3.2. SURFACE MINING--OPERATING COST

3.2.4. MINE PLANT GENERAL OPERATIONS

3.2.4.4. GENERAL ITEMS
COMMUNICATIONS, SANITATION, HOUSEKEEPING, FIRE PROTECTION, AND ELECTRICAL

This set of curves covers the cost for the general operations customarily required in surface mining operations. Examples of services provided are plumbing, miscellaneous repairs, rough and finish carpentry, incidental jobs, tire protection, electrical maintenance, and general housekeeping.

The total daily cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a feed rate (X), in metric tons ore and waste per day. The curves are valid for operations between 100 to 360,000 mtpd, operating three shifts per day. The curves include daily operating and maintenance costs associated with utility trucks, mobile cranes, fire trucks, various cleaning materials, and electrical and plumbing supplies.

BASE CURVE

(L) Labor Operating Cost $(Y_{L\ SMALL}) = 0.430(X)^{1.000}$
$(Y_{L\ LARGE}) = 11.829(X)^{0.520}$

The operating labor costs are distributed as follows:

Direct labor	0%
Maintenance labor	100%

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

	Small (100 to 1,000 mtpd)	Large (1,000 to 360,000 mtpd)	Av salary per hour (base rate)
Crane operator	18%	7%	$17.23
Truck driver	17%	6%	15.89
Carpenter, 1st class	-	7%	17.23
Carpenter, rough	17%	6%	16.33
General laborer	30%	25%	13.86
Plumber, licensed	-	5%	18.11
Plumber, unlicensed	-	4%	17.66
Welder, 1st class	18%	18%	16.78
Janitor	-	13%	14.56
Electrician	-	9%	16.78

The average labor cost is $15.86 per worker-hour (including burden and average shift differential).

The size of the work force required for this work will vary from a small crew of 1 or 2 workers working a fractional day to possibly three shifts of from 50 to 60 workers per day.

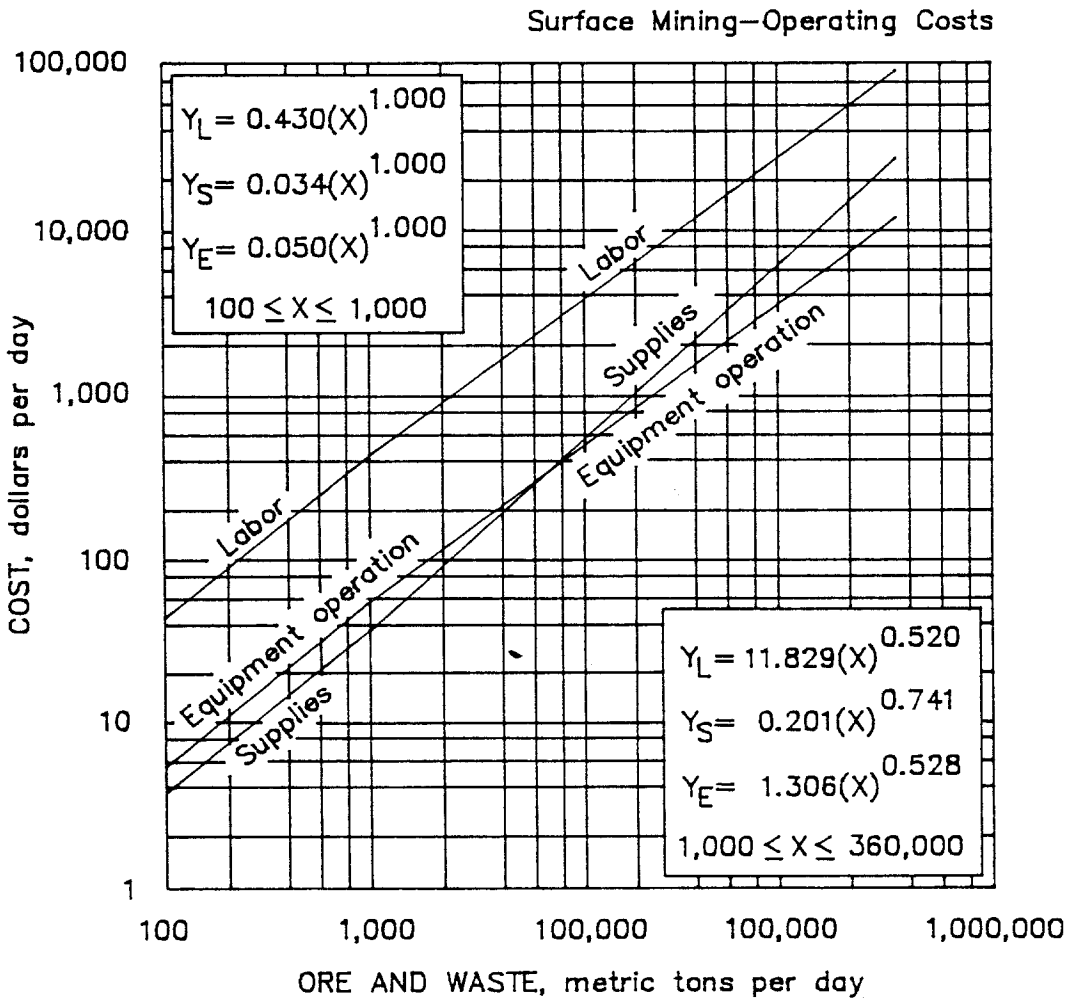
(S) Supply Operating Cost $(Y_{S\ SMALL}) = 0.034(X)^{1.000}$
$(Y_{S\ LARGE}) = 0.201(X)^{0.741}$

The supply cost consists of 100% miscellaneous materials, such as lumber, paper towels, nails, cleansers, etc.

