3.2. SURFACE MINING - OPERATING COST

3.2.5. GENERAL EXPENSES
ADMINISTRATIVE COSTS

These costs include expenses incurred in the everyday operation of the plant and do not include general company overhead. The total daily cost is the sum of three cost curves (labor, supplies, and equipment operation) based on a production rate (X), in metric tons ore and waste per day. The curves are valid for operations between 1,000 to 400,000 mtpd, operating three shifts per day.

3.2.5.1. ADMINISTRATIVE SALARIES AND WAGES

The general expense curve for administrative salaries and wages for surface mines is intended to cover the supervision and various other administrative functions required for mines of varying sizes. The number of administrative (salaried) employees varies from 4 persons working a single shift in the smaller mines to about 100 in the larger mines. Note that the curve is based on the total tonnage moved in a single day, including waste and ore, and costs are per operating day of the mine.

BASE CURVE

(L) Administrative Salaries and Wages $(Y_L) = 7.683(X)^{0.606}$

The direct labor costs (excluding equipment repair labor) consist of the following typical range of personnel:

	Small (1,000 to 40,000 mtpd)	Large (40,000 to 400,000 mtpd)	Av salary per hour (base rate)
Supervision (mine and maintenance).....	44%	41%	$23.13
Clerical (secretarial and accounting).....	18%	20%	13.69
Engineering (mining, geological).....	21%	21%	18.10
Assaying and metallurgical.....	7%	8%	14.43
Purchasing and warehousing.....	7%	6%	14.12
Safety, first aid, security.....	3%	4%	18.85

The average wage for labor is $17.87 per worker-hour (including burden and average shift differential).

Selected median annual salaries are as follows (without burden):

Mine superintendent	$51,600
General mine foreman	34,800
General maintenance foreman	33,600
Chief electrician	40,900
Chief engineer	49,000
Engineers and geologists	35,900
Chief accountant	42,000
Safety director	35,900
Director of purchases	42,000
Secretaries, clerks	13,900

ADJUSTMENT FACTOR

Burden Factor If the burden is other than 32%, multiply the cost obtained from the curve by the following factor:

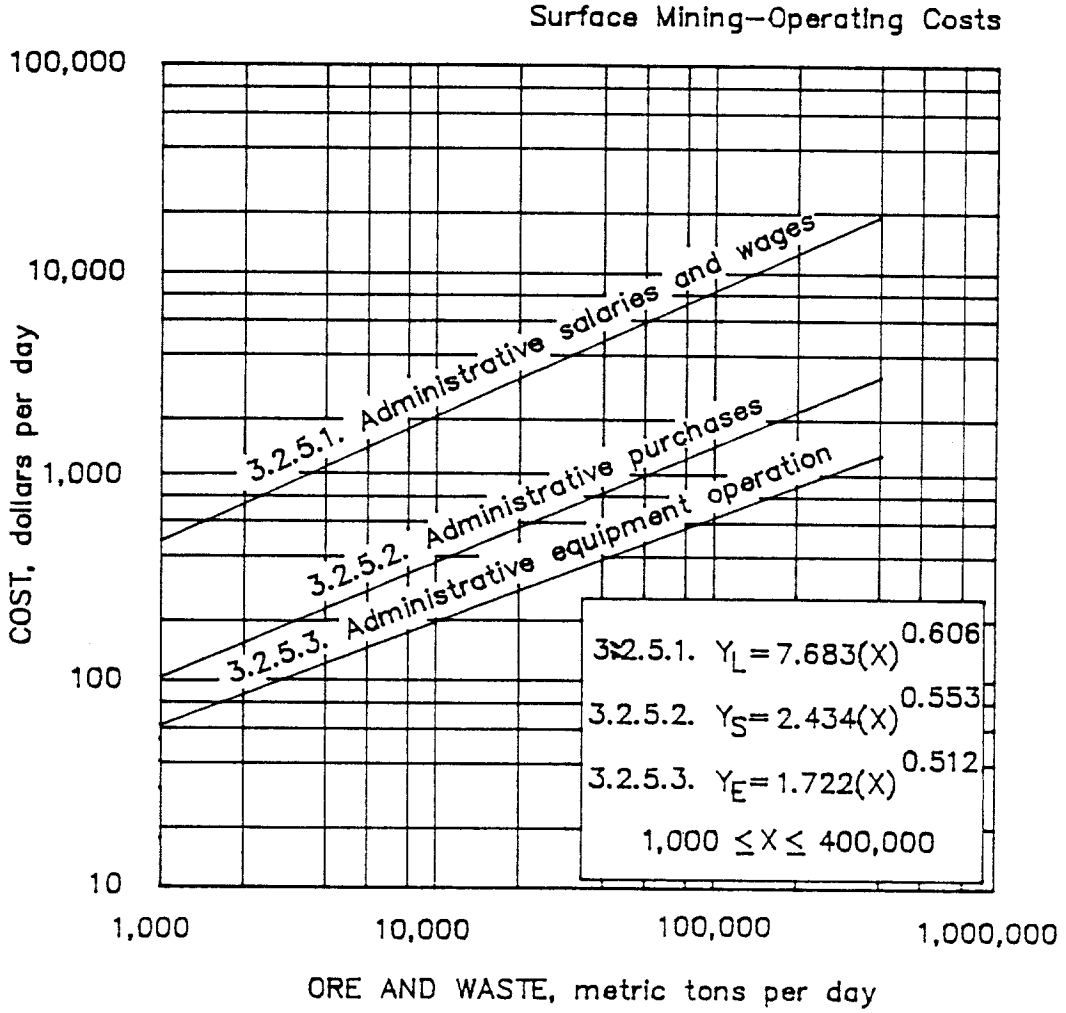
Burden factor $(F_L) = [(1+B)/(1.32)]$
where B = the known burden, expressed as a decimal.

