Cost For Treating Coal Mine Discharges

The interim final rule making for the coal mining point source category established four subcategories for the industry:

Subpart A - Coal Preparation Plant Subcategory;
Subpart B - Coal Storage, Refuse Storage and Coal Preparation Plant Ancillary Area Subcategory
Subpart C - Acid or Ferruginous Mine Drainage Subcategory,
Subpart D - Alkaline Mine Drainage Subcategory.

For the purposes of making an economic analysis of the impact to the coal mine industry for meeting the additional limitations required by the court order of December 16, 1975 (NRDC vs Train, Civ. Dkt. No. 1609-73) establishing additional limitations for the coal mining point source category the industry was segmented into model mines and preparation plants. These models were supplied by the contractor who is preparing the draft economic analysis. (See Figure 1)

I. Bituminous, Sub-Bituminous, Lignite Mining.

Some general comments apply to this industry segment.

Each of the regional segmentations are subdivided into Deep Mining, Surface Mining and Auger Mining. Auger mining is a form of surface mining. For developing effluent limitation guidelines, auger mining is considered under surface mining.

The total number of mines in each segment is from the final MESA statistics for 1973. These statistics do not separate mines in Kentucky by Eastern Kentucky and Western Kentucky as does the suggested segmentation. All mines in Kentucky are included in the Southern Appalachia segment. MESA defines a coal operation as one mine if the pits are: 1. owned by the same company, 2. supervised by the same superintendent, 3. located in the same county.

This definition of coal operations being one mine is used in the statistics for each of the segments where total mines in the segment is shown and the number of mines in the segment visited is shown.

In the deep mine segment for each regional segmentation a rationalization is made based on average percipitation in the geographic area, depth of cover (above or below drainage), total area of the mine, percent extraction, and permeability of overburden. Based on an annual precipitation of 32 to 40 inches per year and published base runoff figures, approximately 30 percent of the percipitation is available to the ground water system. The amount of

TABLE 6.—*Canister bench tests and requirements for chin-style gas mask canisters*

[30 CFR pt. 11, subpt. I, sec. 11.102-5]

Canister type	Test condition	Test atmosphere: Gas or vapor	Concentration (parts per million)	Flow rate (liters per minute)	Number of tests	Maximum allowable penetration (parts per million)	Minimum service life (minutes)[1]
Acid gas	As received	SO_2	5,000	64	3	5	12
		Cl_2	5,000	64	3	5	12
	Equilibrated	SO_2	5,000	32	4	5	12
		Cl_2	5,000	32	4	5	12
Organic vapor	As received	CCl_4	5,000	64	3	5	12
	Equilibrated	CCl_4	5,000	32	4	5	12
Ammonia	As received	NH_3	5,000	64	3	50	12
	Equilibrated	NH_3	5,000	32	4	50	12
Carbon monoxide	As received	CO	20,000	[2] 64	2	(3)	60
		CO	5,000	[4] 32	3	(3)	60
		CO	3,000	[2] 32	3	(3)	60
Combination of 2 or 3 of above types.[5]							
Combination of all of above types[6]							

[1] Minimum life will be determined at the indicated penetration.

[2] Relative humidity of test atmosphere will be 95±3 pct; temperature of test atmosphere will be 25±2.5° C.

[3] Maximum allowable CO penetration will be 385 cm³ during the minimum life. The penetration shall not exceed 500 p/m during this time.

[4] Relative humidity of test atmosphere will be 95±3 pct; temperature of test atmosphere entering the test fixture will be 0+2.5° C −0°.

[5] Test conditions and requirements will be applicable as shown above.

[6] Test conditions and requirements will be applicable as shown above, except the minimum service lives for acid gas, organic vapor, and ammonia will be 6 min instead of 12 min.

TABLE 7.—*Canister bench tests and requirements for escape gas mask canisters*

[30 CFR pt. 11, subpt. I, sec. 11.102-5]

Canister type	Test condition	Test atmosphere: Gas or vapor	Concentration (parts per million)	Flow rate (liters per minute)	Number of tests	Maximum allowable penetration (parts per million)	Minimum service life (minutes)[1]
Acid gas	As received	SO_2	5,000	64	3	5	12
		Cl_2	[illegible]	64	3	5	12
	Equilibrated	SO_2	5,000	32	4	5	12
		Cl_2	5,000	32	4	5	12
Organic vapor	As received	CCl_4	5,000	64	3	5	12
	Equilibrated	CCl_4	5,000	32	4	5	12
Ammonia	As received	NH_3	5,000	64	3	50	12
	Equilibrated	NH_3	5,000	32	4	50	12
Carbon monoxide	As received	CO	10,000	[2] 32	2	(3)	[4] 60
		CO	5,000	[5] 32	3	(3)	60
		CO	3,000	[2] 32	3	(3)	60

[1] Minimum life will be determined at the indicated penetration.

[2] Relative humidity of test atmosphere will be 95±3 pct; temperature of test atmosphere will be 25±2.5° C.

[3] Maximum allowable CO penetration will be 385 cm³ during the minimum life. The penetration shall not exceed 500 p/m during this time.

[4] If effluent temperature exceeds 100° C during this test, the escape gas mask shall be equipped with an effective heat exchanger.

[5] Relative humidity of test atmosphere will be 95±3 pct; temperature of test atmosphere entering the test fixture will be 0+2.5° C −0° C.

7. Section 11.93 is revised to read as follows:

§ 11.93 Canisters and cartridges; color and markings; requirements.

The color and markings of all canisters and cartridges or labels shall conform with the requirements of the American National Standard for Identification of Air Purifying Respirator Canisters and Cartridges, K 13.1–1973, obtainable from the American National Standards Institute, Inc.; 1430 Broadway; New York, N.Y. 10018.

(Secs. 202(h), 204, and 508, 83 Stat. 763, 803 (30 U.S.C. 842(h), 844, 957); Secs. 2, 3, 5, 36 Stat. 370, as amended 37 Stat. 681 (30 U.S.C. 3, 5, 7); Sec. 8(g), 84 Stat. 1600 (29 U.S.C. 657(g)))

[FR Doc.76-7095 Filed 3-12-76;8:45 am]

Title 36—Parks, Forests, and Memorials

CHAPTER I—NATIONAL PARK SERVICE, DEPARTMENT OF THE INTERIOR

PART 7—SPECIAL REGULATIONS, AREA OF THE NATIONAL PARK SYSTEM

Shenandoah National Park; Camping

On November 24, 1975, there was published in the FEDERAL REGISTER (40 FR 54428), a notice of proposed rulemaking with a proposed amendment to Title 36 of the Code of Federal Regulations. The proposed amendment adding new paragraph (g) to § 7.15 should result in the better safeguarding of foods from wildlife in the Park, particularly from the American black bear.

Interested persons were given an opportunity to submit comments not later than December 24, 1975. Very few comments were received from the public, and none were of significant substance to alter the initial submission. Accordingly, paragraph (g) of § 7.15 is added to read as follows:

§ 7.15 Shenandoah National Park.

* * * * *

(g) *Camping.* At all campsites, food or similar organic material must be either: (1) Completely sealed in a vehicle or camping unit that is constructed of solid, nonpliable material; or (2) suspended at least ten (10) feet above the ground and four (4) feet horizontally from any post, tree trunk or branch. This restriction does not apply to food that is in the process of being transported, being eaten, or being prepared for eating.

This regulation will become effective April 14, 1976.

ROBERT R. JACOBSEN,
Superintendent,
Shenandoah National Park.

[FR Doc.76-7492 Filed 3-12-76;8:45 am]

Title 40—Protection of Environment

CHAPTER I—ENVIRONMENTAL PROTECTION AGENCY

SUBCHAPTER N—EFFLUENT GUIDELINES AND STANDARDS

[FRL 504-8]

PART 434—COAL MINING POINT SOURCE CATEGORY

Notice of Availability From an Inspection Standpoint Only "Cost for Treating Coal Mine Discharges"

On October 16, 1975, the Agency published a notice of interim final rule making establishing effluent limitations and guidelines based on best practicable control technology currently available for the Coal Mining Point Source Category (40 CFR 48830). Reference was made in the preamble to certain supplementary materials supporting the study of the industry which are available for inspection and copying.

An additional report entitled "Cost for Treating Coal Mine Discharges" detailing the cost of pollution control has been prepared and is now available for inspection, along with the supplementary materials cited previously, at the EPA Public Information Reference Unit, Room 2922 (EPA Library), Waterside Mall, 401 M Street, S.W., Washington, D.C. 20460. The EPA information regulation, 40 CFR Part 2, provides that a reasonable fee may be charged for copying.

Dated: March 10, 1976.

ANDREW W. BREIDENBACH, Ph.D.,
Assistant Administrator, For Water and Hazardous Materials.

[FR Doc.76-7368 Filed 3-12-76;8:45 am]

available water that perculates to mine level will depend on the coeffecient of permeability at depth. This coeffecient of permeability is in turn related to depth below ground surface, rock types and fracture characteristics. Published data on permeability is generally restricted to comparatively shallow depths of less than 200 feet, and indicates a permeability of 0.01 to 4.0 ft/day. Permeability of overburden from mine visits made during the study performed by Skelly and Loy indicates a permeability of 0 to 1.2 ft/day for mines visited. Slope mines and drift mines average 0.47 ft/day, and shaft mines average 0.42 ft/day for mines making water. Note the deep mines without mine drainage are not included in this average, and that deep mines in the small and medium mine segmentation were purposely selected that had mine drainage.

Drainage from deep mines in the model segments were based on 200 to 600 gallons per acre mined, with all drainage considered to be isotropic under water table conditions.

For all mines in estimating area disturbed it assumed that mining is restricted to single seam extraction. For deep mines the area disturbed is based on the area which would be disturbed over one half of the mine's life. Deep mine area based on half mine life would also take into account older mines working out and the abandoned and sealed areas of these mines where pumping is no longer required.

In the small mine category it is assumed that the tonnage will remain at 50,000 ton per year. In fact, many of the mines included in the less than 50,000 ton per year mined in 1973 are actually new mines with projected tonnage much higher than 50,000 tons per year.

The interim final regulation published October 17, 1975 in the Federal Register defines a coal mine as an active mining area of land with all property placed upon, under or above the surface of such land, used in or resulting from the work at extracting coal from its natural deposits by any means or method including secondary recovery of coal from refuse or other storage piles derived from the mining, cleaning, or preparation of coal. Mine drainage is defined in the interim final guideline as any water drained, pumped or siphoned from a coal mine. In the interim final guideline there are two categories of mine drainage based primarily on the treatment required of the raw mine drainage and generally related to geographic location of the mine. The addendum to the interim final guideline will establish a numerical value for the effluent characteristics mentioned in the interim final guideline. It is anticipated that the addendum to the interim final guideline will further define mine drainage from surface mines so that: "Any drainage from a surface mine or section thereof which has been returned to final contour shall not be required to meet the limitation set forth providing such drainage is not mingled with untreated mine drainage which is subject to the limitations." It also anticipated that "final contour" shall be defined as the surface shape or contour of a surface mine (or section thereof) after all mining and earth moving operations have been completed at that surface mine (or section thereof). For the model surface mines it assumed that the active area is the area affected over a six month period. This area affected over six months may be considered a maximum area as most surface mines will have the area returned to its final contour well within six months. The mine drainage from model surface mines is therefor based on an area affected over a six month period, the 10 year - 24 hour percipitation event as taken from Technical Paper Number 40 - Rainfall Frequency Atlas of the United States or NOAA Atlas II - Precipitation - Frequency Atlas of the Western United States. Maximum mine drainage volumes are assumed from these precipitation events with all of the precipitation going to mine drainage. Retention periods for settling basins are assumed at 24 hours. The size of the acid mine drainage treatment plant at a surface mine is based on a rainfall of 1/3 inch in a day, or the amount of water to be treated based an annual rainfall of 40 inches.

Best practicable control technology currently available costs are total costs. Best available technology economically achievable costs represent cost increments to the BPT costs to attain BAT standards.

The selected approach for costs, cost factors and costing methodology for the model mine segments provided entailed the derivation of costs for the various facilities and activities which, in combination, form the specified treatment processes. Where practical and applicable, the costs are shown as a function of variables which are generally knows for specific mining operations (e.g. daily flow rate, size of impoundment area, amount of flocculant added per volume of waste water).

Capital Investment

Holding/Settling Ponds

All ponds are rectangular in shape, with the bottom length twice the bottom width. The width of the top of the dike is 3 meters. The dikes of the lagoons form a 27-degree angle with the ground surface. The interior area is excavated to depth sufficient to provide all the material needed for the construction of the dikes. The earth is assumed to be sandy loam with granular material.

Costs categories and cost factors used to estimate the costs of the ponds are as follows:

Construction Category	Cost
Excavation and Forming	\$ 1.60/m³
Compacting with Sheep's Foot	2.22/m³
Fine-Grade Ginishing	0.54/m²
Soil Poisoning	1.49/m (circumference)

All cost factors except soil poisoning are based on Reference 1; the latter is from Reference 2. The costs are adjusted to 1974 dollars based on the Marshall and Stevens Equipment Cost Index for Mining and Milling.

Excavation, forming and compacting costs are based on the amount of material in the dike. Fine-grade finishing is computed from the dike surface area (i.e. the product of the perimeter of the cross section of the dike and its circumference). The construction cost is increased by 15 percent to account for site preparation and mobilization costs.

Costs and required areas for ponds ranging in volume from 100 m³ to 100,000 m³ are shown in Figures 2 and 3.

Hydrated Lime System

The major components of the hydrated lime system are tanks, a slurry mixer and feeder with associated instrumentation, pumps and a building to house the latter two components. Hydrated lime system costs as a function of daily flow of waste water are shown in Figure 4. The costs are from Reference 3 excalated to 1974 dollars using the aforementioned Marshall and Stevens index.

The costs in Figure 4 were applied to relatively large operations. A simpler system consisting of a lime storage facility and a lime feeder was devised for the smaller operations. Its costs are:

Lime storage facility	\$500 - \$1,000
Lime feeder (Ref. 2)	\$1,375
Total	\$1,875 - \$2,375

Flash mix tanks are employed in conjunction with a number of the lime treatment systems. A ten minute retention time is assumed for estimating the required size of the tank. Flash mix tank costs are shown in Figure 4. They are from Reference 3 escalated to 1974 dollars.

Clarifiers

Installed costs of clarifiers are presented in Figure 6. Equipment costs were obtained from vendors (Reference 4). Installed costs are estimated to be 2.5 times the equipment purchase price.

Flocculant Feed Systems

The system consists of a tank, a feed pump mounted under the tank, interconnecting piping with relief-return system and stainless steel agitator. The system design and the costs following are from Reference 2.

Tank Size	Cost
190 l (50 gal)	$1,400
570 l (150 gal)	1,800
1,900 l (500 gal)	2,850

Systems were selected for employment at mining operations based on treatment flow requirements.

Filtration Systems

Investment and operating costs of filters are presented in Figure 7. The operating costs include depreciation. The costs are based on Reference 5 and represent preliminary estimates.

Aerators

Aerators consist of a concrete-lined pit sized for 90 minute retention. Aeration is by means of a mechanical surface aerator. Floor thickness of the pits is assumed to be 0.2 m, wall thickness 0.4 m. The cost in place of the floor is estimated to be $16.90/m^2$ and of the walls $268.10/m^3$ of concrete in place. Both unit costs are from Reference 1 escalated to 1974 dollars.

