United States
Environmental Protection
Agency

Region 6 (6AWM)
1201 Elm Street
Dallas, Texas 75270

EPA 906/9-78-003
July, 1978

Engineering Costs and Fees for Municipal Wastewater Treatment Works

An Estimating Technique for Design of Treatment Plants

EPA REVIEW NOTICE

This report has been produced by the Environmental Protection Agency's Region 6. The data base for the study is representative of research in Region 6. However data has been dependent on information collected from others and its use does not validate the information supplied beyond the Region's own calculation.

NOTES

Document is available to the public through the:

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Questions or interpretations regarding this report may be addressed to Ned K. Burleson, Chief, Municipal Facilities Branch (6AWM), Region 6 at FTS 729-2845 (Commercial 214/767-2845).

EPA-906/9-78-003

ENGINEERING COSTS AND FEES

FOR

MUNICIPAL WASTEWATER TREATMENT WORKS

An Estimating Technique for Design Of Treatment Plants

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ABSTRACT

An analysis of costs and manpower efforts required to design wastewater treatment works was conducted by the Construction Grants staff of the Environmental Protection Agency, Region 6. The American Consulting Engineers Council Chapter from the states of Arkansas, Louisiana, New Mexico, Oklahoma, and Texas cooperated in the analysis.

The purpose of the study was to establish a basis for estimating/evaluating manpower requirements and reasonable engineering fees for EPA projects.

Agency personnel collected actual manpower and financial resources expended on designing specific wastewater treatment works projects. This data, adjusted for inflation and other cost fluctuation, provided an empirical basis for statistical comparison with other parameters.

The relationships developed provide a methodology for estimating and analyzing engineering fees for wastewater treatment plant design. The object is to produce a series of nomographs and related tables that can determine the median number of drawings required and corresponding A&E design costs/manhours based upon inputing the following variables: 1) MGD, 2) type of construction (new, upgrade, etc.), 3) treatment process, 4) effluent quality required, and 5) difficulty of drawings.

PERSPECTIVE

This report was prepared by EPA Region 6 personnel. The data base for the study is representative of Region 6. The intent of the report is to present an objective treatment of the subject and provide as much factual evidence as possible.

The study has accumulated historical resources expended by specific consulting engineering firms on EPA Wastewater Treatment Works (WWTW) design.

Resources accumulated have been updated to establish an empirical basis for evaluating future proposed engineering fees. It is assumed that past costs (or resources) can be adjusted for inflation and other influences to provide an approximate average estimate of the cost of similiar future design.

Considering related studies, construction cost estimates and technology updates, each WWTW design is unique. To remain flexible to the diversity of engineering design, the data reported should be accepted as an average surrounded by a relevant range. In effect, the study product has value as a guide but should be used as a tool directed by human judgment. Based upon the curves generated, average Architectural and Engineering (A&E) design costs can be extrapolated. Human judgment should then be applied reflecting the fact that for specific situations costs may be higher or lower than the mean.

Although the particular Region 6 study may not be directly useful to other organizations, it is commended as a research methodology to everyone interested in WWTW design compensation. As more history becomes available, it is expected that the current data base will be expanded and updated regularly providing an accurate and continuing series of cost estimating relationships.

From a practical standpoint, the curves will provide Region 6 with a guideline to indicate significant differences between proposed engineering fees proposed and average fees reasonably reconstructed from historical data. On specific projects the rational resolution of such differences will be solely dependent upon the judgment of the parties involved.

The study data presented are based upon fourth quarter calendar 1977 dollars and EPA regulations/requirements as of that date. Future consideration of the data should reflect adjustments based upon changing economic conditions and mandated scope changes.

In summation, the proper use of the data presented herein is consistent with: 1) insuring fairness to Consulting Engineer Firms, 2) obtaining high quality professional services for EPA projects, and 3) protecting the public interests by assuring that compensation is justified by services rendered.

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ACKNOWLEDGMENTS

Numerous Professional Consulting Engineers practicing in Arkansas, Louisiana, Oklahoma, New Mexico, and Texas made vital contributions to the study. Their advice and assistance was invaluable in accumulating the large quantity of data contained herein.

Sincere appreciation is extended to the Consulting Engineering Firms that allowed EPA analysis access to their records and the various engineering societies mentioned in the report as consultant to the study. In acknowledgment of their cooperation, specific commendation is extended to the Engineering Advisory Committee, EPA Region 6/American Consulting Engineers Council.

The Region 6 study team members are commended for their efforts. In addition to their full-time operating responsibilities, numerous staff assisted with this study. Because operating responsibilities were extensive and most critical, many professionals in the study team volunteered their time after hours. Wherever possible, ancillary tasks related to the study were performed in conjunction with operating functions. For example, while visiting A&E firms to perform financial management systems' evaluation and consultation; Contract Price Analysts accumulated specific job cost data for the study.

It is intended that the outcome of this study will equitably serve the best interests of all parties. The beneficial free flow of communication between Region 6 and the Consulting Engineers demonstrates that mutual protection for EPA, clients and Consulting Engineers is best assured by an atmosphere of mutual respect and cooperation.

CONCLUSIONS

* There was a common interest of all concerned with engineering fees in the plan to create "fee curves".

* There is a predictive relationship between Wastewater Treatment Plant design parameters and averages design costs. Through utilization of a family of curves the variables: 1) MGD, 2) type of construction (new, upgrade, etc.), 3) treatment process, 4) effluent quality required, and 5) difficulty of design drawings can be used to determine average cost and effort.

* Historical data researched shows that there was no reliable predictive relationship between construction costs and the design costs.

* There is little relationship between the size of A&E firms and their Federally approved indirect cost rates.

* The Environmental Protection Agency, the engineering societies, and other entities work well together while compiling data for such a report.

DEVELOPMENT OF FEE CURVES

INTRODUCTION

The percentage of construction cost and multiplier method of contracting/compensating for engineering services on EPA projects is prohibited. Since implementation of this prohibition, there has been considerable speculation regarding the reasonableness of engineering fees. EPA and the A&E firms had expended considerable manhours in efforts to determine reasonable fees for WWTW design. It became apparent that a more efficient method of estimating/evaluating was required.

To provide a sound alternative for determining reasonable wastewater treatment Works Engineering design charges, Region VI performed an analysis of the circumstances that determine A&E design costs.

Regional project files contain the largest possible amount of raw A&E data related to the five state area (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas). An analysis of Region VI A&E fee experience was used as the study's foundation. Data collection consisted primarily of a file search of historical A&E information submitted to Region VI. This data was supplemented by additional sampling data gathered from selected A&E firms having considerable wastewater treatment works experience. Although there are plans to study Steps I, II, III and the various ancillary services; it was decided to isolate Step II "Design of Wastewater Treatment Plants and Lines" as an initial research pilot. Most of the work to date has involved these particular A&E services.

METHODOLOGY FOR "PLANT" RESEARCH

Final data was inputed for sixty-five completed jobs (grant award subsequent to January, 1973) performed by firms confined within Region VI and having between 7 and 170 employees. This total (65) included all possible Region VI jobs with Step II design fees that exceeded $50,000 (42). The additional 23 less costly jobs were selected based on the objective of including the widest representation of Consulting Engineering firms operating in the Region while considering the number of projects required to make valid inferences.

All jobs selected were examined individually and analyzed collectively. To facilitate consistent and systematic "file searching" of jobs selected; a "File Research Data Checklist" was prepared. The 116 items included on the checklist represent the factors that may directly or indirectly affect the A&E charges for wastewater treatment works. The following "Construction Data" excerpts are taken from the File Research Checklist:

Construction Data

Type of Construction (General) ______________________________(59)

Enter one of the following:

New Plant

Upgrade; primary to secondary

Upgrade: primary to tertiary

Upgrade; secondary to tertiary

Upgrade/expansion; primary to secondary

Upgrade/expansion; primary to tertiary

Upgrade/expansion; secondary to tertiary

Expansion at same treatment level

Description of proposed/constructed facilities

-- Inflow rate ______________________________ MGD (75)

-- Influent (BOD) ______________________________ mg/1 (76)

-- Influent (TSS) ______________________________ mg/1 (77)

-- Other influent quality considerations required such as P, NH_3, NO_3 removal ____________________________ (78)

Principal unit process train involved ____________ (79)

Enter one of the following:

Activated sludge (conventional)

Extended aeration

Lagoons

Contact stabilization

Trickling filters, Biofilters

Oxidation ditches

Pure oxygen

Roughing filters and conventional activated sludge

Primary chemical and activated sludge

Biodisc

Physical-chemical

Primary chemical and pure oxygen

Step aeration

Trickling filter and step aeration

The following "Degree of Difficulty" excerpt is taken from another section of the File Research Checklist:

Degree of Difficulty Involved in A&E Work As Determined By A Drawing Review

Total number of drawings __________(99)

Number of easy (E) drawings

-- Land planning sheets __________(100)

-- Pipeline sheets __________(101)

-- Other (E) __________(102)

Total __________(103) __________%(104)

Number of average drawings

-- Process component drawings ____________(105)

-- Structural drawings ____________(106)

-- Architectural and other ____________(107)

Total ____________(108) ____________%(109)

Number of difficult drawings

-- Mechanical sheets ____________(110)

-- Full electrical sheets ____________(111)

-- Experimental component sheets _________(112)

Total ____________(113) ____________%(114)

Project classification ______________________________(115)

In order to account for inflationary trends, dollar values recorded on the checklist for items such as "low bid construction" and "A&E Fee" have been updated to fourth quarter 1977 dollars. Other checklist items include project identification information such as "project location", "geographic classification", and "population served".

Besides file searching information, Region VI Contract Price Analysts visited 21 firms representing all 5 states in the Region. For projects selected, the analysts and firm officials constructed the actual historical costs expended by the firm on the particular job. These historical costs were then updated to current dollars. In effect, for these projects, the A&E Costs for a firm to design a particular wastewater treatment plant in the fourth quarter of 1977 were established. Of the 65 projects file researched, 31 also underwent updated design cost analysis. The basis for costing these jobs was the actual manhours expended. The accumulated manhours were used in generating the manhour table (see Exhibit II). This manhour table makes the technical "number of drawings" curves relevent for firms with varying overhead rates.

The site visits accomplished by our analysts were beneficial, in that, they enabled a free flow of communication between EPA and the various Consulting Engineers. Region VI gained an understanding of the various types of estimating/cost accounting systems used in the profession. The systems encountered at the various firms ranged from primitive informal to sophisticated computerized. The insight of the Consulting Engineers was incorporated into the Region VI study. Many topics of mutual interest were discussed; narrative comments on the discussions are provided as Exhibit III (for the smaller firms) and Exhibit IV (for the larger firms).

Throughout the study to date, the various engineering societies have been informed of study goals and methodology. National and state representatives of the American Consulting Engineers Council, the American Society of Civil Engineers and the National Society of Professional Engineers had the opportunity to participate and provide guidance. Generally, the Societies agreed with the study's purpose, demonstrated considerable positive interest in the research, and asked to be kept informed.

In the actual statistical analysis of the plant design data, the nine variables most likely to affect A&E charges were considered. These variables included:

1. MGD
2. A&E costs in dollars and manhours
3. Construction bids
4. A&E fees
5. Type of construction (new, upgrade, etc.)
6. Treatment process
7. Effluent quality required

8. Number of drawings required and

9. Difficulty of drawings.

To discern the relationships between the variables for which data was accumulated, the statistical method of regression analysis was used. An EPA programmable calculator capable of mechanically printing graphs actually performed the numerous regression analysis.

