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An Executive Summary of Three EPA Demonstration Programs In Erosion And Sediment Control

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AN EXECUTIVE SUMMARY OF THREE EPA DEMONSTRATION PROGRAMS IN EROSION AND SEDIMENT CONTROL

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ABSTRACT

This report presents the highlights of three recently completed programs in the area of sediment and erosion control. These programs were a "Joint Construction Sediment Control Project", Project No. 15030 FMZ; a "Programmed Demonstration for Erosion and Sediment Control Specialists," Project No. S800854 (15030 FMZ); and a "Demonstration of the Separation and Disposal of Concentrated Sediments", Contract No. 68-01-0743.

The "Joint Construction Sediment Control Project" was performed in a natural and agricultural region which was being transformed into an urban community. It consisted of the implementation, demonstration, and evaluation of erosion control practices; the construction, operation, and demonstration of the use of a local stormwater retention pond for the control of stormwater pollution; the construction, operation, and maintenance of methods for handling, drying, conditioning, and disposing of sediment; and performance of a gaging and sampling program to determine the effects of urbanization on the hydrology, ecology, and water quality of natural areas. In addition to the project final report, the EPA document entitled "Guidelines for Erosion and Sediment Control Planning and Implementation"[1] was also prepared under this program.

The "Programmed Demonstration for Erosion and Sediment Control Specialists" project developed a series of presentations on sediment and erosion control and a certification plan for erosion and sediment control specialists. The basic work under the project involved the development of 15 presentations on various topics relating to erosion and sediment control, the conversion of six of these presentations into the audiovisual format, the demonstration of the program, and the evaluation of the audiovisual approach against the conventional technical presentations with slides.

In the "Demonstration of the Separation and Disposal of Concentrated Sediments" a field demonstration was conducted of a system for removing and processing sediments from pond bottoms. The removal system consisted of a MUD CAT dredge, and the portable sediment processing system consisted of a pair of elevated clarifier bins arranged in series, a bank of hydrocyclones, a cartridge filter unit, and a Uni-Flow bag-type fabric filter consisting of 720 one-inch diameter polypropylene hoses. Additional development of the Uni-Flow filter concept through the testing of five-inch diameter prototype hoses was also performed after the field demonstration of the sediment removal and processing system was complete.

This report was submitted in partial fulfillment of Contract No. 68-01-0743 by Hittman Associates, Inc. under the sponsorship of the Environmental Protection Agency. Work was completed as of November 30, 1973.

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ACKNOWLEDGEMENTS

Many individuals, governmental agencies and commercial establishments contributed to the conduct and success of the programs described herein. It would be impossible to name them all. However, the technical contributions, project guidance, critical review, and editorial comments provided by some of the members of this group require individual recognition. They are:

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SECTION I
CONCLUSIONS

The three EPA programs in erosion and sediment control described herein have advanced the state-of-the-art of erosion and sediment control in the areas studied to the point of practical application. Many of the results of the programs can be directly applied to the solution of existing pollution problems and the implementation of pollution control plans.

The EPA document, "Guidelines for Erosion and Sediment Control Planning and Implementation," was the first comprehensive assessment of the state-of-the-art erosion and sediment control practices and procedures.

A comprehensive instructional package for erosion and sediment control specialists has been developed.

Methods for enhancing and disposing of dredged sediment in a environmentally compatible manner have been demonstrated.

SECTION II
RECOMMENDATIONS

It is recommended that additional work of an applied research nature be initiated in erosion and sediment control. Demonstration projects similar to the "Joint Construction Sediment Control Project" should be initiated in other parts of the country in order to gather additional baseline data applicable to other physiographic and climatic regions.

Additional field trials and applications of the equipment utilized in the "Demonstration of the Separation and Disposal of Concentrated Sediments" should also be pursued. This is especially true of the Uni-Flow filter, which is applicable in a variety of wastewater treatment applications.

SECTION III
INTRODUCTION

Prior to the initiation of the EPA applied research program in erosion and sediment control, little work of a practical, comprehensive nature had been conducted in addressing the problems associated with erosion from construction sites and the resulting sedimentation in streams and lakes.

The programs described in the following sections have furthered the state-of-the-art of erosion and sediment control technology in the areas of:

(1) Methods of controlling erosion on site
(2) Methods for cleaning of sediment ponds
(3) Enhancing the characteristics of dredged sediment
(4) Training of erosion and sediment control specialists
(5) Separation and disposal of solids from dredged slurries in an environmentally acceptable manner

Practical implementation of the results generated by these programs in many of the areas described above is now a reality. Application of the results of these programs are presently being utilized in commercial developments and government pollution control plans as well as in continued EPA research and development programs.

SECTION IV

JOINT CONSTRUCTION SEDIMENT CONTROL PROJECT

BACKGROUND

This project was a two-year program conducted in the Village of Long Reach, Columbia, Maryland. It was operated by the Department of Water Resources, State of Maryland, under an Environmental Protection Agency demonstration grant, Project No. 15030 FMZ. Hittman Associates, Inc., of Columbia, Maryland, was the prime contractor for this project. Howard Research and Development Corporation, the developers of Columbia, and the Columbia Parks and Recreation Association, Inc., a nonprofit corporation representing the community used, also participated in this project.

During the period of this demonstration program, a natural and agricultural region was converted to an urban community. This project consisted of:

1. The implementation, demonstration, and evaluation of erosion control practices.

2. The construction, operation, and demonstration of the use of a local stormwater retention pond for the control of stormwater pollution.

3. The construction, operation, and maintenance of methods of handling, drying, conditioning, and disposing of sediment.

4. A gaging and sampling program to determine the effects of urbanization on the hydrology and water quality of natural areas.

This demonstration project was conducted within a 190-acre watershed in the Village of Long Reach. Figure 1 is an aerial view of this watershed. A variety of practices were demonstrated and evaluated in order to develop general criteria and guidelines for implementation of stormwater pollution and erosion control techniques. Specifically, it:

1. Evaluated the effectiveness and costs of conventional and advanced methods of erosion control in urban areas (surface landscape techniques).

2. Evaluated the effectiveness and costs of various methods for the transport, drying, conditioning, and disposal of sediment.

3. Evaluated the effectiveness and acceptability of introducing stormwater and sediment retention ponds in urban communities.

EROSION CONTROL DEMONSTRATION

Objectives

One of the principal objectives of this program was the demonstration of advanced methods of erosion control in developing urban areas and the evaluation of the cost and effectiveness of the methods. The goal of this effort was the development of design, performance, and application criteria that could subsequently be used by developers, planners, designers, engineers, and builders in the development and implementation of grading, sediment, and erosion control plans as required by the "Shore Erosion Control Act" of the State of Maryland, and similar laws and regulations of

