REPORT TO THE CONGRESS

Potential Of Value Analysis For Reducing Waste Treatment Plant Costs

Environmental Protection Agency

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report discusses the need for the Environmental Protection Agency to establish and implement a value analysis program to reduce the costs of waste treatment plants funded under the Federal Water Pollution Control Act Amendments of 1972.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Chairman of the Council on Environmental Quality; the Executive Director of the National Commission on Water Quality; and the Administrator, Environmental Protection Agency.

Comptroller General
of the United States

Contents

ABBREVIATIONS

ACEC	American Consulting Engineers Council
AIA	American Institute of Architects
EPA	Environmental Protection Agency
GAO	General Accounting Office
MBM	McKee-Berger-Mansueto, Inc.
mgd	million gallons per day
OMR	operation, maintenance, and replacement

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

POTENTIAL OF VALUE ANALYSIS FOR REDUCING WASTE TREATMENT PLANT COSTS Environmental Protection Agency

D I G E S T

WHY THE REVIEW WAS MADE

The Chairman, Senate Committee on Public Works, asked GAO to study the potential of value analysis, a cost control technique to reduce federally assisted municipal waste treatment plant construction cost.

Value analysis is a systematic, organized approach for getting the utmost value out of each dollar the Government spends. It is a management tool designed to complement rather than replace other cost reduction and cost-effectiveness techniques.

GAO agreed to summarize

--the results of five value analysis workshops sponsored by the American Consulting Engineers Council and the American Institute of Architects in which GAO had a $4.1 million waste treatment plant studied and

--the efforts of the Environmental Prctection Agency (EPA) to develop and implement a value analysis program.

GAO contracted with McKee-Berger-Mansueto, Inc., which had provided one of the workshop instructors, to consolidate and validate the potential cost savings developed in the workshop studies and include the results in a report. (See the enclosure.) GAO was also assisted by various technical consultants during the study.

FINDINGS AND CONCLUSIONS

Controlling pollution from municipal sources will be costly--billions of dollars--and the most cost-effective use of Federal funds is essential, especially in view of the Nation's inflation and economic problems.

The sheer magnitude of the estimated $107 billion required to construct municipal waste treatment facilities calls for cost controls to insure that Federal funds are used effectively. Even minor percentage reductions in waste treatment facilities' costs would result in great dollar savings and would

--enable States and municipalities to more easily finance their portion of control facilities thus enhancing the probability of earlier construction and

--permit wider distribution of Federal funds for constructing treatment facilities which would result in earlier water quality improvement.

Value analysis during the design phase can potentially minimize the cost of waste treatment facilities, not only for construction but also for operating, maintaining, and replacing the facilities.

The value analysis workshop teams were successful in identifying potential savings in initial capital costs up to 40 percent.

After reviewing the proposals and validating the potential costs savings, GAO's contractor estimated initial potential capital cost savings of $1.2 million and annual operation, maintenance, and replacement cost savings of about $48,000 or about $1.4 million when projected over the estimated 30-year life of the waste treatment plant. Interest cost savings for the 30-year period would be about $2.6 million, therefore, bringing the total potential savings for life of the plant to about $5.2 million.

Because the treatment plant was under construction before the workshop studies were completed, it was impracticable for the cost-saving proposals to be implemented; therefore the amount of actual savings could not be determined.

McKee-Berger-Mansueto, Inc., told GAO that, in applying the value analysis methodology to over 100 construction projects, it had been generally successful in implementing a noticeable percentage of its cost savings proposals.

Although applied to a waste treatment plant for the first time, the value analysis showed potential for reducing waste treatment plant costs without sacrificing essential requirements. (See pp. 5 to 12.)

Cost control program needed

Both EPA and State agencies rely on consulting engineers to design cost-effective, structurally sound waste treatment facilities. Designs prepared by these consulting engineers are reviewed by EPA and State engineers to insure that Federal and State requirements are met and that the proposed plant can reasonably be expected to achieve treatment levels meeting prescribed effluent limitation standards.

Design plans and specifications are not systematically reviewed using such techniques as value analysis to insure that the plant is designed at lowest cost.

Of the 22 consulting engineering firms GAO visited, none used the value analysis approach to reduce or minimize the cost of waste treatment plants. These firms generally do not have a review procedure directed at analyzing the cost impact of one discipline's design decisions on others to insure that the waste treatment plant is designed at lowest cost. (See pp. 13 to 16.)

EPA development of a value analysis program

During GAO's review EPA headquarters officials, recognizing the potential of value analysis, requested assistance in May 1974 from two EPA regional offices in applying the technique on a test basis. This was its first step in developing a value analysis program.

As of December 31, 1974, the studies had not been made. These studies could have been invaluable to EPA in solving several questions on how an effective program could be developed and implemented.

Concurrent with the effort to make the test studies, EPA headquarters officials set the framework to

implement a value analysis program and planned to issue final program guidelines by December 31, 1974. These guidelines were not issued as scheduled partly because the test studies were not made.

EPA's delays in developing and establishing a value analysis program to reduce or minimize the cost of treatment facilities could be costly in terms of lost opportunities for cost savings. (See pp. 16 to 19.)

GAO believes there is a need for EPA to establish an effective cost control program, such as value analysis. However, the current method of using the percentage of construction cost of the facilities to procure consulting engineering firm services is incompatible with establishing such a program because the firms have little incentive for reducing costs and thereby reducing their fees.

EPA's Office of Audit in a July 1973 report also recognized the undesirability of this method of determining engineering firms fees. In a December 1974 draft audit report, EPA stated that 10 firms had been paid excessive profits of $4 million.

EPA needs to revise its regulations--which it was in the process of doing--and require municipalities to use procurement methods other than the percentage-of-construction-cost method. (See pp. 19 and 20.)

Successful Federal value analysis programs

Fourteen other Federal agencies established such programs to be used in the design and/or construction of federally financed facilities.

Four agencies with the most successful programs have reported cumulative cost savings ranging from $3.6 to $233.5 million. These four agencies had established similar management practices which contributed to their success. EPA should consider these practices when developing and establishing its program. (See pp. 21 and 22.)

RECOMMENDATIONS

GAO recommends that the Administrator, EPA, establish and implement a value analysis program and incorporate it into EPA's construction grant program to insure that treatment facilities are constructed at lowest cost. Because of the magnitude of the potential savings to be realized by using value analysis, GAO recommends that the Administrator require that value analysis test studies be made as soon as possible to find answers to several questions that need to be resolved, such as:

--How should waste treatment plants be selected for value analysis studies?