(E) Equipment Operating Cost $(Y_{E\ SMALL}) = 0.050(X)^{1.000}$
$(Y_{E\ LARGE}) = 1.306(X)^{0.528}$

The general equipment cost component distribution is as follows:

	Small (100 to 1,000 mtpd)	Large (1,000 to 360,000 mtpd)
Repair parts.....	30%	37%
Fuel and lube.....	65%	57%
Tires.....	5%	6%



3.2.4.4. General items
COMMUNICATIONS, SANITATIONS, HOUSEKEEPING,
FIRE PROTECTION, AND ELECTRICAL

3.2. SURFACE MINING--OPERATING COST

3.2.4. MINE PLANT GENERAL OPERATIONS

3.2.4.6. PORTABLE POWER GENERATION

This section is to be used in conjunction with section 2.2.4.2. when electric power is unavailable through a commercial power utility company or when it would be uneconomical to run power distribution facilities to the user. The total cost per kilowatt hour replaces the commercial Denver, CO, power rate used in other sections of this manual.

These curves cover the cost of power production from a single portable power unit (see adjustment factor for multiple units) ranging from a small diesel generator with less than 100 kW output to a large gas turbine producing more than 20,000 kW of power.

The total cost is expressed in terms of dollars per kilowatt hour for a specific power output. The curves cover the cost of labor for overhauls and normal repairs, parts for overhauls and normal repairs, and fuel and lube costs. The curves have been divided into three parts: the first part covering horizontal diesel generators from 18- to 400-kW output, the second part covering horizontal diesel generators from 400- to 2,900-kW output, and the last part covering gas turbine generators from 2,900- kilowatt to 23,600-kW output.

Total cost is the sum of two separate cost curves (labor and equipment operation) based on a specific power output rating (X), in kilowatts. The curves are valid for generators between 18- to 23,600-kW. The curves include all daily operating and maintenance costs associated with power production per generator unit.

BASE CURVE

To convert from kilovolt ampere (kV·A) demand to kilowatt power output estimate the power factor (PF). This may vary from 0.80 for electric motor circuits to 1.00 for electric light circuits. The kilowatt output is then determined by kV·A x PF = kW. (Power Output Determination - for surface mine power output (kW), see section 2.2.4.2. For underground mine and mineral processing plant power demand (kV·A), see sections 4.2.5.3. and 6.1.8.4.)

(L) Labor Operating Cost $(Y_{L\ 18\text{-}400\ kW}) = 0.169(X)^{-0.466}$
$(Y_{L\ 400\text{-}2,900\ kW}) = 0.409(X)^{-0.480}$
$(Y_{L\ 2,900\text{-}23,600\ kW}) = 0.008(X)^{-0.445}$

The operating labor costs are distributed as follows:

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

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

		Ag salary per hour (base rate)
Mechanics.....	100%	$18.11

The average wage for labor is $18.11 per worker-hour (including burden and average shift differential).

The labor curves do not contain any operating labor costs since all units operate unattended in an automatic mode (some smaller units may not have automatic starting systems and would require a manual start). The only labor necessary is that which is required for maintenance and scheduled overhauls by mechanics.

(E) Equipment Operation Costs $(Y_E \text{ 18-400 kW}) = 0.145(X)^{-0.075}$
$(Y_E \text{ 400-2,900 kW}) = 0.158(X)^{-0.070}$
$(Y_E \text{ 2,900-23,600 kW}) = 0.131(X)^{-0.122}$

The general equipment operating cost component distribution is as follows:

	Repair parts	Fuel and lube	Tires
Horizontal diesel:			
18 to 400 kW.....	18.0%	73%	9%
400 to 2,900 kW.....	12.0%	79%	9%
Gas turbine:			
2,900 to 23,600 kW.....	11%	75%	14%

The parts category includes normal maintenance parts such as belts and pumps, and major overhaul items such as valves, injectors, brushes, and commutators. The fueling cost is based on $1.00/gal diesel fuel (at 7.093 lb/gal) or $3.20/1,000 ft^3 of natural gas with a Btu rating of 1,050 Btu's per cubic foot.