Conclusions drawn from the calculations considered:

1. The statistical measure of reliability for regression analysis (R^2);

2. The relevance of any positive statistical relationships toward meeting our final study goal, and

3. Logical inference.

Initially, 70 projects were researched. The plant curves are based on 65 of these projects because, for various reasons, 5 of the initial projects were inappropriate for analysis. All 31 of the costed projects were used.

For the most part, projects selected for costing were chosen by Region VI. Selection was based upon a determination that the project was representative and applicable for statistical sampling. In only a few cases did EPA analysts cost a particular project at the suggestion of the cooperating Consulting Engineer. These cases occurred when EPA analysts were unable to reconstruct valid costs on projects originally selected for costing by Region VI. In general, the cost/price and other plant design data inputed is considered accurate and unbiased.

Conclusions Based upon "Plant" Data Analysis

The historical data showed a generally reliable positive relationship between Construction Cost and A&E fee. This is understandable considering that prior to prohibition by EPA; the use of the fee curve method of contracting was in accordance with accepted industry practice.

Notwithstanding the relationship described above, our data indicated a considerably less reliable relationship between Construction Cost and A&E cost. The relationship of A&E fees versus A&E costs showed that as costs increased, fees increased at a slightly higher rate.

Statistically, for a specific "effluent level/type of treatment and construction" there is a predicting relationship between MGD and the number of drawings required. For a particular plant, the generated family of curves determines the number of drawings required for a given MGD.

Relating the number of drawings to A&E costs is another conclusive positive relationship determined. Jobs were grouped by the difficulty of their aggregate make-up of drawings. The job's set of drawings were classified as difficult (C), average (B), and easy (A). Plotting A&E

costs versus the number of drawings for each classification produced three curves with extremely high statistical reliability. The three curves themselves have a high level of confidence based upon logic. All demonstrate economy of scale principles in costs. When the three are considered as a family of curves; for a particular number of drawings, the easy curve predicts the least cost, the average curve a greater cost, and the difficult curve the greatest cost. The family of cost curves can determine A&E costs from the established number of drawings. Based upon the nature of the costs, the costs can then be converted to fees accordingly.

In effect, the essence of the study is a nomograph and related table (see Exhibits I and II) that can determine the median number of drawings required and corresponding A&E design costs/manhours based upon inputing the following variables: 1) MGD, 2) type of construction (new, upgrade, etc.), 3) treatment process, 4) effluent quality required, and 5) difficulty of drawings.

This methodology could be simplified to relate A&E fees to MGD through a family of curves. However, the cost and technical relationships involving the number of drawings would certainly be essential to a credible estimating/negotiating process.

OTHER ISSUES ADDRESSED:

"Status of Research on Collection Lines and Lift Stations"

Research in this area is not yet finalized. Preliminary curves on lines are shown as Exhibit V.

"Statistical Analysis of EPA Approved Indirect Cost Rates for Region VI Consulting Engineering Firms"

See Exhibit VI.

"Bargraphs Produced"

Exhibit VII is a bargraph demonstrating the "hypothetical" profit-loss trend for those projects updated to fourth quarter 1977 dollars.

"A&E Fees related to Construction Costs"

Exhibit VIII is a curve relating A&E Fees to Construction Costs.

"Possible National Relevance of our Plant Methodology/Research"

The MGD versus number of drawings scale on Nomograph Exhibit I and the corresponding manhour table of Exhibit II may be relevent on a national level. As a minimum, the potential to input a multitude of such technical/manhour data exists in all other EPA Regions. Whereas cost data is not relevent from Region to Region, state to state, or city to city; technical/manhour data and the corresponding number of drawings should be relatively constant across geographic boundaries.

"Plant Data Sheets"

Plant data sheets included in Exhibit IX demonstrate the type of data analyzed in the study. Each line of information presented has been verified/corrected by the particular A&E firm involved. Although the firms consider some of this information proprietary, they approved release of their data in a statistical format. The format of Exhibit IX gives no indication as to the identity of the participating firms.

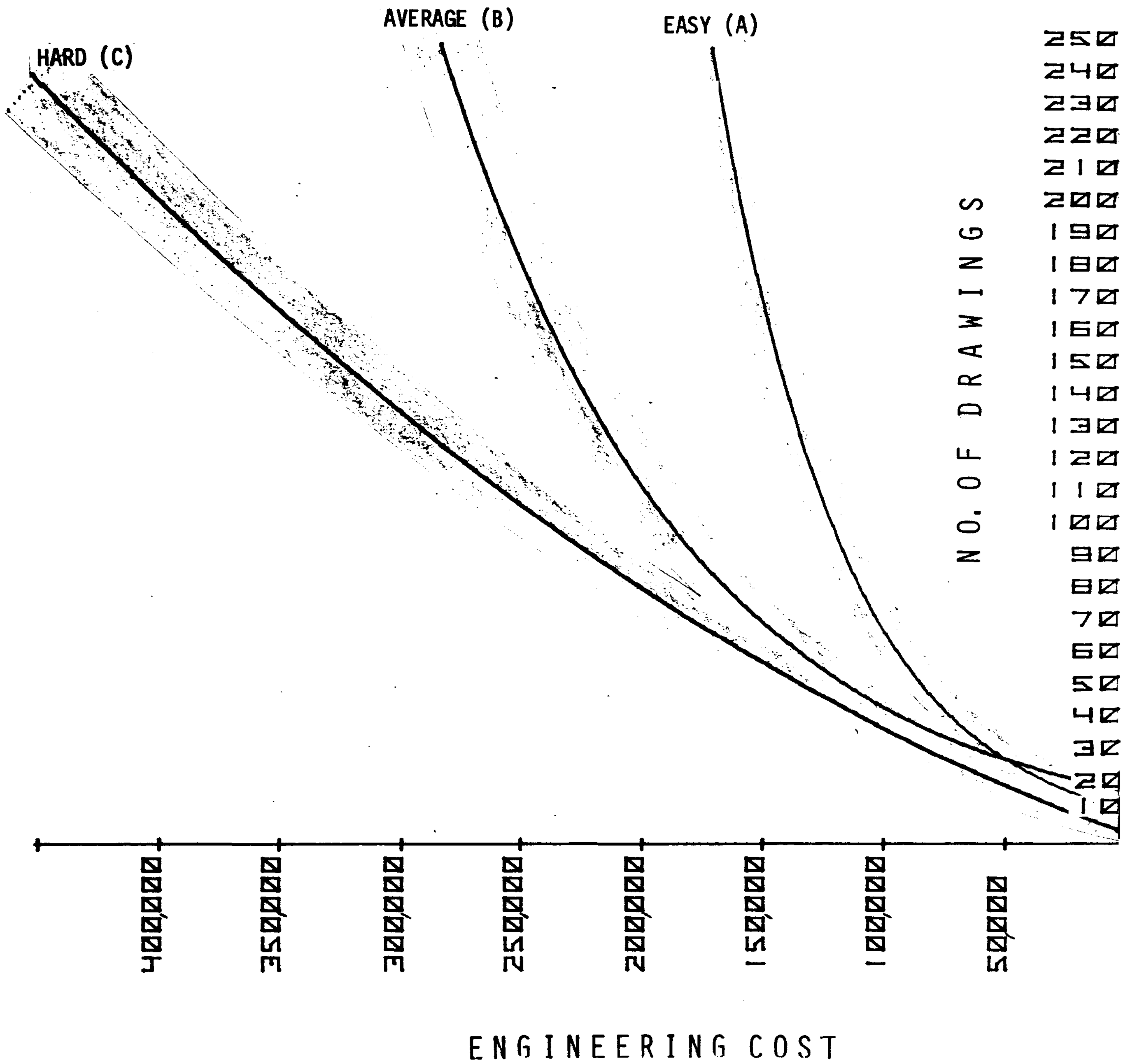
EXHIBITS

USE OF EACH CURVE

The treatment plant curves in the following exhibits are to be read by entering the curve with the treatment process, effluent quality to be designed, and the MGD. For other than new plants the Adjusted MGD is roughly calculated by the formulas below. The center of the initial letter of the process is the beginning of the curve which one follows down to an MGD vertical line. Then horizontal across through the number of drawings to the the curve indicated in parentheses - (A) (B) or (C) - with the treatment process. Then one drops vertically from the A, B, or C curve to read engineering costs. In the case of the "Man-hour" curves one picks the number of manhours for A, B, or C.

APPROXIMATE ADJUSTED MGD CALCULATIONS
(computer curves were used)

Existing usable primary enlarged to secondary:
Adj. MGD = 1/2 X MGD credit for primary plus enlargement increment.
Existing usable secondary to be enlarged:
Adj. MGD = 3/4 X MGD credit for existing secondary plus enlargement increment.
Existing usable primary enlarged to tertiary;
Adj. MGD = 1/4 X MGD credit for primary plus enlargement increment.
Existing usable secondary to be enlarged to tertiary:
Adj. MGD = 1/2 X MGD credit for existing secondary plus enlargement increment.
Of cource, MGD on new projects is not adjusted.


HARD (C)
AVERAGE (B)
EASY (A)
NO. OF DRAWINGS
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
400000
350000
300000
250000
200000
150000
100000
50000
ENGINEERING COST