--Where in the design process could value analysis best be implemented to minimize the costs and delays of implementing changes and thereby maximize potential cost savings?

--Who should make the value analysis study and how should it be funded?

--Who should be responsible for insuring that value analysis is made?

GAO also recommends that EPA finalize its regulations requiring

municipalities to use methods other than the percentage-of-construction-cost method in procuring professional services for designing waste treatment facilities and consider the successful management practices of other Federal value analysis programs when establishing EPA's program. (See pp. 23 and 24.)

AGENCY COMMENTS AND UNRESOLVED ISSUES

EPA generally agreed with GAO's findings. It said that it was strongly committed to having value analysis as part of its construction grant program but was having problems incorporating value analysis into the program. (See pp. 24 and 25.)

MATTERS FOR CONSIDERATION BY THE CONGRESS

This report is being addressed to the Congress because of the broad congressional interest in the high cost of controlling water pollution. Because legislative authorizations for the construction grant program will expire June 30, 1975, the Congress, during its deliberations on future legislative authorizations for the program, should consider the matters discussed in this report.

CHAPTER 1

INTRODUCTION

The Chairman, Senate Committee on Public Works, requested that we study the potential of value analysis for reducing the cost of constructing federally assisted municipal waste treatment plants. Value analysis is a systematic approach for identifying opportunities to reduce construction and operating cost and is synonymous with such terms as value engineering, value management, and value control.

In his January 5, 1973, letter, the Chairman stated that:

> "I am led to believe on reliable information that there is probably as much as five percent 'fat' in conventional sewage treatment plant construction in terms of over-design, over-engineering, and the use of more expensive materials for which suitable alternatives exist. This Committee and the Congress would be greatly assisted by a General Accounting Office study in the general area of Value Engineering of sewage treatment plants recently constructed under the matching grant program of the Federal Water Pollution Control Act. Such a study would facilitate the Committee's efforts to maintain oversight of the development of design standards and criteria."

We agreed to summarize in the report the (1) results of several value analysis workshops sponsored by the American Consulting Engineers Council (ACEC) and the American Institute of Architects (AIA) in which a municipal waste treatment plant was studied and (2) efforts of the Environmental Protection Agency (EPA) to develop and implement a value analysis program.

Because of wide congressional concern on improving water quality and interest in the high cost of pollution control, this report is being addressed to the Congress.

FEDERAL WATER POLLUTION CONTROL ACT

The Federal Water Pollution Control Act Amendments of 1956 (33 U.S.C. 466 (Supp. IV, 1957)) authorized EPA and its predecessor agencies to create the waste treatment construction grant program. The act authorized grants for treatment facility construction to prevent the discharge of untreated or inadequately treated sewage or other waste into waterways. The grant recipient (State, municipality, intermunicipal, or interstate agency) could receive Federal assistance of 30 to 55 percent of the eligible project costs.

The Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. 1251) established a national goal of eliminating the discharge of pollutants into navigable waters by 1985 and an interim goal of providing sufficient water quality for protecting fish, shellfish, and wildlife and for recreation by 1983.

To assist States in meeting these goals, the Congress authorized the allocation of $18 billion[1] to States during fiscal years 1973-75 to help municipalities construct waste treatment facilities. From these funds, EPA, through its construction grants program, makes grants of 75 percent of eligible costs of designing and constructing municipal waste treatment and collection facilities.

STUDY APPROACH

Value analysis had not been applied to the construction of municipal waste treatment plants before our review. To determine the feasibility of the value analysis technique for waste treatment plant construction, we selected the plans and specifications of a commonly constructed plant, designed in 1972 with an estimated construction cost of $4.1 million, and submitted it to five ACEC- and AIA-sponsored value analysis workshops conducted from October 1973 through April 1974. The criteria for selecting the plant were that it had to (1) have been EPA approved, (2) have 2 to 10 million gallons per day (mgd) capacity, (3) use the activated-sludge process, and (4) be in the EPA region with the largest amount of construction grant activity.

The selected plans called for expanding and upgrading an existing plant that provides secondary treatment using an activated-sludge treatment process for 3mgd of predominantly

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[1]On Nov. 22, 1972, the President instructed EPA to allocate to the States $5 billion--$2 billion for FY 1973 and $3 billion for FY 1974--of the $11 billion authorized for constructing sewage treatment plants for FYs 1973-74. Similarly, on Jan. 1, 1974, the President instructed EPA to allocate $4 billion of the $7 billion authorized for FY 1975 for a total allocation of $9 billion and an impoundment of $9 billion. On Jan. 28, 1975, the President instructed EPA to allocate to the States $4 billion of the $9 billion impounded for FY 1976 for a total of $13 billion. However, the Supreme Court decision on Feb. 18, 1975, ruled that the Administrator, EPA, cannot impound or withhold from full allotment sums authorized to be appropriated under section 207 of the 1972 amendments.

domestic sewage with a maximum capability of providing primary treatment for flows up to 12mgd during wet weather. The plant has been in service since 1941 and was expanded in 1955 to its 3mgd capacity.

EPA awarded the municipality a construction grant in June 1973 for expanding the plant to a 4.5mgd treatment capacity. The activated-sludge treatment process was not altered, but filtration was added to meet higher pollutant removal levels required by the State. The construction contract was awarded in December 1973.

One of the instructors of the five workshops was Mr. Alphonse J. Dell'Isola, vice president of McKee-Berger-Mansueto, Inc. (MBM), Washington, D.C.

We therefore contracted with MBM to summarize and validate potential cost savings identified in the workshops. MBM's report (see enclosure)

--discusses the value analysis concept,

--describes the value analysis approach used in the workshops,

--identifies important cost-saving proposals isolated during the workshops,

--includes proposal validations, and

--includes results of a review of cost-saving proposals with the consulting engineering firm which designed the plant.

We were assisted also by Dr. Richard I. Dick, professor, department of civil engineering, University of Delaware, and Dr. Donald T. Lauria, associate professor of environmental sciences, department of environmental sciences and engineering, University of North Carolina.

SCOPE OF REVIEW

In addition to participating in the workshops and contracting with MBM, we interviewed officials in EPA's regions 1 (Boston), 5 (Chicago), and 9 (San Francisco); State water pollution control agencies in California, Connecticut, Illinois, Maine, Massachusetts, and Michigan; and 22 consulting engineering firms to (1) determine whether value analysis was being applied in waste treatment plant construction and (2) obtain their views on the technique's feasibility. We

also interviewed professional value analysts, construction contractors, and officials of professional societies to obtain their views on the benefits of value analysis.