3.2.5.2. ADMINISTRATIVE PURCHASES

(S) Administrative Purchases $(Y_S) = 2.434(X)^{0.553}$
The curve for administrative purchases includes 25% for laboratory supplies; 23% for miscellaneous fees, dues, donations, and professional and computer services when applicable; 21% for supplies for office, engineering, safety, and first aid; 12% for travel and entertainment; 11% for expenses for telephone, telegraph, and postage; 8% for small tools.

3.2.5.3. ADMINISTRATIVE EQUIPMENT OPERATION

(E) Administrative Equipment Operation $(Y_E) = 1.722(X)^{0.512}$
This curve includes administrative equipment operation expense for vehicles such as sedans, pickups, forklifts, and flatbed trucks. The equipment operating cost consists of approximately 72% for fuel, 13% for lubrication, 10% for repair parts, and 5% for tires. The average equipment usage is 26% of its available time.



3.2.5.1.—3. General expenses
ADMINISTRATIVE SALARIES AND WAGES
ADMINISTRATIVE PURCHASES
ADMINISTRATIVE EQUIPMENT OPERATION

3.2. SURFACE MINING--OPERATING COSTS

3.2.6. INFRASTRUCTURE

3.2.6.3. TOWNSITE-CAMPSITE

CAMPSITE

Where conditions such as remote location or seasonal operation require a single-status campsite (i.e., room, board, and recreation facility), the daily operating cost should be derived from the following base cost curve. Today a caterer is usually employed to provide board, housekeeping, and recreation supervision. Heat, lights, garbage disposal, and plant maintenance are usually provided by the owner.

BASE CURVE

The total daily cost is derived from the supply curve based on the total number of persons who occupy the campsite (X). The curve is valid for campsites occupied by 20 to 1,000 persons. All persons receive both room and board.

(S) Supply Operating Cost $(Y_S) = 37.143(X)^{0.897}$

	Small (20 to 450 persons)	Large (450 to 1,000 persons)
Board	61.5%	59.0%
Housekeeping and recreation	23.9%	23.0%
Heat	6.4%	9.0%
Light	2.4%	3.4%
Maintenance	5.8%	5.6%

If the number of persons requiring board varies from the number of persons requiring room, use the following equation:

(S) Supply Operating Cost $(Y_S) = [37.143(X)^{0.897}][0.60(B/R)+0.40(R)]$

where B = number of persons requiring board only,
and R = number of persons requiring room only.

These curves are based on a caterer who provides all necessary personnel for food service, housekeeping, distribution and collection of mail, monitoring recreation, etc., and all necessary supplies, such as pots, pans, dishes, silverware, sheets, pillow cases, blankets, waste cans, recreation supplies, janitorial supplies, food, etc. The evaluator must add the cost for local, State, or Federal taxes where required.

ADJUSTMENT FACTORS

Owner-Operator Factor When the facility is owner-operated rather than catered, multiply the cost obtained from the curve by the following factor:

Owner-operator factor $(F_O) = 0.93$

Diesel Power Factor When the electric power is provided by a diesel-electric system rather than a power line grid, multiply the cost obtained from the curve by the following factor:

Diesel power factor $(F_D) = 1.04$

TRAILER COURT

Where conditions such as remote location or lack of available housing require installation of a family trailer court complete with utilities, laundromat, recreation facilities, blacktop driveway, and possibly swimming pool, the daily operating cost should be derived from the following two curves. The total daily cost is derived from the supply curve, based on the total number of trailer spaces, (X), required. The curve is valid for trailer courts with 20 to 1,000 units.

BASE CURVE

The curves are based on trailer and facility maintenance, insurance, casualty insurance, supervisory and worker wages, plus overhead, heat, and lights.

(S) Supply Operating Cost $(Y_{S\ FREE}) = 49.514(X)^{0.590}$
Company-owned mobile homes, spaces, and facilities where the trailers and spaces are free to supervisors and workers. The company pays all operating costs on the facility.