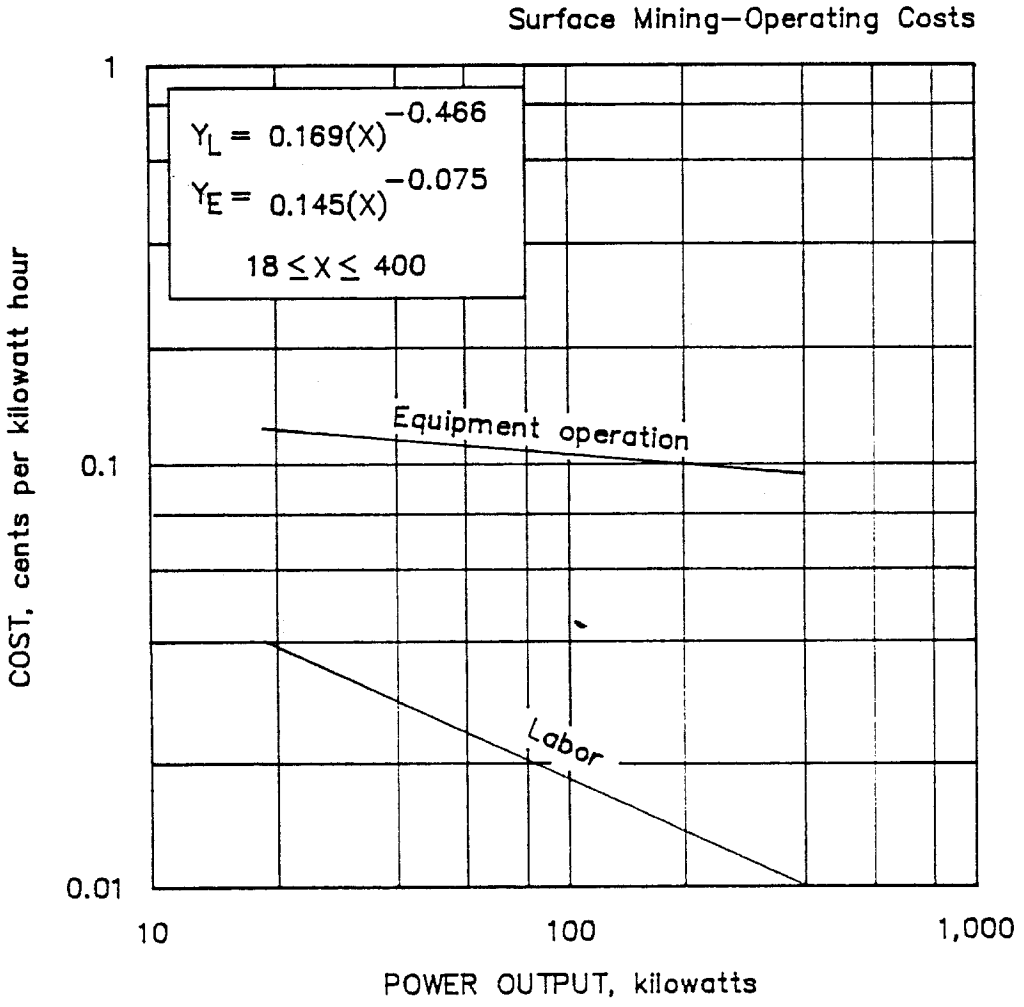
ADJUSTMENT FACTORS

Sulfur Fuels Factor If high sulfur fuels are used, multiply the labor and parts costs by the following factor:

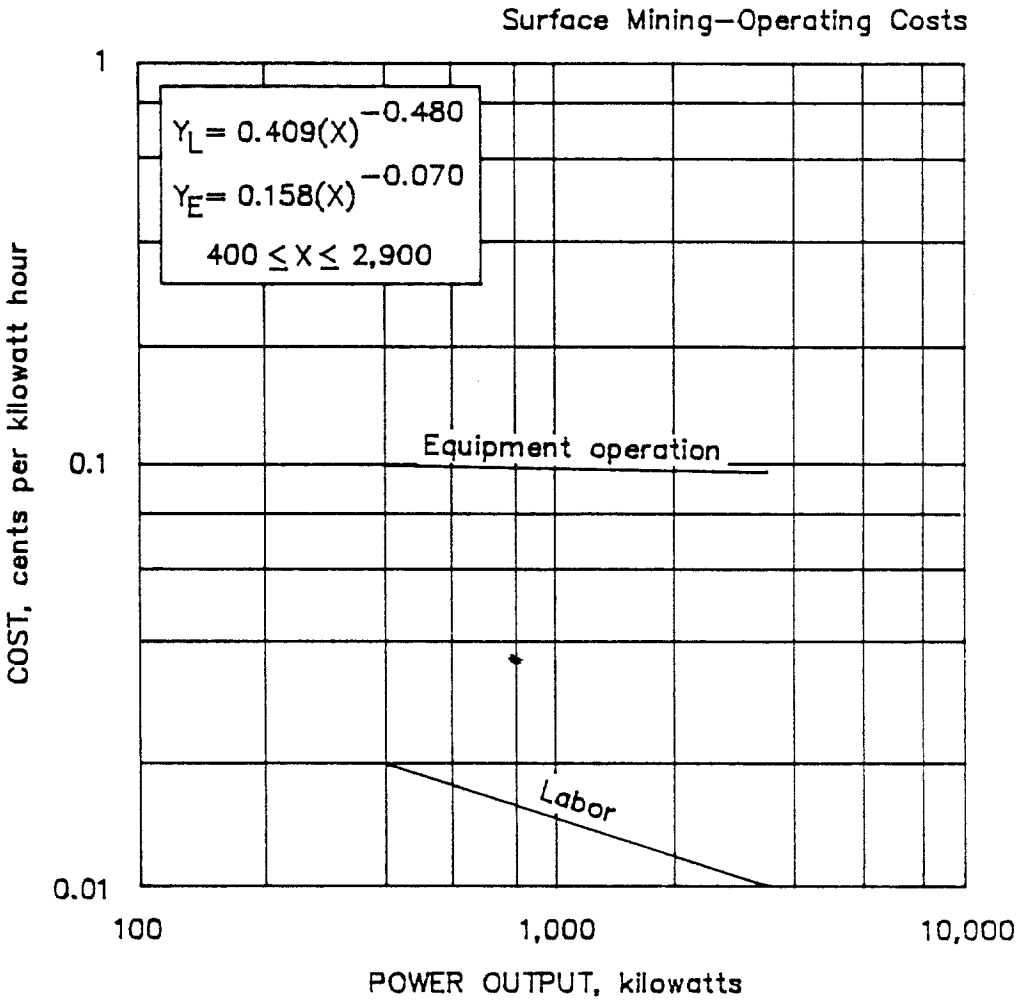
Sulfur fuels factor $(F_L) = 1.333$

Power Rate If power is to be supplied by more than one unit, then the total power output should be divided by the number of required units to obtain the power output per unit (X) needed for entering the curves.

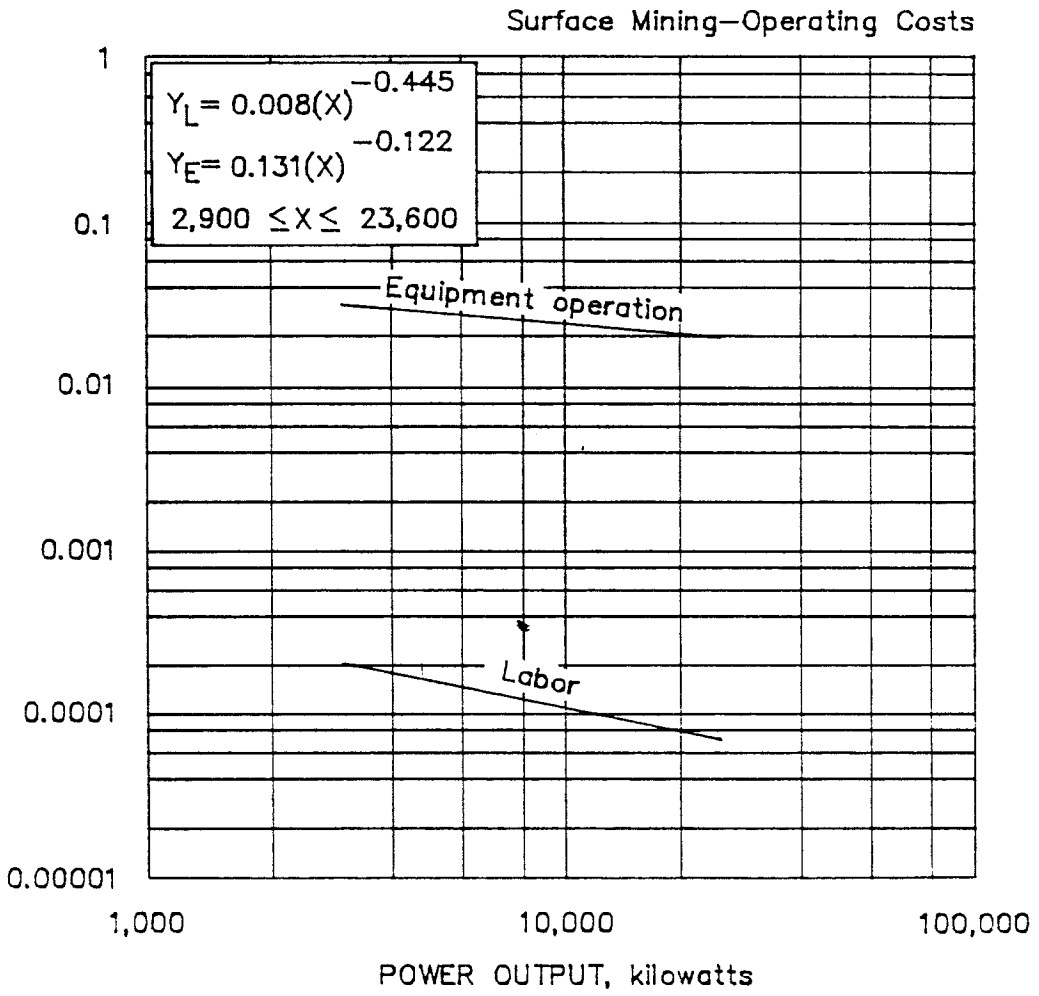
Power Source For those cases where power is supplied to the mine and mineral processing plant from different sources as a result of geographic or economic constraints, separate cost estimates, using this section, must be made to reflect the independent power outputs. This will result in different power costs for mines and mineral processing plants and must be accounted for separately in the mining and mineral processing sections of this manual.