For example, the cost of a 400 m³ pit measuring 4 x 10 x 10 m is as follows:

Floor	10 x 10 x 16.90	$1,690
Walls	±4(4 x 10 x .4) 1 268.10	17,160
	Total	$18,850

The addition of the mechanical aerator, costing $2,800 (Reference 2), results in a total cost of $21,650.

Pumps

Pump costs as a function of pump capacity, expressed in liters/minute, are shown in Figure 8. The types and sizes of pumps required for a particular activity can vary widely, depending on the characteristics of the material being pumped and the height and distance the material must be transported.

Costs are shown for two representative types of pumps. The slurry-pump costs are based on pumping a slurry of 55 percent solids along level ground. The water-pump costs assume that the water is pumped to head of 18 m. Installed pump costs are derived from Reference 6. Standby pumps are assumed necessary in all cases, and their costs are included in the costs shown in Figure 8.

Pipes

The estimation of pipe costs initially requires a determination of the appropriate pipe size. Figure 9 shows the pipe diameter as a function of daily flow for flow rates of 1 and 2 m/sec. Figure 10 presents installed pipe costs as a function of pipe diameter (Ref. 1 and 7).

Ditching

In some cases ditches rather than pipes are used for transporting the waste water. The ditches are assumed to have a 3 m cross section and a depth of 1 m. The estimated cost is $4.90/lineal meter.

Fences

Fences, where required, are costed at $16.40/lineal meter.

Land

Land costs for treatment facilities are included only for deep mining operations at $2,470/ha. In the case of surface mining it is assumed that the land is already owned by the mining company, and the use of the land is short lived (6 months).

Annual Cost

Annual costs are presented. Included in annual costs are land, amortization, and operations and maintenance. The breakdown and bases of these costs are explained below.

Land

Annual land cost represents an opportunity cost. This cost is included only in the deep mine category. It is assumed that surface mines have adequate land available. The annual land cost is based on 10 percent of initial acquisition cost.

Amortization

Annual depreciation and capital costs are computed for facilities and equipment as follows:

$$CA = B \frac{(r)(1+r)^n}{(1+r)^n - 1}$$

where

CA = Annual cost
B = Initial amount invested

r = Annual interest rate

n = Useful life in years

This is often called the capital recovery factor. The computed annual cost essentially represents the sum of the interest cost and depreciation.

An interest rate of 8 percent is used. The expected useful life (n) is 10 years for equipment. The expected useful life for facilities (ponds, fencing, etc.) are based on the mine life. For example, if the mine life is 15 years the capital-recovery factor is .117. This factor times the facility cost yields the amount that must be paid each year to cover both interest and depreciation.

Operation and Maintenance

Operation and maintenance (O & M) consists of the following items.

- Operating personnel
- Facility repair and maintenance
- Equipment repair and maintenance
- Material
- Energy (Electricity)
- Regrading
- Taxes
- Insurance

Operating personnel

Personnel costs are based on an hourly rate of $9.00. This includes fringe benefits, overhead, and supervision (Ref. 1).

Personnel are assigned for the operation of specific treatment facilities as required. Representative man power assignments are:

Lime Treatment	1/2 - 1 hour/shift
Flocculation	1/2 hour/mix

Equipment and Facility Repair and Maintenance

The annual equipment cost and the annual facility repair and maintenance are estimated to be 5 percent and 3 percent, respectively, of capital cost. These factors are based on References 7 and 8.

Reference 8 indicates some variability in these costs for equipment. For example, costs associated with tanks are generally less than 5 percent, wheras costs associated with pumps and piping may be somewhat higher. Thus, the 5 percent value represents an average cost.

Material Costs

The material costs shown below are used in this study. The costs include delivery.

Hydrated Lime	$33.00/KKG	($30.00/short ton)	(Ref. 9)
Flocculant	$2.65/kg	($1.20/lb)	(Ref. 10)

Hydrated lime is used in treating acid mine drainage. The amount used varies from .5 kg/m³ to 1 kg/m³, (4 lb/1000 gal. - 8 lb/1000 gal.) Flocculant usage is assumed to be 10 mg/l (10 ppm).

Energy Costs

The only energy used is electricity. The cost per kilowatt-hour is assumed to be $0.025. This results in a cost of $200/HP/year.

Regrading

Regrading is necessary in those instances where a new settling pond is built every 6 months. Regrading costs are incurred when the mining operation is relocated and the dikes are leveled. The cost for regrading are based on the area of the settling pond. In this study $1150/ hectare ($480/acre) is used. Ref. 7

Taxes and Insurance

Taxes are estimated as 2.5 percent of land cost. Insurance cost is included as 1 percent of total capital cost (Ref. 7).

A. Northern Appalachia (Maryland, Pennsylvania, Ohio, Virginia, West Virginia)

Mines of this region can generally be categorized as being acid or ferruginous in Maryland, Pennsylvania, Ohio and the northern part of West Virginia. Treatment cost for mine drainage is therefore based on treating acid mine drainage for this region. It should be noted however that 2/3 of the production in West Virginia and the mines of Virginia can be categorized as alkaline which requires either no treatment for deep mines or only settling for deep mines and settling for surface mines. This region also has over 50 percent of the total mines in the U.S. in the small deep mine segment (less than 50,000 tons per year) with most of the mines in the alkaline mine drainage category requiring no treatment of mine drainage, or the mine is dry.

However, it is assumed neutralization is required in the case of both deep and surface mining operation to attain BPT standard. For the deep and surface mines, 1 and .5 kilograms of lime, respectively, is used per thousand liters of waste water treated.

The treatment system for the large deep mine model consists of the following major facilities and equipment.

Raw water holding pond
Lime system with flash mix tank
Aeration tank

Clarifier

The clarifier is sized for a retention time of 12 hours. The underflow from the clarifier is pumped back into the mine; the overflow to a nearby creek. The holding pond is sized for 1 day retention x 1.5 to allow for necessary freeboard.

For the large deep mine (seam height = 60") increasing the clarifier retention time to 24 hours would result in a capital cost of $460,175, an annual cost of $255,570 and at cost per KKG of $0.28.

The medium and small deep mine treatment systems do not use a clarifier. Instead, two settling ponds are provided, each sized for 2 day retention x 1.5 for freeboard. The settling ponds are used alternatively in order to allow time to pump the sludge accumulated in the ponds back into the mine.

Application of a similar treatment process to the large, deep mine operation and including the cost of a Mud Cat to remove sludge from the settling ponds would result in the costs shown in Table 1.

In the case of surface mines, mining sites are assumed relocated at six months intervals. A settling pond sized for retention of a 10 year-24 hour rainfall (4") is constructed at each site. To illustrate, the size and cost of the settling pond for the large surface mine (seam height = 60") is computed as follows. The disturbed area during a six month period is 13 ha. The 10 year-24 hour storm results in a drainage of 1,010 m^3/ha. The required lagoon size is 13 x 1,010 - 13,130 m^3. Its cost from Figure 2 is $19,200. This cost is shown as an operating cost.

TABLE 1

Northern Appalachia - Large, Deep Mine - Seam Height = 60"

Capital Cost		
Land		$ 6,175
Facilities		
Holding Ponds		4,940
Settling Ponds (2)		45,000
Fencing		10,365
Equipment		
Lime Storage & Treatment		91,200
Aerator		21,650
Pipes		17,520
Pump		19,680
Pump		5,520
Mud Cat		75,000
	Total	$297,050
Annualized Cost		
Land		$ 620
Amortization		
Equipment		34,340
Facilities		5,670
Oper. Personnel		77,130
Facility Maintenance		1,180
Equipment Maintenance		11,525
Material		68,650
Energy		32,000
Taxes		155
Insurance		2,970
	Total	$234,870
Cost/Day (O & M)		$ 532
$/KKG		0.26

At a surface mine the total rainfall may not reach the settling basin because of percolation. This loss is assumed to provide for the necessary pond freeboard.

The only capital cost incurred at a surface mine is for the lime storage and treatment equipment which is transported from site to site. Labor costs for relocating the equipment (4 man days) are included with operating personnel. The size of the AMD plant at a surface mine is based on a rainfall of 1/3" in a day; the amount of water to be treated on an annual rainfall of 40".

Natural depressions may exist at some surface mines which will elimate the need to construct a settling pond. Assuming this was the case for the small surface mining operation (seam height 36"), its annual cost would be reduced to $6,275 and the cost/ KKG to $0.14. The latter is lower-bound cost. In general, depending on the topography, the costs/KKG for the surface mines can be expected to range from about .6 to 1.0 of the costs shown.

BATEA for both the deep and surface mines consists of the addition of deep bed filtration at the AMD plants. Technically the application of this treatment process is limited to large and medium size operations. If filters are required for suspended solids removal small operations may be able to use filters similar to those used for swimming pools. It should be noted however that suggested suspended solids level for BAT were based primarily on 3 mines exhibiting the very best overall control and treatment technology. These mines do not employ filtration for suspended solids removal. Deep bed filtration is a transfer of existing technology from such industries as the steel and paper industries.

In this region some of the more commonly worked and more productive seams are: Pittsburgh Seam, Kittanning Seams, Freeport Seams, Pocahontas Seams, Five Block Seam, the Number 2 Gas Seam. The model mines reflect the heights of these seams.

1. Deep Mines
   a. Large Mine (Total in segment 225, visited 56)

Mine life 25 years; 1 million tons per year; 70 percent recovery; 60 inch thick seam; 7,000 tons per acre recoverable; 143 acres mined per year; 1,857 mined in 13 years; 400 foot of cover (below drainage); 600 gallons per acre acid mine drainage; 1,114,000 gallons

per day; design 1 and 1/2 million gallons per day AMD plant.
A second model mine was developed with a seam height of 52 inches for co of cost.

b. Medium mine (total in segment 227, visited 3)

Mine life 15 years; 100,000 tons per year; 70 percent recovery; 40 inch thick seam; 4,270 per acre recoverable; 23.4 acres mined per year; 187.4 acres mined in 8 years; 200 foot of cover (above drainage); 600 gallons per acre acid mine drainage; 113,000 gallons per day; design 150,000 gallons per day acid mine drainage treatment facility.

A second model mine was developed for this segment with a seam height of 32 inches for comparison of cost.

c. Small mine (total in segment 439, visited 10)

Mine life 10 years; 50,000 tons per year; 75 percent recovery; 36 inch thick seam; 3920 tons per acre recoverable; 12.8 acres mined per year; 64 acres mined in 5 years; 200 foot of cover (above drainage); 600 gallons per acre acid mine drainage; 38,400 gallons per day; design 50,000 gallons per day acid mine drainage treatment facility.

A second model mine was developed for this segment with a seam height of 40 inches for cost comparison.

2. Surface Mines

a. Large mine (total in segment 101, visited 10)

Mine life 20 years; 1/2 million tons per year; 90 percent recovery; 60 inch thick seam; 7,840 tons per acre recoverable; 64 acres mined per year; 32 acres in the active mine area (13 ha); settling facility is based on 1,010 cum/ha in the active mine area; AMD plant designed for 367 cum/day, settling pond designed for 13130 cum.

For cost comparison a second model was developed with a seam height of 48 inches.

b. Medium mine (total in segment 290, visited 13)

Mine life 10 years; 100,000 tons per year; 42 inch thick seam; 80 percent recovery (including auger mining); 4,880 tons per acre recovered; 20.5 acres per year; 10.25 acres in the active mine area (3.2 ha); 1,010 cum/ha in the active mine area; AMD plant designed for 118 cum/day; settling pond designed for 3232 cum.

A second model mine for this segment was developed with a assumed seam height of 54 inches.

c. Small mine
(total in segment 101, visited 10)

Mine life 5 years; 50,000 tons per year; 90 percent recovery; 36 inch thick seam; 4,705 tons per acre recoverable; 10.6 acres per year mined; 5.3 acres in the active mine area (2.2 ha); 1,010 cum/ha in the active mine area; AMD plant designed for 62 cum/day, settling pond designed for 2222 cum.

A second model mine for this segment was developed using a seam thickness of 54 inches for cost comparison.

BPT and BAT cost for the model deep and surface mining operations in the Northern Appalachia region are shown in tables 2, 3 and 4.

TABLE 2

Northern Appalachia - Deep mines

BPCTCA Costs

Size	Large		Medium		Small	
Annual Tonnage (KKG)	907,000		90,700		45,350	
Seam Height (inches)	60	52	40	32	40	32
Daily Flow (m³)	5,700	6,575	568	710	190	235
Mine Life (years)	25		15		10	
Capital Costs						
Land	$ 4,940	5,930	$3,705	$5,185	$1,850	
Facilities						
Holding Pond	14,400	15,600	2,520	2,880	1,200	
Settling Ponds	N.A.	N.A.	7,680	9,120	1,990	
Fencing	9,265	10,170	8,035	9,510	5,675	
Equipment						
Lime Storage & Equip.	91,200	99,000	5,375	5,735	3,795	4,0
Aerator	21,650	23,590	N. A.	N.A.	N.A.	N.
Clarifier	216,000	228,000	N. A.	N.A.	N.A.	N.
Pipes	17,520	18,000	3,400	3,400	3,400	3,40
Pump-water	19,680	21,600	3,240	3,600	1,800	2,04
Pump-slurry	5,520	5,760	2,500	2,500	2,280	2,28
Total	400,175	427,650	36,455	41,930	21,980	22,94
Annualized Costs						
Land	495	595	370	520	185	18
Amortization						
Facilities	2,225	2,425	2,135	2,515	1,320	1,39
Equipment	55,365	58,995	2,160	2,270	1,680	1,75
Oper. & Maint.						
Oper. Personnel	59,130	59,130	9,855	9,855	3,285	3,28
Facility Maint.	710	775	550	645	265	28
Equipment Maint.	18,580	19,800	725	760	565	59
Material	68,650	79,195	6,840	8,550	2,290	2,83
Energy	33,500	36,200	1,800	1,800	1,000	1,00
Taxes	125	150	95	130	45	4

Insurance	4,000	4,275	365	420	220	23
Cost/Day (O & M)	505	545	55	60	21	2
Cost/KKG	0.27	0.29	0.27	0.30	0.23	0.

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TABLE 2

Northern Appalachia - Deep Mines

BPCTCA Costs

Size	Large		Medium		Small	
Annual Tonnage (KKC)	907,000		90,700		45,350	
Seam Height (inches)	60	52	40	32	40	32
Daily Flow (mB)	5,700	6,575	568	710	190	235
Mine Life (years)	25		15		10	
Capital Costs						
Land	$ 4,940	5,930	$3,705	$5,185	$1,850	$1,850
Facilities						
Holding Pond	14,400	15,600	2,520	2,880	1,200	1,440
Settling Ponds	N.A.	N.A.	7,680	9,120	1,980	2,220
Fencing	9,265	10,170	8,035	9,510	5,675	5,675
Equipment						
Lime Storage & Equip.	91,200	99,000	5,375	5,735	3,795	4,035
Aerator	21,650	23,590	N. A.	N.A.	N.A.	N.A.
Clarifier	216,000	228,000	N. A.	N.A.	N.A.	N.A.
Pipes	17,520	18,000	3,400	3,400	3,400	3,400
Pump-water	19,680	21,600	3,240	3,600	1,800	2,040
Pump-slurry	5,520	5,760	2,500	2,500	2,280	2,280
Total	400,175	427,650	36,455	41,930	21,980	22,940
Annualized Costs						
Land	495	595	370	520	185	185
Amortization						
Facilities	2,225	2,425	2,135	2,515	1,320	1,390
Equipment	55,365	58,995	2,160	2,270	1,680	1,750

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TABLE 2 (Cont'd.)