(S) Supply Operating Cost $(Y_{S\ RENTED}) = 1{,}676.049(X)^{-0.716}$
Company-owned mobile homes, spaces, and facilities where the trailers and spaces are rented to supervisors and workers. The company pays for any loss on the facility.

ADJUSTMENT FACTORS

Swimming Pool Factor When the trailer court does not provide a swimming pool, multiply the curve $(Y_{S\ FREE})$ by the following factor:

Swimming pool factor $(F_{P\ FREE}) = 0.82$

When the spaces and trailers are rented and the trailer court has 52 or more units it will show a profit. If there are less than 52 units multiply the curve $(Y_{S\ RENTED})$, by the following factor:

Swimming pool factor $(F_{P\ RENTED}) = 0.05$

Trailer Space Rental Factor When the occupants rent trailer space for their own trailers, multiply the curve $(Y_{S\ FREE})$ by the following factor:

Trailer space rental factor $(F_{R\ FREE}) = 0.36$

PERMANENT HOUSING

Company totally owned and operated townsites are decreasing in number because of their high cost and persistent social problems. The trend seem to be toward small family housing facilities combined with an existing nearby city.

Large townsite permanent housing:

Today, the military appears to be the greatest user of this type of facility. The Air Force provides housing to its officers and enlisted personnel. The Government pays for housing and facility maintenance, all utilities, supervisor, and worker labor, etc. The average operating costs for 1983 were:

McCord Air Base - 993 units: $6.66 per day per unit
Fairchild Air Base - 1,580 units: $6.93 per day per unit

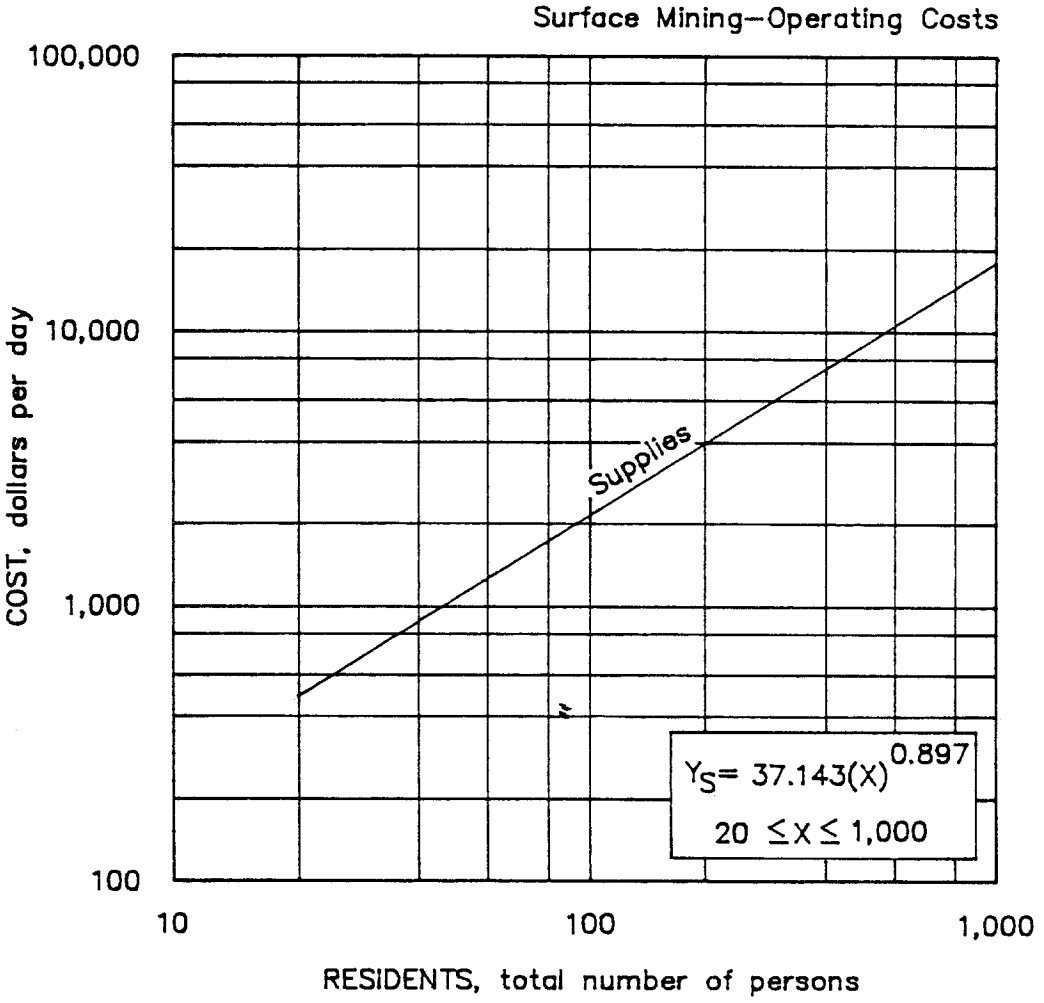
Small townsite permanent housing:

These facilities are generally rented to their occupants at a modest fee with the company paying for the general maintenance, insurance, and taxes. Rent is applied to the capital investment. A new housing facility (175 family units) in the western U.S., cost the company $0.98 per day per unit to maintain.