We reviewed EPA's construction grant program at headquarters and in the three regional offices and examined EPA's documents, records, and other literature.

Finally, we contacted 23 Federal agencies which had construction programs to determine (1) whether they were using value analysis in designing and constructing their facilities and (2) how they were implementing their programs.

CHAPTER 2

VALUE ANALYSIS CAN REDUCE COSTS

The Federal Water Pollution Control Act Amendments of 1972 established interim water quality goals for protecting and propagating fish, shellfish, and wildlife and providing for recreation in and on the water by 1983. In its February 1975 needs survey report to the Congress, EPA estimated that it would cost $107 billion to control pollution from municipal sources, excluding storm water runoff, to achieve the interim goal.

The sheer magnitude of the dollars required to construct municipal waste treatment facilities calls for cost controls to insure that Federal funds are being used effectively. Even minor percentage reductions in waste treatment facilities' costs would result in great dollar savings and would

--enable States and municipalities to more easily finance their portion of control facilities enhancing the probability of earlier construction and

--permit wider distribution of Federal funds for constructing treatment facilities resulting in earlier water quality improvement.

Management has created many cost control techniques to assist it in constructing and operating facilities at lowest cost. Value analysis, when applied in the design phase, is another cost control technique that can potentially minimize the waste treatment facilities' costs, not only for initial construction but also for operating, maintaining, and replacing (OMR) the facilities.

MBM summarized and validated the cost-savings proposals which resulted from the five ACEC and AIA value analysis workshops. MBM reported $1.2 million potential savings in initial capital costs and annual OMR savings of $48,000, or about $1.4 million when projected over the 30-year life of the plant. Interest cost savings for the 30-year period would be about $2.6 million, therefore, bringing the total potential savings for the life of the plant to about $5.2 million.

Because the treatment plant was under construction before the workshop studies were completed, it was impracticable for the cost-saving proposals to be implemented and the amount of actual savings could not be determined. MBM reported that in applying the value analysis methodology to over 100 construction projects, it had been generally successful in implementing a

noticable percentage of its cost-savings proposals.

COST OF CONTROLLING POLLUTION FROM MUNICIPAL SOURCES

The 1972 amendments require municipalities to achieve secondary treatment by July 1, 1977. As generally defined by EPA, secondary treatment will remove at least 85 percent of the biochemical oxygen demand[1] from municipal sewage. The amendments also require municipalities to provide the best practicable waste treatment technology by July 1, 1983, and to eliminate discharge of pollutants into navigable waters by 1985.

Federal commitment

The commitment of Federal funds to States and municipalities for cleaning up our waterways has dramatically increased from $50,000 since fiscal year 1957 to $3 billion in fiscal year 1974. (See graph, p. 7.) Total Federal funds obligated under the waste treatment construction grant program amounted to about $9.2 billion during this period. These funds were used to construct treatment plants, interceptor and outfall sewers, pumping stations, power supplies, and other equipment. The 1972 amendments made collector systems, combined storm and sanitary sewers, and recycled water supply facilities also eligible for Federal assistance.

In a 1973 needs survey report to the Congress, EPA estimated that $16.6 billion would be needed to meet the 1977 requirement and that $43.5 billion would be needed for municipal treatment beyond secondary treatment, sewer rehabilitation to correct infiltration and inflow, sewer construction, and correction of combined-sewer problems.[2] The estimates did not include facility costs for achieving the 1983 and 1985 goals or for solving the pollution problems from storm waters not flowing through combined sewers.

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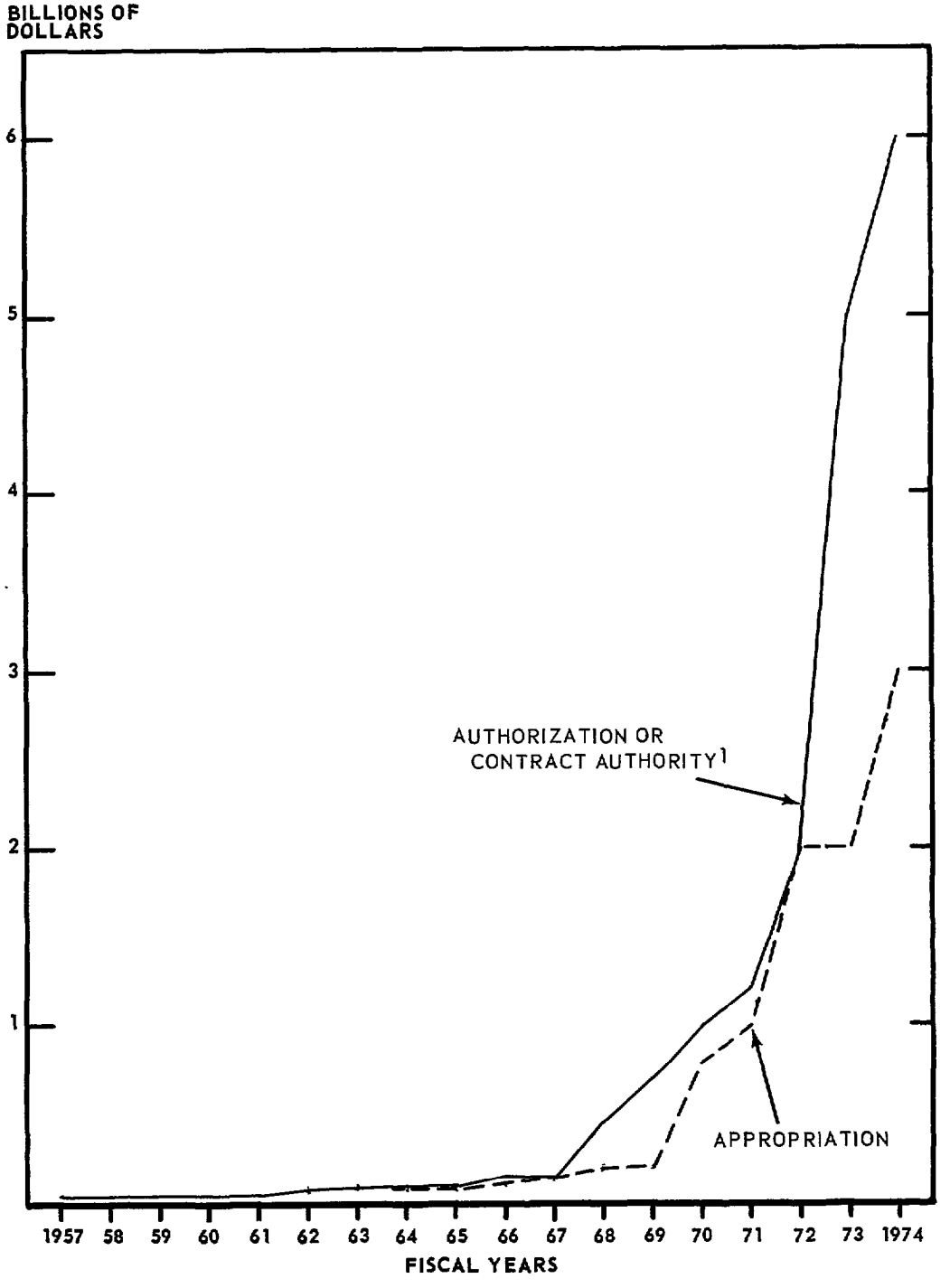
[1] A measure of the oxygen consumed in the biological processes that break down organic matter in water. Large quantities of organic wastes require large amounts of dissolved oxygen. The more oxygen demanding matter, the greater the pollution.