Northern Appalachia - Deep Mines

BPCTCA Costs

Oper. & Maint.						
Oper. Personnel	59,130	59,130	9,855	9,855	3,285	3,285
Facility Maint.	710	775	550	645	265	280
Equipment Maint.	18,580	19,800	725	760	565	590
Material	68,650	79,195	6,840	8,550	2,290	2,830
Energy	33,500	36,200	1,800	1,800	1,000	1,000
Taxes	125	150	95	130	45	45
Insurance	4,000	4,275	365	420	220	230
Cost/Day (O & M)	505	545	55	60	21	22
Cost/KKG	0.27	0.29	0.27	0.30	0.23	0.25

TABLE 3

NORTHERN APPALACHIA - Surface Mines

BPCTCA Costs

	Large		Medium		Small	
Annual Tonnage (KKG)	453,500		90,700		45,350	
Seam Height (inches)	60	48	54	42	54	36
Drainage Area (ha)	13	16	3.2	4.2	1.4	2.2
Drainage/ha (m^3)	1010		1010		1010	
Acid Water Treat. (m^3)/day	367	451	90	118	39	62
Mine Life (Years)	20		10		5	
Capital Cost						
Lime Storage & Treat.	$36,000	$38,400	$ 4,405	$ 4,525	$ 3,675	$ 3,
Total	36,000	38,400	4,405	4,525	3,675	3,
Annualized Cost						
Amortization						
Equipment	5,365	5,720	655	675	550	
Oper. Maint. (6 mos.)						
Settling Pond	19,200	21,600	7,200	8,640	3,600	4,
Ditching	490	490	370	370	245	
Operating Per.	2,720	2,720	1,910	1,910	1,910	1,
Equipment Maint.	900	960	110	115	90	
Materials	1,090	1,355	265	350	115	
Regrading	805	1,035	290	460	185	
Energy	1,000	1,000	200	200	150	
Insurance	360	385	45	45	35	
Total O & M	26,565	29,545	10,390	12,090	6,330	7,
Annual Cost	58,495	64,810	21,435	24,855	13,210	15,
Cost/Day (O & M)	148	164	58	67	35	
Cost/KKG	0.13	0.14	0.24	0.27	0.29	0

TABLE 4
Northern Appalachia

BATEA Costs

Mine Size	Seam Height Inches	Daily Flow m^3	Capital Cost	Annua Cost
Deep Mines				
L	60	5,700	$240,000	$58,000
L	52	6,575	260,000	62,000
M	40	563	60,000	21,000
M	32	710	70,000	23,000
S	40		Not Applicable	
S	32		Not Applicable	
Surface Mines				
L	60	1,100	$ 90,000	$28,000
L	48	1,365	105,000	30,000
M	54	275	40,000	15,000
M	42	350	46,000	16,500
S	54		Not Applicable	
S	36		Not Applicable	

B. Southern Appalachia (Alabama, Kentucky, Tennessee)

Mines in this region can generally be categorized as being alkaline. Treatment cost for mine drainage is therefore based on treating alkaline mine drainage. Many deep mines in this region require no treatment either because they are dry or the raw mine drainage meets effluent guidelines without treatment. However, for deep and surface mine models in this industry segment it is assumed that BPT will consist of settling ponds for all mines.

Pipes are used to transport the waste water to the settling ponds in the case of the deep mines operations; ditches in the case of surface mining operations.

Surface mine operations are assumed relocated at six month intervals. The ponds are sized to retain a 10 year - 24 hour rainfall (5") over the disturbed area. This amounts to 1,270 m^3 of drainage/ha. The disturbed area during any six month period for the large mine (seam height - 60") is 14.6 ha. The required pond size is 1,270 x 14.6 - 18,540 m^3; its cost can be read from Figure 2. The cost is shown as an operating cost.

The costs incurred with the surface mine operations are almost entirely associated with the construction of the settling pond. The actual costs incurred will, therefore, be extremely site dependent. The costs/KKG will be almost directly proportional to the pond construction costs. If the latter are halved, the costs/KKG will be halved.

BATEA for both deep and surface mining operations consists of applying flocculant at the rate of 10 mg/l (10 ppm). Flocculation costs for the surface mining operations are based on annual rainfall in the region (48") over the disturbed areas. The rainfall amounts to about 11,900 m^3/ha/yr. For the large surface mine (seam height = 60"), 14.6 ha are disturbed at any given time and the yearly amount of water which must be treated is 14.6 x 11,900 = 173,740 m^3 or 485 m^3/cay.

The flocculation equipment is treated as a capital cost. The equipment is relocated at each new site.

Some of the more commonly worked and more productive seams in this area are: Marylee Seam, Jelico Seam, Harlan Seams, Hazard Seams, and the Kentucky 9, 10, 11, 12 and 14 Seams. The model mines reflect the height of these seams.

I. Deep Mine

a. Large (total in segment 86, visited 13)
Mine life 25 years; 1 million tons per year; 70 percent recovery; 48 inch thick seam; 4,878 tons per acre recoverable; 205 acres per year mined; 2,665 mined in 13 years; 250 foot of cover (above drainage); 600 gallons per acre alkaline mine drainage, 8070 cum/day.

b. Medium Mine
(total in segment 84, visited 1)
Mine life 15 years; 100,000 tons per year; 70 percent recovery; 42 inch thick seam; 4,270 tons per acre recoverable; 23.4 acres per year mined; 187.4 acres mined in 8 years; 200 foot of cover (above drainage); 600 gallons per acre alkaline mine drainage, 1135 cum/day.

c. Small Mine
(total in segment 254, visited 7)
Mine life 10 years; 50,000 tons per year; 75 percent recovery; 36 inch thick seam; 3,920 tons per acre recoverable; 12.8 acres per year mined; 64 acres mined in 5 years; 250 foot of cover (above drainage); 600 gallons per acre alkaline mine drainage, 145 cum/day.

II Surface Mines (including auger mining)

a. Large
(total in segment 67, visited 9)
Mine life 20 years; one half million tons per year; 80 percent recovery; 60 inch thick seam; 6,970 tons per acre recoverable; 72 acres per year; 36 acres in the active mine area (20.6 ha); 1,270, cum/ha in the active mine area, settling pond designed for 26162 cum.

A second model mine was developed with a seam thickness of 60 inches for cost comparison.

b. Medium Mine (total in segment 84, visited 1)
Mine life 15 years; 100,000 tons per year; 70 percent recovery; 42 inch thick seam; 4,270 tons per acre recoverable; 23.4 acres per year; 16.75 acres in the active mine area (4.1 ha); 1,270 cum/ha in the active mine area, settling pond designed for 5207 cum.

For cost comparison a second model mine was developed with a seam thickness of 60 inches.

c. Small Mine
(total in segment 110, visited 0)
Mine life 2 years; 50,000 tons per year; 80 percent recovery; 36 inch thick seam; 4,705 tons per acre recoverable; 10.6 acres per year mined; 5.3 in active mine area (2.1 ha); 1,270 cum/ha in the active mine area, settling pond designed for 2667 cum.

A second model mine was developed for cost comparison with a seam thickness of 42 inches.

BPT and BAT costs for the deep and surface mines in the Southern Appalachian are shown in Tables 5, 6, 7 and 8.

TABLE 5

Southern Appalachia Deep Mines
BPCTCA Costs

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	Large	Medium	Small
Annual Tonnage (KKG)	907,000	90,700	45,350
Seam Height (inches)	48	42	36
Daily Flow (m^3)	8,070	1,135	145
Mine Life	25	15	10
Capital Cost			
Land	$ 1,730	$ 370	$ 125
Facilities			
Settling Pond	18,000	3,840	1,010
Fencing	5,495	2,540	1,475
Equipment			
Pipes	6,000	3,180	250
Total	31,225	9,930	2,860
Annualized Cost			
Land	175	35	15
Amortization			
Facilities	2,230	745	370
Equipment	895	475	40
Operations & Maint.			
Operating Personnel	3,285	1,640	470
Facility Maint.	705	190	75
Equip. Maint.	895	160	15
Taxes	40	10	5
Insurance	310	100	30
Total	7,940	3,355	1,020
Cost/Day (O & M)	13	6	2
Cost/KKG	0.01	0.04	0.02

TABLE 6

Southern Appalachia Deep Mines

BATEA Costs

	Large	Medium	Small
Average Daily Flow (m^3)	8,070	1,135	145
Seam Height (inches)	48	42	36
Capital Cost			
Flocculation	$ 2,850	$ 1,800	$ 1,400
Total	2,850	1,900	1,400
Annualized Cost			
Amortization			
Equipment	425	270	210
Oper. & Maint.			
Equip. Maint.	145	90	70
Operating Per.	6,570	3,285	1,645
Materials	75,000	10,500	1,400
Total	82,140	14,145	3,325
Cost/Day (O & M)	225	38	9
Cost/KKG	0.09	0.16	0.07

TABLE 7

Southern Appalachia Surface Mines

BPCTCA Costs

	Large		Medium		Small	
Annual Tonnage (KKG)	453,500		90,700		45,350	
Seam Height (inches)	60	42	60	42	42	36
Drainage Area (ha)	14.6	20.6	3.2	4.1	1.8	2.1
Drainage/ha (m^3)	1,270	1,270	1,270	1,270	1,270	1,270
Mine Life (years)	20		10		2	

Annualized Cost

Oper. & Maint. (6 mo.)						
Settling Pond	$26,400	$31,300	$ 7,200	$10,200	$4,800	$ 5,4[illegible]
Ditching	490	490	370	370	245	2[illegible]
Regrading	1,150	1,495	345	460	230	2[illegible]
Total	28,040	33,185	7,915	11,030	5,260	5,9[illegible]
Annual Cost	56,080	66,370	15,830	22,060	10,520	11,9[illegible]
Cost/Day (O & M)	155	185	44	61	28	[illegible]
Cost/KKG	0.12	0.15	0.17	0.24	0.23	0.[illegible]

TABLE 8

Southern Appalachia Surface Mines

BATEA Costs

	Large		Medium		Small	
Average Daily Flow (m^3)	485	698	105	140	60	72
Seam Height (inches)	60	42	60	42	42	36
Average Daily Flow (m^3)	485	698	105	140	60	72
Seam Height (inches)	60	42	60	42	42	36
Capital Cost						
Flocculation	$ 1,800	$ 1,800	$ 1,400	$ 1,400	$ 1,400	$ 1,4
Total	1,800	1,800	1,400	1,400	1,400	1,4
Annualized Cost						
Amortization						
Equipment	270	270	210	210	210	21
Oper. & Maint.						
Equip. Maint.	90	90	70	70	70	7
Operating Per.	1,645	1,645	820	1,645	820	82
Materials	4,690	6,750	1,015	1,355	590	695
Total	6,695	8,755	2,115	3,280	1,690	1,795
Cost/Day (O & M)	18	23	5	8	4	4
Cost/KKG	0.01	0.02	0.02	0.04	0.04	0.04

C. Central Region (Arkansas, Illinois, Indiana, Kansas, Missouri, Oklahoma, Texas, Iowa)

Mines of this region can generally be categorized as being alkaline. Treatment costs for mine drainage is therefore based on treating alkaline mine drainage. It should be noted that some mines in the Tri-state area of Illinois, Indiana, and Kentucky have acid or ferruginous mine drainage. Drainage from these mines have a waste characterization similiar to the mines in the Northern Appalachian section. This acid or ferruginous drainage is most often the product of mining through abandoned surface or deep mines.

However, for the purpose of establishing cost for model mines all drainage in the Central region is assumed to be alkaline. BPT and BAT treatment process, operations, and estimated cost variations are the same as in the Southern Appalachia region described. The 10 yr/24 hr rainfall (5 inches) amounts to approximately 1,270 cum/ha; the annual rainfall (48 inches) amounts to approximately 11,900 cum/ha. Some of the more commonly worked and more productive seams in this region are: Illinois Number 2, 5 and 6; Indiana 3, 5 and 6; Cherokee; Tepo; and the Stigler seams. The model mines reflect the height of these seams.

I. Deep Mines

a. Large
(total in segment 20, visited 3)
Mine life 25 years; 1 million tons per year; 60 percent recovery; 96 inch thick seam; 8,364 tons per acre recoverable; 120 acres per year mined; 1,560 acres mined in 13 years; 500 foot of cover (above drainage); 300 gallons per acre alkaline mine drainage, 1890 cum/day.

b. Medium Mine
(total in segment 5, visited 1)
Mine life 10 years; 150,000 tons per year; 60 percent recovery; 60 inch thick seam; 5,000 tons per acre recoverable; 30 acres per year mined; 150 acres mined in 5 years; 300 foot of cover below drainage; 600 gallons per acre mined alkaline mine drainage, 380 cum/day.

c. Small Mine
(total in segment 5, visited 0)
Mine life 10 years; 50,000 tons per year; 60 percent recovery; 60 inch thick seam; 5,000 tons per acre recoverable; 10 acres per year mined; 50 acres mined in 5 years; 300 foot of cover (below

drainage); 600 gallons per acre alkaline mine drainage, 115 cum/day.

II, Surface Mines

a. Large
(total in segment 20, visited 3)
Mine life 25 years; 1 million tons per year; 90 percent recovery; 72 inch thick seam; 9,400 tons per acre recoverable; 106 acres mined per year; 53 acres in active mine area (21.5 ha); 1,272 cum/ha in the active mine area, alkaline drainage; settling pond designed for 27348 cum

b. Medium Mine
(total in segment 21, visited 3)
Mine life 10 years; 100,000 tons per year; 90 percent recovery; 60 inch thick seam; 7,760 tons per acre recoverable; 13 acres mined per year; 6.5 acres in active mine area (2.6 ha); 1,272 cum/ha in active mine area alkaline mine drainage, settling pond designed for 3307 cum.

For cost comparison a second model mine was developed with a seam thickness of 42 inches.

c. Small Mine
(total in segment 40, visited 1)
Mine lite 2 years; 50,000 tons per year; 90 percent recovery; 42 inch thick seam; 5,350 tons per acre recoverable; 9 acres per year mined; 4.5 acres in active mine area (1.8 ha); 1,272 cum/ha in active mine area alkaline mine drainage, settling pond designed for 2290 cum.

For cost comparisons a second model mine was developed with a seam height of 24 inches.

BPT and BAT costs for deep and surface mines in the central regions are presented in tables 9, 10, 11 and 12.