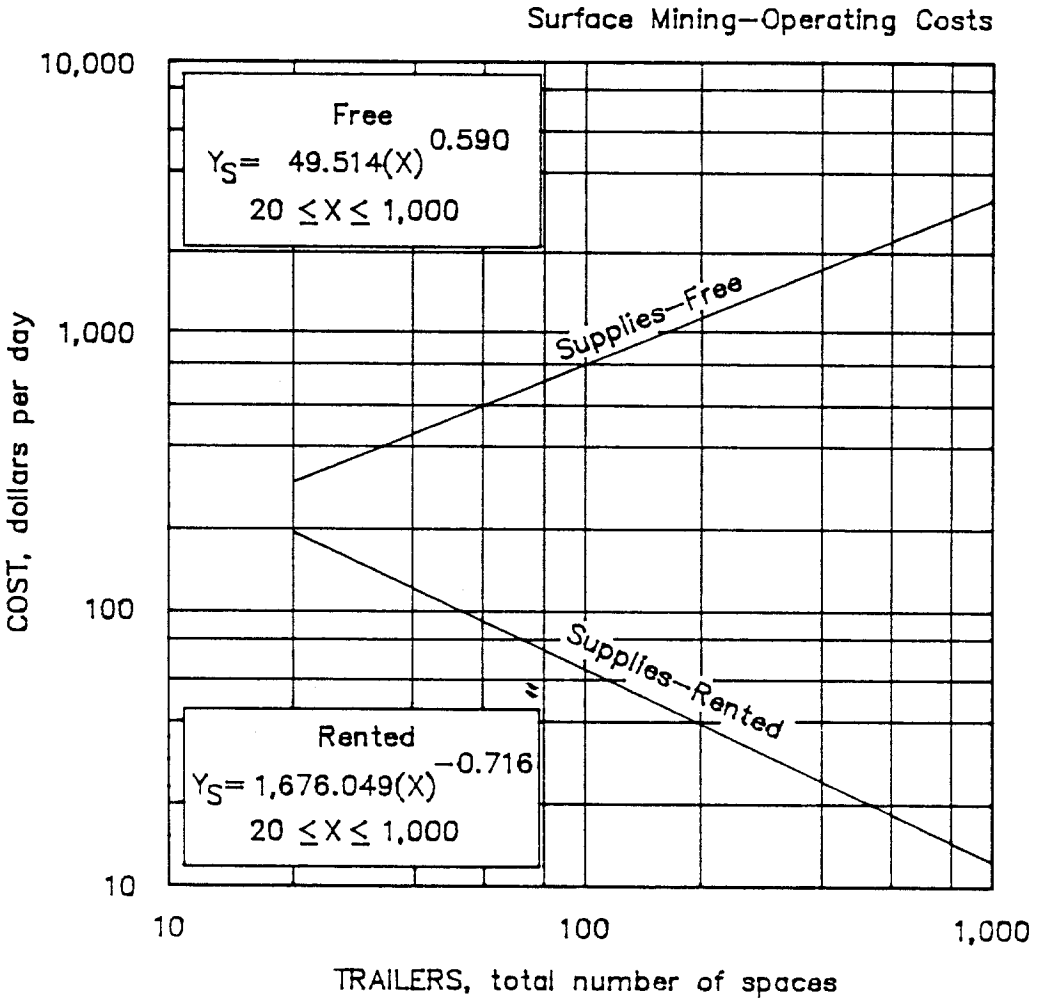
BASE CURVE

The total daily cost is derived from the supply curve based on the total number of housing units, (X), required. The curve is valid for 140 to 1,900 housing units.