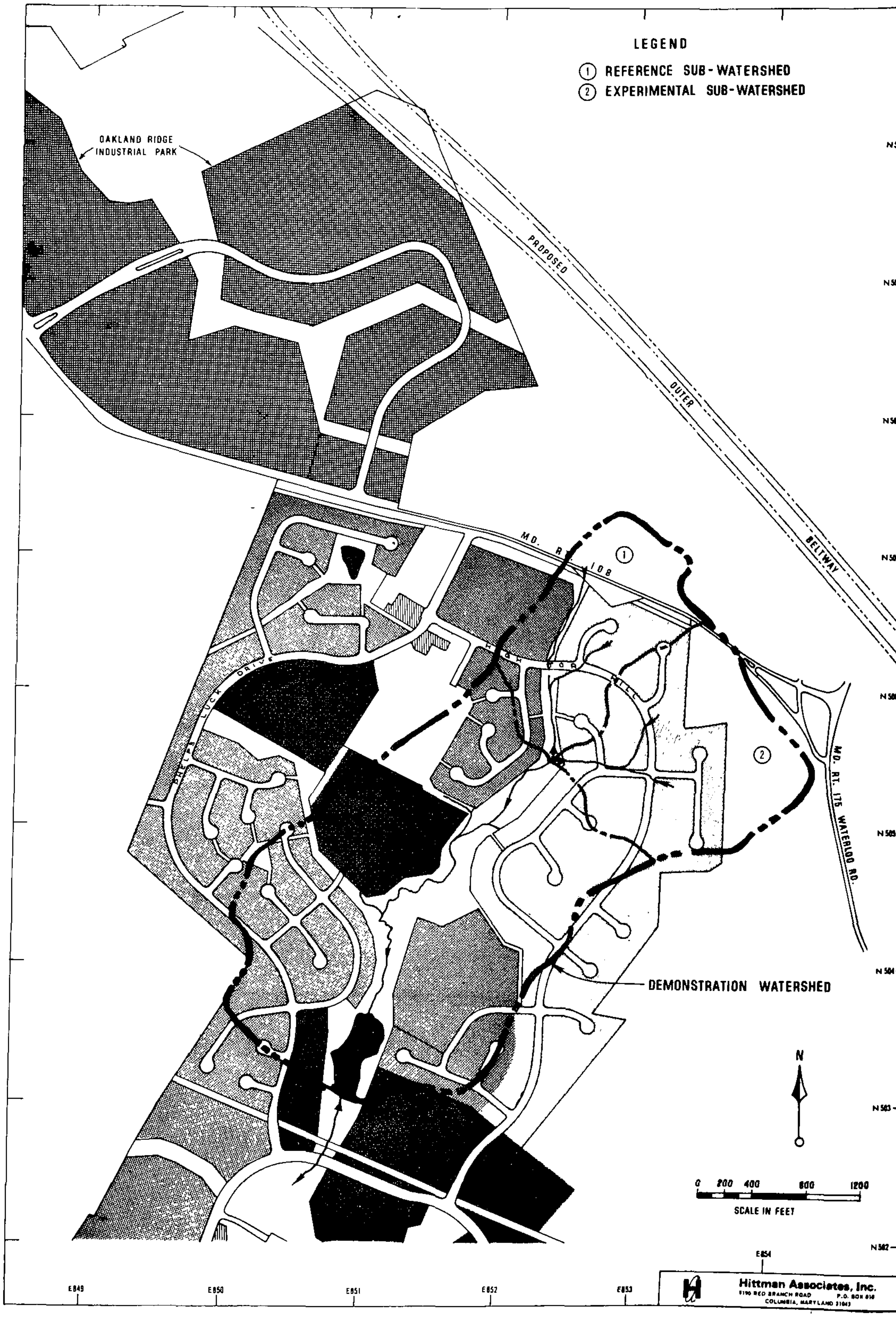

FIGURE 1. Aerial View of Demonstration Watershed

other states, counties, and political jurisdictions. Also, the information on the design and performance of the various erosion control techniques demonstrated and evaluated under this program were documented for use by regulatory agencies in the development of detailed regulations and requirements, and for use in the review and approval of grading, sediment, and erosion control plans submitted in compliance with such regulations.

Procedures

In order to carry out this effort it was necessary to:

1. Monitor and record the status of development. This was accomplished through the use of aerial photographs and repetitive benchmark photography from numerous locations throughout the demonstration area.

2. Install, apply, and monitor the performance of various erosion control practices.

3. Install and operate sampling equipment. As a part of this, surveys and evaluations of readily available sediment sampling equipment were conducted.

4. Collect samples.

5. Conduct surveys of eroded areas and sediment deposits.

6. Monitor and record cost and application information required to implement control of selected practices.

It is well known that erosion control practices, products, and/or techniques must be tailored to individual sites and must be based on such factors as topography, soil conditions, construction operations, etc. Consequently, a wide variety of erosion and sediment control products, practices, and techniques were investigated during the course of the demonstration project in order to provide as large a cross section of application parameters as possible.

In all, a total of 45 products, practices, and techniques were investigated These can be divided into four major categories as follows:

1. Chemical Soil Stabilizers, Mulches, and Mulch Tacks

2. Erosion and Sediment Control Structures

3. Fiber Mulches, Mulch Blankets, and Nettings

4. Special Erosion and Sediment Control Practices

In addition to the above more conventional means of erosion and sediment control, the use of other less conventional ideas for erosion and sediment control were investigated. One such idea involved the possible utilization of recycled glass in erosion control. The conclusions drawn from this specific investigation must be regarded as generally negative because the need for glass to produce products that are currently on the market (all glass brick, glass and clay brick, glass phalt, etc.) far exceeds the supply of used glass. It was further determined that, if all of the used glass in existence could be made available for reuse in these products, the supply would still fall short of the demand.

The evaluation and comparison of the performance of the various erosion control practices required techniques that could quantitatively measure the effectiveness of soil retention. Part of this monitoring program involved the installation of four major automatic stream gaging and sampling stations. Data from these installations were supplemented by samples which were collected by hand.

Results

One of the major results of the erosion control demonstration portion of this project was the publication of the EPA document entitled "Guidelines for Erosion and Sediment Control Planning and Implementation."[1] The principal purpose of the "Guidelines" is to help those responsible for, or engaged in, urban construction prevent the uncontrolled movement of soil and the subsequent damage it causes. The "Guidelines" presents a comprehensive approach to the problem of erosion and sediment control from beginning of project planning to completion of construction. It provides:

1. A description of how a preliminary site evaluation determines what potential sediment and erosion control problems exist at a site being considered for development.

2. Guidance for the planning of an effective sediment and erosion control plan.

3. Procedures for the implementation of that plan during operations.

Technical information on 42 sediment and erosion control products, practices, and techniques is contained in four appendices. In addition, a cross index and a glossary of technical terms used in the document are provided.

The "Guidelines" is designed and intended for use by both technical and lay personnel.

STORMWATER STORAGE AND TREATMENT

Objectives

A major component of this portion of the project was the demonstration of a method of urban stormwater pollution control, using local storage and treatment of stormwater. Even where the most advanced erosion control techniques are employed, considerable erosion can be expected to occur in watersheds undergoing urbanization. Among other sources, the stream channel itself, under the influence of the greatly increased runoff, may contribute substantial quantities of sediment. This phase of the project was developed to prevent this residual sediment from degrading downstream water quality.

The major objective of this phase was the demonstration and evaluation of local storage and treatment of stormwater as a method of controlling stormwater pollution both during and after urbanization. In order to fully explore this application, the demonstration activities were directed to the following:

1. Demonstration of the use of an open pond located in the natural floodplain as a stormwater storage facility and

primary sediment trap

2. Preliminary evaluation of advanced sedimentation devices, such as tube settlers, for use as sediment traps, both alone and in conjunction with the open pond

3. Demonstration of the use of advanced sedimentation devices, should feasibility be determined in the preliminary evaluation

4. Development of design criteria for the use of open ponds and advanced sedimentation devices for control of stormwater pollution in urban areas

5. Preliminary investigation of the use of chemical coagulants and coagulant aids in the control of stormwater pollution

6. Investigation of the effect of the open pond and other stormwater pollution control devices on surrounding land uses and land values

7. Investigation of the effect of the stormwater pollution control and pollution control facilities on floodplain and stream channel ecology, both upstream and downstream

8. Investigation of the effect of the stormwater pollution control and pollution control facilities

on flood plain utilization

Procedures

At the downstream terminus of the demonstration watershed, a lake was constructed to act as a combination sediment trap and stormwater management device. The lake was impounded by constructing an earth-fill dam with an impervious clay core across the main stream channel. Some shaping was then done to the stream valley bottom and sides to obtain the finished pond configuration.

