4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.1. CLEARING

The curve for clearing during preproduction development is based on estimated costs for medium-light growth on terrain with a side slope of 20% to 50%, one shift per day. Estimate one tree, 0.33 m in diameter, per 40 square m^2.

The total cost is the sum of three separate cost curves (labor, supplies, and equipment operation) having a clearing area (X), in total hectares. The curves are valid for operations between 1 and 1,000 ha (from 500 to 1,000 ha, the costs are expected to remain constant). The curves include all daily operating and maintenance costs associated with clearing a land surface for further development.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 2,171.220(X)^{-0.120}$
The operating labor costs are distributed as follows:

Direct labor...............	84%
Maintenance labor..........	16%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

		Av salary per hour (base rate)
Dozer operator............	21%	$16.33
Truck driver..............	6%	15.89
General laborer...........	73%	13.66

The average wage for labor is $14.28 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 269.796(X)^{-0.0303}$
For clearing operations from 1 to 500 ha, the supply cost consists of 78% fuel oil (for burning wood and scrub) and 22% tools, cables, and chokers. For clearing operations of 500 to 1,000 ha, the supply cost consists of 83% fuel oil and 17% tools, cables, and chokers.

(E) Equipment Operating Cost $(Y_E) = 667.618(X)^{-0.0672}$
The general equipment cost component distribution is

	Repair parts	Fuel and lube	Tires
Crawler dozers.............	51%	49%	-
Trucks, pickups, and chainsaws.............	14%	80%	6%

The equipment operating cost consists of 87% for crawler dozers and 13% for trucks, pickups, and chainsaws.

ADJUSTMENT FACTORS

Brush Factor For light clearing conditions where the growth consists mainly of brush and small trees, multiply the curves by the following factors:

Brush factor $(Y_{B\ LIGHT}) = 0.25$

For heavy clearing conditions, defined as when clearing a dense growth of trees (diameter of the trees commonly exceeding 0.33 m), multiply the curves by the following factor:

Brush factor $(Y_{B\ DENSE}) = 1.75$

Side Slope Factor For clearing on terrain with side slopes other than 20% to 50%, multiply the curves by the following factors:

For clearing on terrain with side slopes of 0% to 20%,

Side slope factor $(Y_{S\ 0\%-20\%}) = 0.8$

For clearing on terrain with side slopes of 50% to 100%,

Side slope factor $(Y_{S\ 50\%-100\%}) = 1.2$

For clearing on terrain with side slopes greater than 100%,

Side slope factor $(Y_{S\ +100\%}) = 2.5$

Burning Factor When the burning of cleared brush and trees is prohibited because of environmental regulations, the brush and trees will have to be stacked or buried. If burning is prohibited, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.2$

Supply factor $(F_S) = 0.2$

Equipment operation factor $(F_E) = 1.2$

Equipment Factor Where it is necessary to purchase equipment, or have a subcontractor perform the work, multiply the equipment operation value by the following applicable factor in order to obtain the total value of equipment expense for ownership and operation:

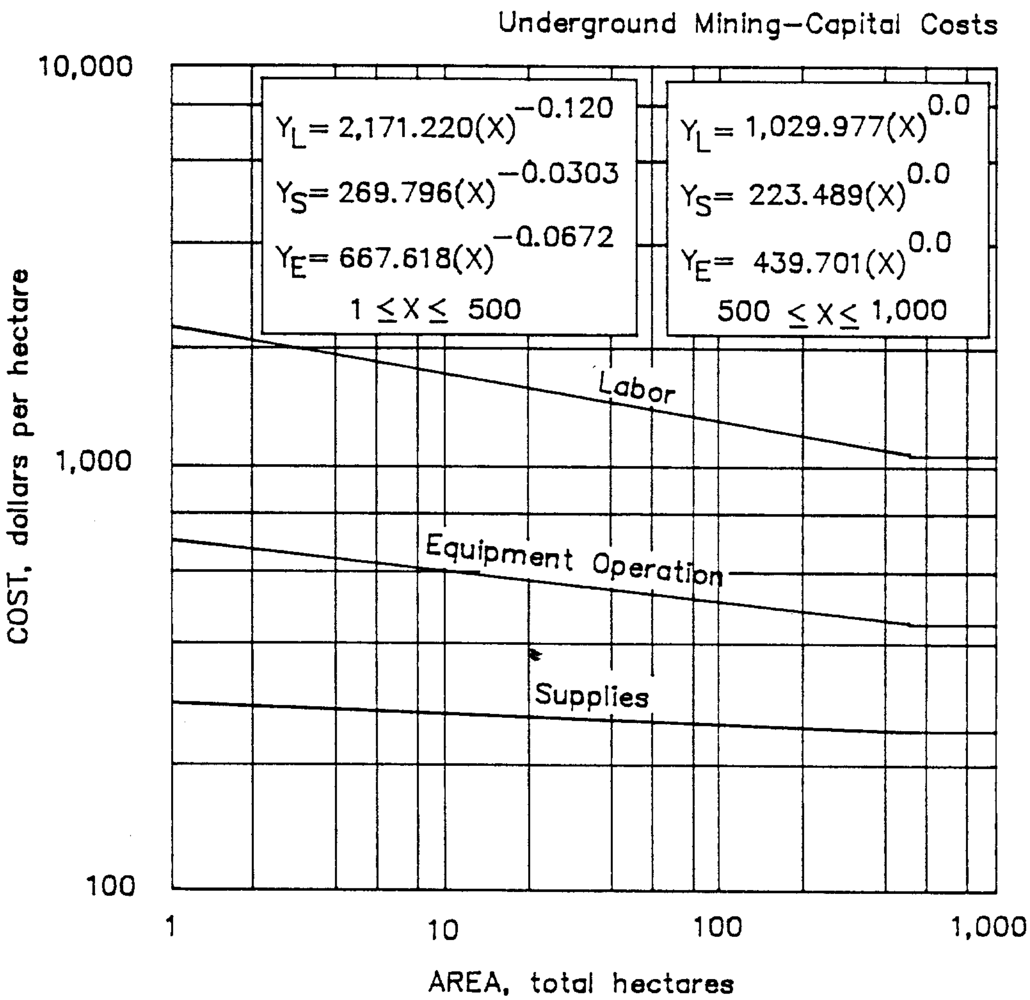
Shifts per day.............	1	2	3
Factor.....................	1.75	1.56	1.50

Subcontractor Factor If a subcontractor is used, multiply the costs obtained from the curves by the following factors to compensate for subcontractor's markup.

Labor factor $(F_L) = 1.50$

Supply factor $(F_S) = 1.20$

Equipment operation factor $(F_E) = 1.20$



4.2.1.1. Clearing

ADJUSTMENT FACTORS

<u>Brush Factor</u> For light clearing conditions where the growth consists mainly of brush and small trees, multiply the curves by the following factors:

Brush factor $(Y_{B\ LIGHT}) = 0.25$

For heavy clearing conditions, defined as when clearing a dense growth of trees (diameter of the trees commonly exceeding 0.33 m), multiply the curves by the following factor:

Brush factor $(Y_{B\ DENSE}) = 1.75$

<u>Side Slope Factor</u> For clearing on terrain with side slopes other than 20% to 50%, multiply the curves by the following factors:

For clearing on terrain with side slopes of 0% to 20%,

Side slope factor $(Y_{S\ 0\%-20\%}) = 0.8$

For clearing on terrain with side slopes of 50% to 100%,

Side slope factor $(Y_{S\ 50\%-100\%}) = 1.2$

For clearing on terrain with side slopes greater than 100%,

Side slope factor $(Y_{S\ +100\%}) = 2.5$

<u>Burning Factor</u> When the burning of cleared brush and trees is prohibited because of environmental regulations, the brush and trees will have to be stacked or buried. If burning is prohibited, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.2$

Supply factor $(F_S) = 0.2$

Equipment operation factor $(F_E) = 1.2$

<u>Equipment Factor</u> Where it is necessary to purchase equipment, or have a subcontractor perform the work, multiply the equipment operation value by the following applicable factor in order to obtain the total value of equipment expense for ownership and operation:

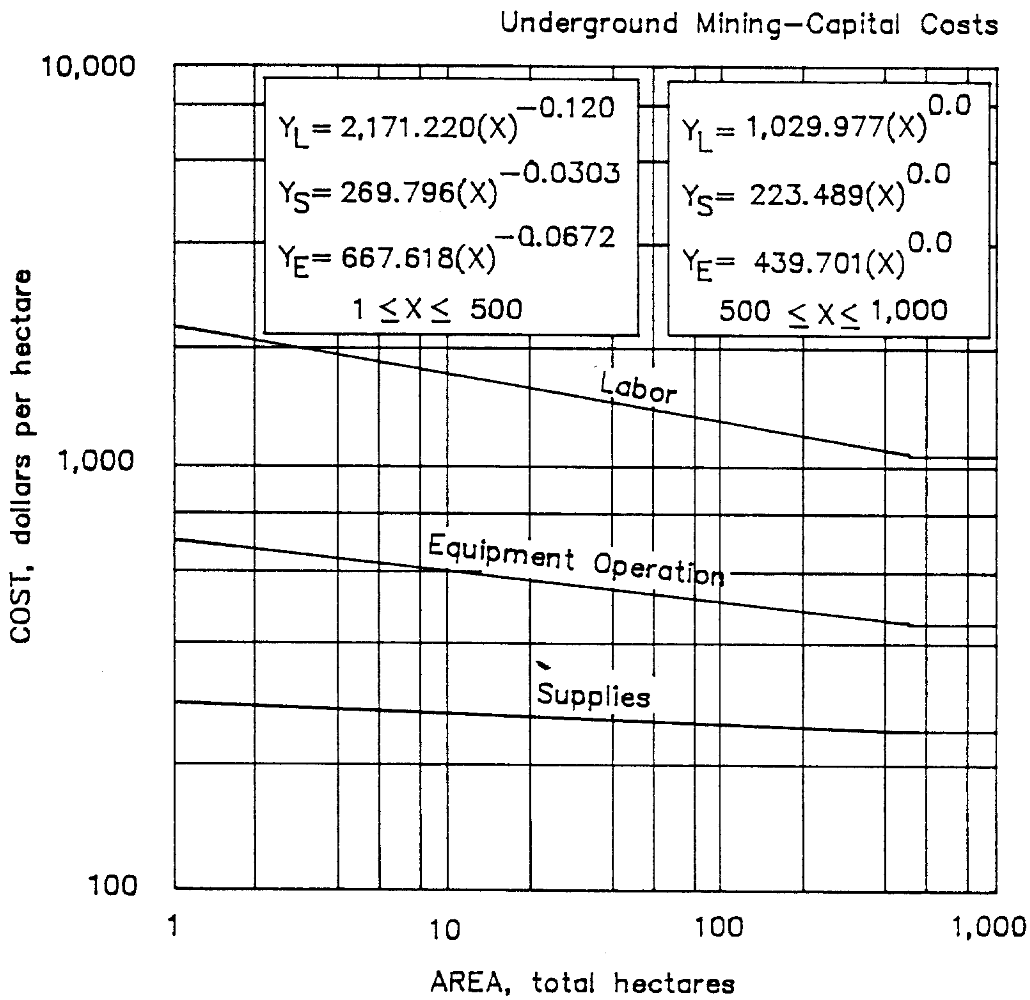
Shifts per day.............	1	2	3
Factor.....................	1.75	1.56	1.50

<u>Subcontractor Factor</u> If a subcontractor is used, multiply the costs obtained from the curves by the following factors to compensate for subcontractor's markup.

Labor factor $(F_L) = 1.50$

Supply factor $(F_S) = 1.20$

Equipment operation factor $(F_E) = 1.20$



4.2.1.1. Clearing

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.2. CORE DRILLING

Core drilling requirements vary considerably from mine to mine. For steeply dipping veins that require continuing development, as mining progresses down- ward, the amount drilled is relatively high; for near surface, flat-lying ore bodies for which grade and ore extent are easily determined, drilling require- ments will be minimal following initial exploration and development. For small to medium sized vein mines, 500 to 2,000 mtpd, typical drilling requirements range from 1,000 to 5,000 m/yr; for large bulk operations, 5,000 to 50,000 mtpd, such as block caving mines, 5,000 m/yr and greater are more typical. The evaluator should determine the approx-imate value appplicable in the instance under study.