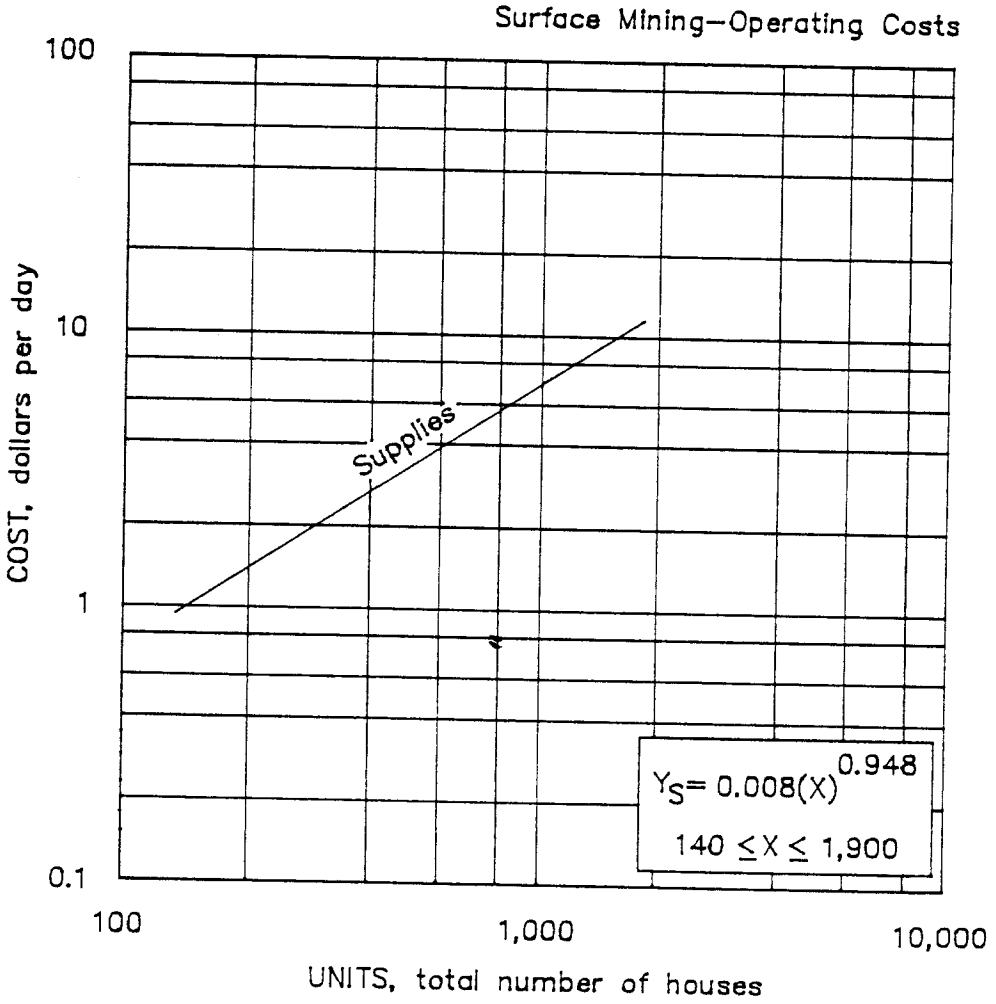
(S) Supply Operating Cost $(Y_S) = 0.008(X)^{0.948}$



3.2.6.3.a Townsite-Campsite
CAMPSITE



3.2.6.3.b Townsite-Campsite
TRAILER COURT



3.2.6.3.c Townsite-Campsite
PERMANENT HOUSING

3.2. SURFACE MINING--OPERATING COSTS

3.2.6. INFRASTRUCTURE

3.2.6.4.1. WASTE WATER TREATMENT
CLARIFICATION

This operation is a solids-contact clarifier used for water clarification by precipitation and/or coagulation. This cost curve is for removal of suspended solids formed after final neutralization of out-of-pipe effluent. The curve includes 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 daily 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 2.74 to 45.72 m (cross-sectional area ranging from 5.9 to 1,642 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 (5.72 to 75 m)	Large (75 to 1,661 m)	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 (5.72 to 75 m)	Large (75 to 1,661 m)
Electric.....	60%	34%
Maintenance.....	40%	66%