3.2.4.6.a Portable power generation



3.2.4.6.b Portable power generation



3.2.4.6.c Portable power generation

3.2. SURFACE MINING - OPERATING COST

3.2.4. MINE PLANT GENERAL OPERATIONS

3.2.4.8. STOCKPILE STORAGE FACILITIES

Stockpile operating costs, as determined in this section, are based on metric tons of stockpiled material reclaimed during a two-shift-per-day operation. The costs represented are only applicable for stockpiles formed and reclaimed by conveyors. The daily reclaim rate is typically about 67% of the stockpile's live storage capacity. Total stockpile capacity is normally about 600% of the daily reclaim rate. For example, a coarse ore stockpile for a mill operating at 10,000 mtpd of ore has a live storage capacity of about 15,000 mt and a total stockpile capacity of 60,000 mt.

The total daily operating cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the production rate (X), in metric tons material reclaimed from the stockpile per day. The curves are valid for operations between 2,000 to 200,000 mtpd, operating two shifts per day.

BASE CURVES

(L) Labor Operating Costs $(Y_L) = 7.229(X)^{0.503}$
The operating labor costs are distributed as follows:

Direct labor.....	33%
Maintenance labor.....	67%

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

		Av salary per hour (base rate)
Mechanic.....	72.0%	$17.99
Conveyor operator.....	14.8%	14.89
Laborer.....	13.2%	13.26

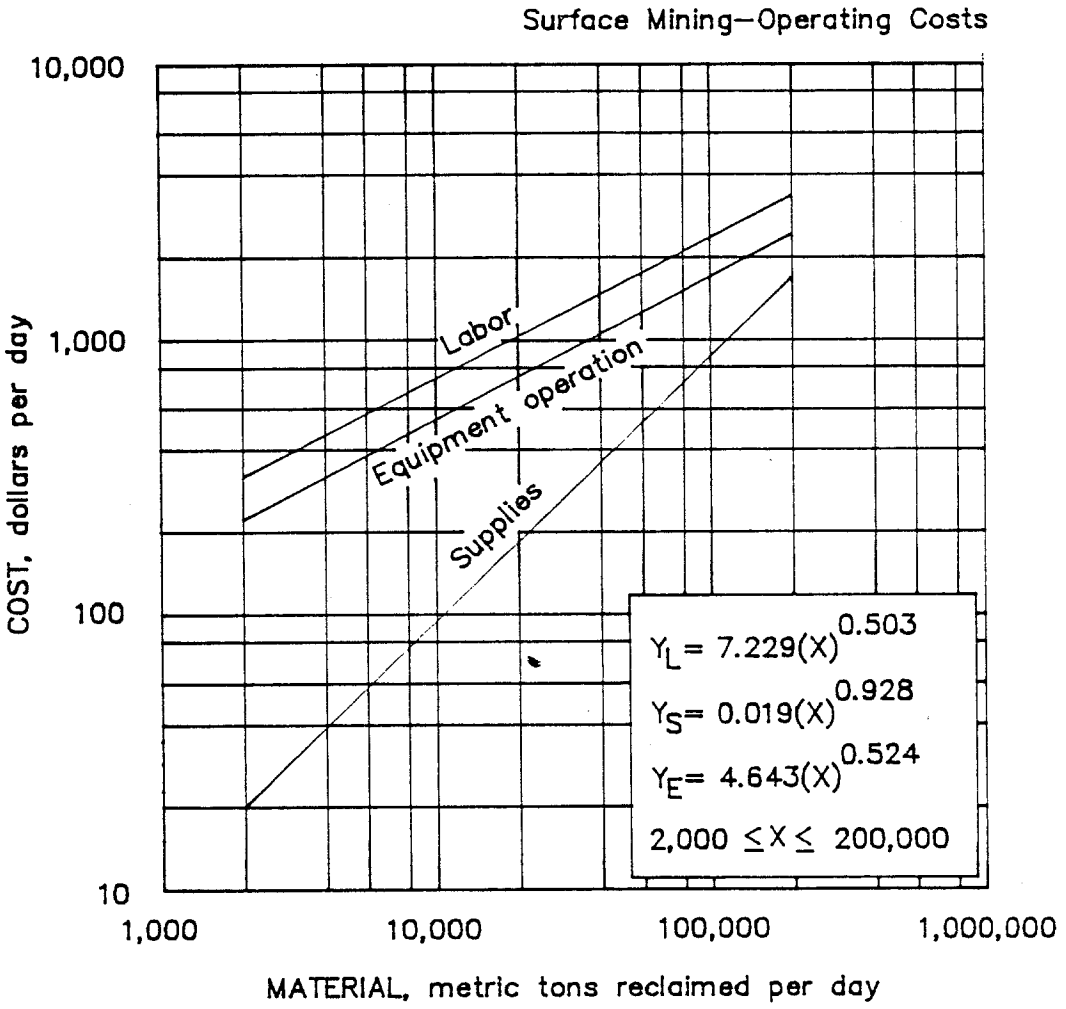
Average operating labor cost per worker-hour is $16.91 (including burden and average shift differential).