TABLE 9

Central Region Deep Mines
BPCTCA Costs

	Large	Medium	Small
Annual Tonnage (KKG)	907,000	136,050	45,350
Seam Height (inches	96	60	60
Daily Flow (m^3)	1,890	330	115
Mine Life (years)	25	10	10
Capital Cost			
Land	$ 740	$ 220	$ 125
Facilities			
Settling Pond	5,880	1,920	960
Fencing	3,610	1,970	1,475
Equipment			
Pipes	3,600	1,620	250
Total	13,830	5,730	2,810
Annualized Cost			
Land	75	20	15
Amortization			
Facilities	900	580	360
Equipment	535	240	40
Operations & Maint.			
Operating Per.	3,285	1,640	470
Facility Maint.	285	115	75
Equip. Maint.	180	80	15
Taxes	20	5	5
Insurance	140	55	30
Total	5,420	2,735	1,010
Cost/Day (O & M)	11	5	2
Cost/KKG	0.01	0.01	0.02

TABLE 10

Central Region Deep Mines

BATEA Costs

	Large	Medium	Small
Average Daily Flow (m^3)	1,890	380	115
Seam Height (inches)	96	60	60
Capital Cost			
Flocculation	$ 2,850	$ 1,800	$ 1,400
Total	2,850	1,800	1,400
Annualized Cost			
Amortization			
Equipment	425	270	210
Oper. & Maint.			
Equip. Maint.	145	90	70
Operating Per.	1,645	1,645	820
Materials	18,000	3,600	1,110
Total	20,215	5,605	2,210
Cost/Day (O & M)	54	15	5
Cost/KKG	0.02	0.04	0.05

TABLE 11

Central Region Surface Mines

BPCTCA Costs

	Large	Medium		Small	
Annual Tonnage (KKG)	907,000	90,700		45,350	
Seam Height (inches)	72	60	42	42	24
Drainage Area (ha)	21.5	2.6	3.8	1.8	3.2
Drainage/ha (m^3)	1272	1272	1272	1272	1272
Mine Life (years)	25	10		2	

Annualized Cost

	Large	Medium		Small	
Oper. & Maint. (6 mos.)					
Settling Pond	$32,400	$ 7,200	$ 9,600	$ 4,800	$ 6,96
Ditching	490	370	370	245	24
Regrading	1,610	290	345	230	34
Total	34,500	7,860	10,315	5,275	7,55
Annual Cost	69,000	15,720	20,650	10,550	15,10
Cost/Day (O & M)	192	43	57	29	4
Cost/KKG	0.08	0.17	0.23	0.23	0.3

TABLE 12

Central Region Surface Mines

BATEA Costs

	Large	Medium		Small	
Average Daily Flow (m^3)	716	88	125	61	106
Seam Height (inches)	72	60	42	42	24
Capital Cost					
Flocculation	$1,800	$1,400	$1,400	$1,400	$1,400
Total	1,800	1,400	1,400	1,400	1,400
Annualized Cost					
Amortization					
Equipment	270	210	210	210	210
Oper. & Maint.					
Equip. Maint.	90	70	70	70	70
Operating Per.	1,645	820	820	820	820
Materials	6,925	850	1,210	590	1.025
Total	8,930	1,950	2,310	1,690	2,125
Cost/Day (O & M)	23	5	6	4	5
Cost/KKG	0.01	0.02	0.03	0.04	0.05

D. Intermountain (Arizona, Colorado, New Mexico, Utah)

Mines in this region can generally be categorized as being alkaline. Treatment cost for mine drainage is therefore based on treating alkaline mine drainage.

Coal seams in this region unlike the coal seams in the Appalachian and Central parts of the United States lie in relatively small basins, are generally not persistent, and are difficult to categorize geologically. Deep mines generally work seams in a range of 4 to 12 feet and a seam thickness of 9 feet was arbitrarily chosen for the deep mines. The seam height for the large surface mine in this region was arbitrarily chosen at 20 feet, medium mine 10 feet, and to reflect for this region the relatively thinner seams of New Mexico and Utah, a seam thickness of 4 foot was chosen for the small surface mine segmentation.

BPT and BAT treatment processes, operations and estimated cost variations are the same as in the Southern Appalachian region. The 10 year/24 hour precipitation event (2.5 inches) amounts to about 635 cum/ha the annual rainfall (16 inches) about 3,965 cubic meters

I. Deep Mines

Deep mines in this region are concentrated in Utah and Colorado with one mine in New Mexico on the Colorado border. Present deep mines in this region are operated in thick seams or "splits" of thick seams.

a. Large Mines
(total in segment 16, visited 8)
Mine life 25 years; 750,000 tons per year; 70 percent recovery;9 foot seam; 11,000 tons per acre recoverable; 68 acres mined per year; 884 acres mined in 13 years; 200 to 2,500 foot of cover (below drainage); 200 gallons per acre alkaline mine drainage, 760 cum/day.

b. Medium Mine
(total in segment 9, visited 1)

c. Small Mine
(total in segment 14, visited 1)

II. Surface Mines

Surface mines in this region include some of the largest mines in the United States in terms of tons per year. These mines strip thick seams of 6 foot to over 30 foot using area methods. The mines are generally located in semi-arrid areas with rainfall of less than 16 inches per year. Where allowed by state laws the mines impound all surface runoff entering their property.

a. Large Mine
(total in segment 6, visited 6)
Mine life 30 years; 3 million tons per year; 90 percent recovery; 20 foot thick seam; 31,400 tons per acre recoverable; 96 acres per year; 48 acres in active mine area (19.4 ha acres); 630 cum/ha alkaline mine drainage, settling basin designed for 12222 cum.

b. Medium Mine
(total in segment 3, visited 1)
Mine life 15 years; 150,000 tons per year; 90 percent recovery; 10 foot thick seam; 15,700 tons per acre recoverable; 9.6 acres per year; 4.8 acres in active mine are (1.9 ha/acre); 630 cum/ha alkaline mine drainage, settling basin designed for 1197 cum.

c. Small Mine
(total in segment 3, visited 0)
Mine life 5 years; 50,000 tons per year; 90 percent recovery; 4 foot thick seam; 6,300 tons per acre; 8 acres disturbed in 1 year; 4 acres in active mine area (1.6 ha/acres); 630 cum/ha alkaline mine drainage, settling basin designed for 1008 cum.

BPT and BAT cost for the deep and surface mines in the Intermountain region are shown in tables 13, 14, 15 and 16.

TABLE 13

Intermountain Region Deep Mines
BPCTCA Costs

		Large
Annual Tonnage (KKG)		680,250
Seam Height (inches)		108
Daily Flow (m^3)		760
Mine Life (years)		25
Capital Cost		
Land	$	320
Facilities		
Settling Pond		2,760
Fencing		2,380
Equipment		
Pipes		2,700
Total		8,160
Annualized Cost		
Land		30
Amortization		
Facilities		490
Equipment		400
Operations & Maint.		
Operating Personnel		1,640
Facility Maint.		155
Equip. Maint.		135
Taxes		10
Insurance		80
Total		2,940
Cost/Day (O&M)		6
Cost/KKG		0.01

TABLE 14

Intermountain Region Deep Mines

BATEA Costs

	Large
Average Daily Flow (m^3)	760
Seam Height (inches)	108
Capital Cost	
Flocculation	$ 1,800
Total	1,800
Annualized Cost	
Amortization	
Equipment	270
Oper. & Maint.	
Equip. Maint.	90
Operating Per.	3,285
Materials	
Total	10,995
Cost/Day (O & M)	29
Cost/KKG	0.02

TABLE 15

Intermountain Region Surface Mines

BPCTCA Costs

	Large	Medium	Small
Annual Tonnage (KKG)	2,721,000	136,050	45,350
Seam height (inches	240	120	48
Drainage Area (ha)	19.4	1.9	1.6
Drainage/ha (m^3)	630	630	630
Mine Life (years)	30	15	5
Annualized Cost			
Oper. & Maint. (6 mo.)			
Settling Pond	$18,000	$3,000	$2,760
Ditching	490	370	245
Regrading	805	175	150
Total	19,295	3,545	3,155
Annual Cost	38,590	7,090	6,310
Cost/Day (O&M)	107	20	18
Cost/KKG	0.01	0.05	0.14

TABLE 16

Intermountain Region Surface Mines

BATEA Costs

	Large	Medium	Small
Average Daily Flow (m^3)	216	22	18
Seam height (inches)	240	120	48
Capital Cost			
Flocculation	$1,400	$1,400	$1,400
Total	1,400	1,400	1,400
Annualized Cost			
Amortization			
Equipment	210	210	210
Oper. & Maint.			
Equip. Maint.	70	70	70
Operating Per.	1,645	820	820
Materials	2,090	215	175
Total	4,015	1,315	1,275
Cost/Day (O & M)	10	3	3
Cost/KKG	.01	0.01	0.03

F. Great Plains (Montana, North Dakota, Wyoming)

Mines in this region can generally be categorized as being alkaline. Treatment costs for mine drainage is therefore based on treating alkaline mine drainage. BPT and BAT treatment processes, operations, and estimated cost variations are the same as in the Southern Appalachian region. The 10 yr/24 hr precipitation event (3 inches) amounts to about 760 cum/ha ; the annual rainfall (16 inches) about 3,965 cum/ha

This region contains much of the low sulfur coal reserves in the United States consisting primarily of sub-bituminous and lignite coals. The coals lend themselves primarily to stripping due the thick seams with little overburden. There are at present few working mines. Those mines working are predominately surface mines stripping the thicker seams. A seam thickness of 40 foot was chosen for the large surface mine model. A seam thickness of 10 foot was chosen for the medium size surface mine model. A seam thickness of 8 foot was chosen for the small size surface mine model.

I. Deep Mines (all presently operating deep mines in this region are located in Wyoming)

a. Large Mine
(total in segment 1, visited 1)
Mine life 30 years; 750,000 tons per year; 60 percent recovery; 6 foot thick seam; 6,300 tons per year recoverable; 119 acres per year; 1,785 acres mined in 15 years; 300 foot of cover (below drainage); 300 gallons per acre alkaline mine drainage; 2040 cum/day alkaline mine drainage.

b. Medium Mine
(total in segment 1, visited 0)
Mine life 15 years; 150,000 tons per year; 60 percent recovery; 6 foot thick seam; 6,300 tons per acre recoverable; 24 acres per year; 192 acres mined in 8 years; 200 foot of cover (below drainage); 600 gallons per acre; 435 cum/day alkaline mine drainage.

c. Small Mine
(total in segment 3, visited 0)
Mine life 15 years; 50,000 tons per year; 60 percent recovery; 6 foot thick seam; 6,300 tons per acre recoverable; 8 acres per acre mined; 72 acres mined in 8 years; 200 foot of cover (below

drainage); 600 gallons per acre; 190 cum/day alkaline mine drainage.

II. Surface Mines

a. Large Mine
(total in segment 18, visited 15)
Mine life 40 years; 5 million tons per year; 90 percent recovery; 40 foot thick seam; 62,700 tons per acre recoverable; 80 acres per year; 40 acres in active mine area (16.2 ha/acre); 755 cubic meters per ha/acre; settling basin designed for 12231 cum.

b. Medium Mine
(total in segment 4, visited 0)
Mine life 15 years; 150,000 tons per year; 90 percent recovery; 10 foot thick seam; 11,800 tons per acre recoverable; 12.7 acres per year mined; 6.35 acres in active mine area (2.6 ha/acre); 755 cubic meters per ha/acres alkaline mine drainage, settling basin designed for 1963 cum.

c. Small Mine
(total in segment 12, visited 0)
Mine life 15 years; 50,000 tons per year; 90 percent recovery; 9 foot thick seam; 12,500 tons per acre recoverable; 4 acres per year mined; 2 acres in active mine area (0.8 ha/acres); 755 cubic meters per ha/acre in active mine area alkaline mine drainage, settling basin designed for 608 cum.

BPT and BAT costs for the deep and surface mines in the Great Plain region are presented in tables 17, 18, 19 and 20.

TABLE 17

Great Plains Region Deep Mines
BPCTCA Costs

	Large	Medium	Small
Annual Tonnage (KKG)	680,250	136,050	45,350
Seam height (inches)	72	72	72
Daily Flow (m^3)	2,040	435	190
Mine Life (years)	30	15	15
Capital Cost			
Land	$ 840	$ 245	$ 125
Facilities			
Settling Pond	6,960	2,100	1,200
Fencing	3,820	2,065	1,475
Equipment			
Pipes	3,780	1,620	250
Total	15,400	6,030	3,050
Annualized Cost			
Land	85	25	15
Amortization			
Facilities	960	490	315
Equipment	565	240	40
Operations & Maint.			
Operating Personnel	3,285	1,640	470
Facility Maint.	325	125	80
Equip. Maint	190	80	15
Taxes	20	5	5
Insurance	155	60	30
Total	5,500	2,665	970
Cost/Day (O&M)	11	5.25	1.65
Cost/KKG	0.01	0.02	0.02

TABLE 18

Great Plains Region Mines

BATEA Costs

	Large	Medium	Small
Average Daily Flow (m^3)	2,040	435	190
Seam Height (inches)	72	72	72
Capital Cost			
Flocculation	$ 2,850	$ 1,800	$ 1,400
Total	2,850	1,800	1,400
Annualized Cost			
Amortization			
Equipment	425	270	210
Oper. & Maint.			
Equip. Maint.	145	90	70
Operating Per.	1,645	1,645	1,645
Materials	19,730	4,200	1,840
Total	21,945	6,205	3,765
Cost/Day (O&M)	60	16	10
Cost/KKG	0.03	0.05	0.08

TABLE 19

Great Plains Region Surface Mines

BPCTCA Costs

	Large	Medium	Small
Annual Tonnage (KKG)	4,535,000	136,050	45,350
Seam Height (inches	480	120	96
Drainage Area (ha)	16.2	2.6	0.8
Drainage/ha (m^3)	755	755	755
Mine Life (years)	40	15	15
Annualized Cost			
Oper. & Maint. (6 mo.)			
Settling Pond	$18,000	$4,320	$2,040
Ditching	490	370	245
Regrading	805	230	115
Total	19,295	4,920	2,400
Annual Cost	38,590	9,840	4,800
Cost/Day (O&M)	107	27	13
Cost/KKG	0.01	0.07	0.10

TABLE 20

Great Plains Region Surface Mines

BATEA Costs

	Large	Medium	Small
Average Daily Flow (m^3)	180	29	9
Seam Height (inches)	480	120	96
Capital Cost			
Flocculation	$1,400	$1,400	$1,400
Total	1,400	1,400	1,400
Annualized Cost			
Amortization			
Equipment	210	210	210
Oper. & Maint.			
Equip. Maint.	70	70	70
Operating Per.	1,645	820	820
Materials	1,740	280	90
Total	3,665	1,380	1,190
Cost/Day (O & M)	9	3	3
Cost/KKG	.01	0.01	0.03

F. West (Alaska and Washington)

There are presently five mines in this region. In Alaska there is one medium size surface mine. In Washington there are two small deep mines, and one small surface mine and one large surface mine.

BPT and BAT treatment processes, operations and estimated costs variations are the same as in the Southern Appalachia region. The 10 yr/24 hr precipitation event (5 inches) amount to about 1,270 cubic meters per ha/acre; the annual rainfall (50 inches) about 12,400 cubic meters per ha/ acre.

Physical conditions in the seams in the state of Washington minimize underground mining, and the size of underground mining operations. The present surface mine operating in the state of Alaska is stripping a seam 150 foot thick with a production of 170,000 tons in 1973.

BPT anf BAT cost for the western region surface mines are shown in tables 21 and 22.

TABLE 21

West Region Surface Mines

BPCTCA Costs

	Large	Medium
Annual Tonnage (KKG)	2,902,400	63,490
Seam Height (inches)	600	1,800
Drainage ARea (ha)	8.3	0.6
Drainage/ha (m^3)	1,275	1,275
Mine Life (years)		10
Annualized Cost		
Oper. & Maint. (6 mo.)		
Settling Pond	$21,000	$2,400
Ditching	490	370
Regrading	920	140
Total	22,410	2,910
Annual Cost	44,820	5,820
Cost/Day (O&M)	125	16
Cost?KKG	0.02	0.09

TABLE 22

West Region Surface Mines

BATEA Costs

	Large	Medium
Average Daily Flow (m^3)	293	21
Seam Height (inches)	600	1800
Capital Cost		
Flocculation	$1,800	$1,400
Total	1,800	1,400
Annualized Cost		
Amortization		
Equipment	270	210
Oper. & Maint.		
Equip. Maint.	90	70
Operating Per.	820	820
Materials	2,835	205
Total	4,015	1,305
Cost/Day (O&M)	10	3
Cost/KKG	.01	0.02

II ANTHRACITE MINING

In the interim final regulation anthracite mining is included with bituminous coal and lignite mining as it was determined that rank of coal did not affect the chemical characteristics of raw mine drainage.