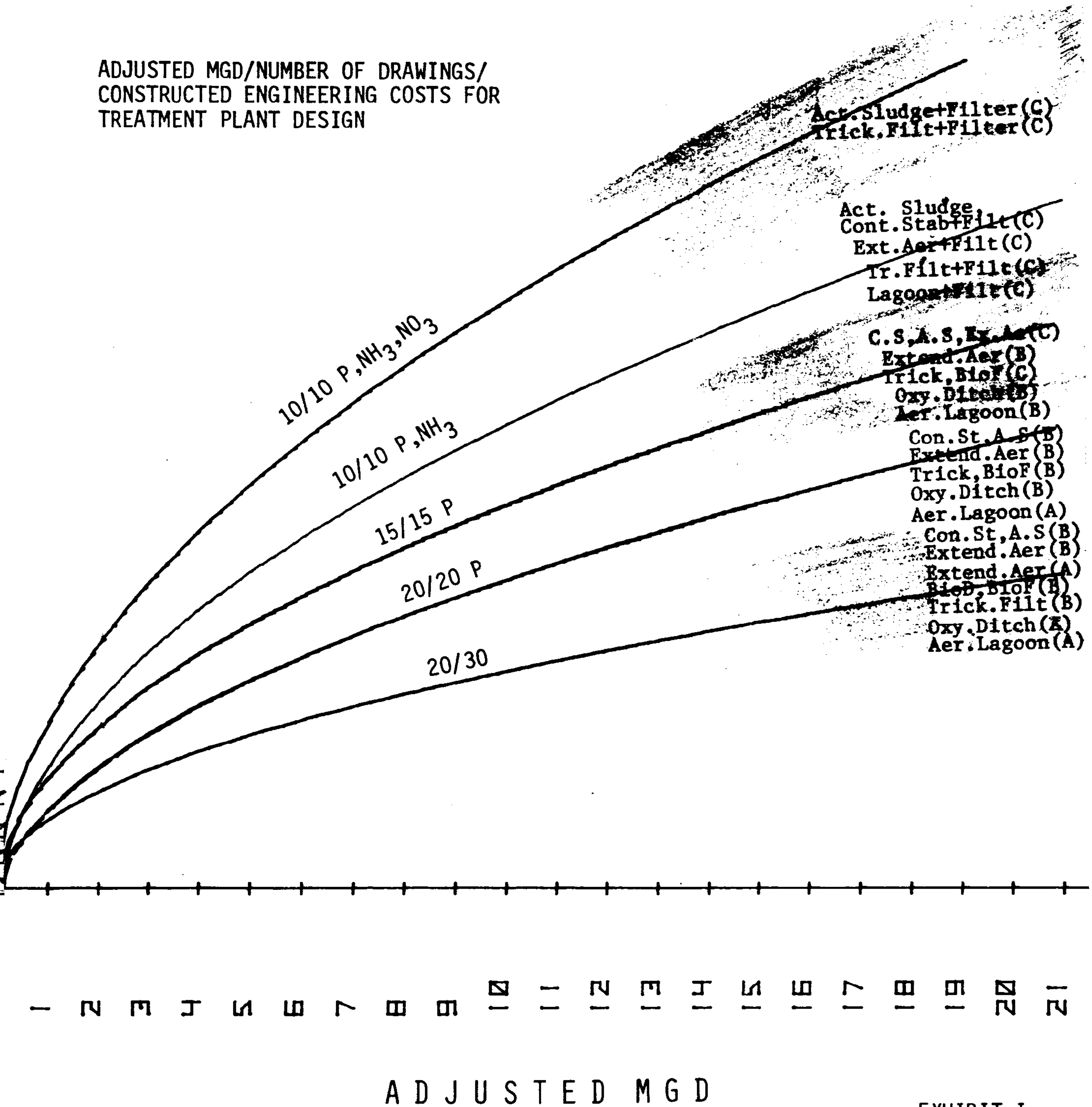
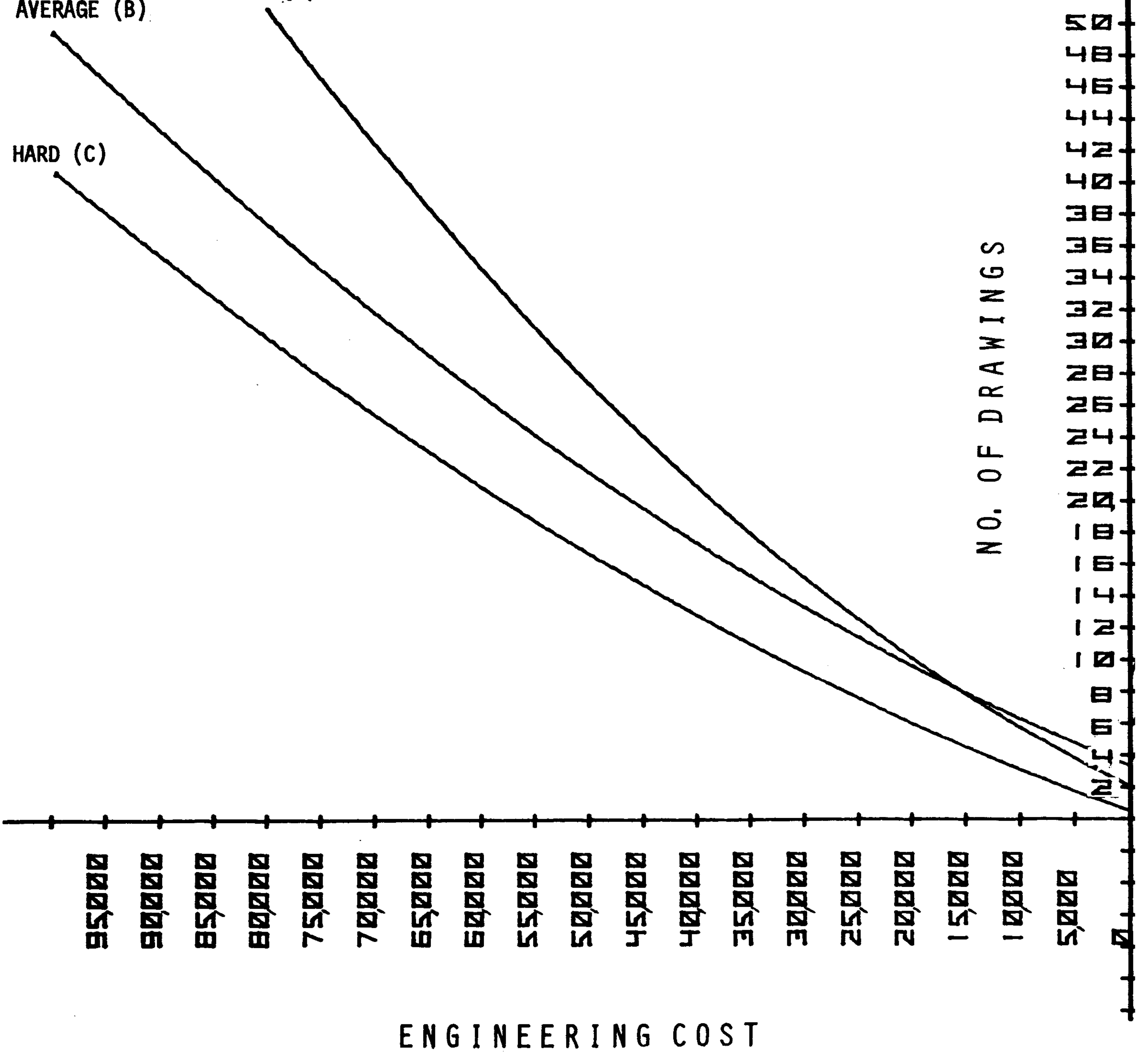

ADJUSTED MGD/NUMBER OF DRAWINGS/
CONSTRUCTED ENGINEERING COSTS FOR
TREATMENT PLANT DESIGN
Act.Sludge+Filter(C)
Trick.Filt+Filter(C)
Act. Sludge,
Cont.Stab+Filt(C)
Ext.Aer+Filt(C)
Tr.Filt+Filt(C)
Lagoon+Filt(C)
C.S,A.S,Ex.Ae(C)
Extend.Aer(B)
Trick,BioF(C)
Oxy.Ditch(B)
Aer.Lagoon(B)
Con.St,A.S(B)
Extend.Aer(B)
Trick,BioF(B)
Oxy.Ditch(B)
Aer.Lagoon(A)
Con.St,A.S(B)
Extend.Aer(B)
Extend.Aer(A)
BioD,BioF(B)
Trick.Filt(B)
Oxy.Ditch(A)
Aer.Lagoon(A)
10/10 P,NH3,NO3
10/10 P,NH3
15/15 P
20/20 P
20/30
ADJUSTED MGD

EXHIBIT I

ADJUSTED MGD/ NUMBER OF DRA
ENGINEERING COSTS FOR TREAT
OF SMALL PLANTS



WINGS/ CONSTRUCTED
MENT PLANT DESIGN

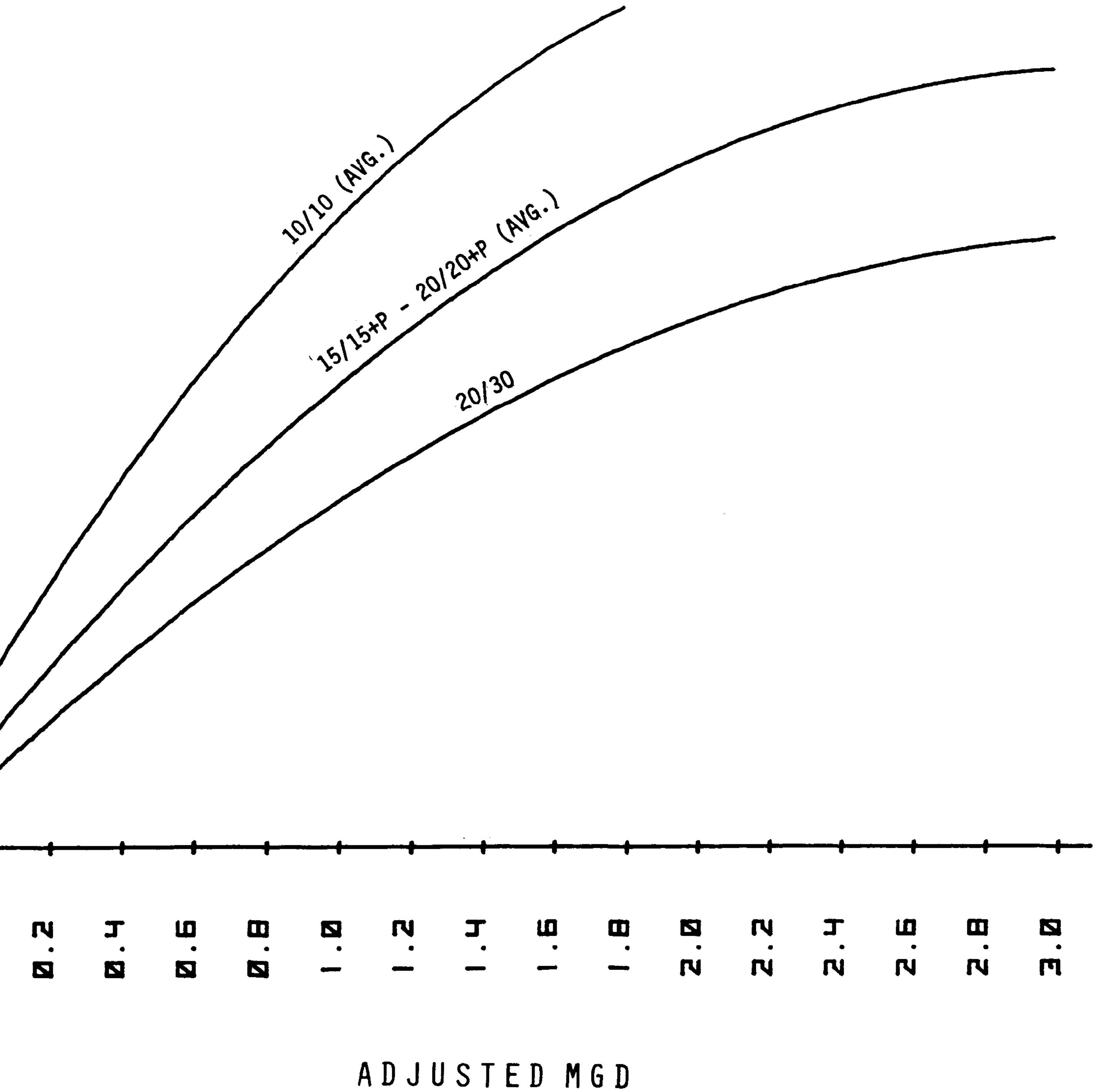


EXHIBIT I-A

HARD(C)

NO. OF DRAWINGS	IX-VII	VI-IV	III-I	Environ.	Drafter	Surveyor	Clerical
250							
240							
230							
220							
210							
200							
190							
180							
170	3000		8500		10000		
160	2750		7500		8500		
150	2350		6200		7800		
140	1950	5400	4400		6800		1250
130	1500	4800	3400		6000		1020
120	1250	4200	2600		5200		720
110	950	3500	2100		4700		580
100	700	2900	1600		3900		450
90	500	2500	1300		3200		360
80	300	2100	1100		2700	770	280
70	200	1650	800		2200	360	230
60	100	1300	600		1700	150	180
50		950	500		1300	50	130
40		750			1000	40	80
30		500					
20							
10							

AVERAGE(B)

NO. OF DRAWINGS	IX-VII	VI-IV	III-I	Environ.	Drafter	Surveyor	Clerical
250							
240							
230							
220							
210							
200							
190							
180							
170							
160							
150							
140					5800	2800	
130			2410		5300	2600	340
120		3000	2100		4700	2450	320
110	800	2600	1800		4230	2350	295
100	570	2250	1550		3800	2230	290
90	390	1910	1180		3400	2000	270
80	260	1650	790		2900	1810	245
70	150	1340	630		2300	1700	225
60	95	1110	520		1850	1400	185
50	65	980	430		1500	1150	155
40	45	780	350		1100	750	130
30	30	570	270		700	400	110
20	20	350	200		350	250	90
10							

