant of animal colonization is vegetation and habitat structure. On the sites examined in this study, animal diversity and abundance were dependent upon accessibility to the site, suitability of feeding cover and breeding habitat, and invasion ability of the animal species.

The conclusion of the study was that factors governing succession in a region also act on upland dredged material disposal sites, but generalized patterns are modified by factors that relate to the island nature of the disposal areas.

This study was conducted as part of DMRP Task 4B, Terrestrial Habitat Development, of the Habitat Development Project, Dr. Hanley K. Smith, Manager. This contract was managed by Ms. Jean Hunt. The report was published as Contract Report D-77-2 and is now available.

This bulletin is published in accordance with AR 310-2. It 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 bulletin 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, Miss. 39180, or call AC 601, 636-3111, Ext. 3233.

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