Anthracite coal is found to some extent in four states; Pennsylvania, Colorado, New Mexico and Washington. Approximately 90 percent of mineable anthracite with present day mining technology is found in Pennsylvania. All current anthracite mining operations are found in Pennsylvania. Comments on anthracite mining are limited to mines in Pennsylvania.

Mining methods for anthracite include deep mining, strip mining, and culm bank. For the purpose of developing effluent limitations guidelines, culm bank mining is included with strip mining.

Mining methods for anthracite are influenced to a great extent by past mining in the area. Most mines are doing a second and third pass at mining in the area. Culm bank recovery accounts for approximately 36 percent of the anthracite tonnage shipped in 1973.

Mines and seams of anthracite are most often interconnected and are generally inundated. Water drainage tunnels established in the 1800's convey large quantities of mine drainage from abandoned mines. Currently operating mines often must handle large quantities of drainage. This drainage from active mines is: treated to meet Pennsylvania effluent standards of less than seven milligrams per liter of iron, alkalinity greater than acidity, pH 6 to 9; or is effectively not discharged to a receiving stream with drainage going to abandoned mines; or the mine is located in one of ten water sheds covered in pollution abatement escrow fund, Pennsylvania act 443, 1968 in which case the mine can discharge to a receiving stream untreated mine drainage and pay 15 cents per sellable ton mine.

For the purpose of developing effluent limitation guidelines only mines discharging to a receiving stream are considered. These mines would be located in the northern and eastern middle anthracite fields. Mines not discharging to a receiving stream are not covered. Mines discharging to one of the ten water sheds are not covered as the drainage to the water shed is treated in a state owned treatment facility.

Unlike bituminous and lignite mines where mine drainage is fundamentally related to precipitation with side concerns from adjacent or abandoned mines, anthracite mine drainage is primarily from abandoned areas, seams, or mines. There is no relationship between mine drainage volumes and tons mined, area mined, roof exposed, depth of cover, or permiability.

In 1973 there were 82 mining operations listed by the state of Pennsylvania as deep anthracite mine operations. Of these 82 operations, 12 had no mine production for the year, 21 had a production of less than 500 tons per year, and 2 deep anthracite mines had a production of over 50,000 tons in 1973.

In 1973 there were 115 mining operations listed by Pennsylvania as surface mine operations. Of these 9 operations were backfilling with no production, 44 operations were operating in culm banks, 27 operations had a production of less than 500 tons in 1973, and 34 surface mining operations had a production of over 50,000 tons per year.

I. Deep Mines

a. Large (visited 1)

One large deep mine is located in the northern and eastern middle fields. This mine had no discharge with drainage returned to abandoned mines. The mine visited has a production of approximately 90,000 tons per year and contributes 15 cents per ton to the state of Pennsylvania. To continue in production the mine pumps 1,500 gallons per minute 24 hours per day or approximately 2.2 million gallons per day of mine drainage.

A primary consideration in opening a new large deep anthracite mine is cost of pumping. This consideration is quite aside from the cost of treating acid mine drainage. Facilities to meet current Pennsylvania effluent requirements would be adequate to meet new source performance standards.

b. Small (visited 0)

Five small deep mines are located in the northern and eastern middle anthracite field of which two had no production in 1973. A telephone survey indicated the remaining three mines had an effective "no discharge".

As with large deep mine facilities, a small deep mine to meet current Pennsylvania effluent requirements would be adequate to meet new source performance standards.

II. Surface Mines

a. Large (visited 2)

Included in this category are 14 culm bank mines. Twelve large surface mines are located in the northern and eastern middle anthracite fields. A mine visited in the northern field consists of three pits with an annual production of 1 1/2 million tons per year. This mine has no discharge with all mine drainage going to abandoned areas and abandoned mines.

As with deep mines, facilities for large surface mines to meet current Pennsylvania effluent requirements would be adequate to meet new source performance standards.

b. Small (visited 0)

Included in this category are 30 culm bank mines. Twenty five small surface mines are located in the northern and eastern middle anthracite fields of which 18 had no production in 1973. As with large surface mines, facilities for small surface mines to meet current Pennsylvania effluent requirements would be adequate to meet new source performance standards.

III. Coal Preparation Plants

The segmentation for coal preparation plants makes the distinction between anthracite preparation plants, or breakers, and bituminous preparation plants. The development document refers to three general stages or extent of coal cleaning and for the purpose of developing effluent limitation guidelines preparation plants were studied under these 3 stages of coal preparation or cleaning. For the purpose of developing effluent limitation guidelines anthracite preparation plants or breakers are included under Stage 2 preparation plants as anthracite preparation plants generally use hydraulic separation or dense media separation with or without fine coal cleaning but universally without froth flotation.

Coal preparation plants using Stage 1 preparation are esentially dry and for the purpose of developing effluent limitation guidelines can be considered as having no discharge from the preparation plant. Industry and industries statistics consider Stage 1 preparation as basically shipping "raw coal".

Approximately 50 percent of the bituminuous coal mine is cleaned in Stage 2 or Stage 3 preparation plants. These preparation plants are located primarily in states which have existing effluent limitations on preparation plant discharges. Of the over 180 preparation facilities visited or included in the Skelly and Loy study through industry supplied data, over 100 preparation plants had or reported closed water circuits. The preparation plants visited which did not have closed water circuits had some form of treatment for solids removal prior to discharge.

Stage 3 preparation plants with froth flotation are at present limited to plants cleaning metallurgical coal. The very nature of the coal cleaning process eliminates coal finds in the discharge. Refuse fines are removed separately in thickeners with filtration of the underflow and the filtrate and overflow from the refuse thickner closing the water circuit. Stage 3 preparation plants require makeup water to balance water lost on coal, refuse, and loss in thermal drying. All Stage 3 preparation plants visited or included in the study through industry supplied data used closed water circuits and affected no discharge from the preparation plant itself.

Stage 2 preparation plants include preparation plants employing wet cleaning of coal but without froth flotation.

Preparation plant models are developed to illustrate capital cost for closing the water circuit in a 100, 500, and 1,000 ton per hour Stage 2 preparation plants by incorporating either settling ponds or thickners and disc filters. In each example for which settling ponds are constructed cost are presented for discharges containing 5, 10 and 15 percent solids. These capital costs are derived from information contained in the Development Document, section 8 - Cost, Energy and Non Water Quality Aspects. The operation and maintenance annual cost for the model preparation plants consist of the following items: operating personnel, repair and maintenance, energy, taxes and insurance. Personnel costs are based on an hourly rate of $9.00 per hour. The annual equipment maintenance cost and the annual facility repair and maintenance are estimated to 5 and 3 percent of capital cost. Energy cost is based on the cost of electricity which is extimated at 2 1/2 cents per killowat hour; this results in a cost of $200 per horsepower per year. Taxes are estimated at 2.5 percent of land cost. Insurance cost is included at 1 percent of total capital cost.

The capital cost presented represent replacement of existing facilities.

Figure 10 is a summary of coal preparation plants as taken from the 1974 Keystone Manual (represents 1973 data).

Model A - Stage 2 plant, 100 TPH raw feed and 100 GPM effluent with pond closure.

1. 5% solids in effluent (30 tons/day)

2. Capacity Primary Pond

Storage (30 tons/day x 45 cu. ft./ton) 27 ft/cu yd = 50 cu yd/day
Surface Area (50 cu yd/day x 5 days x 4 wk x 6 mo.) 4 yd(depth) = 625 sq.
Storage 6 mo + 3 ft settling zone and 3 ft safety -
2500 cu yd + 1250 cu yd = 3750 cu yd.

b. Pumping Costs - for 100 ft head and 2000 linear ft.

Pumps - 1 primary and 1 back-up = 2x5 1/2 hp pumps @$1200 ea = $2400	
Valves - 5x4 in gates @ $300 ea=$1500	
2x4 in checks $350 ea= $ 700 - total valves =	$22000
Piping - 200 ft of 4 in steel @ $5.00/ft & $7,00/ft inst.=	$24000
Pump Inst. - Lump Sum	$ 1000
Total	$29,600
Call	$30,000

c. Primary and Auxillilary Pond Const. Cost - with V-ditch for runoff

Primary Pond = 3750 cu yd @ $1.00/cu yd =	$3750
Auxilliary Pond = 1250 cy yd @ $1.00/cu yd =	1250
Diversion Around Ponds (3 sides each) = 355 lin. ft of 2 ft deep V-ditch at $2.50/lin. ft.	900
Total =	$5900

Grand Total = $30,000 + $5,900 = $35,900

Model A

2. 10% solids in effluent (60 ton/day)

a. Capacity Primary Pond

Storage - (60 x 45) 27	= 100 cu yd/day
Surface Area - (100 x 5 x 4 x 6) 4	= 1250 sq yd
Storage 6 mo. + 6 ft zone = 5000 + 2500	= 7500 cu yd

b. Pumping Costs = same as for 1 = $30,000

c. Primary and Auxilliary Pond Const. Cost - with V-ditch

Primary Pond = 7500 cu yd @ $1.00/cy yd	=	$7,500
Auxilliary Ponds = 2500 cu yd @ $1.00/cu yd	=	2,500
Diversion V-ditch = 500 lin. ft @$2.50	=	1,250
Total		$11,250

Grand Total = $30,000 + 11,250 = $41,250

Model A

3. 15% solids in effluent (90 ton/day)

a. Capacity Primary Pond

Storage - (90 x 45) 27	=	150 cu yd/day
Surface Area - (150 x 5 x 4 x 6) 4	=	1875 sq yd
Storage 6 mo. + 6 ft zone - 7500 + 3750	=	11250 cu yd

b Pumping Costs = same as for 1 and 2 = $30,000

c Primary and Auxilliary Pond Const. Cost - with V-ditch

Primary Pond = 11,250 cy yd @ $1.00/cy yd	=	$11,250
Auxilliary Pond = 3,750 cu yd @ $1.00/cu yd	=	3,750
Diversion V-ditch = 615 lin ft. @ $2.50/lin ft	=	1,550
Total		$16,550

Grand Total = $30,000 + $16,550 = $46,550

Model A

Annual Operating & Maintenance	5% solids	10% solids	15% solids
Operating Personnel (2 hr/day)	$3780	$3780	$3780
Facility Maintenance	177	338	497
Equipment Maintenance	1500	1500	1500
Energy	1100	1100	1100
Taxes	25	25	25
Insurance	359	413	466
	$6941	$7156	$7368

Model B - Stage 2 plant, 500 TPH raw feed and 1500 GPM effluent with pond closure.

1 5% solids in effluent (450 ton/day)

2 Capacity Primary Pond

Storage - (450 x 45) 27	=	750 cy yd/day
Surface Area - (750 x 5 x 4 x 6) 4	=	22,500 sq yd
Storage 6 mo. + 6 ft zone - 90,000 + 45,000	=	135,000 cu yd

b. Pumping Costs - for 100 ft. head and 2000 linear ft.

Pumps - 1 primary and 1 back-up = 2x88 hp pumps @$7000 ea	=	$14,000
Valves - 5x6 in gates @$500 ea = $2500		
2x6 in checks @$550 ea $1100 Total Valves	=	3,600
Piping - 200 ft of 6 inch steel @$12.00+inst/ft @ $10.00	=	$44,000
Pump Inst - Lump Sum	=	1,000
Total	=	$62,600
Call	=	$63,000

c. Primary and Auxilliary Pond Const. Cost - with V-ditch

Primary Pond = 135,000 cy yd @ $1.00/cu yd	=	$135,000
Auxilliary Pond = 45,000 cu yd @ $1.00/cu yd		45,000
Diversion V-ditch = 2130 lin. ft. @ $2.50/lin ft		5,300
Total		$185,300

Grand Total = $63,000 + $185,300 $248,300

Model B

2. 10% solids in effluent (900 ton/day)

a. Capacity Primary Pond

Storage - (900 x 45) 27	=	1500 cu yd/day
Surface Area - (1500 x 5 x 4 x 6) 4	=	45000 sq yd
Storage 6 mo. + 6 ft zone - 180,000 + 90,000	=	270,000 cy yd

= $63,000

b. Pumping Costs = Same as for 1

c. Primary and Auxilliary Pond Const. - with V-ditch

Primary Pond

Primary Pond = 270,000 cu yd @ $1.00/cu yd.	= 270,000
Auxilliary Pond = 90,000 cu yd @ $1.00/cu yd	= 90,000
Diversion V-ditch - 3000 lin. ft. @ $2.50/lin ft	= 7,500
Total	367,500

Grand Total = $63,000 + $367,500 =$430,500

Model B

3. 15% solids in effluent (1350 ton/day)

2. Capacity Primary Pond

Storage - (1350 x 45) -	=32,250 cu
Surface Area - (2,250 x 5 x 4 x 6(- 4	=67,500 sq yd
Storage 6 mo. + 6 ft. zone - 270,000 + 135,000	= 405,000 cu

b. Pumping Costs = Same as for 1 and 2 = $63,000

c. Primary & Auxilliary Pond Const. with V-ditch

Primary Pond = 405,000 cu yd @ $1.00/cy yd. =	$405,000
Auxilliary Pond = 135,000 cu yd @ $1.00/cu yd =	$135,000
Diversion V-ditch = 3700 lin. ft @ $2.50/lin. ft =	9,250
	$549,250

Grand Total = $63,000 + $549,250 = $612,250

Model B

Annual Operating & Maintenance	5% solids	10% solids	15% solids
Operating Personnel (4 hr/day)	7560	7560	7560
Facility Maintenance	5559	11025	16478
Equipment Maintenance	3150	3150	3150
Energy	17600	17600	17600
Taxes	125	250	375
Insurance	2483	4305	6123
	$36477	$43890	$51286

Model C - Stage 2 plant, 1000 TPH raw feed and 3000 GPM effluent with pond closure.

2. 5% solids in effluent (900 ton/day)

a. Capacity Primary Pond

Storage - same as model B 2 = 1500 cu yd/day
Surface Area - same as Model B 2 = 45000 sq yd
Storage 6 mo + 6 ft zone - same as Model B = 270000 cu yd

b. Pumping Costs - for 100 ft head and 2000 linear ft.