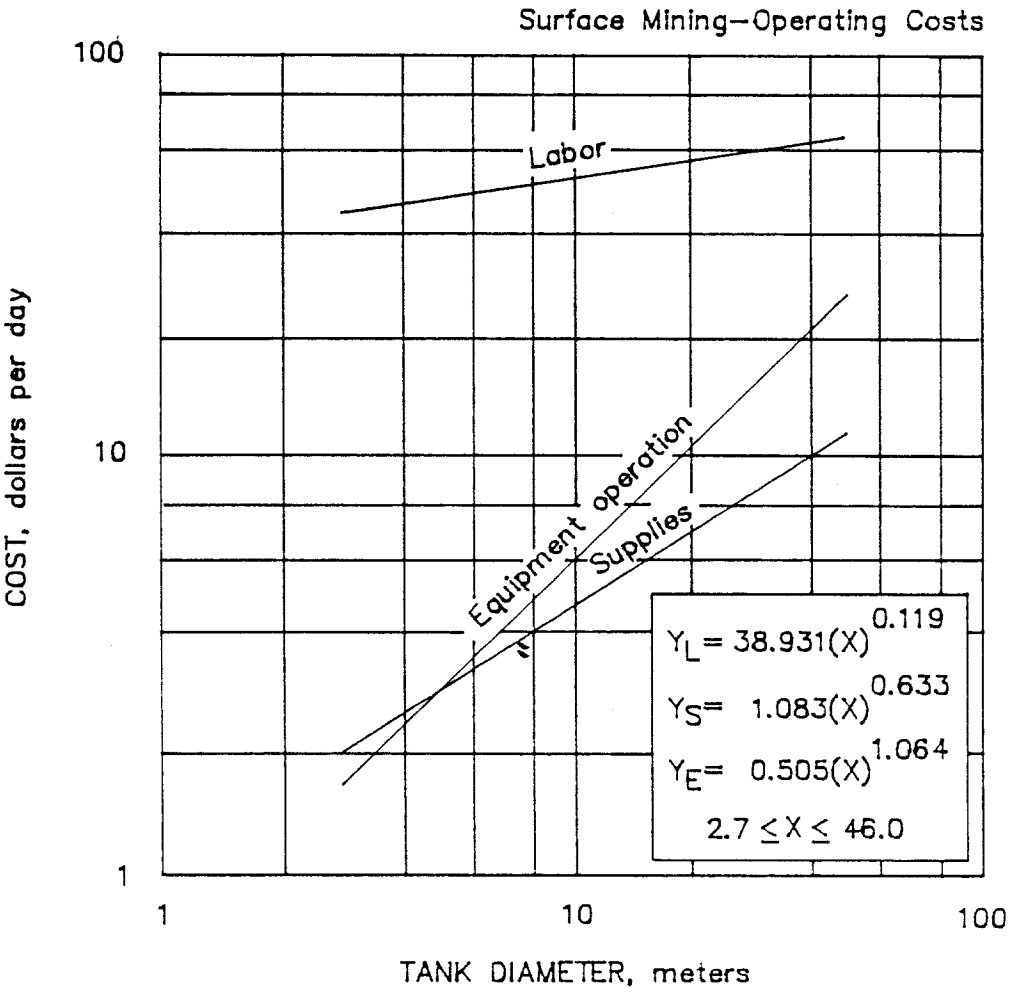
(E) Equipment Operating Cost $(Y_E) = 0.505(X)^{1.064}$
The equipment operating cost consists of 100% for repair parts and covers the daily operation cost for all clarification equipment.

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.



3.2.6.4.1. Wastewater treatment
CLARIFICATION

3.2. SURFACE MINING - OPERATING COSTS

3.2.6. INFRASTRUCTURE

3.2.6.4.2. WASTE WATER TREATMENT
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 that manual if further detail in neutralization costs is needed. Additionally, other waste water treatment methods are costed in the 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 daily 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 and 876 L/s (22.8 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).

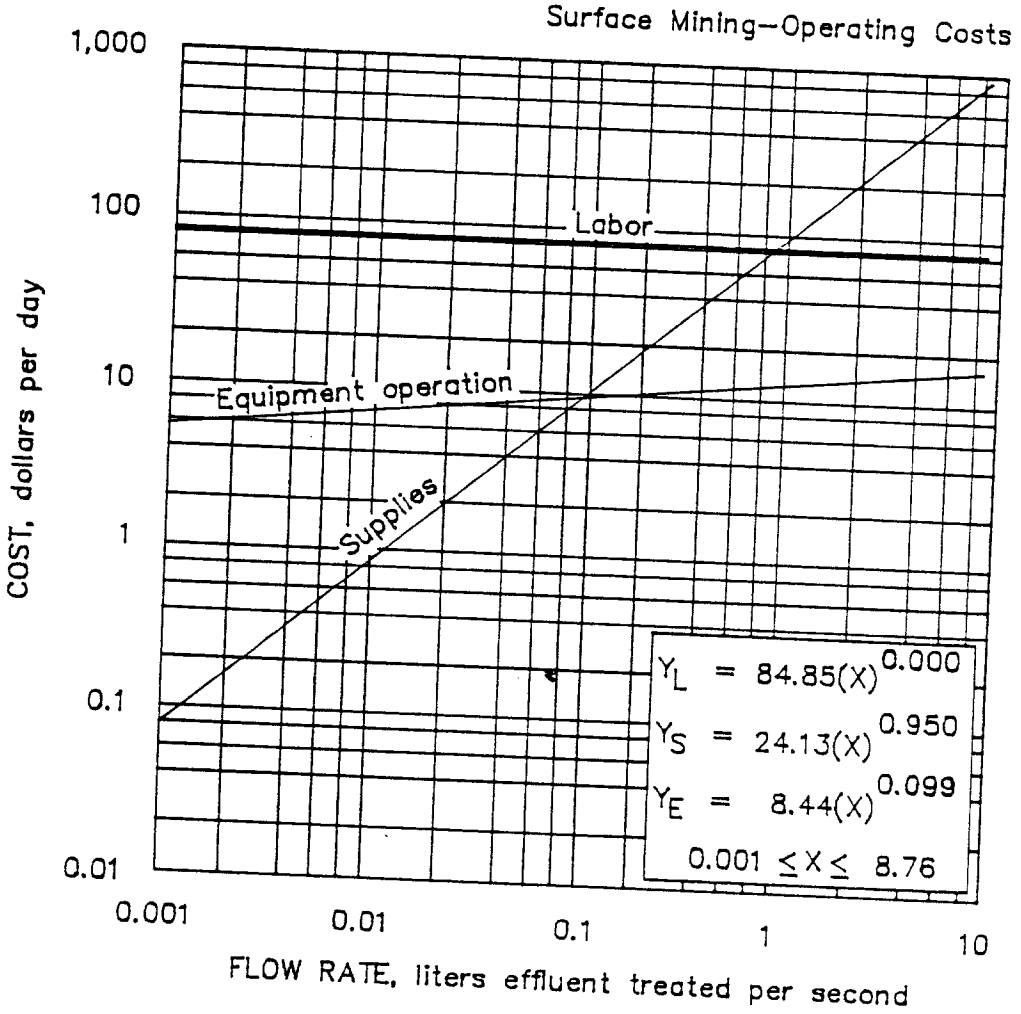
(S) Supply Operating Costs $(Y_{S\ 0.001\text{-}8.76\ L/s}) = 24.13(X)^{0.950}$
$(Y_{S\ 8.76\text{-}876\ L/s}) = 21.282(X)^{0.997}$

