9.1. INFRASTRUCTURE--OPERATING COSTS

9.1.6. WASTEWATER TREATMENT

9.1.6.1. CLARIFICATION

This operation is a solids-contact clarifier used for water clarification by precipitation and/or coagulation. This cost curve is intended to remove suspended solids formed after final neutralization of out-of-pipe effluent. The curves include all principal costs associated with the operation of the unit. It does not include costs for sludge removal. The unit can selectively or simultaneously remove turbidity, color, organic matter, manganese, iron, alkalinity, taste, and odor.

The total cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a tank diameter (X), in meters. The curves are valid for tank diameters between 2.7 to 46.0 m (cross-sectional area ranging from 5.72 to 1,661 m^2), operating three shifts per day. Costs are based on an overflow rate of 0.377 $(L/s)/m^2$.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 38.931(X)^{0.119}$
The operating labor costs are distributed as follows:

Direct labor...............	100%
Maintenance labor..........	0%

The labor costs consist of the following typical range of personnel:

	Small Dia (5.72 to 75 meters)	Large Dia (75 to 1,661 meters)	Av salary per hour (base rate)
Laborer....................	60%	54%	$13.66
Laboratory.................	40%	46%	15.89

The average labor cost per worker-hour is $14.43 (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 1.083(X)^{0.633}$
The supply curve consists of electric power and maintenance supplies.

	Small Dia (5.72 to 75 meters)	Large Dia (75 to 1,661 meters)
Electric...................	60%	34%
Maintenance................	40%	66%

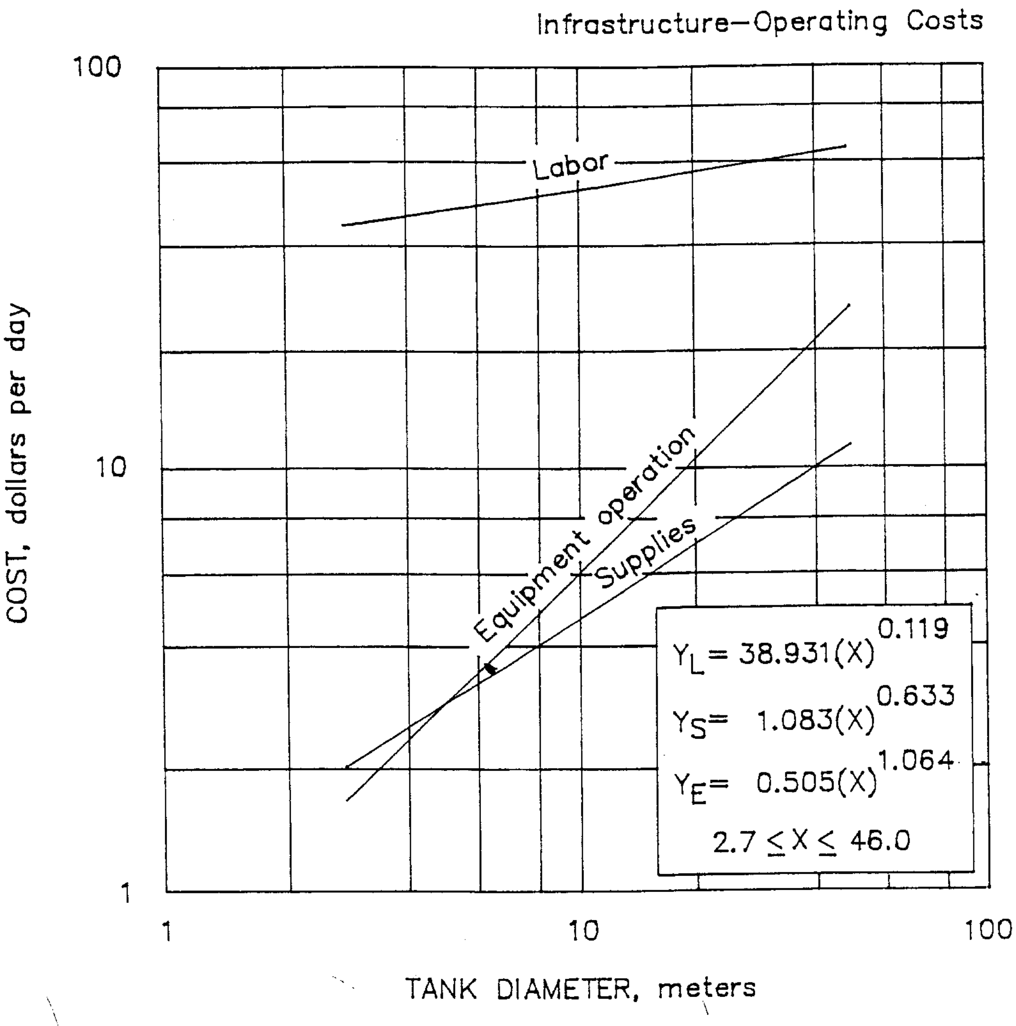
(E) Equipment Operating Cost $(Y_E) = 0.505(X)^{1.064}$
The equipment operating cost consists of 100% for repair parts and covers the daily operation cost for all clarification equipment.