Pumps - 1 primary and 1 back-up = 2x100 hp pumps @$11,700 ea = 23,
Valves - 5 x 12 in gates @$900 ea = 4,
2 x 12 in checks @$1,000 ea = 42000 total valves = 6,
Piping - 2000 ft of 12 inch steel @$25.00 for pipe and installment = 50,0
Pump Inst - Lump Sum = 1,0
Total =$80,9
Call $81,0

c. Primary and Auxilliary Pond Const. Cost - with V-ditch

Primary Pond - 270,000 cy yd @ $1.00/cu yd	= $270,000
Auxilliary Pond - 90,000 cu yd @ $1.00/cu yd	$ 90,000
Diversion V-ditch - 3,010 lin. ft @ $2.50/lin ft	$ 7,500
Total	$367,500
Grand Total = $81,000 + $367,500	$448,500

Model C

2. 10% solids in effluent (1800 ton/day)

a. Capacity Primary Pond

Storage - (1810 x 45) 27 = 3,000 cu yd/day
Surface Area - (3,000 x 5 x 4 x 6) 4 = 67,500 sq yd
Storage 6 mo. + 6 ft zone - 270,000 + 135,000 = 405,000 cu yd

b. Pumping Costs = Same as 1 =$ 81,000
c. Primary and Auxilliary Pond Const. Cost - with V-ditch

Primary Pond - 405,000 @ $1.00/cu yd	= $405,000
Auxilliary Pond - 135,000 @ $1.00/cu yd	$135,000
Diversion V-ditch - 3700 ft @ $2.50	9,250
Total	$549,250
Grand Total = $81,000 + $549,250	$630,250

Model C

3. 15% solids in effluent (2700 ton/day)

a. Capacity Primary Pond

Storage - (2700 x 45) 27 = 4,500 cu yd/day
Surface Area - (4,500 x 5 x 4 x 6) 4 = 135,000 sq ft

b. Pumping Costs = Same as 1 and 2 = $81,000

c. Primary and Auxilliary Pond Const. Cost - with V-ditch

Primary Pond - 810,000 cu yd @ $1.00/cu yd	=	$810,000
Auxilliary Pond - 270,000 cu yd @$1.00/cu yd		$270,000
Diversion V-ditch - 5,200 lin. ft. @ $2.50/lin ft		$ 13,000
Total		$1,093,000

Grand Total = $81,000 + $1,093,000 $1,174,000

Model C

Annual Operating & Maintenance	5% solids	10% solids	15% solids
Operating Personnel (4 hr/day)	7560	7560	7560
Facility Maintenance	11025	16478	32790
Equipment Maintenance	4050	4050	4050
Energy	20000	20000	20000
Taxes	250	350	700
Insurance	4485	6303	11740
	$47370	$54741	$76840

Model D

Stage 2 plant, 100 TPH raw feed and 3 TPH solid refuse mixed in water and closure via thickeners and disc filters.

1. Install 75 ft thickener and disc filter

Thickner Cost - 75 ft. @$1750/ft	=	$131,250
Disc Filter	=	$ 20,000
Total		$151,250

ModelcfE

Stage 2 plant, 500 TPH raw feed and 10 TPH solid refuse in water and closure via thickeners and disc filters.

1. Install 125 ft thickener and disc filter

Thickener Cost - 125 ft @$1750/ft		=	$218,750
Disc Filter		=	$ 70,000
	Total	=	$288,750

Model F

Stage 2 plant, 100 TPH raw feed, 30 TPH solid refuse in water and closure via thickeners and disc filters.

1. Install 160 ft thickener and disc filter

Thickener Cost - 160 ft @ $1750/ft		=	$280,000
Disc Filter		=	$200,000
	Total	=	$480,000

Annual Operating & Maintenance	Model D	Model E	Model F
Operating Personnel (3 hr/day)	5670	5670	5670
Equipment Maintenance	4938	10062	18400
Energy	20000	30000	60000
Insurance	1513	2888	4800
	$32121	$48620	$88870

Coal storage areas associated with preparation plants are normally designed to affect good drainage from a coal storage area, particularly clean coal storage areas. Treatment of drainage from coal storage areas is generally limited to solids removal with the drainage often used as make-up water in the preparation plant; or the drainage is combined with other drainage for treatment particularly if the drainage is acid or ferruginuous.

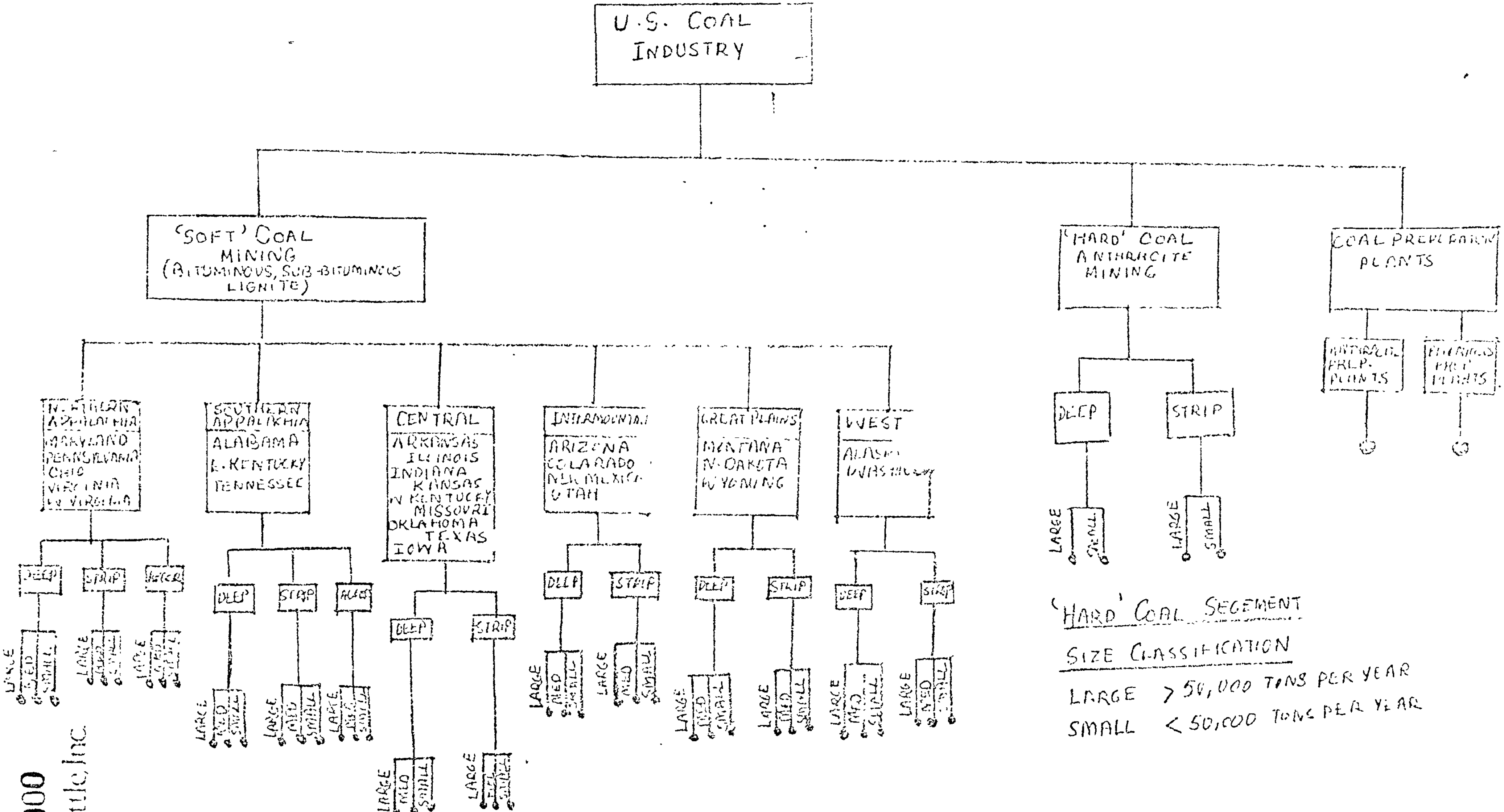
For those preparation plants which may elect to treat drainage from coal storage areas separate from other drainage the capital cost of treatment would depend primarily upon the size of the coal stock pile. This coal stock pile is related to the loading facilities at the preparation plant. For a loading facility designed for a 10,000 ton unit train, a 15,000 ton open stacker may be required with a ground area of less than 1 acre. A settling basin to treat the drainage from this coal stock pile would require a capital investment of less than $2000.

Refuse disposal areas are presently required by Public Law 91-173 to be so constructed that the air flow through the pile is restricted by compaction of the refuse; drainage through and off the refuse pile is required; and the surface around the refuse pile must be protected from erosion by drainage facilities. In many mines producing acid or ferruginuous mine drainage, the drainage from refuse piles is treated along with the mine drainage. Where refuse is not returned to the strip pits or underground, or the drainage is not treated with the mine drainage; new or additional treatment facilities may be required.

The size of these treatment facilities would be a function of the precipition in the area and the size of the refuse pile. Stage 2 and Stage 3 preparation plants reject varies from 15 to 35 percent of the raw coal mined. If a 20 percent reject is assumed for a mine producing 1 million ton per year with a 25 year life, approximately 6 and 1/2 million tons of refuse will be produced by the mines preparation plant during the life of the mine. This refuse would cover between 20 to 25 acres of surface. This area would require a settling basin of approximately 4 million gallon capacity. The capital cost for this settling facility is approximately $20,000. If the mine served by the preparation plant produced acid or ferruginuous mine drainage an additional $22,000 may be required for AMD treatment facilities.

Drainage from a preparation plants ancilliary area would probably be treated in the mine drainage treatment facility, or in the coal storage or refuse storage drainage treatment facility. To cover those preparation plants which might elect to treat preparation plant ancilliary area drainage separate from other drainages a survey was made of represented coal preparation plants in Pennsylvania, Ohio and West Virginia. These plants have a capacity of from 225 tons per hour to 800 tons per hour clean coal. These ranges in capacity do not reflect the total area included in the preparation plant ancilliary area. As example, a preparation plant with a 250 ton per hour capacity reported 10 acres affected; and a preparation plant with a larger capacity (800 tons per hour) reported a total area of less than 4 acres.

Assuming 10 acres included in the coal preparation plant ancilliary area; approximately $8,500 capital investment would be required for settling facilities. If an AMD treatment facility were required to treat acid drainage and addition $4,500 capital investment would be required.



'HARD' COAL SEGEMENT

SIZE CLASSIFICATION

LARGE > 50,000 TONS PER YEAR

SMALL < 50,000 TONS PER YEAR

'SOFT' COAL SEGEMENT

SIZE CLASSIFICATION

LARGE	> 200,000	TONS PER YEAR
MEDIUM	50,000-200,000	TONS PER YEAR
SMALL	< 50,000	TONS PER YEAR

FIGURE 1. INDUSTRY SEGMENTATION

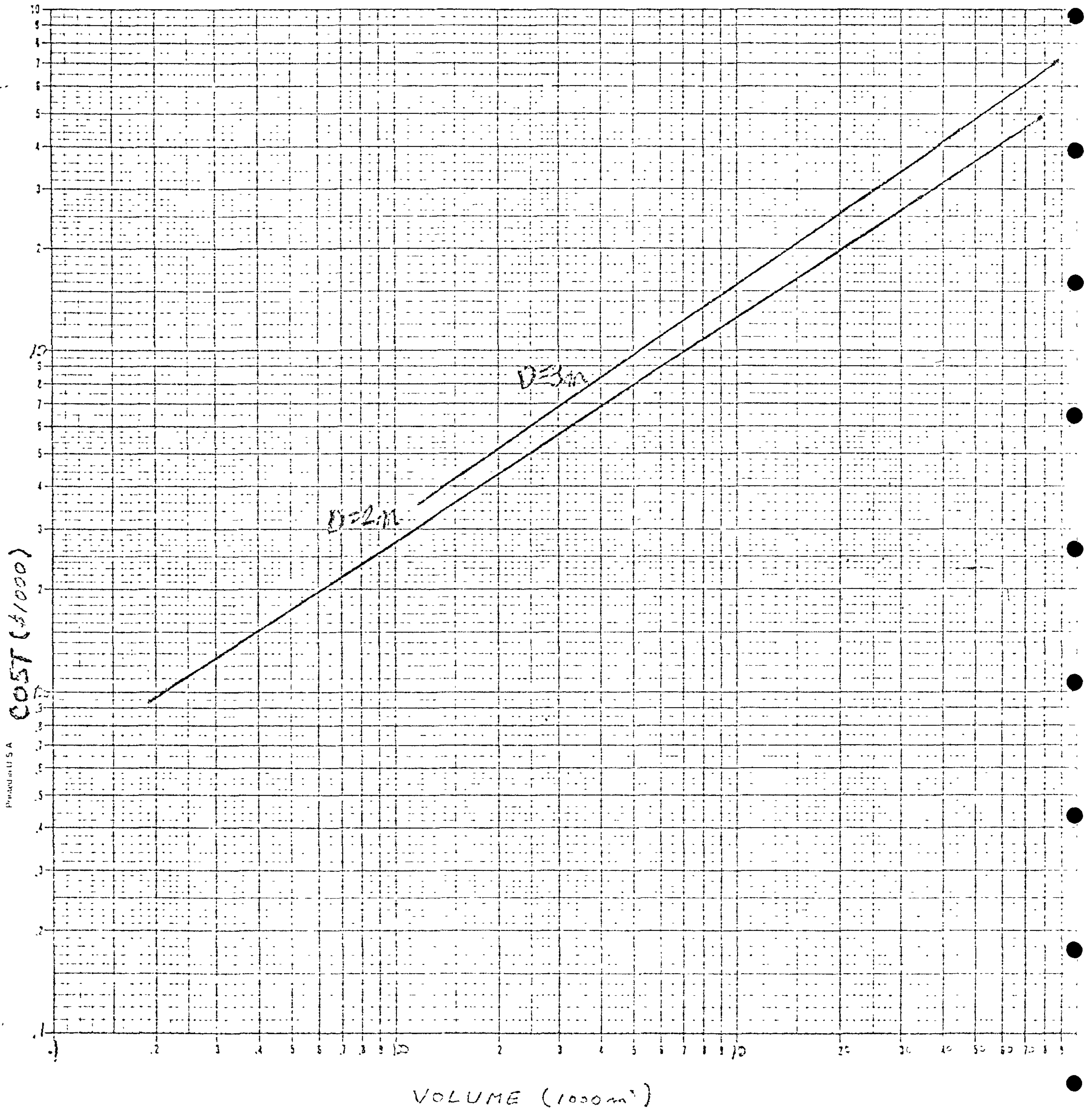


FIGURE 2 POND COST (D=DEPTH)