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

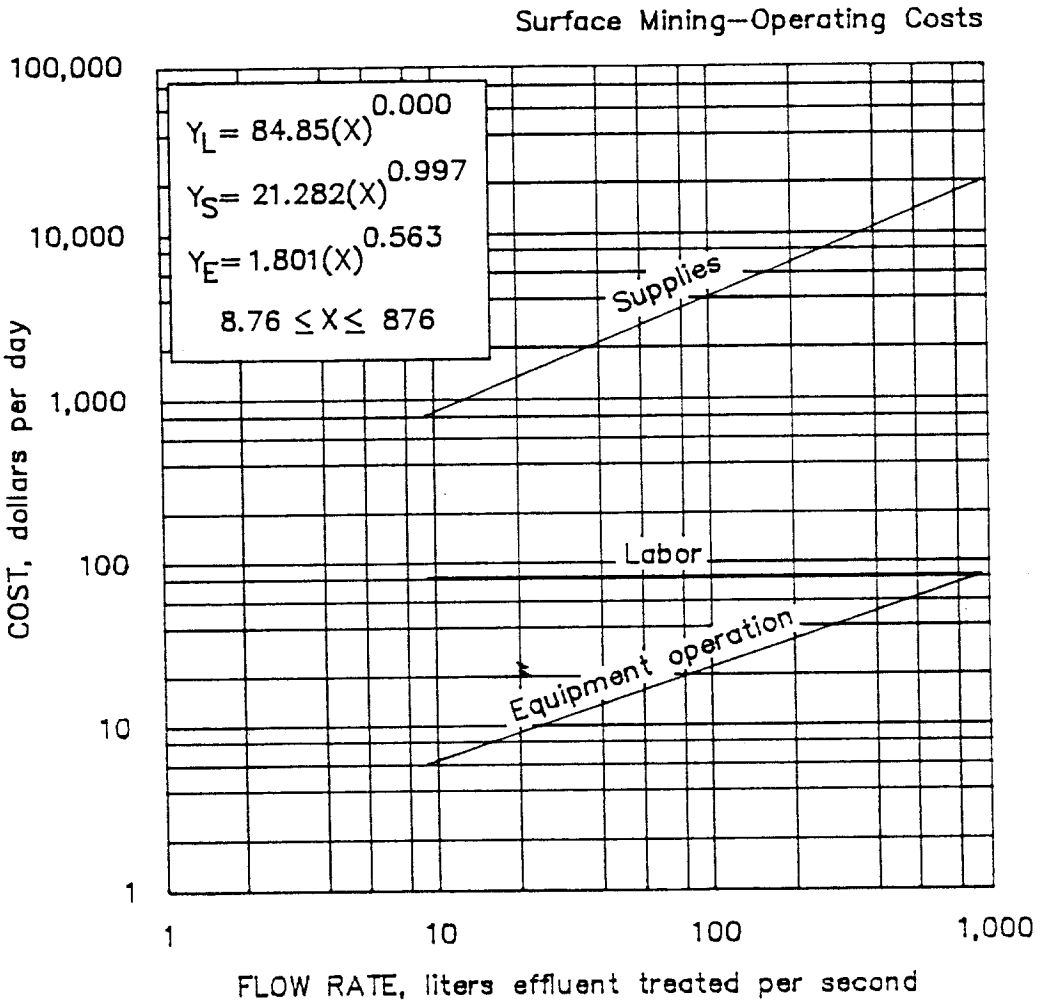
	Small (0.001 to 8.76 L/s)	Large (8.76 to 876 L/s)
Electric power.....	3%	2%
Water.....	80%	89%
Chemicals and lime.....	17%	9%

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

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



3.2.6.4.2.a Wastewater treatment
NEUTRALIZATION



3.2.6.4.2.b Wastewater treatment
NEUTRALIZATION

3.2. SURFACE MINING--OPERATING COST

3.2.7. RESTORATION DURING PRODUCTION

Mine restoration is the process of initiating and accelerating the natural continuous trend toward recovery (stabilization, etc.), the type of environment (desert, flatland, grasslands, mountains, etc.) and the restoration requirements by law in any given State (which range from none to very strict). Some states require permits prior to disturbing the ground surface. Typically, the permit specifies that the area must be reclaimed, hectare for hectare, to a use similar to the prior use or other beneficial use. Most restoration activities for mines include regrading and leveling plant sites (and revegetation of the disturbed area) but do not include backfilling (in most cases backfilling is not required by law).