ADJUSTMENT FACTORS

Flocculant Factor Normally, additional flocculants are not needed in the mine waste water treatment after neutralization. However, if polymers are needed or used, add the following factor to the supply cost obtained from the curve:

Supply factor $(F_S) = 0.334(D)^{1.812}$
where D = clarifier tank diameter, in meters.

The polymer is based on a standard dosage of 1.5 mg/L influent and an average polymer cost of $2.10/lb.



9.1.6.1. Wastewater treatment
CLARIFICATION

9.1. INFRASTRUCTURE--OPERATING COSTS

9.1.6. WASTE WATER TREATMENT

9.1.6.2. NEUTRALIZATION

The Environmental Protection Agency's publication EPA-600/2-82-00/d "Treatability Manual, Vol. IV, Cost Estimating," April 1983, was the source of cost development. One is referred to this manual if further detail in neutralization costs is needed. Additionally, other waste water treatment methods are costed in this EPA manual.

The operating cost curves are used when neutralization of waste water effluent (out-of-pipe) is required. The basic design variable is waste water flow. It is assumed that flow equalization is provided by a tailings pond. The costs apply to the neutralization of either acidic or basic waste water streams originating from mine, mill, or combined mine and mill after it flows out-of-pipe from the central impoundment pond. In most mining operations further waste water treatment costs are not required. The system consists of chemical addition and two-stage neutralization tanks. It is assumed that pH and suspended-dissolved solid content of influent to the system will be unknown at this level of costing. Basis of design uses a standard dosage of 100 mg/L lime and 100 mg/L acid to achieve a pH of 7.0 over a pH range of 6.5 to 8.0.

BASE CURVES

The total cost is the sum of three cost curves (labor, supplies, and equipment operation) based on the waste water flow rate (X), in liters of effluent to be treated per second per day. The curves are valid for operations between 0.001 to 876 L/s (22.8 gal/d to 20 million gal/d), operating three shifts per day. The curves include all costs associated with the operation of a neutralization system such as labor, lime, acid, power, service water, and laboratory expenses.

(L) Labor Operating Costs $(Y_L) = 84.85(X)^{0.000}$
The operating labor costs are distributed as follows:

Direct labor...............	100%
Maintenance labor..........	0%

The labor costs consist of the following typical range of personnel:

		Av salary per hour (base rate)
Laborer....................	89%	$15.80
Laboratory.................	11%	15.80

The average labor cost per worker-hour is $15.80 (including burden and average shift differential).