During the course of this demonstration project, the hydraulic performance characteristics of the pond were monitored with respect to efficiency as a stormwater management device. Stream gaging and sampling stations monitored the water quantity and quality entering and leaving the pond. Cross sections of the pond bottom were surveyed quarterly. Operating records of the drawdown device valve openings and closings were kept in order to attempt an analysis of the effect of operating procedure on the pond's efficiency as a stormwater management device. In addition, the quarterly airphoto coverage kept track of the changes to the surface characteristics of the pond area and its watershed.

Methods for the treatment of the stormwater before its release from the pond were investigated. The purpose of this was to determine if a water quality significantly higher than would normally be released from the pond could be economically achieved. If the preliminary analyses indicated that such a feasibility existed, the selected treatment system(s) would be demonstrated. It was found, however, that, because of the relatively high natural trap efficiency of the pond, additional treatment methods or devices would not economically increase the water quality of the pond outflow water.

In conjunction with the stormwater aspects of this demonstration program, a survey of the residents of the Village of Long Reach was conducted. Generally, the survey was designed to gather opinions and suggestions in three major areas. First, suggestions were requested as to how the residents would like to see the area adjacent to the lake and the floodplain upstream developed for recreation. Secondly, the residents were asked how they were currently utilizing the lake and floodplain areas (the construction activities had not been completed and only minor recreation development had been accomplished). The third major interest was concerned with the basic desirability of a four-acre pond and the effect of this pond on real estate, aesthetic, and recreational values.

Results and Conclusions

It was found that the type of design used for the dam and retention pond was adequate from a stormwater management and sediment trap point of view. In addition, its presence in the development was readily accepted by the residents. This acceptance is especially apparent if such ponds can be converted to aesthetically acceptable and harmonious use after construction is complete.

Based on limited observations, the actual trap efficiency of the pond during selected storm overflow conditions was found to be generally higher than predicted on a theoretical basis. Also, under base flow conditions, little difference in the water quality between the pond influent and effluent was noted.

SEDIMENT HANDLING, DRYING, CONDITIONING, AND DISPOSAL

Objectives

One of the most important aspects of stormwater control is the handling and ultimate disposal of accumulated sediment. The most efficient sediment retention system can be rendered useless if the collected sediment is merely transferred to another area in such a manner as to allow its reentry into surface waters. Sediment handling and disposal is difficult and costly. Sediment, as such, has little economic value, so that there is considerable incentive for the employment of low cost yet effective disposal techniques.

The objectives of this phase of the study were:

1. Evaluation and demonstration of various means of removing sediment from each of the sediment collection systems.

2. Evaluation and demonstration of techniques for transporting wet sediment from the collection systems to the drying facility.

3. Evaluation and demonstration of techniques for conditioning sediment prior to application to drying beds.

4. Evaluation and demonstration of methods for efficient drying of sediment.

5. Evaluation and demonstration of methods of ultimate disposal of sediment, including organic and inorganic additives to alter sediment properties.

Procedures

The primary facility for entrapping sediment from stormwater runoff in the project watershed was the stormwater retention pond. In order to reduce the quantity of sediment being transported into the pond and to help facilitate sediment removal, an engineered forebay was designed and constructed. In essence, an engineered forebay is a settling basin located at the junction of a stream with a pond and separated from the pond proper by a submersed weir or dam. A forebay serves as an entrapment device for both bed load and suspended sediments.

The techniques finally selected for demonstrating sediment removal were conventional dragline, underwater scoop with a long reach, and utilization of the forebay as a sediment holding and dewatering area prior to hauling away by conventional dump truck. After sediments from the forebay had been removed, the drag line bucket was replaced with the long reach sediment scoop arrangement. Sediment from the pond was then scooped into the forebay and loaded by backhoe onto dump trucks. The arrangement of scooping sediment into the forebay and simultaneous removal from the forebay and loading by backhoe resulted in the most efficient sediment removal technique that was demonstrated.

Several methods were considered for effective drying of sediment. These included the use of both chemical and physical methods to enhance the rate of drainage and drying. A wide variety of chemical conditioners were tested under laboratory conditions for their effect on sediment drainability. The test results indicated that, in general, chemical conditioners would be impractical under field conditions. Physical methods of sediment dewatering proved to be reasonably effective and practical. The physical techniques investigated included the use of the forebay as a partial draining device during pond cleaning, sand drying beds, grass filter strips, and surface scarification of disposed sediment to enhance drying.

Field studies were conducted to determine the feasibility of manipulating sediment in order to acquire a material with improved characteristics. Several low cost and usually available materials were tested for their effectiveness as sediment conditioners. These included digested sewage sludge, fly ash, woodchips, high magnesium lime, and 10-10-10 fertilizer.

<u>Results and Conclusions</u>

Overall, the selected sediment removal techniques proved an effective way of cleaning the pond and forebay. However, the drag line operation proved to be somewhat time-consuming and inefficient because the bucket frequently spilled sediment material before it could be loaded.

During the sediment conditioning experiments, the following general observations were noted:

1. Grass seed germination occurred first on plots containing digested sewage treatment plant sludge.

2. Plots containing fly ash germinated two weeks later than control plots.

3. Areas containing woodchips had stunted and sparse grass growth.

4. Grass coverage and density was greatest on the fertilizer and sewage sludge plots.

5. Plant response on plots treated with lime was similar to the control plots.

6. Plots treated with lime experienced dense rapid grass growth during the first few weeks. Signs of nutrient deficiency became apparent during the second month of growth.

HYDROLOGY, WATER QUALITY & ECOLOGY

Objectives

The investigations conducted under this part of the demonstration program can be divided into four general categories:

1. Hydrology and water quality of urbanizing areas.

2. Stream channel morphology studies.

3. Application of the EPA Storm Water Management Model.[2]

4. Monitoring of the changes in the ecology of the stream channel and floodplain which were associated with urbanization.

Within these four major categories, the detailed objectives were as follows:

1. Measurement and recording of hydrologic events, including rainfall at three raingage stations and streamflow at four stream gages.

2. Operation of a comprehensive water quality monitoring program covering all portions of the demonstration watershed as well as at least one downstream sampling point.

3. Observation of physical and ecological changes in floodplains and stream channels as a result of urbanization and of erosion control and stormwater quality control.

4. Maintenance, through aerial photography and other methods, of a detailed inventory of land use and watershed activities through the period of the demonstration project.

5. Acquisition of a periodic inventory of the fauna and flora within the stream channel, floodplain, and pond environs as the area went from rural to urban in nature.

Procedures

The established gaging and sampling stations were utilized to study the changes in the surface water hydrology and water quality brought about as a watershed goes from a completely natural state to a fully developed urban area. The extent of urbanization was recorded by aerial photography, hand-held camera photography, and field observations. A total of twelve months of gaging and sampling records were acquired during the life of this project.

Bench marks were established, and initial cross sections were surveyed at eight locations along the main stream channel of the demonstration watershed and at five places along the pond bottom. These initial cross sections were completed at a time which corresponded roughly to the completion of rough grading of the major roads, but when no other development had occurred in the watershed. The sections were resurveyed on a quarterly basis to determine what changes, if any, occurred in the channel configuration during the various phases of construction.

Data was compiled from the gaging records for input to the EPA Storm Water Management Model computer program. The Model is basically a tool developed to aid in predicting the amount of runoff and pollutants delivered from a watershed from given rainfall events in a completely urban area. During the course of this project, three major and a number of minor runs of the Model were completed. However, because of the low degree of urbanization prevalent in the demonstration project watershed throughout the project and the discontinuous storm sewer system, the applicability of the Model could not be fully tested.

The changes in the ecology of the stream channel, floodplain, and pond associated with urbanization were monitored. Observations were made of the physical appearance and any noticeable changes were recorded. A total of five surveys were conducted in the watershed over a period of two and one-half years. Changes in or loss of arboreal species, vegetative cover, and aquatic species were noted.