EASY(A)

NO. OF DRAWINGS	IX-VII	VI-IV	III-I	Environ.	Drafter	Surveyor	Clerical
250							
240							
230							
220							
210							
200							
190							
180							
170							
160							
150							
140							
130							
120							
110							
100							
90							
80			1000		2750		
70		1280	920		2300	750	
60	360	1200	840		1900	630	
50	310	1100	740		1400	480	165
40	270	950	570		800	350	130
30	220	600	350		500	180	90
20	130	200	50		200	60	40
10							

AVERAGE MAN-HOURS (TOTAL)

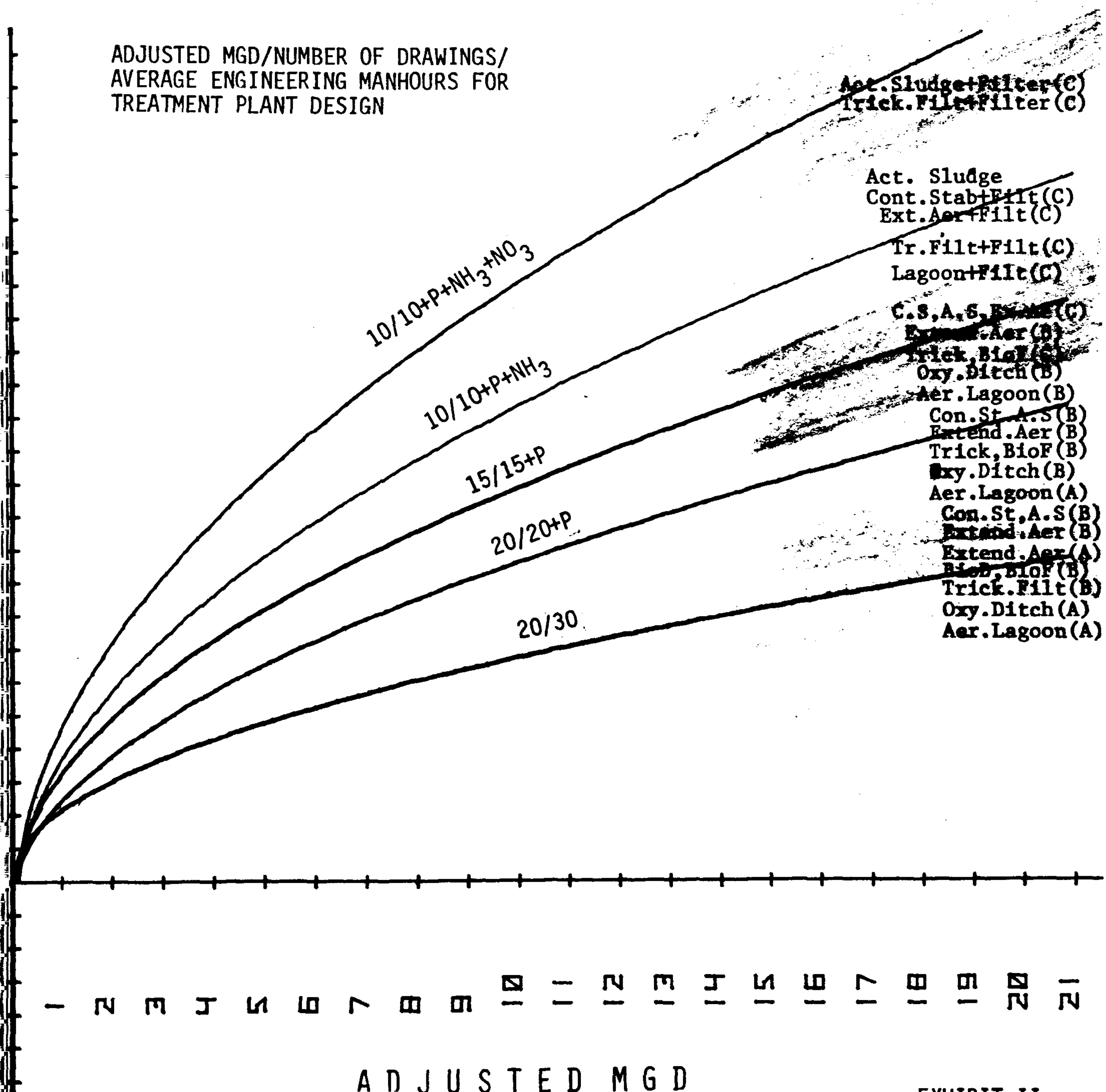

ADJUSTED MGD/NUMBER OF DRAWINGS/
AVERAGE ENGINEERING MANHOURS FOR
TREATMENT PLANT DESIGN
10/10+P+NH3+NO3
10/10+P+NH3
15/15+P
20/20+P
20/30
Act. Sludge
Tr.Filt+Filt(C)
Aer.Lagoon(B)
Trick,BioF(B)
Aer.Lagoon(A)
Con.St,A.S(B)
Trick.Filt(B)
Oxy.Ditch(A)
Aer.Lagoon(A)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
ADJUSTED MGD

EXHIBIT II

STUDY INSIGHT/SMALLER ENGINEERING FIRMS

Generally, the smaller firms (less than 25 staff) have different operating characteristics than do their larger counterparts. Discussions with smaller firm principals indicated that many such firms do not maintain sophisticated accounting, estimating and procurement systems. In such cases, the principals expressed the belief that sophisticated systems would not prove cost effective to their operations. The operating systems of many of the smaller firms are less formal and comprehensive than the systems required by EPA and government regulations. It is noteworthy, however, that many small firms are attempting to upgrade their systems and bring them into compliance.

In general, smaller firms believe that EPA should be less stringent and more flexible regarding small firm's systems requirements. They believe that such an EPA policy would simply provide equity to the small firms operating on EPA sponsored projects.

The following statements summarize certain opinions voiced by various principals of small firms:

- small firms proportionally have more unallowable expenses than large firms.

- the curves developed by the current EPA research explicitly represent EPA eligible costs only; clients/grantees should be made aware that they will undoubtedly incur additional "ineligible" costs.

- the ASCE Manual 45 Curves are well defined and useful. The clients/grantees are familiar with the "fee curve" system; the Consulting Engineers experience considerable difficulty in convincing "small" grantees that other methods of computing compensation are required and more reasonable.

- new and changing EPA regulations cause considerable delays in completion of projects; it appears EPA's zealousness to write regulations that address all "exceptions" and "past unusual circumstances" are actually counterproductive to the Consulting Engineers and their clients.

- it is extremely difficult for a Consulting Engineer to approach a client with a grant amendment/scope change.

- "interest" is an unallowable expense and yet delay in receipt of payment for engineering services is beyond the control of the Consulting Engineer.

- if EPA's proposal review considers a Consulting Engineer's profit as a percentage of his cost; in effect EPA is providing the Consulting Engineers with a potential incentive to increase allowable "overhead".

EXHIBIT III

STUDY INSIGHT/LARGER ENGINEERING FIRMS

The study cannot make any generalizations regarding the operating characteristics of the larger firms. The accounting, estimating and procurement systems encountered at firms with greater than 25 staff ranged from primitive informal to sophisticated computerized.

The following statements summarize certain opinions voiced by various engineers/principals of larger firms:

- A&E costs are affected by the expertise of the particular client; total costs and sheet costs should be evaluated based upon both the technical aspects and the "client expertise" aspect.

- Federal governmental imposition is burdening the engineering profession; such imposition is responsible for changing the face (structure) of many A&E firms.

- Region 6 should conduct a "Public Hearing" on the results of its current fee study.

- EPA should recognize a proportionate higher profit for Step II services; Step II is more difficult and demanding than Steps I and III.

- indirect cost rates accepted fluctuate depending on which Federal agency is doing the reviewing/auditing.

- quality of engineering services vary; EPA regulations are interpreted differently by various Consulting Engineers thereby creating product/services disparities.

- proportionately, inspection costs are increasing in relation to design costs.

- A&E firms "promote" EPA requirements.

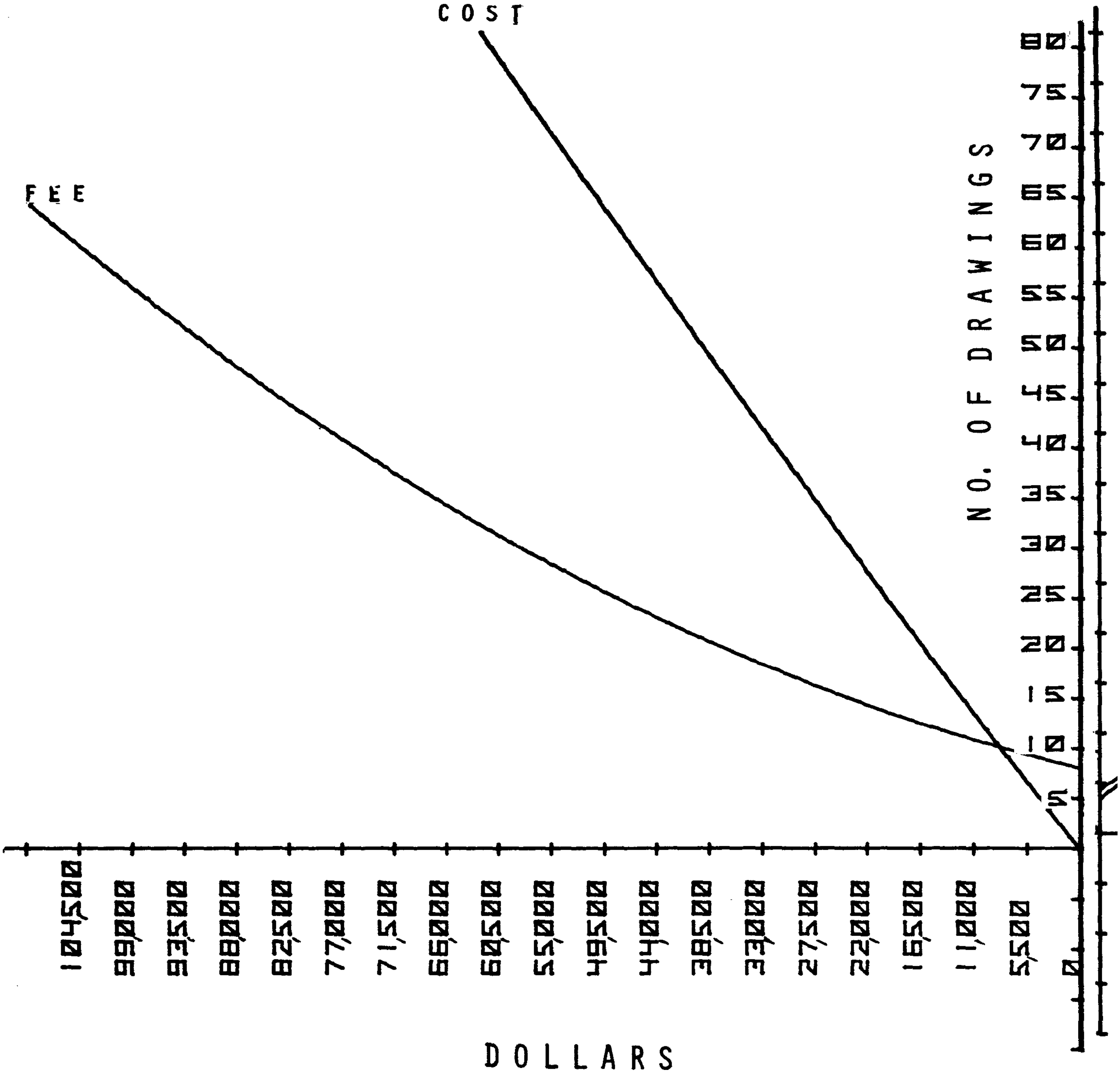
- A&E costs vary based upon the client reviewer, the state reviewer, and the EPA reviewer.