Surface rotary or diamond drills may also used for assay control and ore body defi-nition. This is especially true if the ore body is relatively flat lying and near surface. If the evaluator feels that this is characteristic of the case under study, the appropriate surface mining section should be consulted for pertinent costs.

BASE CURVES

The core drilling costs in this section are predicated upon utilizing a diamond drill capable of penetrating to 300 m, an AWG bit (hole size is 4.80 cm, 1.89 in), and an average penetration rate of 12.2 m per shift. All costs are per meter drilled and consider move and down time. Total costs for an in-house drilling program can be estimated as $44.75/m.

The total cost per day is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a drilling rate (X), in meters per day, times the cost per meter. Costs are based on an operating schedule of one shift per day.

(L) <u>Labor Operating Cost</u> (Y_L) = ($21.38/m)(X)
The operating labor costs are distributed as follows:

Direct labor...............	97%
Maintenance labor..........	3%

The operating labor costs are based on straight days pay, drilling bonuses have been ignored, and consist of the following typical range of personnel:

		Av salary per hour (base rate)
Drillers...................	50%	$18.11
Drillers helper............	50%	13.66

Average wage for labor is $15.89 per worker-hour (including burden and average shift differential).

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.3. SINKING SHAFTS

The total cost per meter is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a face area (X), in square meters. The curves are valid for areas between 4 and 40 m^2, with average advances of 1.9 m/d in the smaller shafts and 1.3 m/d overall in the larger shafts, operating three shifts per day. The curves are based on circular shafts with concrete lining. The total cost per meter is multiplied by the total meters of excavation needed during development to obtain the capital cost.

Services installed in the shaft include guides, manways, and air, water, vent, and signal lines. Sinking is considered to be done with a sinking headframe. Costs for permanent hoisting facilities are included in section 4.2.3.1. (Hoisting Facilities).

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 615.595(X)^{0.542}$
The operating labor costs are distributed as follows:

Direct labor...............	84%
Maintenance Labor..........	16%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

		Av salary per hour (base rate)
Miners.....................	34%	$18.44
Helpers....................	22%	15.09
Support....................	44%	17.04

Average wage for labor is $16.35 per worker-hour (including burden and average shift differential)

(S) Supply Operating Cost $(Y_S) = 182.051(X)^{0.558}$
The supply cost consists of 21% explosives, 34% steel items, 38% miscellaneous items, 6% electricity, and 1% timber. Supplies include drill bits and steel, powder, caps, timber, hanging rods, vent line, compressed air pipe, pump line, water line, concrete line, blasting lines, and bell cord.

(E) Equipment Operating Cost $(Y_E) = 681.476(X)^{0.407}$
The equipment operating cost consist of 88% for repair parts, 7% for fuel and lubrication, and 5% for tires (tires used on topside crane and loader servicing the shaft sinking). The equipment operating curve covers daily maintenance and repair, repair parts, and lubrication for drills, fans, muckers, and other equipment used to sink the shaft.

ADJUSTMENT FACTORS

Rock Hardness Factor Shaft sinking productivity is directly related to rock hardness. If the compressive strength of the rock is known, or an estimate can be made from table A-1, multiply the costs obtained from the curves by the following factors (base rock strength = 31,700 psi):