Results and Conclusions

Over the term of the demonstration period, the following base flow water quality observations were made from the water quality sampling program as the area went from rural to urban:

1. Turbidity and suspended solids increased.

2. Alkalinity, hardness, and chloride remained about the same.

3. Nitrite, nitrate, and total phosphate concentrations in the surface waters increased significantly.

During the hydrology studies, a comparison was made between two gaged subwatersheds within the larger demonstration watershed. Table 1 presents some of the pertinent characteristics of these two subwatersheds. From the hydrology studies, the following conclusions were drawn:

1. Throughout the term of the demonstration project the experimental subwatershed generally produced less storm runoff per unit area than the reference subwatershed.

2. Smaller runoff events generally produce a greater difference in runoff per unit area between the two subwatersheds than do larger runoff events, although exceptions do occur as in any natural system.

TABLE 1. REFERENCE AND EXPERIMENTAL SUBWATERSHED CHARACTERISTICS

Characteristic	Reference Subwatershed Description	Experimental Subwatershed Description
Natural ground cover	60% open field, 40% wooded	95% wooded, 5% open field
Storm sewers	Storm sewers empty into natural stream channel.	No natural stream channels, completely storm sewered.
Development	Medium and low density housing. Approximately 20% of area devoted to school site, including parking lot.	All low density housing.
Average slope of ground	Approximately 4%	Approximately 4%

3. As development progressed in the two subwatersheds, less of a difference in the runoff yields between the two subwatersheds resulted.

In the area of stream channel morphology, it was noted that the overall long-term trend was one of channel downcutting in the upper reaches of the stream and deposition or aggradation in the lower reaches. The continued cutting of the outside banks and deposition at the toe of meanders was also observed, as was general channel widening due to increased runoff.

The lotic environment of the stream was all but destroyed. Its' condition was due almost entirely to a lack of stability, with accompanying heavy sedimentation and abrasive particle transport; loss of pools and protective cover left little chance of natural recovery by former populations. It was determined that stream channel recovery might be possible, in part, if:

1. The stream banks are stabilized with vegetation.

2. Pools are reestablished.

3. Sediment transport is greatly reduced.

4. The stream bottom is stabilized.

5. Runoff containing organic compounds is strictly controlled.

6. Stormwater management practices are implemented to reduce the volume of periodic surges.

7. Base flow during dry periods can be maintained.

The lentic environment of the pond, although severely affected at times, gave the impression of an ecosystem showing rapid trends toward a natural succession of life-forms.

SECTION V

PROGRAMMED DEMONSTRATION FOR EROSION AND SEDIMENT CONTROL SPECIALISTS

BACKGROUND

This project, the "Programmed Demonstration for Erosion and Sediment Control Specialists," was performed under an Environmental Protection Agency demonstration grant, Project No. S800854 (15030 FMZ) to the Water Resources Administration, State of Maryland. Hittman Associates, Inc., Columbia, Maryland was the prime contractor.

The purpose of the project was to develop a series of presentations on sediment and erosion control and a certification plan for erosion and sediment control specialists, utilizing technology developed on EPA Grant No. 15030FMZ (Joint Construction Sediment Control Project), and to demonstrate its workability. This involved the development of 15 presentations on various topics relating to erosion and sediment control, the conversion of six of these presentations into the audiovisual format, the demonstration of the program, and the evaluation of the audiovisual approach against the conventional technical presentations with slides.

Although the demonstration program was developed for the State of Maryland, it was anticipated that there would be a nationwide need for such a program. Accordingly, it leans heavily towards general philosophy and universally applicable principles and practices.

DEVELOPMENT OF PRESENTATIONS

The primary effort of this program was the development of the 15 conventional presentations, complete with visual aids and student handouts, and six audio-visual programs consisting of film scripts, written scripts, work books, and instructor's manuals.

This work involved the taking and collection of over 4,000 separate 35-millimeter color and black and white photographic slides, the contributions of several writers, and close coordination with the audiovisual subcontractor for technical review of program material.

Conventional Presentations

The topics for 15 conventional presentations were selected so as to provide an integrated program, rather than a series of presentations on random topics relating to erosion and sediment control. However, each presentation was written so that it would entirely, or in large part, stand by itself. In setting up the program the presentations were grouped under three categories - Basic, Specialized, and General. The breakdown is as follows:

1. Basic Presentations

   Presentation No. 1 - Goal, Objectives and Principles of Erosion and Sediment Control

   Presentation No. 2 - Soils

   Presentation No. 3 - Climatology, Hydrology and Hydraulics

   Presentation No. 4 - Rainfall-Runoff Relationships

   Presentation No. 5 - Erosion and Sedimentation

Presentation No. 6 - Plant Materials

2. Specific Presentations

Presentation No. 7 - Control of Sediment Generated on Construction Sites

Presentation No. 8 - Control of Runoff During Construction

Presentation No. 10 - Vegetative Soil Stabilization

Presentation No. 12 - Temporary Soil Stabilization

Presentation No. 13 - Prevention of Waterway Erosion

3. General Presentations

Presentation No. 9 - Erosion and Sediment Control Planning

Presentation No. 11 - Wooded Site Development

Presentation No. 14 - Sediment Control Laws and Regulations for the State of Maryland

Presentation No. 15 - Foreman-Inspector Responsibilities

The "Basic" category treats the introductory and background aspects of erosion and sediment control and provides the participant with the basic knowledge to more fully comprehend the "Specialized" presentations. The "Specialized" category covers the actual techniques for controlling erosion and sedimentation. The "General" category is intended to provide the participant with the general knowledge required to implement the total program of erosion and sediment control and to make him aware of his importance and function within the control framework.

In addition to the writing of the presentation material, erosion and sediment control products and practices were demonstrated in Columbia, Maryland for the purpose of obtaining photographs for use as visual aids.

The desired method of operation in preparing the conventional presentations was to write the script, complete with recommended visual aids, have it reviewed by the Maryland Water Resources Administration, and then to collect the visual aids and write the student handout. Photography was often performed concurrently with the writing of the script, except during the winter months when pertinent construction activity had stopped.

The length of the presentations varied depending upon how much information had to be presented. The lecture time varied from approximately 30 minutes to about 75 minutes. The number of slides used in the presentations ranged between 47 and 104. In all, over 1,100 slides were used in the 15 conventional presentations.

As noted earlier, the materials for each conventional presentation consisted of a narrator's script, visual aids, and a participant's handout. Each script contains a content outline and the complete narration of the presentation. To provide for the synchronization of the visual aids with the narration, reference was made to the required visual in the script. The visual references were numbered consecutively and a brief description of the subject matter was provided.

The participant's handouts contained the important information covered in the narrator's script, grouped under topical headlines.

Audiovisual Presentations

The six audiovisual presentations were prepared by Educational Communications, Incorporated of Wayne, Pennsylvania with technical assistance from Hittman Associates and the Maryland Water Resources Administration. The six conventional presentations which were converted into audiovisual presentations were:

Presentation No. 1 - Goal, Objectives and Principles of Erosion and Sediment Control

Presentation No. 5 - Erosion and Sedimentation

Presentation No. 7 - Control of Sediment Generated on Construction Sites

Presentation No. 8 - Control of Runoff During Construction

Presentation No. 10 - Vegetative Soil Stabilization

Presentation No. 15 - Foreman-Inspector Responsibilities

Two criteria were used in selecting the presentations for conversion into the audiovisual format. First, the presentations were chosen so as to make up a coherent, abbreviated package that could be used immediately and then later be integrated into an expanded program, including nearly all of the remaining presentations not yet converted into the audiovisual format, and any other presentations that may be developed. The second selection criteria was that all three of the presentation categories be represented, i.e., Basic, Specific, and General.

The first steps in the development of the audiovisual presentations were to define the target population, general performance objectives, and terminal behavior, and to select the audiovisual hardware.