If backfilling is employed in the restoration plan use the Excavation, Load and Haul Overburden and Waste section (3.2.1.4.), to obtain backfilling cost. The revegetation cost varies greatly depending on the method used (hand or machinery), materials used, type of seeds or plants, fertilizer, mulch, chemicals (such as lime for reducing acidity), and whether irrigation is necessary. Climate and ground slope are factors that determine the type and, therefore, the costs of restoration. The costs given in the following tabulation are representative costs for a specific restoration task. The actual cost could range higher or lower than the cost given in the table.

Where restoration methods use motorized equipment, the cost components (from the Industrial Chemicals Index) are the following: 40% for labor, 40% for equipment operation, and 20% for supplies (fertilizer, seed, mulch, etc.). The cost components for equipment operation are 65% for fuel and lubrication, 25% for repair parts, and 10% for tires. If restoration work is accomplished manually, then the cost components (from the Industrial Chemicals Index) are 60% for labor and 40% for supplies.

COST COMPARISONS OF RESTORATION METHODS

	Cost per hectare	Remarks
SPECIFIC RESTORATION WORK (INDEPENDENT OF CLIMATE OR GEOGRAPHY)		
Revegetation on steep slope--roadside slopes, tailing slopes, or waste dump slopes, using hydroseeder with fiber mulch.	$1,000-1,500	Based on using 18 kg/ha of seed, 73 kg/ha of fertilizer, and expenses to use a boom crane, pickup truck, 2 equipment operators, and a swamper.
Transplanting trees or shrubs by hand on moderate to steep slopes.	5,000	Assume 2,500 trees hand planted per hectare at $2 per tree or shrub.
Sand and gravel restoration, includes placers; leveling, grading, topsoiling, reseeding.	3,000	Based on a typical sand-and-gravel operation near Denver, CO.
Annual maintenance (fertilizers added for above).	160	Cost for applying fertilizer.
Restoration of borrow pit - backfilling leveling and reseeding.	400-600	None.
RESTORATION IN HIGH ALTITUDE (MOUNTAINOUS) TERRAIN		
Regrading and reseeding - not including topsoiling.	$4,000	Regrading for adequate drainage to minimize erosion, seedbed preparation, and reseeding (including transplanting trees and shrubs).
Maintenance (added to regrading cost).	130	Purchasing-applying fertilizer--application cost for 1 yr. If application is on area where at least 30-cm depth of topsoil has been added, only 1 year's application needed. If topsoil has not been added, then as many as 4 applications may be required over a 6- to 8-year period.
Topsoil removal not necessary for access to ore body--added to regrading cost (if necessary to remove topsoil to gain access to ore body, then only $1,300/ha of this cost would be attributed to restoration cost).	7,000	Using $2.30/$m^3$ cost of stockpiling soil to cover a disturbed area to a depth of 30 cm. Assume topsoil moved and emplaced once. If moved, then stored and moved again to final placement, cost could double).
RESTORATION IN ARID AND SEMIARID LANDS		
Soil added	$5,000	Required to achieve restoration on only the most severely disturbed sites. Generally serves to accelerate the rate of achieving permanent self-sustaining vegetation.

COST COMPARISONS OF RESTORATION METHODS--Continued

	Cost per hectare	Remarks
RESTORATION IN ARID AND SEMIARID LANDS--Continued		
Seeding and irrigation in arid climate on tailings dams, waste dump sites, road slopes.	$12,000-15,000	Irrigation system cost (sprinkler or drip tube) is estimated at $8,000/ha. Water assumed to be pumped on site at annual rate of 12,000 to 18,000 m^3/ha at $63 to $67 per 1,000 m^3 of water.
Seed and fertilizer broadcast on surface --no soil coverage or mulch.	700	Minimum slope where seed will cover naturally with soil. Seed broadcast manually.
Hydromulching with 680 kg wood fiber per hectare plus seed and fertilizer.	1,900-2,500	Most common southwestern U.S. hydromulch mix; will hold seed and fertilizer in place on steep and smooth slopes.
Straw or hay broadcast with straw blower on surface at 3,400 kg/ha.	2,500	Very effective as energy absorber and mulch. Not used on steep slopes. Cost increase significant if slopes over 14 m from access.