[2] Combined sewers carry both sewage and storm water runoff. During dry weather, combined sewers generally carry all the sewage to treatment plants; during storms, only part of the sewage and storm water is carried to the treatment plants, and the remainder is discharged, untreated, directly into waterways.

CONSTRUCTION GRANTS FOR MUNICIPAL WASTE TREATMENT PLANTS



In FY 1973 $2.6 billion additional was authorized, $1.9 billion appropriated, and $1.2 billion obligated to reimburse municipalities for previous expenditures.

[1] The 1972 amendments changed funding method from authorized appropriations to contract authority.

EPA, in a February 1975 report to the Congress on its nationwide survey, stated that it would cost $107 billion to (1) construct municipal waste treatment facilities to meet the 1983 goals, (2) correct infiltration and inflow, (3) build new sewers, and (4) correct combined-sewer overflows. EPA reported that it would cost an additional $235 billion to solve the pollution problem from storm waters not flowing through combined sewers.

VALUE ANALYSIS CONCEPT

Value analysis is a systematic, organized approach designed to optimize the value of each dollar spent. It is a management tool for complementing rather than replacing other cost reduction and cost-effectiveness techniques.

Value analysis questions the function of an item or method by asking:

--What is it?

--What must it do?

--What does it cost?

--What is it worth?

--What other material or method could be used to do the same job?

--What would the alternative material or method cost?

Through a system of investigation using trained, interdisciplinary teams of architects and engineers, high-cost areas are identified and modified or eliminated if they do not contribute to the system's basic functions. Using creative techniques and current technical information on new materials and methods, less costly alternatives for specific functions are developed and proposed to the designer.

In designing waste treatment plants, designers decisions have a great impact on the plant construction costs once Federal, State, and local officials have established performance standards and facility requirements. Constraints are often imposed on the designers and decisions are made by groups of engineers of various disciplines operating independently of one another. Yet each discipline's decisions may adversely affect costs in other areas. For example, the mechanical engineer's choice of equipment restricts the electrical engineer's choice of feeder sizes for the electrical

distribution system. To offset this, value analysis relies on an interdisciplinary team of designers to develop alternatives to that design.

During the design phase, the interdisciplinary value analysis team should be able to systematically identify high cost, secondary functional areas of a waste treatment plant and propose less costly alternatives.

Once alternatives are identified and cost-saving proposals are developed, the team would meet with the designing firm to discuss and agree upon those proposals that could be incorporated into the design plans and specifications. The value analysis studies should be scheduled at the key design review points, however, to preclude any delays in the design process. (See enclosure, pp. 5 to 11.)

WORKSHOP APPLICATION

The primary purpose of the ACEC- and AIA-sponsored workshops was to train participants in value analysis methodology. Our objective in using the workshops was to determine whether applying the value analysis methodology to the design and construction of a waste treatment plant could show ways of reducing costs without impairing the plants basic function.

In the 5 workshops a total of 11 workshop teams were successful in identifying potential savings in initial capital costs up to 40 percent. Because of conditions inherent to any workshop study, the results of any individual team study have to be viewed cautiously.

The time shortage was the major constraint that workshop participants faced. In addition to learning a new methodology, participants also had to become familiar with the waste treatment plant design in a week. The time limitation resulted in only approximation of financing and annual OMR costs of alternatives. Lacking complete information, the participants sometimes made rough estimates and assumptions adequate for training purposes but not necessarily accurate. (See enclosure, pp. 13 to 36.)

Recognizing a workshop environment's limitations, we contracted with MBM to summarize and validate the potential savings identified by the workshop teams. The potential savings MBM validated are summarized below.

Area	Potential savings	
	Initial	Annual OMR
Buildings	$ 230,000	$ 6,500
Electrical distribution	112,000	-
Plant layout	420,000	-
Underground structures	92,000	-2,000
Process changes	369,000	43,600
Total	1,223,000	$48,100
Total OMR savings (note a)	1,443,000	
Total interest savings (note b)	2,568,300	
Total potential savings	$5,234,300	

[a]Based on 30-year project life; present value savings would be $597,000

[b]Based on simple interest at 7 percent for 30 years. (See enclosure, p. 38.)

The potential reduction in initial capital, OMR, and interest costs of the waste treatment plant studied resulted from proposals to change the treatment process and to eliminate or modify items not essential to required performance. These proposals involved trade-offs in areas of secondary performance which, had they been carried out, would probably have

--limited the future plant expansion flexibility,

--decreased some support equipment reliability,

--increased the maintenance of some support equipment, and

--reduced the esthetics of the physical plant.

Although these secondary features of the plant may have to be sacrificed, the potential reduction in the facility construction cost would be great and the plant's basic function of treating waste would not be impaired.

Since the study project was under construction before the workshop series was completed, the proposals could not be carried out and the amount of actual savings could not be determined.

Officials of the designing firm, in commenting on the cost-saving proposals, indicated that the proposals generally fell into three categories.

1. Some could have been implemented had they been proposed during the design phase.

2. Some proposals were technically feasible, but, because of regulatory agency requirements and engineering judgment, they probably would not have been implemented.

3. Some proposed changes were not practicable because of technical considerations.

(See enclosure, p. 45.)

If the proposals had been implemented, Federal, State, and local governments would have shared the initial capital cost savings on the basis of the construction grant formula--75-percent Federal and 25-percent State and local governments--and each would have benefited from the reduced financing costs. In addition, the municipality would have benefited from the OMR savings over the project's life.

For ease in presenting the proposals developed in the five workshops, MBM developed five consolidated team reports which are included in the enclosure.