It was decided by The Water Resources Administration, State of Maryland, that the presentations would be made available to private contractors and governmental pollution control agencies. The target population within these two sectors was defined as construction foremen and inspectors. It was assumed that the personnel within these categories would have completed a high school education. It was further assumed that the construction foremen were well-versed in practical procedures for translating engineering designs into structures on the construction site. The governmental inspectors, on the other hand, were assumed to have had less construction experience and the inability, in most cases, to translate engineering designs.

General Performance Objectives

A foreman who studied the audiovisual presentations was expected to acquire the following abilities:

1. To be able to look at a plan and visualize it functionally on the site.

2. To be able to schedule the work so measures to prevent runoff are coordinated with other construction.

3. To recognize various control structures on the plan and transfer these to the site.

4. To understand his role and responsibilities and his relationship with government inspectors.

5. To determine whether the proposed plan will perform adequately on the site and be able to go back to the designer with recommendations for changes, if needed.

A government inspector taking this program was expected to develop the following abilities:

1. To understand his role and responsibilities.

2. To understand the cross relationship between himself and the contractors' foreman.

3. To determine if the construction site is in compliance with the plan and if it will effectively control runoff.

4. To be able to report on the reasons for problems and make proposals for their correction.

5. To be able to make a decision as to what recommendations he can make and what changes must go back for redesign and approval.

6. To be able to prepare effective reports concerning each particular situation.

The terminal behavior determined at the outset of the development of the presentations was twofold. At the conclusion of each of the audiovisual programs, trainees would be required to complete a written test. These tests would incorporate various forms of questions relating directly to the subject matter just covered. It was expected that 90 percent of the participants would score a correct response on 90 percent of the questions. Secondly, as a more long term requirement of this project, it was expected that participants would gain increased motivation to perform their assigned tasks efficiently and cooperate with all those charged with the responsibility of reducing erosion damage.

Audiovisual Hardware

It was decided that the audiovisual equipment should have the following characteristics:

1. Be able to present filmstrips which are automatically synchronized to the sound.

2. Have the sound tape and filmstrip enclosed in one integral cassette.

3. Have the capability of being used as a front screen projector which could be viewed by groups of approximately 15 persons.

4. Be capable of conversion to a rear screen projector for individual viewing.

5. Be small and compact enough for an individual to take home.

Each audiovisual presentation was packaged in plastic cassettes containing both a magnetic tape sound track and a synchronized 16-millimeter film strip. Each cassette has a running time of approximately 15 to 20 minutes. It is estimated that the total time required to present each cassette is about 30 minutes. This includes time for workbook exercises and discussions.

Workbooks were also prepared for the audiovisual presentations. These were designed to serve as an additional reinforcement and as a reference document that the participant could retain. In addition to containing questions to be answered at each workbook stop during the program presentation, the workbooks contain a review test and a descriptive outline of the subject matter.

To assist the supervisor in giving the programs, a manual was prepared for each program. These documents contain information on how to set up the program and operate the audiovisual machines, list the primary objectives of the program, provide a listing of suggested discussion topics, and contain the answers for all of the questions in the participant's workbook.

PROGRAM DEMONSTRATION AND EVALUATION

As part of the program, a demonstration was conducted to evaluate the conventional presentation approach versus the audiovisual approach. As visualized, the conventional approach would use a scientist or engineer with little or no public speaking experience to narrate a slide show and distribute student handouts. In nearly all cases, the narration would be read verbatum from the script. It was further assumed that during the question and answer period which follows each presentation, some additional information, not found in the script, may be interjected.

The audiovisual approach was assumed to involve the use of an audiovisual machine and workbook in the presence of a supervisor. His primary function would be to lead group discussions and answer questions. The ideal audience for this approach consists of no more than 15 persons.

The demonstration and evaluation was conducted on a typical target audience consisting of inspectors and construction foremen. Due to the coincidence of the demonstration and evaluation program with the active construction season, it was not possible to obtain enough time to demonstrate all of the presentations and evaluate all six audiovisual programs against their conventional counterparts. A total of three audiovisual presentations were used.

Procedure

Government inspectors and contractor's foremen were invited to participate in the demonstration and evaluation program. A total of 26 men participated.

Each man was given a form prepared by the Water Resources Administration on which he could record profile information. Each form was numbered consecutively from one through twenty-six. Following an introduction and statement of the purpose of the project, the men with odd-numbered forms were asked to leave the room and go to another location where they were shown the audiovisual program. Those with even-numbered forms were asked to stay in the first room and were then given a conventional presentation. Both groups were equally divided with respect to employment and level of education.

During the first period, both groups viewed the presentation on "Goal, Objectives and Principles of Erosion and Sediment Control". The group with odd numbers received the information via an audiovisual program and the group with even numbers received it via a conventional slide-illustrated presentation. In the second period the groups viewed the material on "Erosion and Sedimentation". Again, the odd numbered group received the audiovisual version and the even numbered group received the conventional presentation.

Both groups were then given identical evaluation tests. Following the test, the two groups reversed their roles. That is, the odd numbered group received a conventional presentation and the even numbered group received an audiovisual program. They both were exposed to the same subject. Both groups were then given a form on which to evaluate the two different methods of presentation.

Results

The group which received the audiovisual presentation did score higher on the evaluation test than the group which received the conventional presentation. However, the difference in test scores was not highly significant.

The evaluation of the presentation by the individuals in the two groups did present some additional insights. Of the 13 subjects who received the audiovisual presentation, 11 were favorable toward it, while only eight were favorable toward the conventional presentation from the group initially receiving that presentation. Both groups clearly preferred the audiovisual presentation over the lecture.

CERTIFICATION PLAN

A requirement of this demonstration program was to develop a plan for the certification of erosion and sediment control specialists in the State of Maryland It was decided that the primary thrust of the plan would be to certify the onsite erosion and sediment control specialists. The word "specialist" is intended to mean only construction foremen or supervisors. The majority of the governmental inspectors are not specialists in that they are also responsible for the inspection of other construction-related functions and pollution sources. Of course, it was felt that the erosion and sediment control inspector should not be denied the opportunity to acquire the certification, only that its acquisition not be considered an essential requirement of his job. However, it is important that the governmental inspector be exposed to the program developed in this demonstration. It was felt that State and local agencies responsible for erosion and sediment control will readily and voluntarily utilize the program. Strong leadership by the state will be an important factor in this regard.

On the other hand, it was felt that many of the private construction contractors performing grading work will not quickly, nor fully utilize the States' program unless they are legally required to have a certified specialist in charge of the implementation of erosion and sediment control plans on their construction sites. This requirement can be accomplished by an amendment to the existing Maryland Sediment Control Law and/or Regulations. This amendment would state to the effect that all contractors performing grading operations shall have an on-site certified erosion and sediment control specialist to supervise the implementation of the erosion and sediment control plans.

An integral part of a program to certify erosion and sediment control specialists would be the dissemination of the materials developed in this demonstration to the counties, contractors, and educational institutions to help personnel to become knowledgeable erosion and sediment control specialists.

In that it will take some time to certify these specialists, it was decided that an interim certification should be initially issued and a time limit set for full certification. It was recommended that an interim certification be required by July 1, 1974, at which time the amendment to the law and/or regulation would become effective, and that a full certification be required by July 1, 1976.

The minimum requirements for interim certification should be three years grading or related construction experience, one year of which must be in a supervisory capacity which includes responsibility for the implementation of erosion and sediment control plans. No test would be required, but an application would have to be made to the Maryland Department of Natural Resources and approved by the board and an interim certificate issued to the applicant.

Full certification would require five years of grading or related construction experience, two years of which must be in a supervisory capacity which includes responsibility for implementing erosion and sediment control plans. Up to two of the three years of nonsupervisory experience could be substituted by job-related, post-high school education. The applicant would have to apply to the State for the certification and pass a written or oral test on the subject of erosion and sediment control. The test would be geared to the training program developed in this demonstration and would be administered two or more times a year, depending upon demand. The applicant would be allowed to take an oral exam if he failed the written test at least twice and had taken the prescribed state training program consisting of the audiovisual presentations. No limit would be set on the number of times the applicant could take the test.