- EPA regulations cause A&E costs to increase; construction costs are also increased.

- historically, the fee curves provided the A&E firm with a profit on Step II (design) and a loss on Step III (inspection).

- to make an adequate profit, an A&E firm must undercut its "estimated" hours.

EXHIBIT IV


COST
FEE
NO. OF DRAWINGS
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
104500
99000
93500
88000
82500
77000
71500
66000
60500
55000
49500
44000
38500
33000
27500
22000
16500
11000
5500
DOLLARS

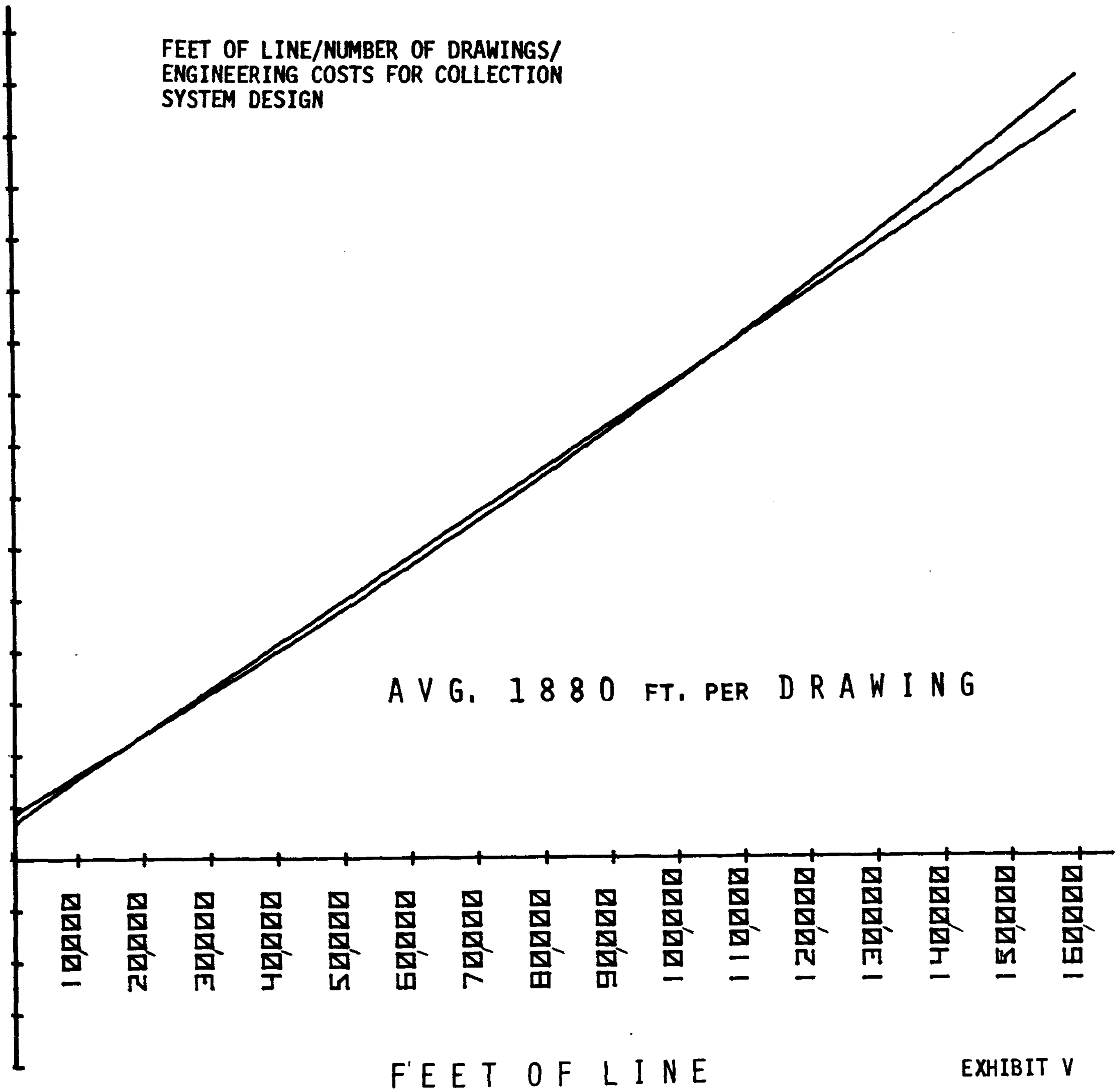

FEET OF LINE/NUMBER OF DRAWINGS/
ENGINEERING COSTS FOR COLLECTION
SYSTEM DESIGN
AVG. 1880 FT. PER DRAWING
10,000
20,000
30,000
40,000
50,000
60,000
70,000
80,000
90,000
100,000
110,000
120,000
130,000
140,000
150,000
160,000
FEET OF LINE

EXHIBIT V

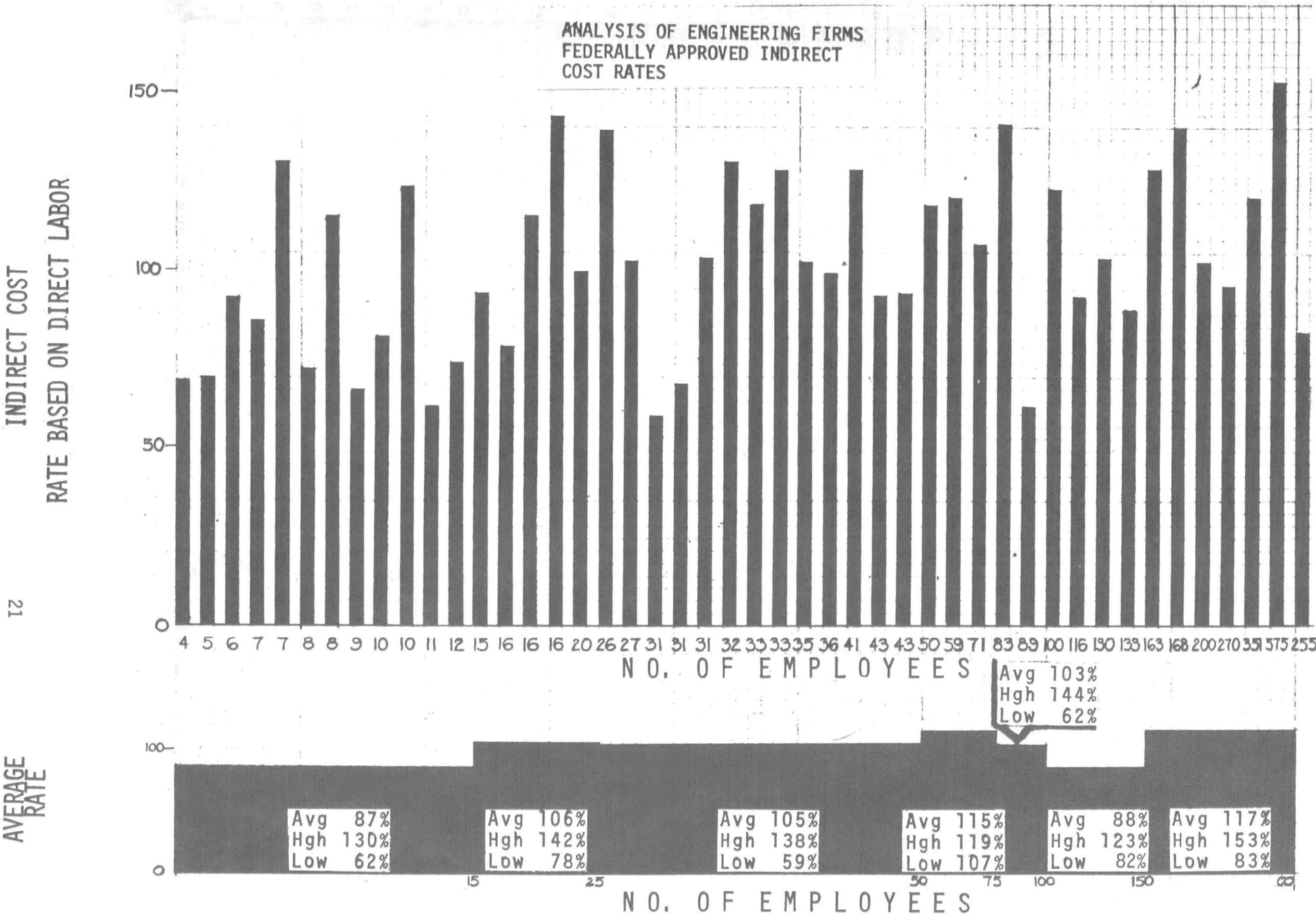
ANALYSIS OF A&E FIRMS' FEDERALLY APPROVED INDIRECT COST RATES

Region 6 performed an analysis of A&E firms' Federally approved indirect cost rates. The analysis, consisting of firms doing business within Region 6, attempted to relate indirect cost rates to firm size. Based upon total data accumulated, little relationship between the size of A&E firms and their Federally approved indirect costs rates was found. However, upon data categorization of firms with between 1 and 75 employees, it was noted that the "average" indirect cost rates per size category increased as the corresponding average size of the firms increased. For firms with approximately 75 to 150 employees, the average rates per size category dipped slightly with the corresponding average size increase. For firms with more than 150 employees, the average indirect cost rates again began to increase in relation to the increasing average size of the firm. The results described are graphically and specifically illustrated by tables on page 2 of this exhibit.

Indirect cost rates fluctuate depending on the treatment and classification (direct or indirect) of resources (eg. manhours/labor costs and travel, equipment, materials, supplies, etc./other costs). Generally, the more resources a firm charges directly the lower their indirect cost rate becomes. A reduction in the resources charged directly will cause an increase in the indirect cost rate.