--Buildings, appendix II

--Electrical distribution, appendix III

--Plant layout, appendix IV

--Underground structures, appendix V

--Process change, appendix VI

Following is a discussion of the more important potential cost-saving proposals MBM reported.

Buildings

Cost-saving proposals included consolidating the garage and laboratory buildings, reducing building floorspace from 17,500 to 10,500 square feet, and replacing brick masonry and stone fascia structures with preengineered buildings. (See enclosure, pp. 41 and 57.)

Electrical distribution

Cost-saving proposals included relocating the main transformer and switchboard closer to the major electrical loads, rerouting feeders, resizing duct and feeders to actual loads,

using aluminum cables, and using switches and fuses instead of circuit breakers. (See enclosure, pp. 41 and 73.)

Plant layout

Cost-saving proposals included rerouting the interceptor sewerline, consolidating facilities permitting the use of common-wall construction, and redesigning aeration tanks. (See enclosure, pp. 42 and 85.)

Underground structures

Cost-saving proposals included using (1) ultimate-strength design for concrete and higher strength reinforcing, (2) high ground water table to offset and resist internal pressures, (3) precast separator walls, and (4) stabilized earth embankment instead of concrete walls for sludge-drying beds. (See enclosure, pp. 43 and 97.)

Process change

Using the rotating biological contactor process instead of the activated-sludge process was proposed. When the plant was designed in 1971, the rotating biological contactor process had not been adequately demonstrated and was not commonly used in the United States. Since then, the process has been recognized as viable and is being used on a limited basis and was therefore believed feasible for the study project. This demonstrates the need for a value analysis study of projects with long periods between design completion and construction to take advantage of technological advances occurring during that period.

The process change would affect construction costs by eliminating the need for aeration tanks and appurtenant blowers, blower building, and much of the piping. In addition, horsepower requirements would be reduced by about 285 horsepower. (See enclosure, pp. 43 and 109.)

CHAPTER 3

NEED FOR IMPROVED COST CONTROL PROGRAM

Most municipalities contract with consulting engineering firms for designing municipal waste treatment facilities. EPA and States rely upon the consulting engineering firms to design cost-effective waste treatment facilities. The firm's design plans and specifications are not usually reviewed to insure that the plant is designed at lowest cost.

None of the consulting engineering firms we visited used the value analysis approach to reduce or minimize the waste treatment plant costs by identifying high-cost areas of secondary importance and proposing less costly alternatives to municipalities, the States, and EPA.

Billions of taxpayers' dollars will be needed to construct and operate municipal waste treatment facilities to clean up the Nation's waterways. The workshop studies showed that there is potential for reducing or minimizing waste treatment facilities' construction and operating costs.

EPA headquarters officials, recognizing the potential of value analysis, requested assistance from two EPA regional offices in May 1974 to test the technique as the first step in developing a value analysis program. Headquarters officials, however, were unable to obtain regional office participation because of staffing limitations and, as of December 31, 1974, the studies had not been made. These studies could be invaluable to EPA in solving several unanswered questions on how to develop and implement an effective program.

Along with the effort to do the test studies, EPA headquarters officials set the framework to carry out a value analysis program and on December 11, 1974, issued to the regional offices, interim policy guidance on value analysis use. EPA had not issued the final program guidelines as of December 31, 1974, as planned, partly because the test studies had not been done.

EPA's delays in developing and establishing a value analysis program to reduce or minimize treatment facilities costs could be expensive in terms of lost opportunities for cost savings.

Fourteen other Federal agencies have established such programs to be used in the design and/or construction of federally financed facilities. Four agencies with the most successful programs reported cumulative cost savings

from $3.6 to $233.5 million. All four of these agencies had established similar management practices contributing to their success. EPA should consider these practices when developing and establishing its program.

VALUE ANALYSIS NOT USED IN WASTE TREATMENT FACILITIES' DESIGN

Municipalities are responsible for planning, designing, constructing, operating, and maintaining federally funded waste treatment facilities. Most municipalities, especially the smaller ones, do not have the engineering capability to plan, design, and supervise construction of a treatment facility and obtain this capability by hiring consulting engineering firms.

Professional services provided by a consulting engineering firm generally include

--selecting the treatment process;

--preparing design plans, specifications, and cost estimates;

--supervising facility construction;

--preparing the Federal financial assistance grant application; and

--representing the municipality at State and EPA regional offices.

The consulting engineer's fundamental task is to design a waste treatment facility that minimizes cost subject to meeting effluent limitation standards and constraints imposed by EPA, States, municipalities, and the designer himself. The constraints include requirements of safety; flexibility; reliability; beauty; ease of operation; desirability; and, to some extent, State and local building codes. Additionally, several consulting engineering firms we visited have said that a municipality's desire to minimize its own OMR costs, for which there is no Federal financial assistance, creates a design contraint which may lead to increased capital costs to reduce OMR costs. Most constraints, however, are imposed subjectively by the designer resulting from its engineering experience.

The sequence of designing a waste treatment plant was basically the same for the 22 consulting engineering firms we visited. Once the overall waste treatment system is selected and approved by the State and EPA during the preliminary planning phase, value judgments are made during

the design phase as each engineer (1) identifies alternatives within his area of expertise, (2) evaluates them on the basis of performance and cost, and (3) selects, using his professional judgment, those best suited to meet the constraints imposed on the project.

After a sanitary engineer develops a schematic process flow diagram, showing the locations and sizes of components, and an architect or structural engineer establishes basic design concepts for the various structures, each discipline concurrently completes the details of the plant within its area of expertise. These individual judgments are reviewed by upper management to insure that (1) they are logical and based on sound engineering premises, (2) there is no conflict between the decisions of the various disciplines participating in the design, and (3) the cost estimates compare reasonably with preliminary estimates.

A project manager and/or project engineer usually oversees the design process to insure that timetables are met within the firm's budgetary constraints. However, there is no apparent systematic review procedure directed at analyzing the cost impact of one discipline's design decisions on others to insure that the waste treatment plant is designed at the least cost for the life cycle of the plant.

Designs prepared by the consulting engineers are reviewed by EPA and State engineers to insure that Federal and State requirements are met and that the proposed plant can reasonably be expected to achieve treatment levels to meet prescribed effluent limitation standards.