The program would be administered by a Maryland Board of Erosion and Sediment Control Specialists, composed of five to seven representative members appointed by the Secretary of the Maryland Department of Natural Resources.

SECTION VI

DEMONSTRATION OF THE SEPARATION AND DISPOSAL OF CONCENTRATED SEDIMENTS

BACKGROUND

Hittman Associates, Inc., under Contract No. 68-01-0743 to the U. S. Environmental Protection Agency, conducted a demonstration of the separation and disposal of concentrated sediments from the dredging operations on a small lake. The purpose of the demonstration project was twofold. One, was to demonstrate a technique for relatively small maintenance dredging operations which would have minimal adverse effects on the surrounding water body. The second purpose of the program was to demonstrate a portable sediment processing system which could be set up to process the slurry from the dredge in a relatively small area, remove the majority of the solids, return clean water to the pond, and then be dismantled and moved after the dredging operation is complete.

After the field demonstration was complete, further experiments were performed on one of the promising pieces of equipment in the processing system. This equipment item, known as the Uni-Flow filter, is essentially a bag-type fabric filter. The dirty water is pumped to the inside of fabric hoses and allowed to filter through the hoses. Summary results of both the field demonstration and the additional experiments on the Uni-Flow filter are contained in this section.

REMOVAL SYSTEM

The system utilized for removing sediment from the demonstration pond bottom consisted of a 30-foot 2-inch long MUD CAT dredge manufactured by

National Car Rental Systems, Inc. MUD CAT Division. Figure 2 is an overall view of the MUD CAT dredge. It is specially designed for use on small lakes, and to impart minimum turbidity to the water while dredging. The dredge moves in straight-line directions by winching itself along a taut, fixed cable. Bottom sediment removal equipment on the dredge consists of an eight-foot long, horizontally-opposed, adjustable depth, power-driven auger and a pump which is rated at approximately 1500 gallons per minute with a 10 to 30 percent solids concentration of the slurry.

PROCESSING SYSTEM

The development of a portable sediment separation system centered around the use of a hydrocyclone initial stage followed by the Uni-Flow filter. Other alternative or additional devices were also evaluated for possible inclusion

FIGURE 2. MUD CAT Dredge

in the processing system based on the equipment's degree of portability, cost, expected performance, and the physical characteristics of the dredge spoil.

The portable sediment processing system selected for testing consisted of a pair of elevated settling bins, a bank of hydrocyclones, a standard cartridge-type water filter unit, and a bag-type filter known as a Uni-Flow. Basically, the Uni-Flow filter consists of a number of hanging hoses. The dirty water is pumped into the inside of the hoses and is allowed to filter through them. Periodically, the collected sludge is flushed from the inside of the hoses. The design of the Uni-Flow filter was based on experiments performed on a full-scale test stand. The total processing system was tested in a number of different arrangements during the course of dredging operations.

In order to economically demonstrate a fully portable system, the total flow from the dredge was split after the initial solids removal phase. Thus, the fully portable system was designed to process a nominal 500 gpm. The remaining flow of approximately 1000 gpm was sent to a temporary earthen holding/settling basin. Figure 3 is a schematic diagram of the overall sediment processing and sludge disposal system.

Initial Solids Removal

Two elevated bins, each with an initial capacity of 36 cubic yards were installed in series as the initial solids removal phase. These storage bins are of the type used in concrete batch plant operations. The discharge from the dredge was pumped directly to the first bin where settling of suspended solids occurred. The slurry was then allowed to overflow into the second bin where additional settling occurred. From the second bin, the flow was split to either a temporary holding basin or to a feed pump for the hydrocyclones. Figure 4 shows the bins used for the field demonstration.