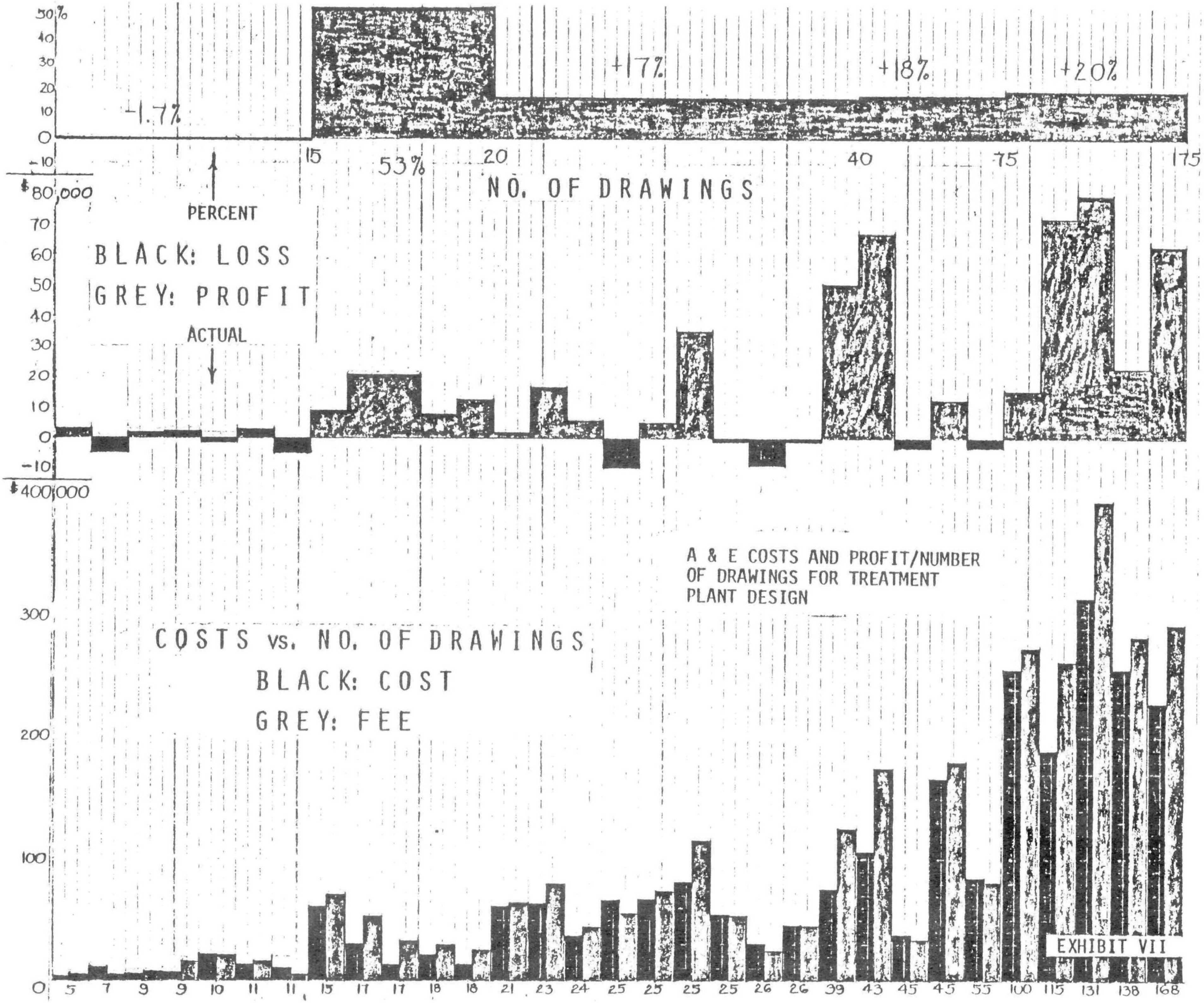
In developing this exhibit, data was inputed from Region 6 contract price analysis files on 46 A&E firms. Included in the analysis are the most current available indirect cost rates as approved by Federal audit agencies or as developed during the "Region 6 Analysis of Architectural-Engineering Compensation for Wastewater Treatment Works Design." The rates analyzed are based consistently on direct labor costs. Direct labor costs are defined as base salaries exclusive of the employer's portion of payroll overhead, bonuses, benefits, or burden.

In formulating rates used in this analysis, the general cost principles of 40 CFR 1-15.4 and 1-15.2 were applied.



ANALYSIS OF ENGINEERING FIRMS
FEDERALLY APPROVED INDIRECT
COST RATES
INDIRECT COST
RATE BASED ON DIRECT LABOR
150
100
50
0
4 5 6 7 7 8 8 9 10 10 11 12 15 16 16 16 20 26 27 31 31 31 32 33 33 35 36 41 43 43 50 59 71 83 89 100 116 130 133 163 168 200 270 351 575 2550
NO. OF EMPLOYEES
Avg 103%
Hgh 144%
Low 62%
AVERAGE RATE
100
0
Avg 87%
Hgh 130%
Low 62%
Avg 106%
Hgh 142%
Low 78%
Avg 105%
Hgh 138%
Low 59%
Avg 115%
Hgh 119%
Low 107%
Avg 88%
Hgh 123%
Low 82%
Avg 117%
Hgh 153%
Low 83%
15 25 50 75 100 150
NO. OF EMPLOYEES

EXHIBIT VI


50%
40
30
20
10
0
-10
-1.7%
53%
+17%
+18%
+20%
15
20
40
75
175
NO. OF DRAWINGS
PERCENT
$80,000
70
60
50
40
30
20
10
0
-10
BLACK: LOSS
GREY: PROFIT
ACTUAL
$400,000
300
200
100
0
A & E COSTS AND PROFIT/NUMBER
OF DRAWINGS FOR TREATMENT
PLANT DESIGN
COSTS vs. NO. OF DRAWINGS
BLACK: COST
GREY: FEE
EXHIBIT VII
5 7 9 9 10 11 11 15 17 17 18 18 21 23 24 25 25 25 25 26 26 39 43 45 45 55 100 115 131 138 168

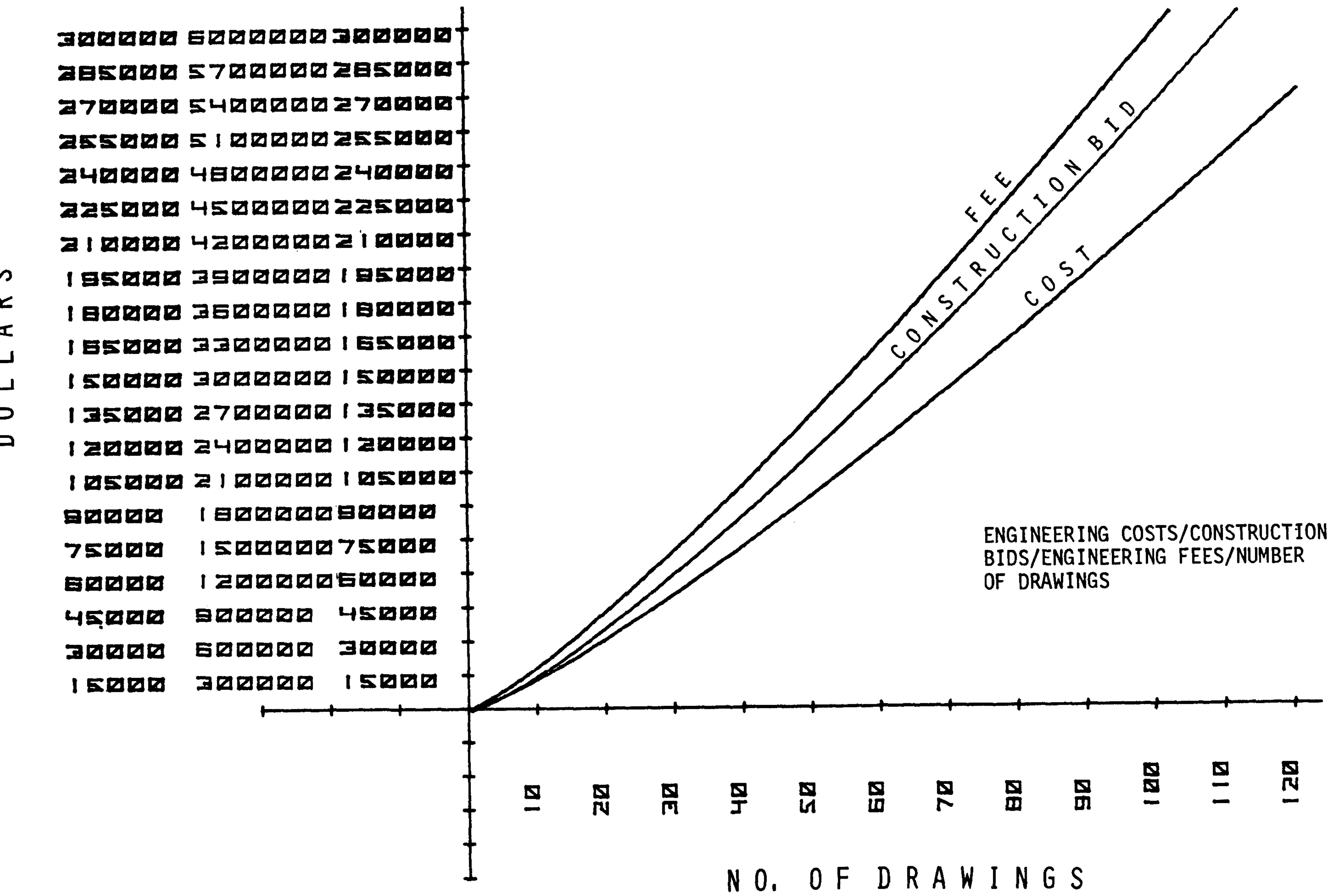


EXHIBIT VIII

Effluent Quality	PROJECT NO.	E.P.A. Serial	Project Location	Design Consulting Firm	Adjusted Design MGD	Actual Design MGD	Number of Drawings	Hardness of Drawings	STEP 2 MANHOU… Engineers IX	VIII	VII	VI	V	IV	III	I–II	Envr.	Chief Survey	Rodman	Chief Draft	Draft…
30/30	**AERATED LAGOON**																				
	1				.051	.051	5	A		55								8	15		
	2				.15	.15															
	3				.25	.25	6	A–													
	4				.313	.034 .330	9	A		163											
	5				.40	.40	11	A		241			3								
	6				3.75	1.0 4.25	55	A			179	179	620	425	1860		69	241	723		11
	OXIDATION DITCH																				
	7				.72	.72	38	A													
	TRICKLING FILTERS																				
	8				1.03	1.3 2.0	33	C													
	9				2.35	1.87 3.75	10	A		223	376							17	33		
	10				3.0	4.0 6.0	15	B			419	1440	234			182				82	[illegible]
	BIOFILTER - BIODISC																				
	11				5.62	2.25 7.3	61	C–			290	479	2503	8		1063		416	415		
	12				10.0	6.0 12.0	115	B+			401	401	1385	948	4155		153	538	1614		25
	EXTENDED AERATION																				
	13				.11	.083 .150	9	A		182				74							
	14				.75	.75	15	A													
	15				1.535	1.535	26	B		273		541				271		132	214	367	7
	16				1.8	1.8	27	B+													
	17				3.0	3.0	31	B–													
	CONT. STAB - ACT. SLDG.																				
	18				.24	.24	7	B–													
	19				.75	.75	16	B–													
	20				.90	.20 1.0	25	C		306			633				761		9		9
	21				2.0	2.0	39	C–		159				802					180	130	5

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DESIGN PROCESS TRAIN DESCRIPTION