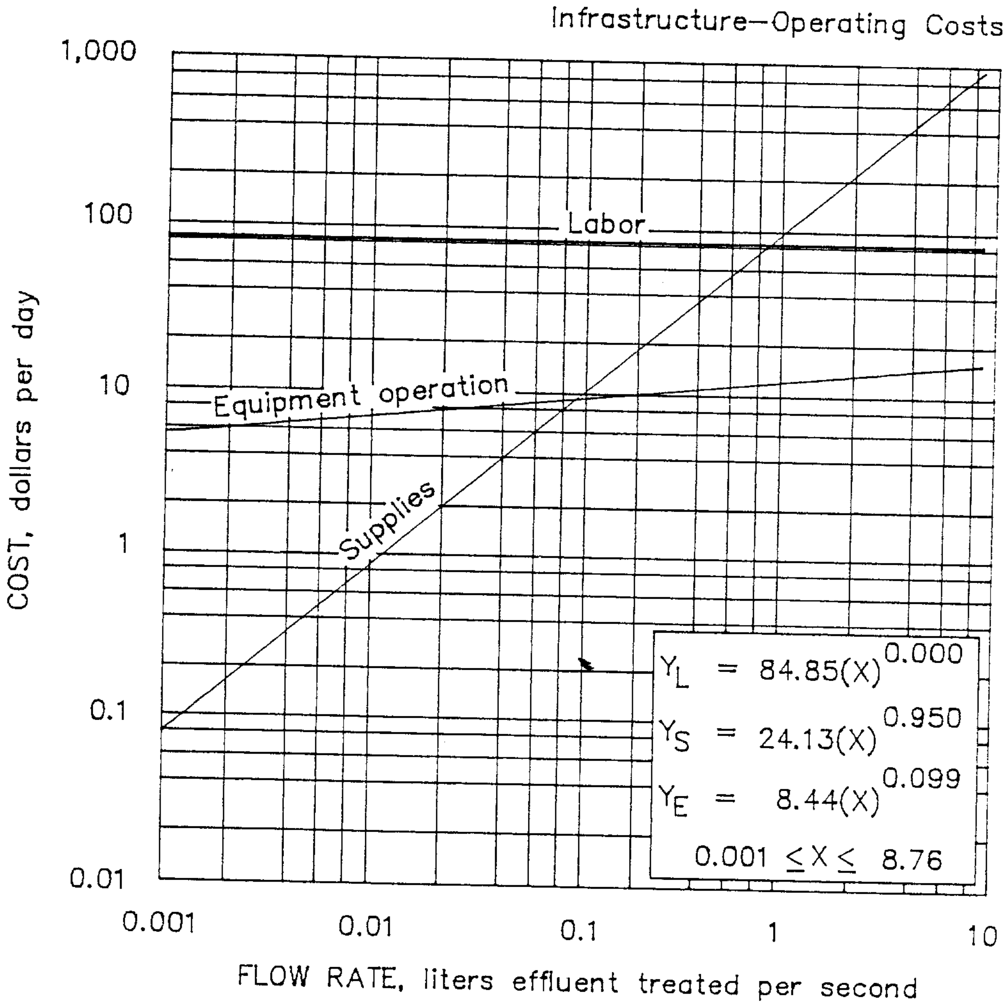
(S) Supply Operating Costs $(Y_{S\ 0.001\text{-}8.76\ L/s\ RATE}) = 24.13(X)^{0.950}$
$(Y_{S\ 8.76\text{-}876\ L/s\ RATE}) = 21.282(X)^{0.997}$

The supply costs consists of electric power, water, and chemicals and lime in the following proportions:

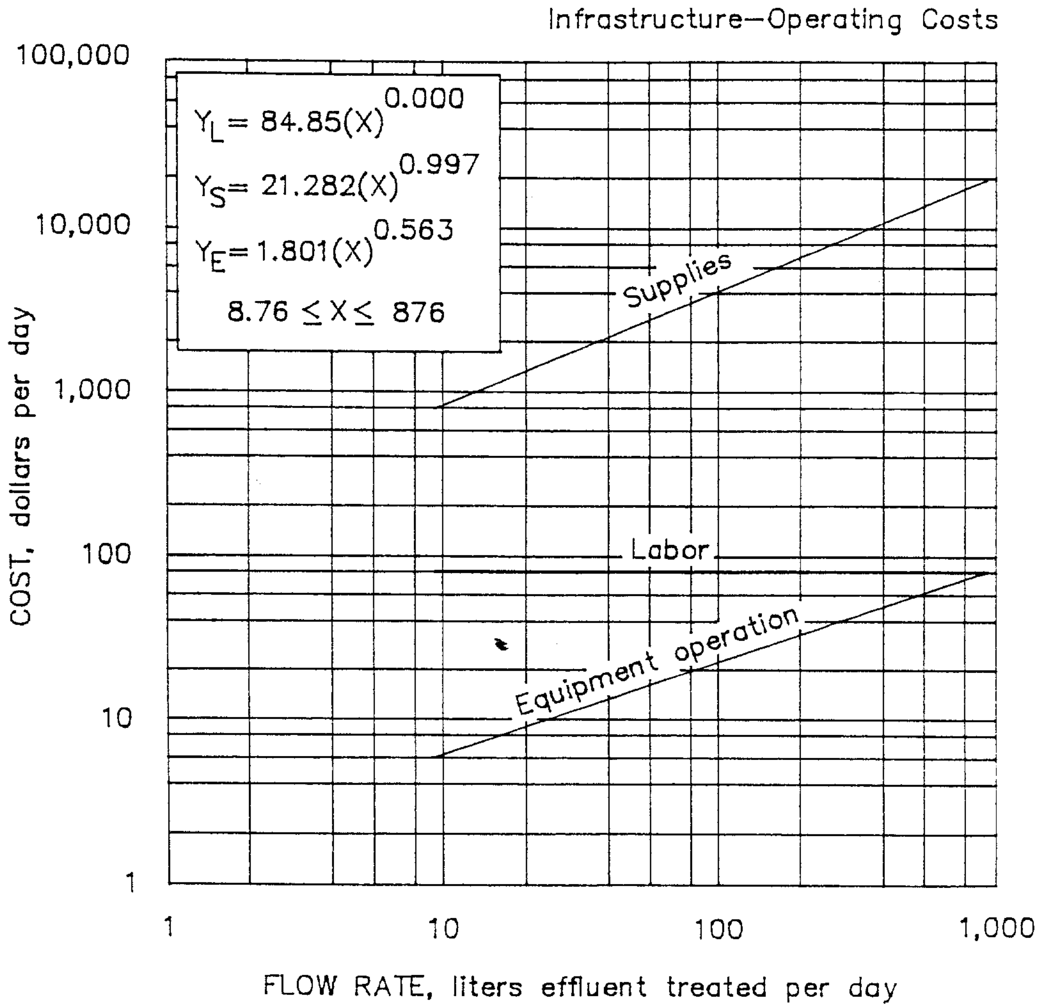
	Small (0.001 to 8.76 L/s)	Large (8.76 to 876 L/s)
Electric power.............	3%	2%
Water......................	80%	89%
Chemicals and lime.........	17%	9%

(E) Equipment Operating Costs $(Y_{E\ 0.001\text{-}8.76\ L/s\ RATE}) = 8.44(X)^{0.099}$
$(Y_{E\ 8.76\text{-}876\ L/s\ RATE}) = 1.801(X)^{0.563}$

The equipment operating cost consists of 100% for repair parts and covers the daily operation cost for all neutralization equipment.