EPA regional personnel responsible for reviewing construction grant applications generally have not been reviewing architectural and structural aspects of a waste treatment plant design, including materiel and equipment selections. A regional official stated that review procedures in that region would detect only obvious deficiencies. One region reviewed plant cost estimates for reasonableness by using regionally developed costs of various wastewater flows for selected processes, whereas another used headquarters-developed flow costs for a geographical area. Updated annually, these costs represent average historical trends rather than what a plant should cost. No effort has been made to improve the cost effectiveness of the plant as designed by using value analysis.

EPA does, however, withhold the municipality's final grant payment pending final inspection to determine whether the plant meets design criteria. If the plant does not meet the design criteria, the municipality must correct the problems identified before receiving final payment.

EPA places responsibility for administrative and technical review at the State level, subject to EPA overview in such areas as planning, technical review of plans and specifications, and review of operation and maintenance manuals. As States assume more responsibility for the review process, EPA's direct role will be greatly reduced. As of June 30, 1974, EPA had certified 24 States for reviewing plans and specifications and 25 States for reviewing operation and maintenance manuals.

The extent of State reviews of waste treatment plant designs depends upon the technical capability and availability of the State staff. Four of the six States we visited reviewed preliminary planning decisions made by the consulting engineering firm to insure that a variety of alternative solutions to a municipality's waste treatment problems were considered and that the best overall solution was selected on the basis of the information the firm provided. Only one of these States developed its own data base for this purpose.

In reviewing final plans and specifications, all six States emphasized the capability of the project to meet prescribed effluent discharge limitations. Technical items, such as tank-loading levels, equipment sizes, and projected wastewater flows, may be validated. These States did not specifically review structural, architectural, or electrical aspects of the designs but scanned them for obvious deficiencies and excessive ornamentation. There were no provisions for value analysis in the construction grant review processes of the six States.

EPA DEVELOPMENT OF A VALUE ANALYSIS PROGRAM

In April 1974 EPA began developing a value analysis program by proposing to conduct two test studies under grant conditions. In July 1974 EPA set the framework for establishing a program based on the test studies' results. EPA, however, has not been successful in conducting the test studies; therefore, the program has been delayed.

To carry out a program which emphasizes reducing construction costs, EPA will also need to revise its regulations requiring municipalities to reimburse consulting engineering firms in ways other than by the percentage of construction cost presently being used.

EPA studies

EPA studies to determine the feasibility of applying value analysis under actual grant conditions--75-percent

Federal and 25-percent State and local governments funding ratio--were to be made in two EPA regions by September 1974. EPA headquarters officials notified the two regions of the proposed studies in May 1974 and requested their assistance in making them. Both regions, however, stated they could not assist because required staffing was not available.

EPA, in August 1974, again requested the assistance of the two regional offices to make the studies and provided both regions with suggested criteria for project selection. EPA still proposed to complete the studies in September 1974.

The August request stated that the studies were the next step in EPA's effort to incorporate value analysis into the construction grant program. However, as of December 31, 1974, neither regional office had identified a prospective project for the studies. One regional representative stated that, because of staffing limitations, no attempt had been made to solicit consulting engineering firms for a project to make the proposed studies. The other region made only telephone contacts with consulting engineering firms and cited the following reasons for its inability to identify a project for the studies.

"1. It is the opinion of A-E [consulting engineer] and the State personnel that any value engineering study should be 100% Federally funded rather than only being a grant eligible cost. Under the present system the municipality is required to finance a portion of the value engineering study.

"2. Many of the projects under design at this time are subject to rigid completion schedules. The affected parties are reluctant to agree to a value engineering study which inevitably would delay the completion of such projects.

"3. A-E firms are hesitant to release projects for a value engineering study because of limited experience in the procedures involved in conducting such studies."

These reasons suggest that (1) States and municipalities are reluctant to participate in funding studies which might delay projects and (2) consulting engineering firms are reluctant to accept the uncertainties of studies made for the first time under actual grant conditions. This reluctance is understandable and could possibly be alleviated if EPA were to make and fund the test studies as research projects.

As previously stated, EPA had not made the studies as of December 31, 1974. These studies could provide answers

to several questions that need to be resolved before a program is implemented, such as:

--How should waste treatment plants be selected for value analysis studies?

--Where in the design process could value analysis best be implemented to minimize the costs and delays of implementing changes and thereby maximize potential cost savings?

--Who should make the value analysis study and how should it be funded?

--Who should be responsible for insuring that value analysis is made.

EPA-proposed test studies could be invaluable in answering these questions and in providing information on how a value analysis program can best be implemented under actual grant conditions.

Setting the program framework

EPA plans to initially establish a value analysis program on a voluntary basis. After designers and State and local governments better understand the technique and the program, EPA plans to require value analysis on those projects with the greatest savings potential.

The framework for a value analysis program was established in a July 1974 memorandum from the Deputy Assistant Administrator for Water Program Operations to the Assistant Administrator for Planning and Management, which stated:

"Our first goal is to implement a program in which value engineering studies are accomplished during the design phase and are paid for as a part of the design engineer's professional services. We recognize, however, that there is also opportunity for savings by using the value analysis techniques in the Step 1 facilities planning phase and also in the Step 3 construction phase."

The memorandum included a schedule for carrying out value analysis including issuing

--a program memorandum by July 1974 explaining voluntary use of value analysis,

--draft guidance material by September 1974, and

--final guidance material and approved implementation of a value analysis program by December 1974.

The memorandum also called for an immediate expansion of EPA's effort in value analysis from its 0.3 staff-years effort to one full-time value analysis manager of headquarters. Additionally, a full-time value analysis specialist position would be authorized in regions 1 through 5 and part-time positions by late fiscal year 1975 in the remaining five regions.

As of October 15, 1974, EPA had hired a consultant to assist in developing a value analysis program and four employees had successfully completed the ACEC-AIA value analysis workshops. One of these employees was assigned to the full-time value analysis manager position at headquarters.

On December 11, 1974, EPA issued to the regional offices its program memorandum providing interim policy on value analysis use in the construction grant program but had not issued any guidance material, nor approved implementation of a program, nor authorized any regional office value analysis positions.

Changing the method of procuring consulting engineering firms' services

Traditionally, municipalities reimbursed consulting engineering firms for designing waste treatment facilities on the basis of a percentage of construction cost of the facilities. The percentage used in determining the fees was generally based on a fee curve established by the American Society of Civil Engineers and ranged from 5.64 to 11.63 percent of construction costs, depending upon the magnitude of those costs.

Such a fee structure is incompatible with the establishment of an effective cost control program, such as value analysis, because it penalizes a firm by

--requiring additional efforts to modify facility design plans and specifications to implement cost-saving proposals and

--decreasing construction costs thereby decreasing fees.