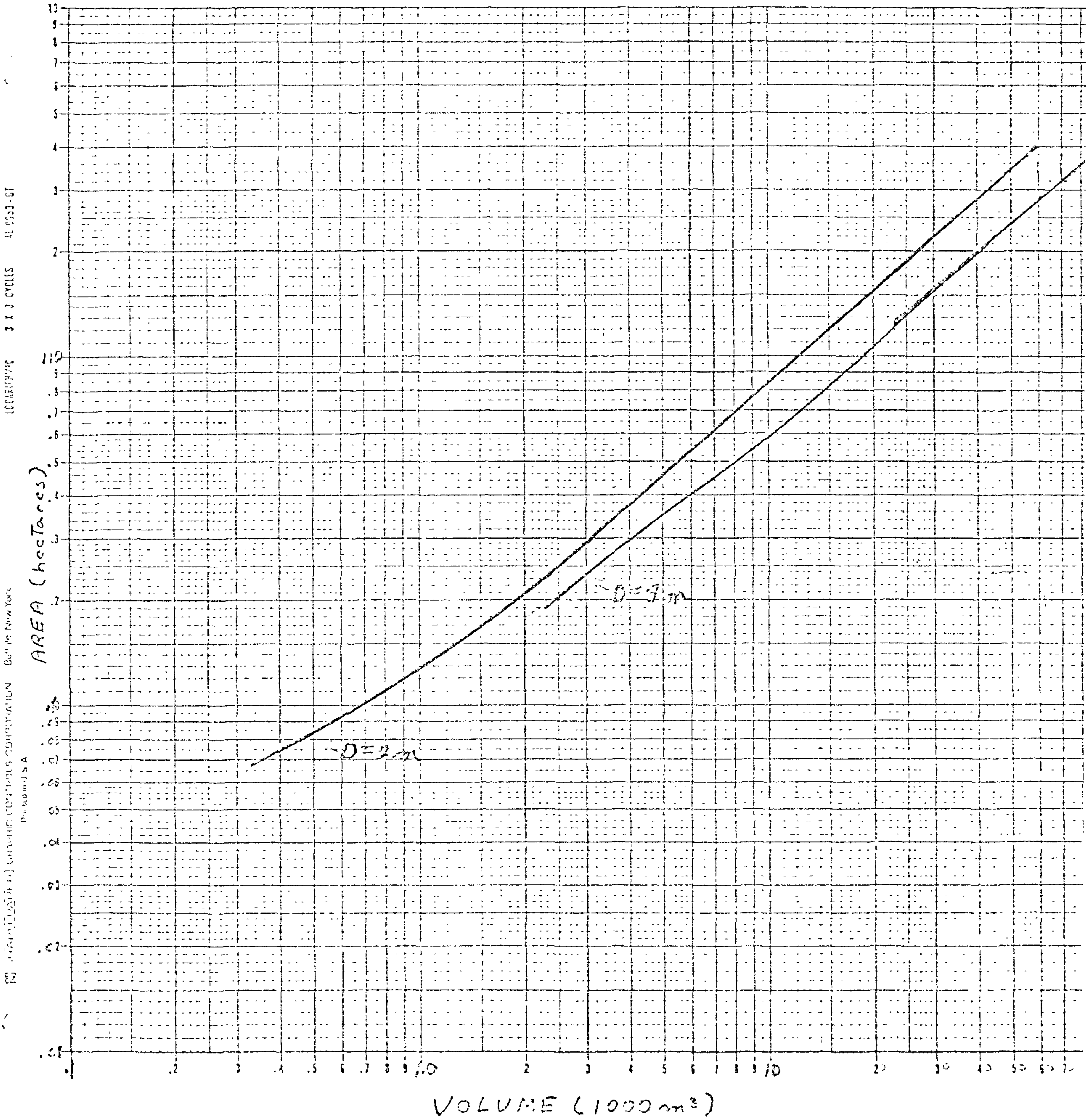


FIGURE 3 POND AREA

0000063

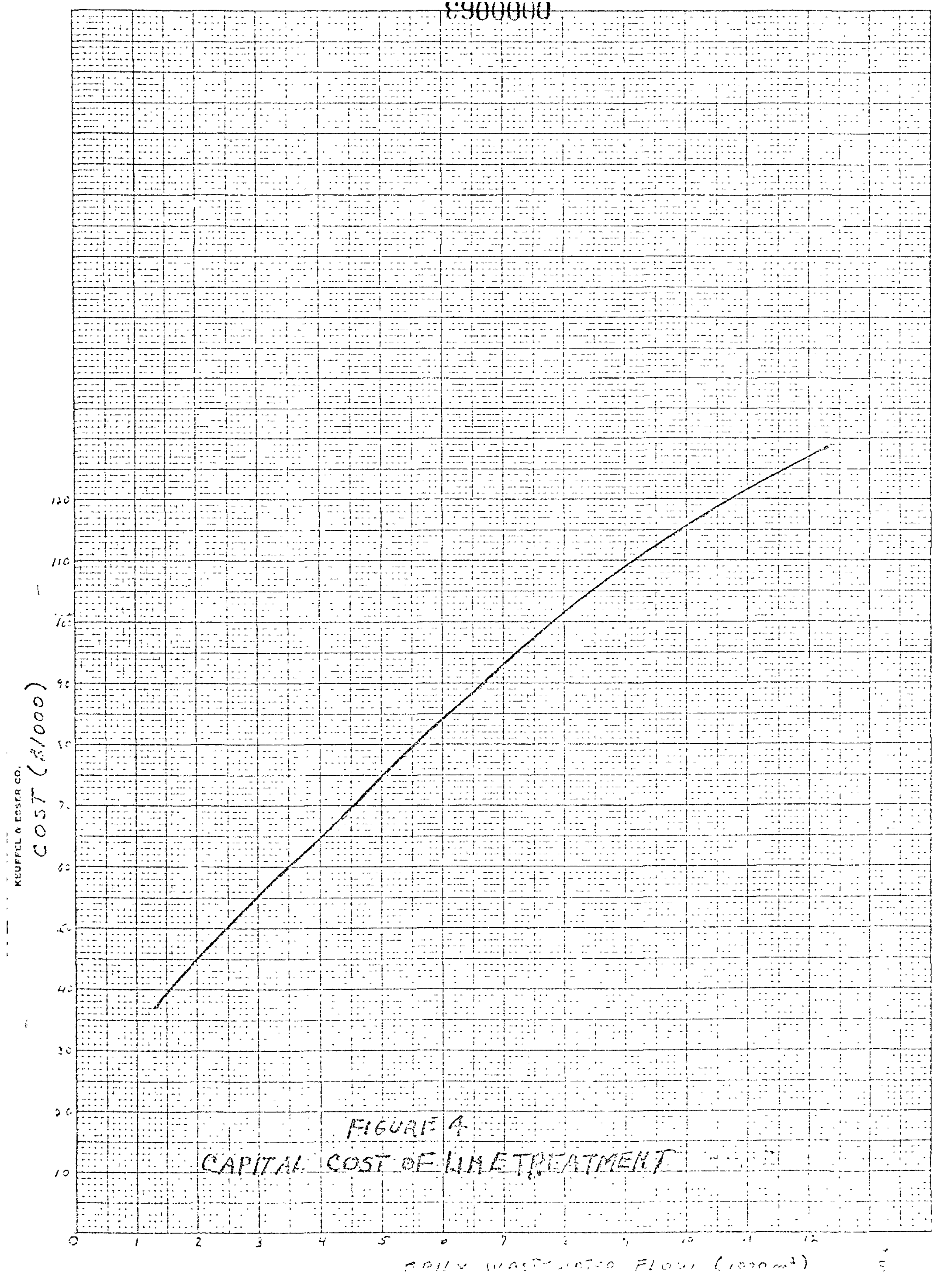


FIGURE 4
CAPITAL COST OF LIME TREATMENT

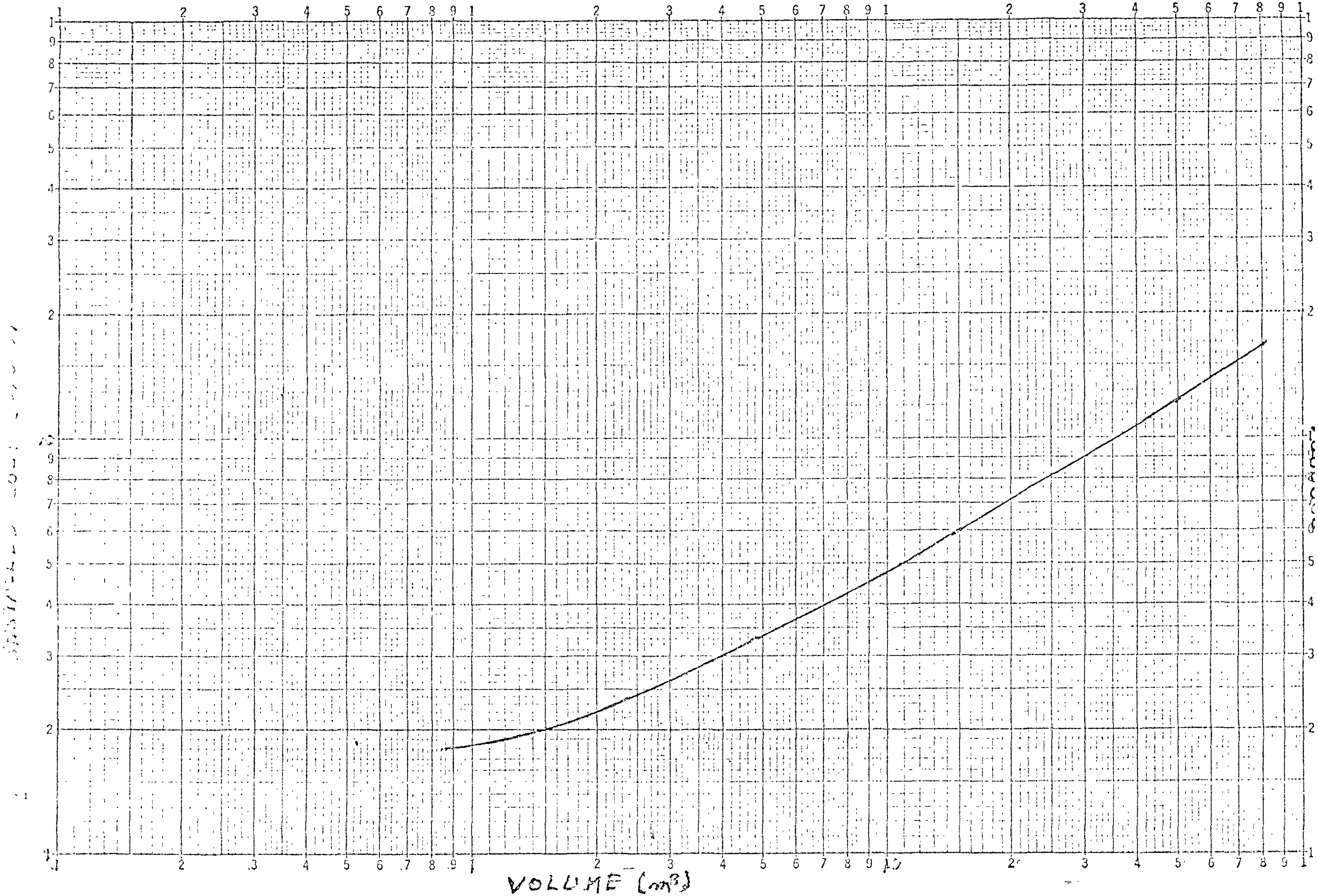


FIGURE 5 FLASH TANK COST

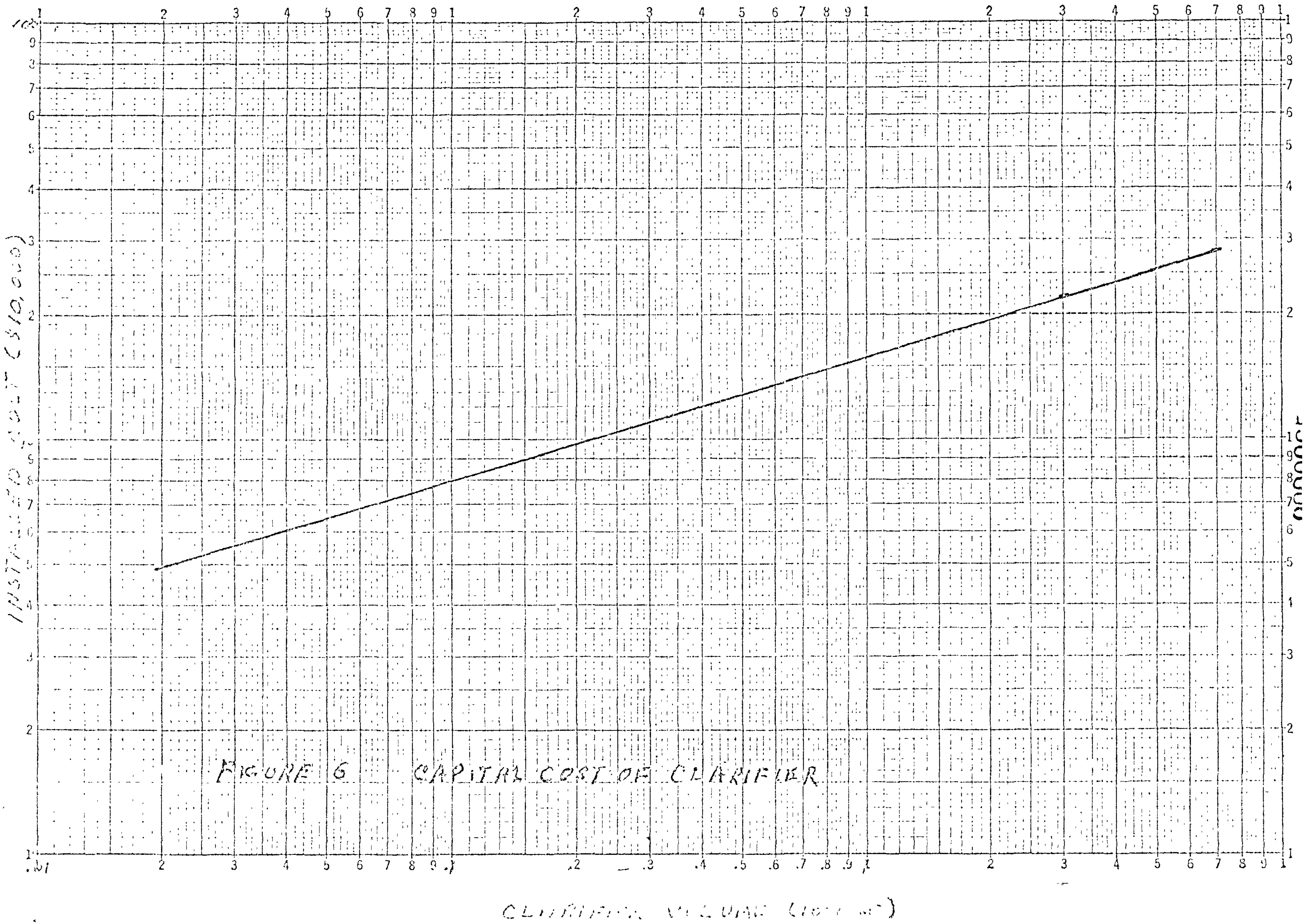


FIGURE 6 CAPITAL COST OF CLARIFIER

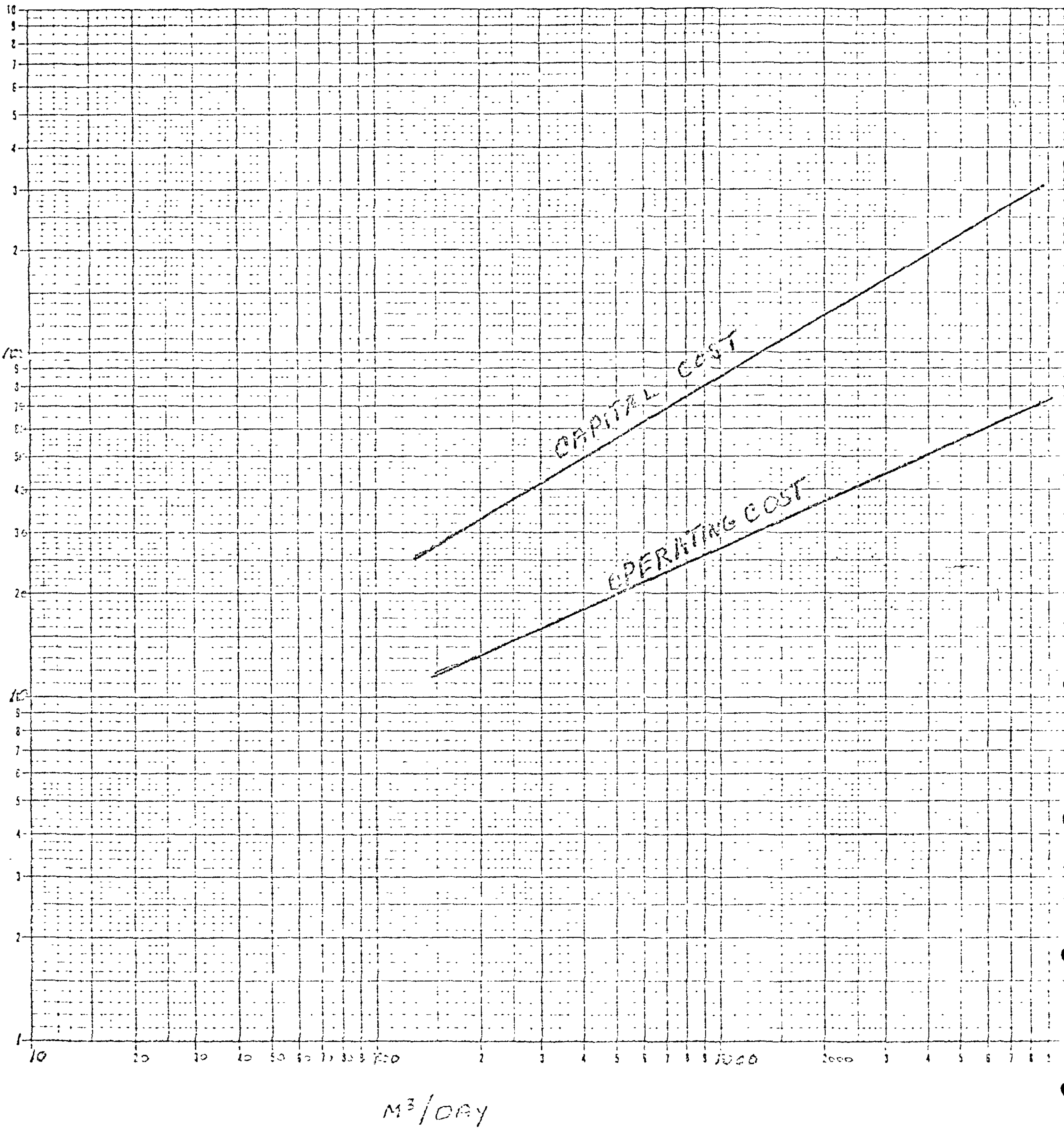


FIGURE 7 FILTER COST

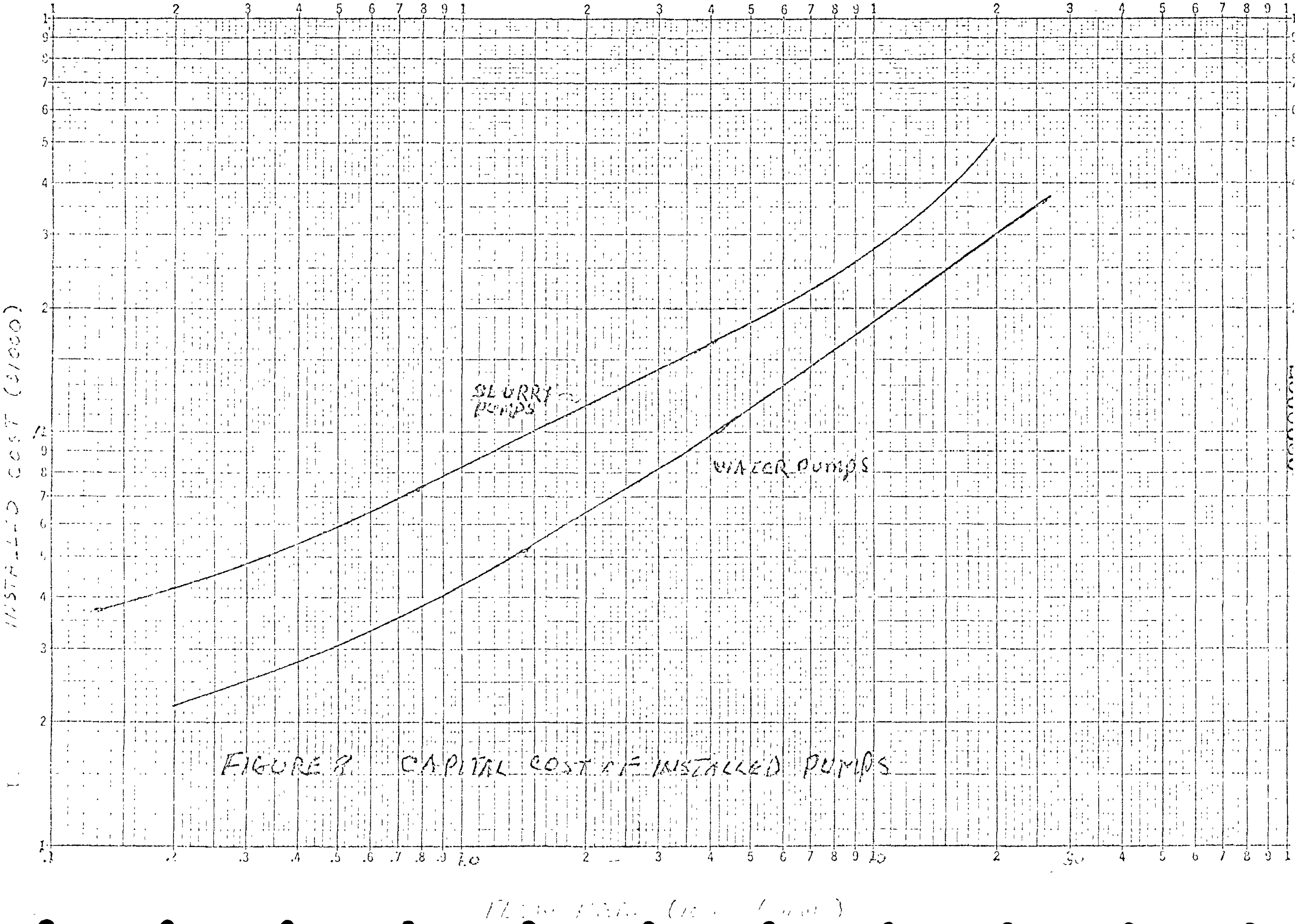
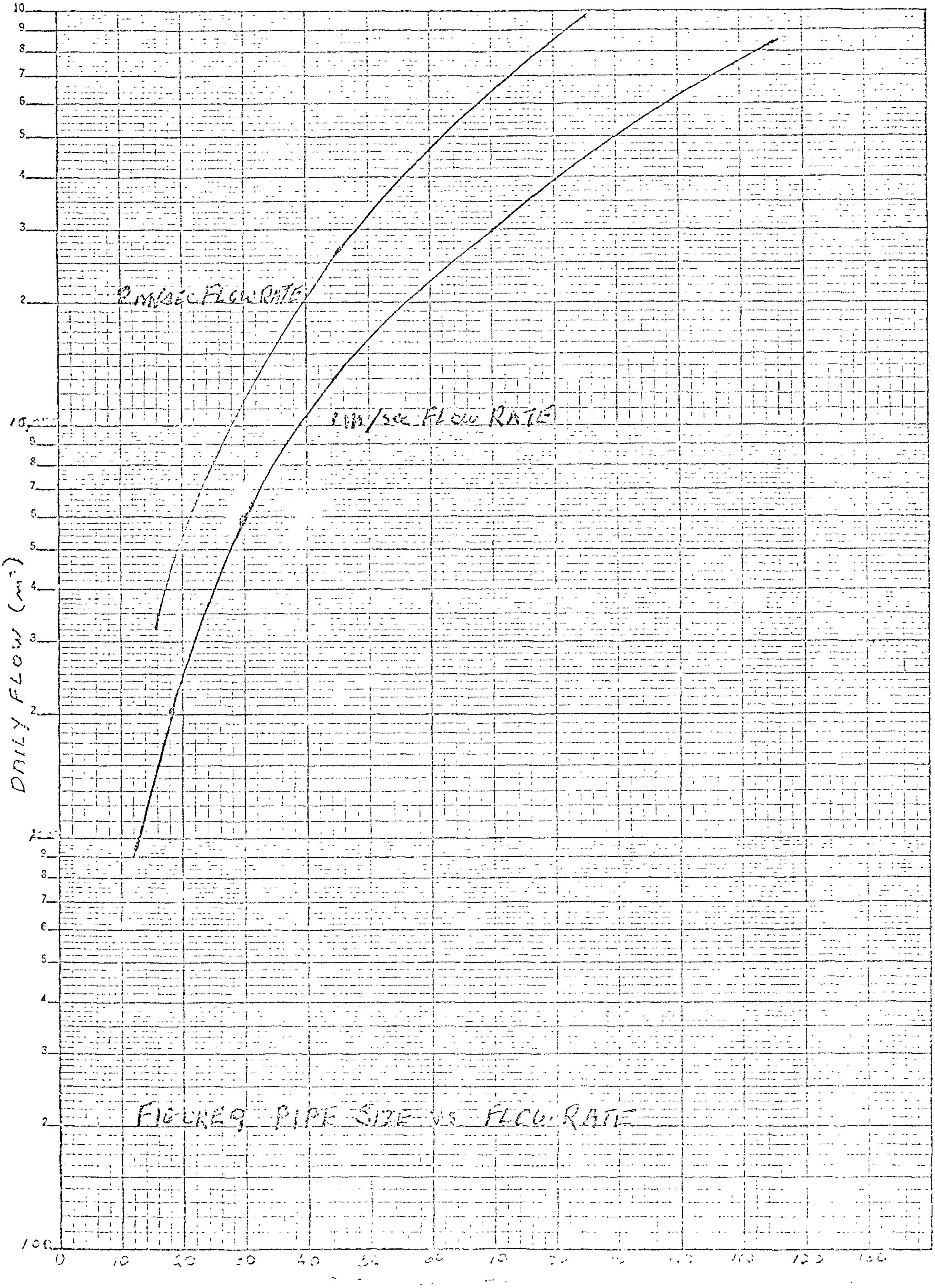


FIGURE 8 CAPITAL COST OF INSTALLED PUMPS



2 m/sec FLOW RATE
1 m/sec FLOW RATE
DAILY FLOW (m³)
10, 9, 8, 7, 6, 5, 4, 3, 2, 10,000, 9, 8, 7, 6, 5, 4, 3, 2, 1,000, 9, 8, 7, 6, 5, 4, 3, 2, 100
0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130
FIGURE 9 PIPE SIZE vs FLOW RATE

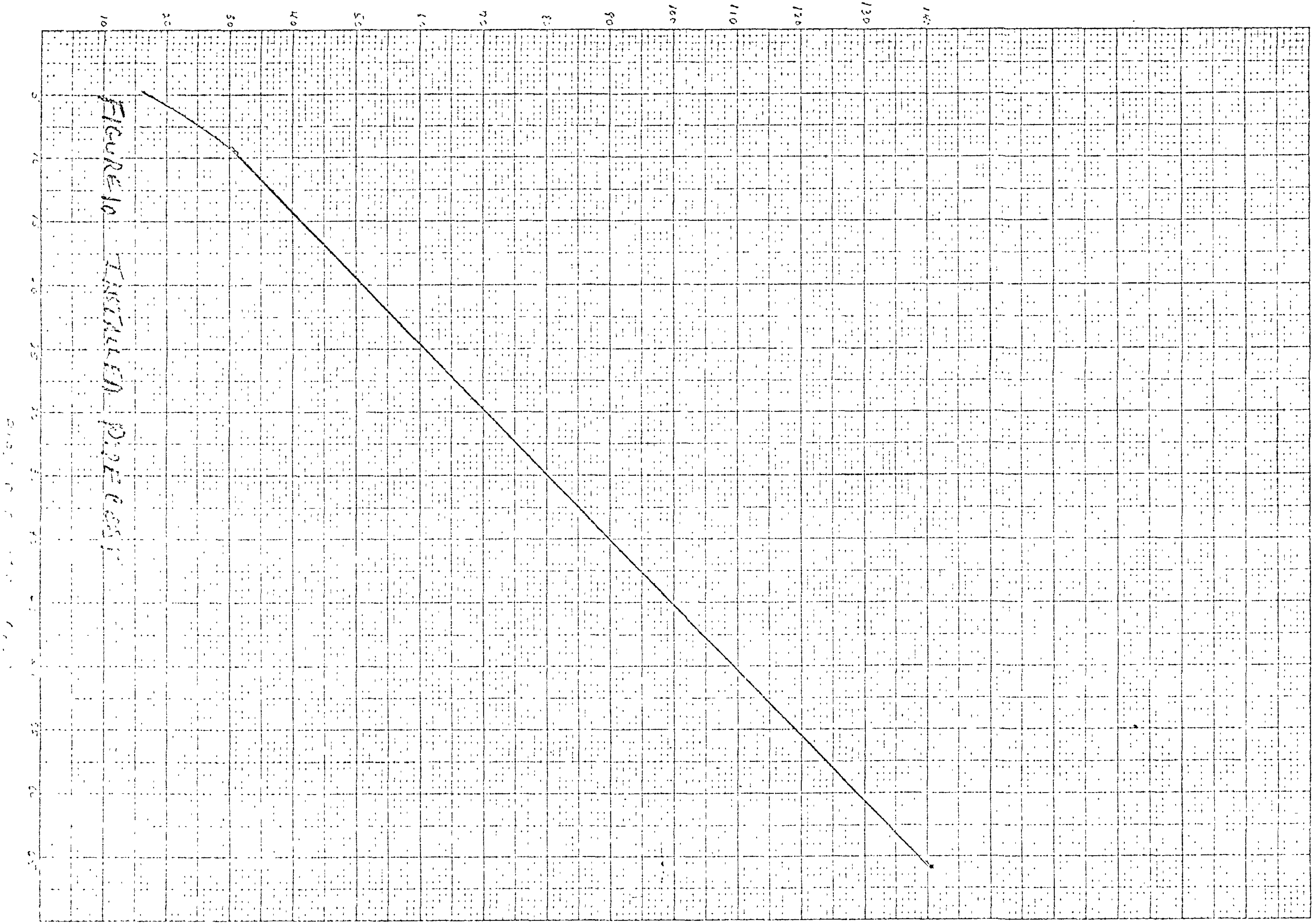

INSTALLED PIPE COST ($/m LENGHT)
FIGURE 10 INSTALLED PIPE COST

FIGURE II

COAL PREPARATION PLANT CLASSIFICATION

From 1974 Keystone Manual (1973 Data)

State	Stage 2	Stage 3
ALABAMA	20	3
COLORADO	2	1
ILLINOIS	29	4
INDIANA	10	0
KANSAS	2	0
KENTUCKY	55	11
MISSOURI	2	0
MONTANA	1	0
NEW MEXICO	0	1
OHIO	19	0
PA. (Anthracite)	23	2
PA. (Bituminous)	48	14
TENNESSEE	4	0
UTAH	4	1
VIRGINIA	30	10
WASHINGTON	1	0
WEST VIRGINIA	92	48
WYOMING	2	0
TOTAL	344	95