Draft II	Draft I	Secre-tary	Clerk	Print	DESIGN PROCESS TRAIN DESCRIPTION	Type Proj. New, Add On Upgrade	update step 2 costs	updated step 2 fees	updated construction bid	% Updated	bid date	nat. con. crv.	nat. con. $ mill.
	90				NEW: 6-CELL SERIES LAGOON, INTERMITTENT DISCHARGE	NS	3,172	6,570	106,367	0	12/77	2	.3
					NEW: 2-CELL LAGOONS, SLUDGE DISPOSAL IN LAGOONS	NS		16,920				2	.5
					NEW: AERATED LAGOONS, CLARIFIER, RETURN SLUDGE, BYPASS PREVENTION POND	NS		9,461	158,050	9	9/76	1	1.2
	131				EXISTING POND & FLOW EQUILIZATION RESERVOIR RETAINED AS PRIMARY NEW 2-CELL AERATION BASIN, FINAL CLARIFIER, SLUDGE RETURN, SLUDGE DRYING BEDS	UP ES	6,648	8,607	128,500	3	5/77	2	1.4
	146		57		NEW: AERATED LAGOONS, CLARIFIERS, RETURN SLUDGE, HOLDING POND, SLUDGE LAGOON	NS	13,106	16,470	276,500	7	10/76	1	.7
1149			130		EXISTING CLARIFIER, BAR SCREENS & LIFT STATION USED AS REFURBISHED HEAD OF PLANT WITH FORCE MAIN TO NEW PLANT OF AERATED LAGOONS & FINAL CLARIFIER	UP ES	84,640	81,300				2	8.1
					NEW: OXIDATION DITCH, FINAL CLARIFIERS, SLUDGE DRYING BEDS	NS		59,371	799,035	9	5/76	1 (8)	1.0
					REFURBISH PRIMARY & SECONDARY CLARIFIERS & DIGESTER ADD NEW AERATION BASIN, SECONDARY CLARIFIER, PRESSURE FILTERS, SLUDGE DRYING BEDS	ES		75,066	1,072,380	22	7/73	2	2.6
	388				REFURBISH PRIMARY & SECONDARY CLARIFIERS, TRICKLING FILTERS DIGESTERS, SETTLING POND. ADD NEW HOLDING POND, CHEMICAL PRECIPITATION, CHLORINATION	ES	22,396	20,720	538,500	0	10/77	3	3.5
66		114			REFURBISH PRIMARY & SECONDARY CLARIFIERS, PRIMARY & SECONDARY TRICKLING FILTERS, PRIMARY & SECONDARY DIGESTERS. ADD NEW SUPER RATE TRICKLING FILTER, FINAL CLARIFIER, DIGESTER	ES	61,878	71,040	1,810,400	0	3/78	2 (8)	8.5
	1937		181		REFURBISH PRIMARY & SECONDARY CLARIFIERS, HIGH RATE TRICKLING FILTERS, PRIMARY & SECONDARY DIGESTERS. ADD NEW ROTATING BIODISC, THICKENER, PRIMARY DIGESTER	US	168,000	169,869	EST 3,112,255			1 (8)	7.5
2566			289		REFURBISH PRIMARY CLARIFIERS ADD NEW PRIMARY CLARIFIER, BIODISC TREATMENT, SECONDARY CLARIFIERS, SCUM TANK, THICKENER, AERATED SLUDGE LAGOONS	UP ES	189,028	261,300	5,953,000	0	10/77	3 (7)	11.0
	159				RETAIN OXIDATION POND. ADD NEW AERATION BASINS, FINAL CLARIFIER, SLUDGE RETURN	UP ES	8,234	10,632	211,297	2	8/77	2	1.5
					NEW: AERATION BASINS, CLARIFIERS, EMERGENCY HOLDING POND, SLUDGE HOLDING PONDS	NS		20,791	519,350	10.5	5/76	2	3.0
734		126			NEW: AERATION BASINS, CLARIFIERS, AEROBIC DIGESTERS, SLUDGE DRYING BEDS	NS	46,125	44,988	1,080,212	0	3/77	1	2.0
					REFURBISH PRIMARY CLARIFIERS. ADD NEW MECHANICAL AERATORS, SINGLE STEP EXTENDED AERATION, SUN DRIED SLUDGE, LANDFILL	UP ES		68,100	1,658,608	0	8/77	2 (7)	2.8
					NEW: AERATION BASINS, AEROBIC DIGESTERS, PONDS, LANDFILL	NS		63,250	2,218,000	0	8/77	1	5.0
					NEW: CLARIFIER, PREFAB CONTACT STABILIZATION AEROBIC DIGESTER, SLUDGE DRYING BEDS	PREFAB NS		9,341				1	.7
					RETAIN DIGESTER & SLUDGE DRYING BEDS. ADD NEW BIOFILTER, ACTIVATED SLUDGE, FINAL CLARIFIER.	ES		28,629	595,764	14	8/75	1	.8
912			83		REFURBISH IMHOFF TANKS AS DIGESTERS ADD NEW ACTIVATED SLUDGE DIFFUSED AERATION TANKS, CLARIFIERS, AEROBIC DIGESTERS, SLUDGE DRYING BEDS	UP ES	67,941	73,109	1,392,546	12	12/75	2 ½(7)	2.3
558			205		NEW: PRIMARY CLARIFIER, ACTIVATED SLUDGE, FINAL CLARIFIER, AEROBIC DIGESTER, SLUDGE DRYING BEDS	NS	73,952	125,199	2,306,477	0	6/77	1	3.8

EXHIBIT IX

Effluent Quality	PROJECT NO.	PROJECT E.P.A. Serial	PROJECT Project Location	Design Consulting Firm	Adjusted Design MGD	Actual Design MGD	Number of Drawings	Hardness of Drawings	STEP 2 MANHOU Engineers IX	VIII	VII	VI	V	IV	III	II I	Envr.	Chief Survey	Rodman	Chief Draft
20/20	**OXIDATION DITCHES**																			
	22				.40	.4	45	B		351				34		695		17	35	416
	23				.401	.283 .613	18	B-(A)		7		876				416				
	24				0.8	0.8	21	A+(B)				443	982						242	
	25				1.0	1.0		A+(B)				478	1310						375	
	26				1.19	.760 1.760	17	A+				982							161	10
	27				1.20	1.20	23	A+(B)				465	1151							
	28				1.436	1.436	17	B−(A)		7		876				416				
	29				1.75	2.0 3.0	26	B−												
	30				2.0	2.7 4.0	27	A+												
	TRICKLING FILTERS																			
	31				5.0	2.0 6.0	56	C−												
	EXTENDED AERATION																			
	32				.066	.066	11	A+ B−(A)	36			99		197	4	2			80	12
	33				.10	.10	7	A+ B−(A)	36			62		331	2	5			67	20
	34				2.5	3.5 5.0	30	B−												
	35				2.75	2.75	25	B−(B)		240		1180				580		306	495	
	CONT. STAB-ACT. SLDG.																			
	36				.128	.128	18	A		129		1		694		147				26
	37				2.2	.8 2.8	19	A+ B−(A)												
	38				6.75	2.5 8.0	100	C−		113		1182	4000							

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DESIGN PROCESS TRAIN DESCRIPTION

Draft II	Draft I	Secre-tary	Clerk	Print	DESIGN PROCESS TRAIN DESCRIPTION	Type Proj. New, Add On Upgrade	updated step 2 costs	updated step 2 fees	updated construction bid	% Updated	bid date	nat. con. crv.	nat. con. $ mill.
718			177		ORBITAL CHANNEL STABILIZATION UNIT, PRIMARY CLARIFIERS, SLUDGE DRYING BEDS	NS	38,113	33,304	744,032	0	6/77	2	1.2
8	8				EXIST. OXIDATION DITCH, 2 CELL PONDS, RETAIN OXIDATION DITCH, NEW OX. DITCH, FINAL CLAR., SLUDGE BEDS	ES	11,925	25,214		0		2	1.05
1039			84		NEW: OXIDATION DITCH, HOLDING POND, CLARIFIERS, SLUDGE DRYING BEDS	NS	61,005	63,085	903,430	0	5/77	2	2.1
655			110		NEW: OXIDATION DITCH, CLARIFIERS, HOLDING POND, SLUDGE DRYING BEDS	NS	66,034	56,362	1,065,215	0	5/77	2	2.5
11	551				REFURBISH OXIDATION DITCH FINAL CLARIFIER. ADD NEW OXIDATION DITCH, FINAL CLARIFIER, CHLORINATION	ES	30,407	52,326	608,957	14	11/75	2	1.8
900			100		NEW: OXIDATION DITCH, HOLDING POND, CLARIFIERS, SLUDGE DRYING BEDS	NS	62,521	79,999	1,014,839	0	5/77	2	3.0
8	8				NEW: OXIDATION DITCH, FINAL CLARIFIERS, SLUDGE DRYING BEDS, CONVERT EXISTING IMHOFF TANK & FINAL CLARIFIER INTO CHLORINE CONTACT CHAMBERS	NS	11,925	32,786		0		2	3.2
					EXISTING: SECONDARY PONDS. ADD AERATION FOLLOWED BY POLISHING POND, PHYSICAL/CHEMICAL ALGAE SLUDGE FLOTATION, SLUDGE DRYING BEDS, LANDFILL	ES UT		109,604	1,717,500	6	8/76	4 (8)	5.0
					EXISTING: SECONDARY PONDS. ADD AERATION FOLLOWED BY POLISHING POND, PHYSICAL/CHEMICAL ALGAE SLUDGE PLOTATION, SLUDGE DRYING BEDS. LANDFILL	ES UT		128,504	3,159,330	6	8/76	4 (8)	6.0
					RENOVATE EXISTING PRIMARY CLARIFIERS, ADD TRICKLING FILTERS, CHLORINATION, THICKENERS, VACUUM FILTERS, SLUDGE BURNING	EP US		132,708	2,189,000	36	1/71	2 (7)	6.0
	367	30		12	NEW: AERATION CHAMBERS (PREFAB), 2 FINAL SETTLING PREFAB TANKS, CHLORINATION, SLUDGE DRYING BEDS	PREFAB NS	10,425	5,486	155,769	7	1/77	2	.26
	337	35			NEW: AERATION CHAMBERS (PREFAB), 2 FINAL SETTLING TANKS, SLUDGE RETURN, CHLORINATION, SLUDGE DRYING BEDS	PREFAB NS	11,860	6,040	214,783	7	10/76	2	.40
					EXISTING: PRIMARY CLARIFIER, ROCK FILTERS, FINAL CLARIFIER, DIGESTER, SLUDGE DRYING BEDS. NEW PRIMARY CLARIFIERS, EXTENDED AERATION TANK, FINAL CLARIFIER, P. REMOVAL, LAGOON, FILTER, THICKENER	ES UT		159,518	2,740,860	21	1/74	5 (8)	8.0
	2637				NEW: GRIT SEPARATION CYCLONE, EXTENDED AERATION BASINS, FINAL CLARIFIERS, CHLORINATION	NS	80,811	116,255		0		2	5.5
204			129		OXIDATION POND RETAINED. ADD CONTACT STABILIZATION, DIGESTER, CHLORINATION, SLUDGE DRYING BEDS	NS	21,487	29,525	252,839	2	9/77		
					REFURBISH EXISTING HEADWORKS, AERATION TANKS-FINAL CLARIFIERS, ANAEROBIC DIGESTERS. NEW PREFAB CONTACT STABILIZATION UNIT, AEROBIC DIGESTERS, DEWATERER	PREFAB ES		102,635	1,485,600	7	3/76	2	4.2
1088			227		CONVERT 2 ANAEROBIC DIGESTERS TO AEROBIC DIGESTERS. REFURBISH THICKERENER & PRIMARY CLARIFIER. NEW: AERATED GRIT CHAMBER, PRIMARY CLARIFIER, ACTIVATED SLUDGE, FINAL CLARIFIERS, THICKENER	UP ES	257,192	273,240	3,100,000	15	2/75	2 (7)	10.0

Effluent Quality	PROJECT NO.	E.P.A. Serial	Project Location	Design Consulting Firm	Adjusted Design MGD	Actual Design MGD	Number of Drawings	Hardness of Drawings	STEP 2 MANHO… Engineers IX	VIII	VII	VI	V	IV	III	II I	Envr.	Chief Survey	Rodman	Chief Draft
15/15 P	**AERATED LAGOONS**																			
	39				.325	.325	8	B–												
	40				.75	1.0 1.0	21	B												
	41				.75	1.05 1.25	22	B–												
	42				3.3	2.53 4.36	42	B–												
	OXIDATION DITCH																			
	43				.213	.213	26	B–		86		396		24	574	73		86	204	4
	44				1.5	1.0 2.25	44	B												
	TRICKLING FILTERS																			
	45				6.0	8.0 12.0	55	C												
	BIOFILTER																			
	46				1.7	1.14 2.20	73	B+												
	CONT. STAB. — ACT. SLDG.																			
	47				.25	.25	28	B+												
	48				.6	.6	16	B+												
	49				1.2	.3 1.45	25	B–				1545				1261			210	
	50				3.5	2.2 4.0	174	C												
10/10 P. NH_3	**TRICKLING FILTER**																			
	51				2.0	2.0	45	C		435			2532				1372		359	
	52				3.0	3.0	44	B												
	53				10.85	20.0 25.85	168	C+		625		1869		3754						80
	BIODISC																			
	54				9.0	2.0 10.0	116	C												
	EXTENDED AERATION																			
	55				4.1	6.85 7.60	99	C–												
	CONT. STAB. - ACT. SLDG.																			
	56				.50	.50	18	C												
	57				.50	.50	24	B			85		170	255		339				
	58				.80	.80	21	B–												
	59				1.2	1.2	29	B–												
	60				6.5	2.0 7.5	131	C –		806		1007	1813		7253			20	181	