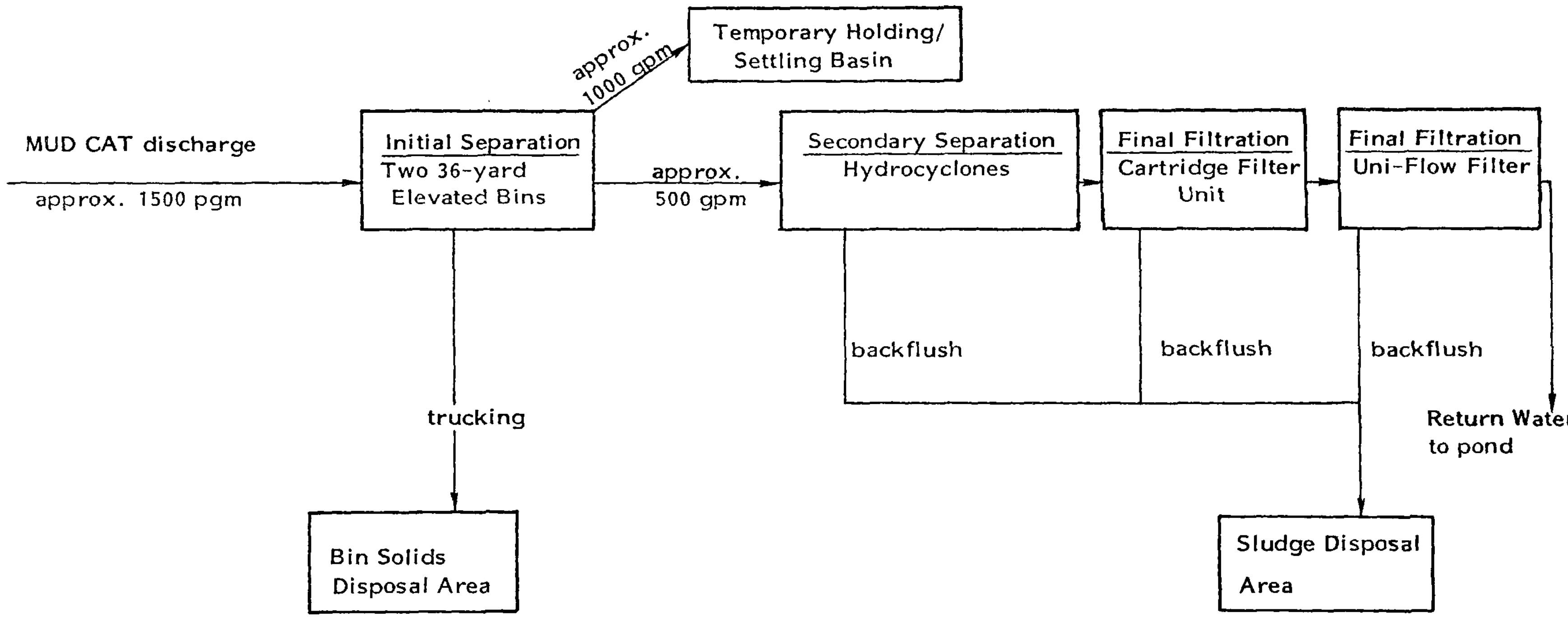

Figure 3. Schematic of Processing and Sludge Disposal System

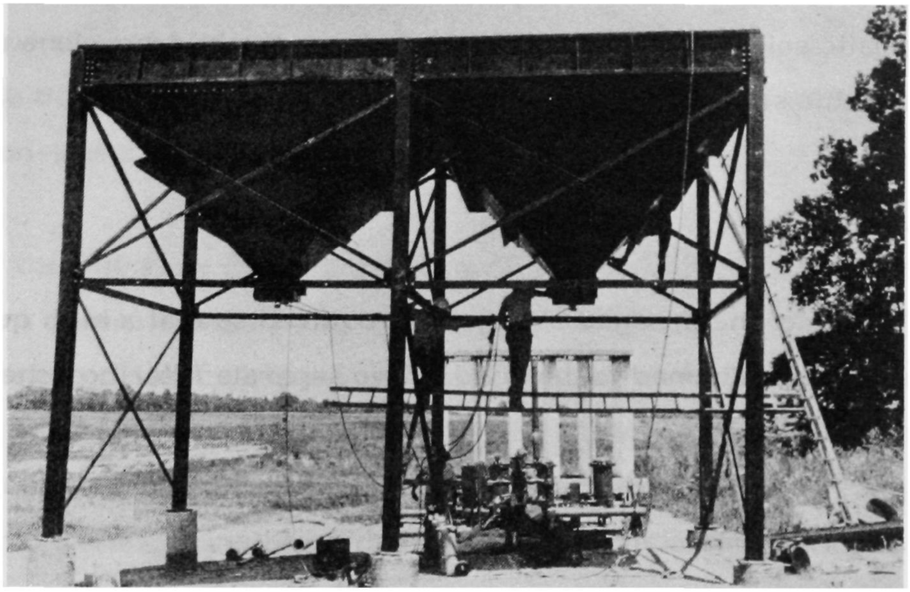

FIGURE 4. Initial Solids Removal: Elevated Bins

To empty the bins of sediment, the dredging operation was shut down and the water was decanted from the bins. This operation was usually scheduled for either immediately before the midday break or before final shut-down at the end of the day. The sediment was then allowed to dry during the break, and emptying of the bins through the bottom doors began after lunch or the first thing the next morning. At this time, the sediment was never fluid enough to drop unaided into the dump trucks underneath the bins. Therefore, standard hand-held concrete vibrators were utilized to help fluidize and drain the sediment into the trucks.

Secondary Separation

A bank of hydrocyclone cones comprised the secondary separation step of this portable sediment handling system. The hydrocyclones utilized for this demonstration project were manufactured by DEMCO Incorporated and consisted of six four-inch, style H cones with abrasion-resistant urethane liners, and equipped with three-gallon silt pots, a closed underflow header, and automatic solids unloading. Figure 5 shows the hydrocyclone unit as installed in the sediment processing system.

Final Filtration

Final filtration of the dredged slurry was required so that a high quality effluent could be returned to the pond. Two separate filtering schemes were utilized for this step:

1. A commercially available polishing filter.

2. A prototype of the Uni-Flow wet bag-house type filter.

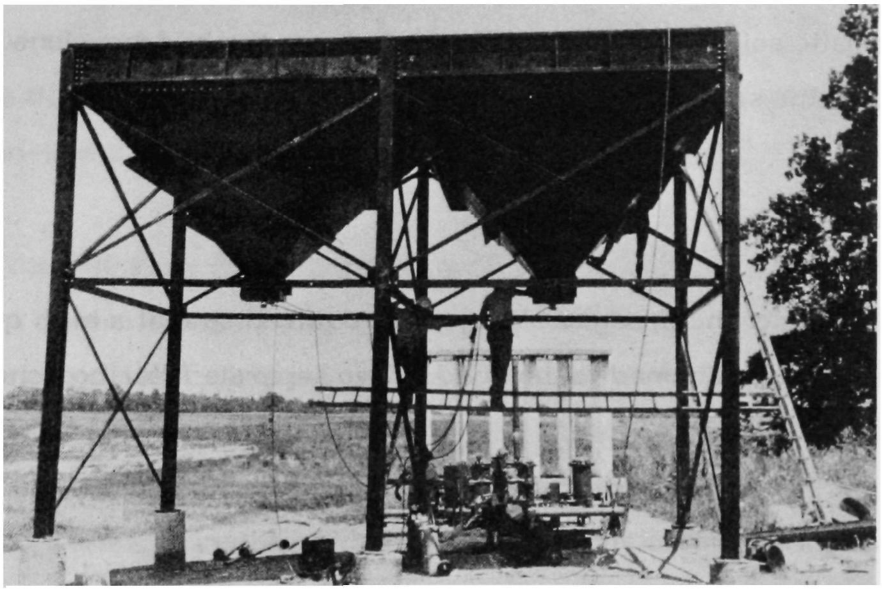

FIGURE 5. Secondary Separation: Hydrocyclones

The commercially-available filter selected for the field trials was of the cartridge filter type. The unit consisted of four model 16-17-51 Crall filters, each of which contained 51 permanent sand cartridges with filter openings rated at 25 microns. An on-line automatic backflush cycle was installed so that one filter unit could be backflushing while the other three remained on-line. Figure 6 shows this cartridge filter unit.

Basically, the Uni-Flow filter is a system of hollow fabric "soaker" hoses that present a more or less solid, impermeable barrier to suspended material. The dredged slurry is pumped into the center of the hoses, the suspend ing liquid permeates through the hoses and is collected in a filtrate collector and is piped away. The loose sludge within each hose is periodically discharged into a sludge collector and is removed from the filter unit.

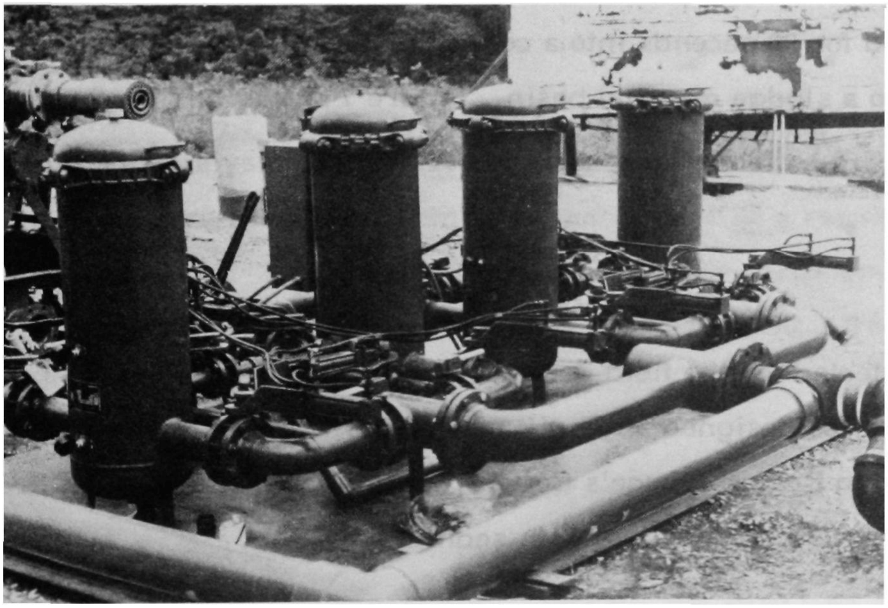

FIGURE 6. Final Filtration: Cartridge Filter Unit

Previous experiments with the Uni-Flow filter performed by the Aqua-Ion Corporation under EPA Contract No. 68-01-0043 indicated that such filters showed promise for use as a final polishing filter for suspended sediment slurries in that high quality effluent water could be expected. Further experiments were conducted under this program in order to arrive at design criteria for a prototype unit which would be capable of processing the expected 500 gpm of flow. Relying on the previous basic data, one-inch diameter, 10 to 20-foot long hoses of both cotton and polypropylene fabrics was tested on a small, three-hose test stand.

The final design criteria arrived at through these tests produced a unit which contained 720 one-inch diameter, 10-foot long, woven polypropylene hoses. The hoses were arranged in six banks of 120 hoses each. This enabled the shutting-down of one bank for hose maintenance or replacement while the other five banks could be kept on-line. The slurry was pumped into a top header which distributed the influent to each bank of hoses. The filtrate from the hoses was collected in a bottom tray and allowed to flow by gravity back to the pond. Every 5 1/2 minutes, the sludge within the hoses was drained for 30 seconds into a collection trough and allowed to flow by gravity into a sludge disposal basin. Figure 7 shows this prototype Uni-Flow filter.