	78.4%	21.6%

REFERENCES

1. "Building Construction Cost Data - 1974", Robert Snow Means Company, Construction Consultants, Publisher.

2. Process Plant Construction Estimating and Engineering Standards, Vol. 4; prepared by International Construction Analysts, Downey, California.

3. Cost-Data Development and Economic Analysis, Supplement B-2 to "Development Document for Effluent Limitations Guidelines for the Metal Ore Mining and Dressing Industry", 18 April 1975.

4. Environmental Elements Corporation, Baltimore, Maryland.

5. Telcom with the DE LAVAL Separator Co., Poughkeepsie, N.Y., 22 January 1976.

6. Catalog of Denver Equipment Company, Denver, Colorado.

7. CSMRI Project J31120, Colorado School of Mines Research Institute, 15 October, 1974.

8. "Capital and Operating Costs of Pollution Control Equipment Modules - Vol. II - Data Manual", EPA-R5-73-0236, Socioeconomic Environmental Studies Series, Office of Research and Development, USEPA, July 1972.

9. "Development Document for Interim Final Effluent Limitations Guidelines for the Coal Mining Industry", EPA 440/1-75-057, October 1975.

10. "An Appraisal of Neutralization Processes to Treat Coal Mine Drainage", EPA-670/2-73-093, November 1973.