EPA's Office of Audit also recognized the undesirability of this method of determining consulting engineering firms' fees for designing waste treatment facilities. In its July 12, 1973, audit report entitled "Report on Review of Consulting Engineer Agreements Awarded Under Waste Water Treatment

Facility Construction Grants," EPA's Office of Audit stated:

> "Additional controls are needed to assure that engineering subcontracts are sufficiently specific to safeguard the interests of the Federal government. Specifically, we found that most engineering contracts were generally not definitive with respect to nature and quantity of services to be provided or to the amount of costs to be incurred or billed for such services. In addition, most of the contracts utilized the less than desirable or totally unacceptable 'percentage of cost' or 'cost plus percentage of cost' methods. These weaknesses prevent EPA from having the information necessary to properly review the reasonableness of engineering costs proposed in our construction grant applications. Without improved guidelines in these areas, EPA can exercise no effective control to prevent consulting firms from realizing excessive profits."

In a subsequent December 13, 1974, audit report entitled "Consolidated Draft Report on the Tentative Results of the Initial 41 Interim Construction Grant Audits," EPA stated that grantees were not obtaining engineering services at reasonable prices.

EPA's review of 10 engineering firms which allowed EPA access to their financial records, disclosed that engineers' profits ranged from 26 to 268 percent of costs and that the firms had been paid excessive profits of $4 million. EPA stated that this condition is, in part, attributable to EPA management's past failure to issue and implement effective and timely regulations for the procurement of engineering services.

The Director, Municipal Construction Division, in an October 23, 1974, Program Guidance Memorandum to regional administrators stated that consulting engineering contracts "based on a percentage of the construction cost, which results in penalizing the engineer for designing the most economical facility to perform a function, shall not be used." The Director stated that other types of contractural arrangements, such as fixed price, per diem, or cost plus a fixed fee, were preferred. EPA officials said that they were considering revising the regulations pertaining to consulting engineering contracts to incorporate this policy.

These procurement methods would not penalize consulting engineering firms for additional efforts to modify facility design plans and specifications to implement cost-saving proposals resulting from cost control programs, such as value analysis.

SUCCESSFUL FEDERAL VALUE ANALYSIS PROGRAMS

Value analysis was first used in Federal Government construction projects by the Department of the Navy in 1954. Since then, 14 of 23 Federal agencies involved in financing the cost of constructing facilities have incorporated value analysis programs in the design and/or construction of facilities with varying degrees of success.

Four agencies--the Corps of Engineers, the Department of the Navy, the General Services Administration, and the Veterans Administratrion--operating the more successful programs have developed similar management practices contributing to their success. The four agencies have reported cumulative program savings ranging from $3.6 to $233.5 million. Many of the management practices established by these agencies could benefit EPA, and therefore EPA should consider them in its effort to incorporate value analysis into its construction grant program. A summary of the more important management practices are discussed below.

Program management

Establishing a value analysis program does not insure an effective approach to cost control. The four Federal agencies emphasized the need for strong, active top-management support of the value analysis effort generally including

--issuing an affirmative policy statement on value analysis and

--assigning a full-time program manager to direct the program with reporting responsibility directly to the executive office.

The program manager should be responsible for establishing program goals, setting up an organizational structure, and providing motivation and training to his agency's employees.

According to an official of one agency, a successful program must have a manager who is capable of organizing and managing the program and who is trained in the principles, application, and mananagement of value analysis.

Establishing goals and procedures

The program elements being used by the agencies included establishing

--specific program goals to provide a common base for measuring the program's effectiveness;

--implementation procedures to serve as the standard operating procedure for the day-to-day program operation;

--reporting procedures to provide data on the program's progress and to disseminate results of the previous studies; and

--evaluation procedures to ascertain the extent of compliance with established policies and directives, determine the reliability of the data generated, appraise the quality of performance in planning and managing the program, and evaluate the program's effectiveness in reducing costs.

For example, reporting systems used by the agencies included requirements for providing specific information, such as comparisons of costs versus savings, number of studies made, number of personnel trained, number of inspections made in field offices, and summaries of proposed changes. Value analysis study results were disseminated periodically to field locations in the form of pamphlets, reports, memoranda, and revised specifications.

The proper management of any program requires the continued evaluation of current program status against previous planning. For example, this evaluation was accomplished by some of the agencies through periodic audits of program effectiveness, performance reports, and quantitative measurements of program performance, such as return on investment.

Motivation and training

All four agencies believed that effective publicity and motivational programs were necessary for promoting interest and program participation. Examples of such efforts include publicizing the program through pamphlets, brochures, and posters; conducting seminars; and recognizing individual efforts through cash awards and certificates.

Since value analysis of waste treatment plant design is new to EPA and State personnel, as well as to consulting engineers, an extensive training program will be needed. Numerous types of training courses, ranging from 2 to 80 hours, exist and are being used by various agencies. One agency, with a large in-house capability, has provided some degree of training by its own instructors to over 10,000 personnel and considers this effort an important reason for its program's success.

CHAPTER 4

CONCLUSIONS, RECOMMENDATIONS, AND AGENCY COMMENTS AND OUR EVALUATION

CONCLUSIONS

Controlling pollution from municipal sources will be costly--billions of taxpayers dollars--and the most cost-effective use of Federal funds is essential, especially in view of the Nation's inflation and economic problems. EPA therefore needs to develop cost control programs, such as value analysis, and incorporate them into its construction grant program to insure that treatment facilities are constructed at lowest cost.

Although applied to a waste treatment plant for the first time, the results show that value analysis has potential for reducing waste treatment plant costs without sacrificing essential requirements.

The potential savings that may be achievable through value analysis should be a sufficient basis for EPA's taking aggressive action to make its studies to fully evaluate the benefits and implementation alternatives of a value analysis program. EPA delays could be costly in terms of lost opportunities for saving taxpayers' dollars.

Before a successful program can be developed, EPA needs to revise its regulations--which it was in the process of doing--and require municipalities to use methods other than the percentage-of-construction-cost method of procuring professional services for designing waste treatment facilities.

Other Federal agencies have proved the benefit of value analysis in designing and/or constructing federally financed facilities. EPA could benefit by considering the management practices of four of the more successful programs in developing and establishing its program.

RECOMMENDATIONS

We recommend that the Administrator, EPA, establish and implement a value analysis program and incorporate it into EPA's construction grant program to insure that treatment facilities are constructed at lowest cost. Because of the magnitude of the potential savings to be realized by using value analysis, we recommend that the Administrator

require that value analysis test studies be made as soon as possible to find answers to several questions that need to be resolved, such as:

--How should waste treatment plants be selected for value analysis studies?