9.1.6.2.a Wastewater treatment
NEUTRALIZATION



9.1.6.2.b Wastewater treatment
NEUTRALIZATION

Table A-1 - Thickener applications

Thickener application	Unit area, m^2/mtpd
Alumina, Bayer process:	
Red mud monohydrate ore:	
Primary	5.1 - 6.7
Secondary	3.1 - 4.1
Other washing	2.0 - 3.1
Red mud trihydrate ore:	
Primary	2.0 - 3.1
Washers	1.0 - 1.5
Final	1.0 - 1.5
Hydrate, fine or seed	1.2 - 3.1
Asbestos	0.7 - 1.5
Cement:	
Wet process	1.5 - 2.6
Kiln dust	0.3 - 1.8
Cobalt-nickel sulfides	1.0 - 2.0
Copper:	
Concentrate	0.2 - 2.0
Tailings	0.4 - 1.0
$(NH_4)_2CO_3$ leach residue	0.5 - 1.0
Cyanide slimes	0.5 - 1.3
Flue dust, power plant	0.2 - 1.0
Gold tellurides	1.3
Heavy media ferrosilicon	1.3
Iron ore:	
Fine concentrate (65%-90%, -325 mesh)	0.04- 0.08
Coarse concentrate (45%-65%, -325 mesh)	0.02- 0.05
Tailings[1]	0.43
Lead concentrates	0.7 - 1.8
Lime mud:	
Acetylene generator	1.5 - 3.4
Lime-soda process	1.5 - 2.6
Magnesium hydroxide:	
From brine	6.1 -10.2
From sea water	20.5 -41.0
Manganese:	
Leach residue	10.2 -20.5
Sulfide precipitate	41.0 -61.4
Molybdenum:	
Concentrate	1.0 - 1.5
Scavenger concentrate	0.5
Sulfide	0.2 - 0.5
Slimes	1.0 - 1.5
Nickel:	
$(NH_4)_2CO_3$ leach residue	0.5 - 3.1
Acid leach residue	0.8
Sulfide concentrate	2.6
Pickle liquor and rinse water	3.6 - 5.1
Potash slimes	4.1 -12.8
Silver concentrate	1.3
Tin concentrate	1.3
Uranium:	
Acid-leached ore residue	0.2 - 1.0
Alkaline-leached ore residue	1.0
Precipitate	5.1 -12.8
Zinc concentrate	0.3 - 0.7

[1]Hematites at 20% feed are limited by overflow rate.

Table A-2 - Loose density factors

Commodity	kg/m^3	lb/ft^3	Factor	Commodity	kg/m^3	lb/ft^3	Factor
Phosphate......	753	47	1.12	Copper Ore[1]...	1,859	116	0.96
Coal...........	801	50	1.10	Iron Ore			
Bauxite........	1,314	82	1.02	30% Fe......	2,052	128	0.95
Limestone......	1,554	97	1.00	50% Fe......	2,340	146	0.93
Dolomite.......	1,554	97	1.00	60% Fe......	2,597	162	0.90
Granite........	1,603	100	0.99				

[1]sulphides up to 10% Cu

NOTE--To convert pounds per cubic foot (lb/ft^3) to kilograms per cubic meter (kg/m^3) multiply by 16.028 (lb/ft^3 X 16.028 = kg/m^3).

Table A-3. - Major slurry pipelines and their characteristics

Material	Pump Type	Length, km	Diam., mm	Velocity, m/sec	Pressure, kg/cm^2	S.G.	Particle Size, mm	% Solids	Flow, L/min
bauxite........	plunger	73	200	2.1	NA	2.3	0.4	55	3,785
beach sand.....	centrifugal	3	508	4.6	21	2.70	2.3	35	52,990
coal...........	piston	174	273	1.5	86	1.40	1.2	52	6,245
	piston	440	457	1.7	126	1.40	2.3	50	17,030
	piston	1,667	965	1.7	NA	1.40	2.3	50	64,350
copper conc....	plunger	27	168	1.7	141	4.3	0.2	65	1,820
	plunger	111	114	1.5	162	4.3	0.15	65	520
	plunger	61	143	1.8	148	4.30	0.15	65	720
gilsonite......	plunger	116	168	1.2	144	1.05	4.7	46	1,250
gold tailings..	centrifugal	11	200	1.4	80	2.7	0.1	45	3,400
gold quartz....	Mars pump	mine hoist	200	1.4	80	2.7	0.6	50	2,200
hematite.......	plunger	403	508	1.7	141	4.9	0.07	60	18,930
	plunger	48	508	1.7	NA	4.9	0.07	60	18,930
iron sands.....	centrifugal	8	219	4.9	33	4.9	0.6	60	8,710
limestone......	piston	27	194	1.8	90	2.70	0.6	60	3,100
	piston	92	273	1.4	148	2.70	0.4	61	3,260
	piston	10	219	1.5	68	2.70	0.3	60	2,350
magnetite......	plunger	86	244	1.7	141	4.9	0.15	60	4,390
	gravity	48	219	1.8	4	4.9	0.10	60	4,160
	plunger	26	273	1.8	1,230	4.9	0.10	60	6,430
	plunger	32	219	1.8	101	4.9	0.07	60	4,160
phosphate......	centrifugal	6	457	4.2	14	3.2	1.2	40	37,850
	plunger	113	244	2.1	1,900	0.3	0.3	65	7,950

NA Not available

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