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DESIGN PROCESS TRAIN DESCRIPTION

Draft II	Draft I	Secre-tary	Clerk	Print	DESIGN PROCESS TRAIN DESCRIPTION	Type Proj. New, Add On Upgrade	updated step 2 fees	updated step 2 fees	updated construction bid	% Updated	bid date	nat. con. crv.	nat. con. $ mill.
					NEW: AERATED POND, AEROBIC SETTLING PONDS, MULTI-MEDIA FILTRATION	NT		12,499	358,973	14	10/75	5	1.3
					ADD TO PONDS — AERATION, AIR FLOTATION (PHYSICAL CHEMICAL REDUCTION OF ALGAE SLUDGE), SUN DRIED SLUDGE, LANDFILL	EP UT		41,200	570,200	3	3/77	3 (7)	2.8
					ADD TO SINGLE CELL LAGOON-2 SETS OF 2 IN SERIES AERATED LAGOONS, DUAL FILTERS & DUAL CLARIFIERS FOR TERTIARY TREATMENT OF ALGAE, SLUDGE DRYING BEDS	EP UT		36,690					
					ADD TO PONDS — AERATED GRIT REMOVAL 105 ACRE AERATED PONDS, ALUM FEEDERS, SAND FILTERS	EP UT		110,192				4	4.0
578			109		NEW: DUAL ORBITAL CHANNEL STABILIZATION UNITS, CLARIFIERS, DUAL MEDIA FILTRATION, SLUDGE DRYING BEDS	NT	29,967	25,284	610,364	3	5/77	4	1.2
					REFURBISH IMHOFF TANKS, TRICKLING FILTERS. ADD NEW OXIDATION DITCH, CLARIFIERS, SLUDGE DRYING BEDS, HOLDING POND FOR IRRIGATION SYSTEM	ES		80,813	1,683,600	20	8/74	3 (7)	3.8
					ADD 50% TO EXISTING PRIMARY & FINAL CLARIFIERS, TRICKLING FILTERS, ANAEROBIC DIGESTERS, SLUDGE LAGOONS	ES UT		145,000	3,725,000	0	12/77	4	9.0
					ADD TO STABILIZATION PONDS - ACTIVATED BIOFILTERS, HIGH RATE TRICKLING FILTER TOWERS, FINAL CLARIFIERS, POLISHING POND, SLUDGE TO LANDFILL	EP UT		181,010	3,476,000	7	9/76	3	4.5
					NEW, EMERGENCY HOLDING POND, ACTIVATED SLUDGE, OZONATION, FINAL SETTLING POND CONVERTIBLE TO CHEMICAL TREATMENT FOR P&NH3 REMOVAL	NT		16,318	696,211	12	1/76	4	.9
					NEW: CONTACT STABILIZATION, AEROBIC DIGESTER, SUN DRIED SLUDGE, LANDFILL	NT		61,500				4	2.0
	239				REFURBISH: WALKER SPARJAR PACKAGE CONTACT STABILIZATION TREATMENT UNITS. ADD NEW CONTACT STABILIZATION BASIN, SLUDGE DRYING BEDS	ES	53,214	52,232	897,955	6	9/76	3 (8)	1.4
					ADD TO PONDS — COMPLETE MIX ACTIVATED SLUDGE, REPRESSURE OIL FIELD WITH EFFLUENT, CL_2 TREATED SLUDGE TO LANDFILL	EP US		246,100	4,004,770	7	3/76	5 (7)	9.0
	3248	600	426		NEW: PRIMARY & FINAL CLARIFIER, ARTIFICIAL MEDIA TRICKLING FILTERS (SINGLE STAGE) MICROSCREENER, ANAEROBIC DIGESTERS, SLUDGE DRYING BEDS	NT	166,971	180,230	3,432,955	9	6/76	2	4.3
					NEW 2 STAGE HIGH RATE TRICKLING FILTERS, FLOCCULATING FINAL CLARIFIER, SMALL HOLDING PONDS, VACUUM FILTRATION OF SLUDGE	NT		219,593	3,959,000	7	6/76	4	7.5
	3304		302		REFURBISH, AERATED GRIT REMOVAL, PRIMARY & SECONDARY CLARIFIER, TRICKLING FILTER, THICKENER, CENTRIFUGERS, 1ST & 2ND STAGE ANAEROBIC DIGESTERS, AEROBIC DIGESTERS	ES UT	229,437	292,075	10,123,000	0	9/77	4	28.0
					ADD NEW: OXYGENATION TANK, BIOLOGICAL CLARIFIER, CENTRIFUGE, EMERGENCY SLUDGE HOLDING BEDS								
					ADD TO PRIMARY LAGOONS - BIODISC EXTENDED AERATION, NITRIFICATION BASIN & FILTRATION WITH THE EXISTING PONDS TO BE USED FOR SLUDGE STORAGE	EP UT		853,600				5	22.0
					REFURBISHED PRIMARY & SECONDARY CLARIFIERS, DIGESTERS, AERATION BASIN, ADD NEW COMPLETE DIFFUSED AERATION, TERTIARY CLARIFICATION, THICKENER, LANDFILL	ES UT		271,491	4,388,468	12	5/75	2	5.5
					NEW: CONTACT STABILIZATION, RAPID SAND FILTERS, HOLDING PONDS, AEROBIC DIGESTER	NT		48,958	1,128,927	7	10/76	4	2.0
1193			60		NEW: CONTACT STABILIZATION W/OPTION TO GO TO WASTE ACTIVATED SLUDGE	NT	36,985	42,533	550,000	0	9/77	4	1.4
					NEW: CONTACT STABILIZATION, RAPID SAND FILTERS	NT		43,355	1,294,514	0	6/77	4	2.5
					NEW: CONTACT STABILIZATION, RAPID SAND FILTERS, HOLDING POND	NT		64,000	1,810,000	0	6/77	4	3.2
	8261		806		EXISTING CONVERTED TO AERATED EQUILIZATION TANKS. ADD NEW PRIMARY CLARIFIER, PURE OXYGEN ACTIVATED SLUDGE, FINAL CLARIFIERS, COMPLETE SAND FILTRATION AEROBIC DIGESTER.	EP UT	312,760	393,186	11,900,000	0	9/77	3 ½(7)	12.8
					THICKENER, HOLDING TANKS, DEWATERER. PHOSPHORUS REMOVAL, ANAEROBIC DIGESTER (STRIPPER), CLARI-FLOCCULATOR								

	PROJECT								STEP 2 MANHOU											
									Engineers											
Effluent Quality	NO.	E.P.A. Serial	Project Location	Design Consulting Firm	Adjusted Design MGD	Actual Design MGD	Number of Drawings	Hardness of Drawings	IX	VIII	VII	VI	V	IV	III	II-I	Envr.	Chief Survey	Rodman	Chief Draft
10/10	**TRICKLING FILTERS**																			
P NH_3 NO_3	61				10.0	10.0	354	C												
	CONT. STAB. - ACT. SLDG.																			
	62				2.3	3.6 5.0	61	C–												
	63				4.75	.5 5.0	107	C–												
	64				6.57	12.0(PRM) 5.57(TRT)	138	C–		2848	346	322		2489	2156					72
	65				16.0	16.0	246	C												

RS

DESIGN PROCESS TRAIN DESCRIPTION

Draft II	Draft I	Secretary	Clerk	Print	DESIGN PROCESS TRAIN DESCRIPTION	Type Proj New, Add On Upgrade	updated step 2 costs	updated step 2 fees	updated construction bid	% Updated	bid date	nat. con. crv.	nat. con. $ mill.
					NEW: PRIMARY & FINAL CLARIFIERS, PRIMARY EFFLUENT HOLDING BASINS TRICKLING FILTERS, NITRIFICATION TANKS & CLARIFIER, RAPID MIX & FLOCCULATORS — PHOSPHORUS REMOVAL	NT		1,017,750	10,344,000	18	2/74	5	22
					CLARIFIERS, RECARBONATION, FINAL FILTERS, EFFLUENT STORAGE RESERVOIR, SLUDGE HOLDING TANKS, THICKENER, SLUDGE STORAGE								
					REFURBISH ACTIVATED SLUDGE, ANAEROBIC DIGESTION. ADD NEW ACTIVATED SLUDGE 2 STAGE LIME FLOCCULATION, CLARIFIERS, FILTERS, SLUDGE DRYING BEDS	ES UT		135,000	4,038,758	0	11/77	5	7
					ADD NEW TO EXISTING SECONDARY PLANT: PRIMARY & FINAL CLARIFIERS, DIFFUSED AIR ACTIVATED SLUDGE, NITRIFICATION BASINS & CLARIFIERS, SOLIDS CONTACT REACTOR (P REMOVAL),	ES UT		277,911	10,964,310	9	8/76	5	12
					GRAVITY THICKENER FLOC CARRYOVER BASIN, SAND GRAVITY FILTERS, COIL VACUUM FILTER SLUDGE REMOVAL UNIT, SLUDGE HOLDING TANKS, SLUDGE FLOTATION UNIT								
	2307		327		OXIDATION POND RETAINED FOR SLUDGE DISPOSAL, ADD NEW AERATED GRIT CHAMBER PRIMARY & FINAL CLARIFIERS, COMPLETE MIX ACTIVATED SLUDGE, DUAL MEDIA FILTERS, CENTRIFUGE, DIGESTERS,	NT	257,719	281,218	5,066,900	0	11/77	4	12.0
					NEW: ACTIVATED SLUDGE, MULTI-MEDIA FILTRATION	NT		1,623,367	31,028,060	19	8/74	5	32

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA 906/9-78-003	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Engineering Costs and Fees for Municipal Wastewater Treatment Works - An Estimating Technique for Design of Treatment Plants.		5. REPORT DATE Date of Issue July, 1978 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Municipal Facilities Branch, EPA Region 6 Dr. Ned K. Burleson, Chief; Le Young, Project Director		8. PERFORMING ORGANIZATION REPORT NO.
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15. SUPPLEMENTARY NOTES

Presented at, EPA Grants Chiefs' Conference ; Washington, D.C. May 1978

16. ABSTRACT

An analysis of costs and manpower efforts expended to design wastewater treatment works was conducted by the Construction Grants staff of the Environmental Protection Agency, Region 6. The American Consulting Engineers Council Chapter from the states of Arkansas, Louisiana, New Mexico, Oklahoma, and Texas cooperated in the analysis.

The purpose of the study was to establish a mutual basis for estimating/evaluating manpower requirements and reasonable engineering fees for EPA projects.

Agency personnel collected actual manpower and financial resources expended on designing specific wastewater treatment works projects. This data, adjusted for inflation and other cost fluctuation, provided an empirical basis for statistical comparison with other parameters.

The relationships developed provide a methodology for estimating and analyzing engineering fees for wastewater treatment plant design. The study's essence is a nomograph and related table that can determine the median number of drawings required and corresponding A&E design costs/manhours based upon inputing the following variables: 1) MGD, 2) type of construction (new, upgrade, etc.), 3) treatment process, 4) effluent quality required, and 5) difficulty of drawings.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Engineering Cost - Fee, Wastewater Treatment Plant Design	Engineering Design Costs Engineering Design Fees	13B

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