--Where in the design process could value analysis best be implemented to minimize the costs and delays of implementing changes and thereby maximize potential cost savings?

--Who should make the value analysis study and how should it be funded?

--Who should be responsible for insuring that the value analysis is made?

We also recommend that EPA finalize its regulations requiring municipalities to use methods other than the percentage-of-construction-cost method in procuring professional services for designing waste treatment facilities and consider the successful management practices of other Federal value analysis programs when establishing EPA's program.

AGENCY COMMENTS AND OUR EVALUATION

In a letter dated March 18, 1975 (see app. I), EPA told us that it was in general agreement with our findings.

EPA pointed out that it was strongly committed to having value analysis as a part of its construction grant program but was experiencing problems incorporating value analysis into the program.

EPA stated that it

--had moved as fast as practicable in the use of value analysis considering the general lack of understanding of how it worked;

--was a grant agency and not a direct contract agency; and

--was proceeding step by step, recognizing that moving too fast would be counterproductive in view of the limited capability available to accomplish value analysis for municipal waste treatment facilities.

EPA agreed that its early estimates of when value analysis studies could be completed were too optimistic despite its efforts to conduct such studies under actual grant conditions. EPA pointed out that the predominant reason for the delays was poor timing; that is, the value analysis study would have resulted in unacceptable project delays.

We recognized that EPA was having problems incorporating value analysis in the grant program but had EPA moved forward in conducting its studies under test conditions some of these problems may have been resolved. EPA, however, stated that funding the studies on a 100-percent research basis would not be appropriate because this would imply that value analysis was a demonstration of a questionable concept and set a poor precedent.

We believe that conducting the studies on a test basis would not create a negative attitude toward the acceptance of the value analysis concept. The main purpose of EPA's water pollution research and demonstration program has been to gain the acceptance from consulting engineering firms and municipalities of new and improved technology to be used in the construction grant program. In view of the problems that EPA is experiencing in trying to use value analysis under actual grant conditions, EPA should reappraise its approach and consider conducting value analysis studies on a test basis to expedite incorporating value analysis into the construction grant program.

With regard to the use of the percentage-of-construction-cost method in procurring consulting engineering services, EPA stated that its current draft regulations forbid this method of procurement. Until these draft regulations are published in the Federal Register and finalized, municipalities can continue to use this method in procurring engineering services.

EPA pointed out that the four Federal agencies we highlighted as having successful value analysis programs are direct contract agencies which are different considerably from EPA's program of grants to municipalities. EPA agreed, however, that it could benefit from the value analysis experiences of other agencies.

APPENDIX I

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAR 18 1975

Mr. Henry Eschwege
Director, Resources and Economic
Development Division
U. S. General Accounting Office
Washington, DC 20548

Dear Mr. Eschwege:

With your letter of February 7, 1975, you transmitted copies of the General Accounting Office's (GAO's) draft report entitled, "Potential for Reducing the Costs of Waste Treatment Plants by Using Value Analysis." We appreciate the opportunity to review this draft report and are in general agreement with the concepts expressed and findings listed.

Our specific comments are as follows:

1. EPA is strongly committed to having value analysis, or value engineering (VE) as a part of the construction grant program. Under Program Guidance Memorandum 45, December 11, 1974, we have provided information on the voluntary use of VE and its grant eligibility to each of our Regional Offices.

2. EPA has moved as fast as practicable in the use of VE, considering the general lack of understanding of how VE works and the fact that EPA is a "grant" agency (not a direct contractor). EPA is proceeding step by step, recognizing that moving too fast will be counterproductive in view of the limited capability now available to accomplish VE for waste water treatment facilities.

3. The GAO report correctly notes that our early estimates of when VE studies could be completed were too optimistic. We have visited six Regional Offices and held detailed discussions with nine consulting engineers and two municipalities. Despite this intensive effort (which will continue) we have not yet been able to start one VE study under actual grant conditions. The predominant reason given is poor timing, i.e., that the VE study would result in unacceptable project delays. We have previously considered the

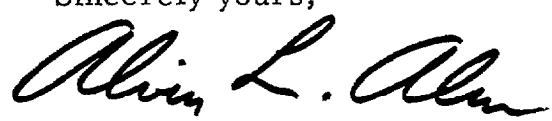
APPENDIX I

GAO suggestion that EPA fund VE studies on a 100 percent research basis. It was our judgement that this process would not be appropriate. VE should be used in the regular grant process, and the full funding would both imply VE was a demonstration of a questionable concept and set a poor precedent for future actions. We do not rule out this approach, but believe the conventional process should be tried.

4. The percentage of construction cost method of procuring architect/engineer services by EPA grantees was forbidden by our Program Guidance Memorandum No. 42, dated October 23, 1974. In addition, the current draft of procedures for contracting for personal and professional services for inclusion in the Title II Regulations for PL 92-500 also forbids this type of contract.

5. While we agree that EPA can benefit from the VE experiences of other agencies, we believe that the GAO report implies that four Federal agencies with effective VE programs have construction programs similar to EPA's. In fact, all four of these agencies are direct contract agencies. This is substantially different from EPA's program of grants to municipalities. To our knowledge, only one of these four agencies routinely uses VE in the design process. GAO should analyze the reported savings of those agencies to differentiate between savings in design (the EPA approach) and savings in construction contractor change proposals.

Sincerely yours,



Alvin L. Alm
Assistant Administrator
for Planning and Management

APPENDIX II

PRINCIPAL EPA OFFICIALS RESPONSIBLE FOR ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
ADMINISTRATOR:		
Russell E. Train	Sept. 1973	Present
John R. Quarles, Jr. (acting)	Aug. 1973	Sept. 1973
Robert W. Fri (acting)	Apr. 1973	Aug. 1973
William D. Ruckelshaus	Dec. 1970	Apr. 1973
ASSISTANT ADMINISTRATOR FOR WATER AND HAZARDOUS MATERIALS:		
James L. Agee	Apr. 1974	Present
Roger Strelow (acting)(note a)	Feb. 1974	Apr. 1974
Robert L. Sansom (note a)	Apr. 1972	Feb. 1974
DEPUTY ASSISTANT ADMINISTRATOR FOR WATER PROGRAM OPERATIONS:		
John T. Rhett	Mar. 1973	Present
Louis De Camp (acting)	Sept. 1972	Mar. 1973
Eugene T. Jensen	June 1973	Sept. 1972

[a]Before April 22, 1974, the title of this position was Assistant Administrator for Air and Water Programs.

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