(S) Supply Operating Costs $(Y_S) = 0.019(X)^{0.928}$
The supply cost consists of 100% electric power.

(E) Equipment Operating Costs $(Y_E) = 4.643(X)^{0.524}$
The equipment operating cost consists of 94% for repair and maintenance parts and 6% for lubrication.

ADJUSTMENT FACTOR

Shift-Reclaim Rate If a stockpile facility is operated one shift per day, multiply the daily reclaim rate by two; calculate the operating costs from the base curves using the adjusted reclaim rate; then decrease the calculated cost by 50% to arrive at the adjusted cost. If the facility is operated three shifts per day, multiply the daily reclaim rate by 0.67; calculate the operating costs from the base curves using the adjusted reclaim rate; then increase the calculated cost by 50% to arrive at the adjusted cost.



3.2.4.8. Stockpile storage facilities

3.2. SURFACE MINING--OPERATING COST

3.2.4. MINE PLANT GENERAL OPERATIONS

3.2.4.10.1. WATER AND DRAINAGE SYSTEM
DRAINAGE AND DISPOSAL SYSTEM

The curves apply to the most common dewatering method, which consists of pumping and disposing of water out of the mine. The curves are valid for an adjustable pumping head and distance of 110 m and 1.184 km, respectively.

The total daily cost is the sum of three cost curves (labor, supplies, and equipment operation) having a water-pumping volume (X), in cubic meters of water per day. The curves are valid for operations between 100 to 60,000 m^3/d, operating three shifts per day. These curves include all daily operating and maintenance costs associated with pumping, minor ditching, and other related items.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 0.149(X)^{0.704}$
The operating labor costs are distributed as follows:

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

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

	Small (100 to 10,000 m^3/d)	Large (10,000 to 60,000 m^3/d)	Av salary per hour (base rate)
Mechanic 1st class.....	55%	28%	$16.78
Mechanic 2nd class.....	-	26%	15.89
Helper.....	45%	46%	13.66

The average wage for labor is $15.55 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 0.020(X)^{0.995}$
The supply cost consists of 100% electric power. Power is primarily used to overcome the static and the friction heads associated with pumping.

(E) Equipment Operation Cost $(Y_E) = 0.352(X)^{0.693}$
The equipment operating cost consists of 97% minor parts and 3% lubrication with the daily cost related to pumping and minor pipe line, ditch, and sump maintenance.

ADJUSTMENT FACTORS

Pumping Head Factor The operating cost curves are based on 100-m static head (lift) and 10-m friction head (in a standard new steel pipe line). For actual heads, multiply the costs obtained from the curves by the following factor:

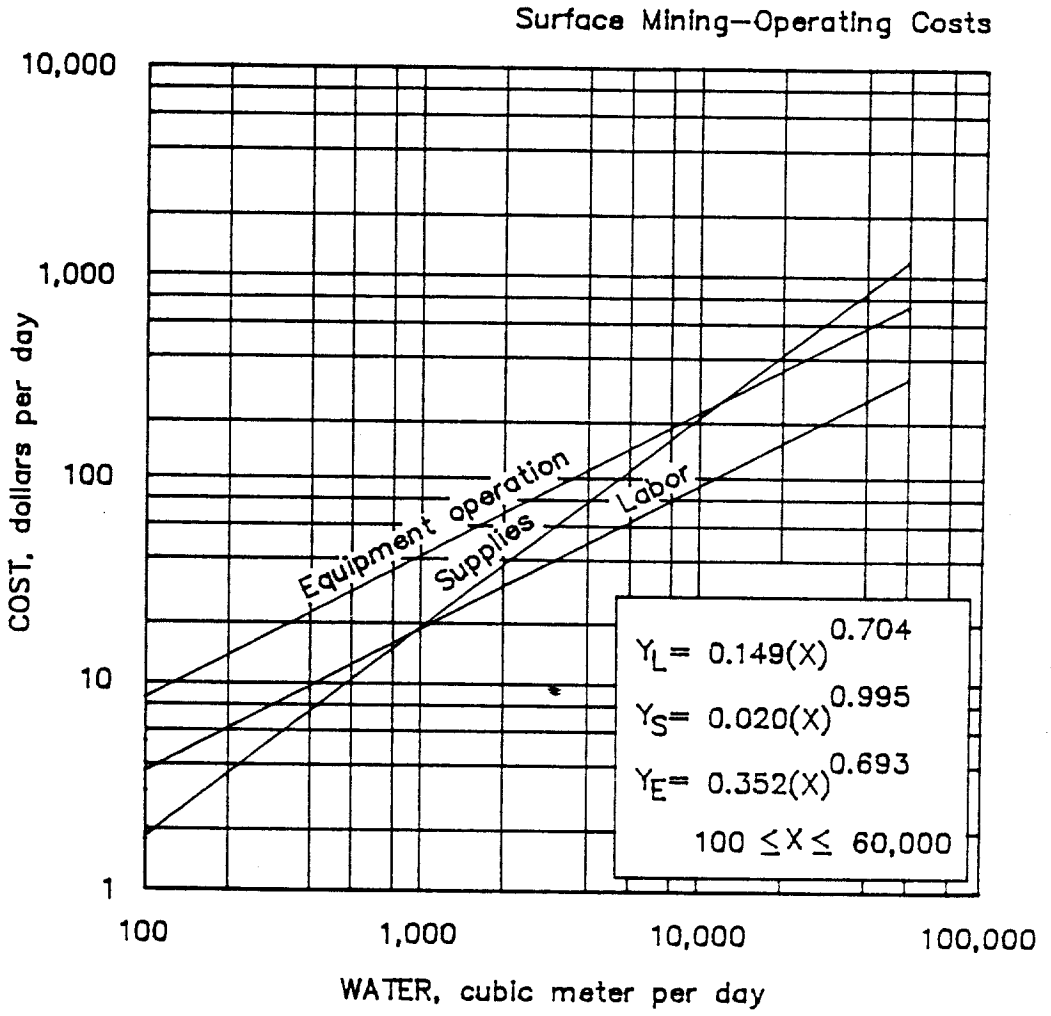
Pumping head factor $(F_H) = H/110$
where H = actual head (static, friction, velocity, and fitting), in meters.

For preliminary estimates of H, add to the actual static head (lift) 8 ms for each kilometer of new steel pipe line through which pumping is done.

For accurate determinations of H, add to the actual static head the sum of friction, velocity, and fitting heads obtained from hydraulics handbooks for actual pipe quality, pipe diameter, and pipe line pumping distance.

Pumping Distance Factor The curves are based on a pumping distance of 1.184 km (0.184 km in the mine and 1 km outside). For actual distances, multiply the costs obtained from the curves by the following factor:

Pumping distance factor $(F_D) = D/1.184$
where D = actual pumping distance, in kilometers.



3.2.4.10.1. Water and drainage system
DRAINAGE AND DISPOSAL SYSTEM

3.2. SURFACE MINING--OPERATING COST

3.2.4. MINE PLANT GENERAL OPERATIONS

3.2.4.10.2. WATER AND DRAINAGE SYSTEM
WATER SUPPLY SYSTEM (MAKEUP WATER)

Water is used in surface mines for dust control on haulage roads and for equipment cooling. The water supply system operating cost for a surface mine (and/or an adjoining mineral processing plant, section 7.1.8.14.2., IC 9143) is based on daily water consumption.

The total daily cost is the sum of three separate curves (labor, supplies, and equipment operation) for a volume (X), in cubic meters of water per day. The curves are valid for operations between 1,000 to 150,000 m^3/d, operating three shifts per day. The curves cover all daily maintenance and operating costs associated with water wells, storage tanks, pipelines, and distribution.

These curves are valid for a total pumping head ranging from 260 to 330 m with an average of 291 m, and pumping distances ranging from 3 to 53 km.

To estimate mine water demand, multiply the daily mine capacity (ore and waste) by 0.07. The 0.07 factor is the approximate number of cubic meters of water required per metric ton mined.

For mines where slurry transportation is required and a high percentage of water is reclaimed (e.g., Florida phosphate mines), 0.16 to 0.23 m^3/mt of material slurried (dry weight) could be assumed to be a valid value for (X).

If the total daily volume (mine and processing plant makeup water) is known, the manual user should enter this volume in the equations given below (unless the processing plant is supplied with water from an independent source). The total daily cost may be alloted as follows[1]:

(a) 9% to section 3.2.4.10.2. (surface mine)

(b) 91% to section 7.1.8.14.2. (mineral processing, IC 9143).

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 1.937(X)^{0.445}$
The operating labor costs are distributed as follows:

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

[1]Percentages derived from Bureau of Mines IC 8285 dealing with water consumption for U.S. mines and mineral processing plants. Different percentages may be used if an actual breakdown of mine and mineral processing plant water consumption is known.

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

	Small (1,000 to 13,000 m^3/d)	Large (13,100 to 150,000 m^3/d)	Av salary per hour (base rate)
Mechanic-welder.....	25%	14%	$16.33
Pipefitter.....	34%	39%	22.80
Helper.....	41%	47%	13.66

The average wage for labor is $16.63 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 0.045(X)^{0.997}$
The supply cost consists of 100% electric power. Power is required to overcome the static head (well depth and lift) and pipeline head losses.