TEST SITE

The site selected for the field demonstration was a two-year old, 1.7 acre pond which was designed and built as a sediment retention basin. The pond was located in Prince George's County, Maryland. At the time of dredging the pond was 99 percent filled with sediment.

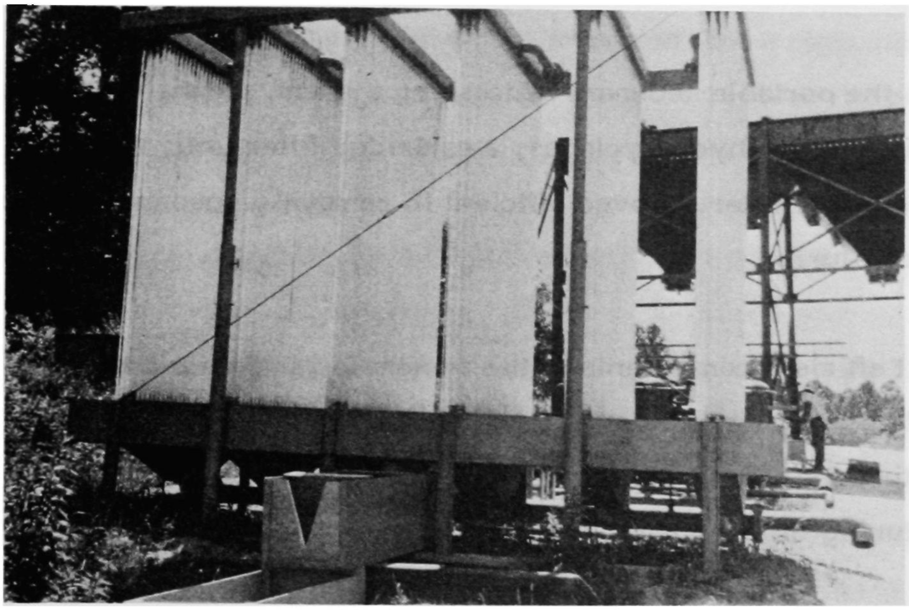

FIGURE 7. Final Filtration: Uni-Flow Filter

FIELD DEMONSTRATION RESULTS AND CONCLUSIONS

Removal System

A sampling and analysis program was initiated to determine the amount of sediment which was resuspended into the pond water as a result of the dredging operations. Samples were taken around the periphery of the dredge at various distances from the dredge and at various depths. These samples were analyzed for their suspended solids concentrations.

The MUD CAT dredge proved very efficient in removing the deposited sediments from the pond bottom and in preventing the resuspension of the sediments during the dredging operations. Overall, the MUD CAT dredge lived up to its design criteria of being an efficient means of removing sediment from ponds and lakes up to 10.5 feet in depth.

Processing System

Overall, the portable sediment processing system, consisting of two elevated clarifier bins, hydrocyclones, a cartridge filter unit, and a Uni-Flow bag-type fabric filter, proved efficient in removing suspended sediment from a dredged slurry.

The most efficient components of the system for sediment removal were the elevated bins (initial solids removal phase) and the Uni-Flow filter. They were both very effective in removing suspended solids from the dredged slurry during the field demonstration.

The hydrocyclones were not as efficient in removing suspended solids from the dredged slurry as originally anticipated. Use of a closed underflow header with silt collection pots and automatic solids unloading on the hydrocyclones was found to be not economically justified in a portable sediment processing system. In addition, it was concluded that the use of hydrocyclones for dredged spoil processing should be limited to removing sand size, i.e., 74 microns or larger particles. The majority of the suspended solids in the slurry fed to the hydrocyclones during the field demonstration were smaller than sand size.

The usefulness of the cartridge filter unit in the processing system was marginal. Operating and maintenance restrictions would probably preclude the widespread utilization of such units for processing dredged slurry unless the suspended solids concentration of the slurry could first be reduced to near the design level of the units.

Overall, the removal system utilized proved to be a labor-intensive operation

This program demonstrated that sediment basins can be cleaned without the availability of adjacent sediment deposition sites and that a high quality return water can be produced through use of a portable sediment processing system.

ADDITIONAL TESTS: LARGE DIAMETER FABRIC FILTER HOSES

Procedure

Fabric filter hoses of greater than one inch in diameter were tested and evaluated on a separate test stand after the field demonstration of the portable sediment processing system was completed. In particular, larger diameter filters were investigated for their ability to resist blocking with sediment, the chief problem with the smaller diameter fabric filters. In addition, the larger diameter filters were tested for:

1. Filtration rate, expressed as the ratio of gallons per minute of effluent to square feet of filter surface area.

2. Pressure handling ability.

3. Tendency of the filter tubes to bow with increased pressures.

4. Quality of the effluent.

5. Total effluent flow.

6. Filtration cycle time (time between backflushes).

7. Ease of cleaning during a normal backflush (sludge draining) cycle.

Five-inch nominal diameter hoses were selected for testing. This size was selected because it is one of the standard diameter bags which are used in air bag houses for stack gas filtering. The underlying consideration during the large diameter hose test program was to investigate the adaptability of standard air bag technology to the water filtration field, and in particular, to the processing of slurries with high suspended solids concentrations. If larger diameter hoses proved feasible for water filtration, available, off-the-shelf equipment might then be adapted to solve a current problem.

Testing was performed in two phases. In the first phase, four different fabric filter materials were subjected to various tests, and the results of the tests were compared to determine the fabric material which exhibited the best performance characteristics in terms of the seven handling characteristics described above. At the conclusion of the first phase tests it was evident that a multifilament polypropylene fabric performed the best, both in terms of the effluent quality and the average flow rate through the hose.

The primary goal of the second phase of the five-inch hose testing was to maximize the flow rate through the hose yet maintain a high overall effluent water quality. An additional consideration was to reduce the operational hardware requirements of any full scale prototype as much as possible. Consequently, the following parameters were varied during the second phase of testing:

1. Type of backflushing operations

2. Presence of wire mesh cylinder inside filter column

3. Presence of wire mesh cylinder outside filter column

4. Presence of wire mesh cylinder outside and inside filter column

5. Length of the fabric filter column

6. Time duration of the test

7. Suspended solids concentration of the influent

Results and Conclusions

Overall, the five-inch diameter polypropylene hoses tested performed better than the one-inch hoses utilized on the Uni-Flow filter during the field demonstration. Further utilization of the one-inch diameter hoses for wet filtration was thus abandoned.

It was determined that five-inch diameter, eight-foot long polypropylene hoses with wire caging on both the inside and outside of the hose were more suited for further development than the other configurations tested. This hose yielded comparable effluent qualitites and throughflow rates and required less hardware than the other hoses.

It was recommended that further tests be performed on the applicability of the five-inch diameter Uni-Flow hoses to the filtering of other types of wastes and pollutants. Based on limited tests, these hoses showed promise for application to other wet bag filtration areas.

SECTION VII

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16. *Abstract*

This report presents the highlights of three recently completed programs in the area of sediment and erosion control. These programs were a "Joint Construction Sediment Control Project," Project No. 15030 FMZ; a "Programmed Demonstration for Erosion and Sediment Control Specialists," Project No. S800854 (15030 FMZ); and a "Demonstration of the Separation and Disposal of Concentrated Sediments," Contract No. 68-01-0743.

The first program demonstrated and developed guidelines for erosion and sediment control in urbanizing areas, the second produced a series of 15 presentations on sediment and erosion control, and the third program consisted of a field demonstration of a system for removing and processing sediments from pond bottoms.

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17b. *Identifiers* *Guidelines, *Columbia, Maryland, *Presentations, *Suspended solids separation, Pond dredging, Grade control

17c. *COWRR Field & Group* 02E, 02H, 02J, 04A, 04C, 04D, 05C, 05D, 05G

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