(E) Equipment Operating Cost $(Y_E) = 0.054(X)^{0.864}$
The equipment operating cost consists of 95%for parts and 5% for lubrication with the daily cost related to pipe lines, pumps, and storage tanks.

ADJUSTMENT FACTORS

Pumping Distance Factor To correct for actual pumping distance, D, multiply the costs obtained from the curves by the following factor:

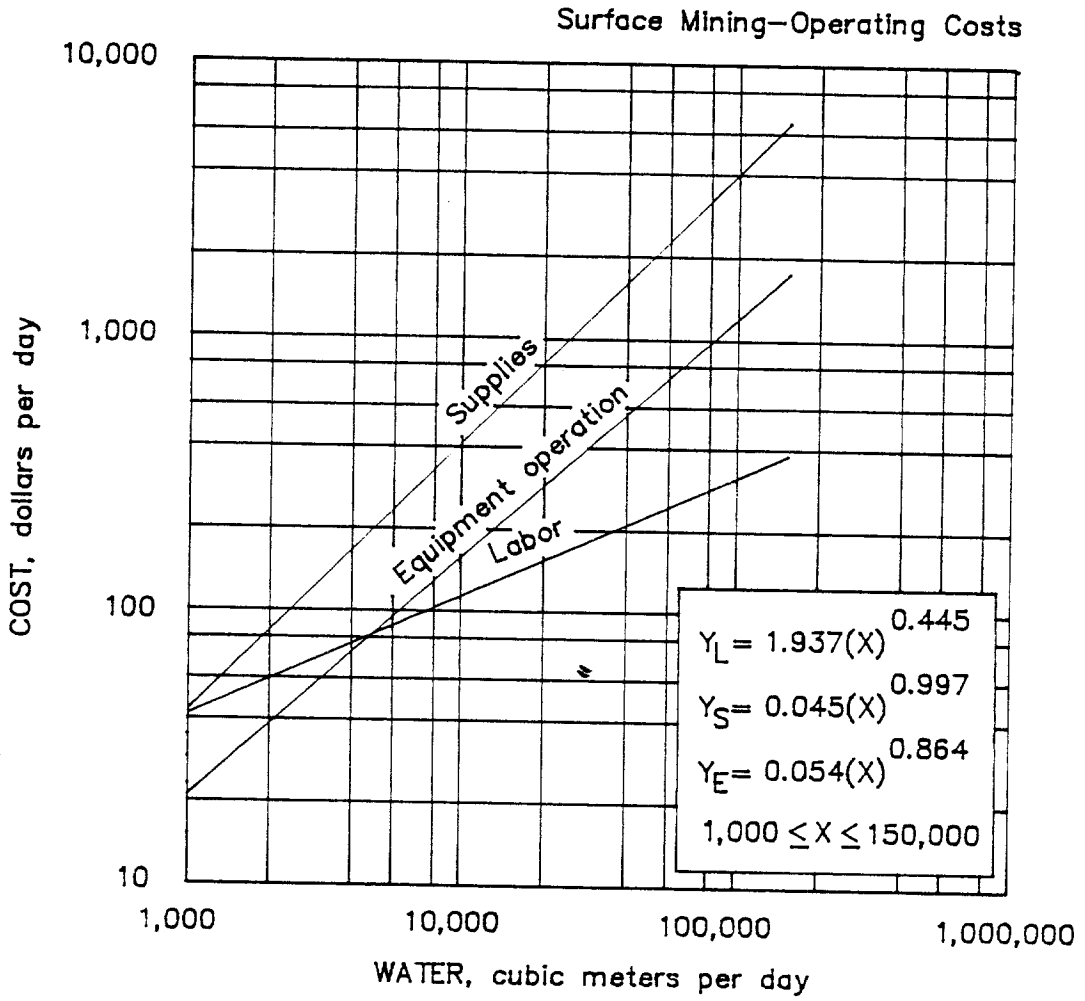
Pumping distance factor $(F_D) = 0.850+1.948(D)(X)^{-0.549}$
where X = daily volume, in cubic meters per day,
and D = actual distance, in kilometers.

Because a change in distance results in a change in friction head, also multiply the costs by the dynamic head portion (16%) of the factor, F_H.

Pumping Head Factor The curves are based on 244-m static head (well depth and lift) and a 47 m friction (dynamic) head. To adjust for actual total heads, H, multiply the costs obtained from the curves by the following factor:

Pumping head factor $(F_H) = H/291$
where H = the sum of static, friction, velocity, fitting, and discharge heads, in meters.

Purchased Water If water is purchased, estimate the labor, supply, and equipment operation costs (from the delivery point to the mine and processing plant) and add them to the purchasing cost.



3.2.4.10.2. Water and drainage system
WATER SUPPLY SYSTEM (MAKEUP WATER)