Labor factor $(F_L) = 0.388(C)^{0.093}$

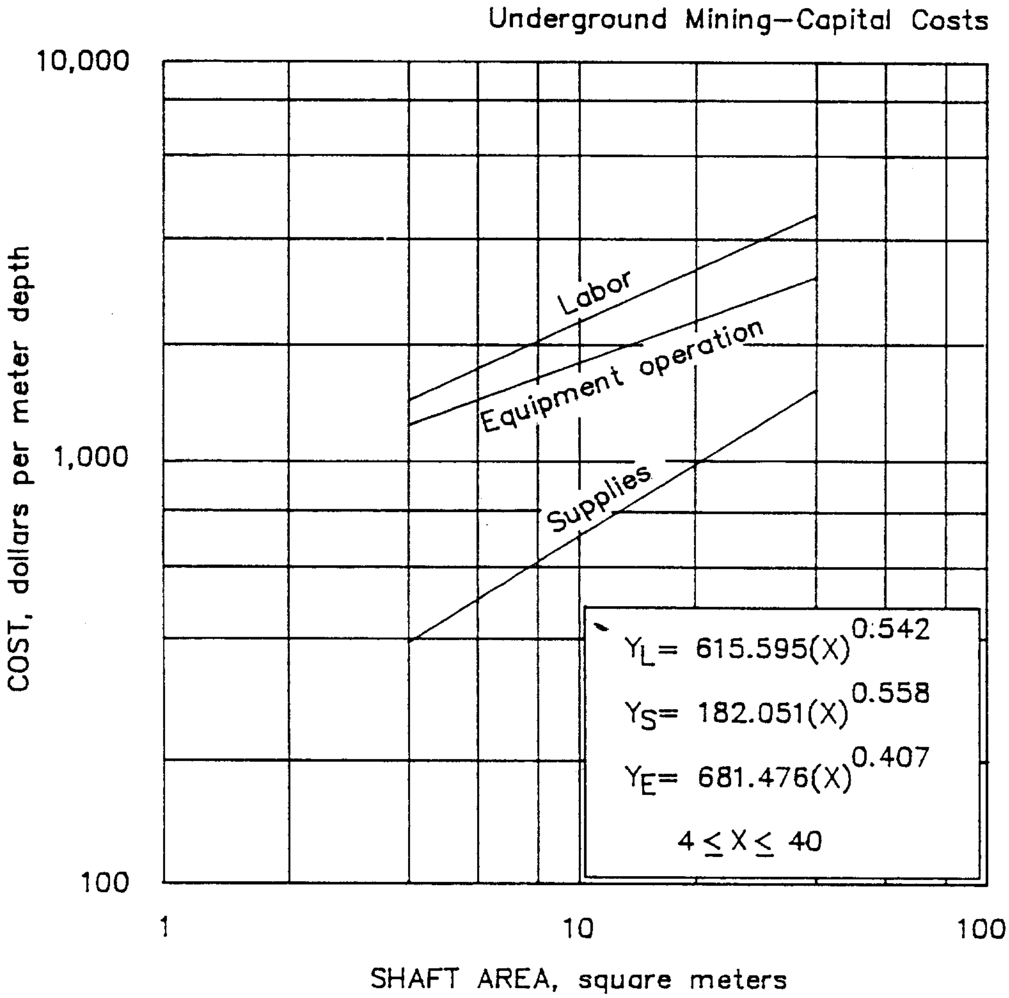
Supply factor $(F_S) = 0.579(C)^{0.054}$

Equipment operation factor $(F_E) = 0.715(C)^{0.033}$
where C = compressive rock strength, in pounds per square inch.

Timber Factor If the shaft is to be lagged with timber instead of lined with concrete, multiply the costs obtained from the curves by the following factor:

Timber factor $(F_T) = 0.482(X)^{0.077}$
where X = face area in square meters.

Assume a timber-lined shaft would have a rectangular configuration.



4.2.1.3. Sinking shafts

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.4.1. DRIFT DEVELOPMENT
SMALL DRIFTS FOR RAIL HAULAGE

Costs derived from these curves apply to drifts with average rock hardness, abrasiveness and standing characteristics are assumed. Advance rates range from 2 to 3 m/d, with productivity averaging 0.39 m per worker-shift. It has been assumed that 10% of the drift will require support consisting of 6-ft expansion shell rock bolts on a regular pattern. Drilling is accomplished with 3-in jacklegs.

The drifting cycle includes drilling, loading, blasting, venting, mucking, scaling, track laying, lunch, and travel. Muck is loaded into 2- or 3-yd^3 development cars using an overshot mucker. Blasted material is hauled an average of 200 m to either a fill point or reconveyance point (ore pass, hoisting station, etc.). The expense of additional handling must be added through the hoisting and/or haulage curves.

Total cost per meter is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a face area (X), in square meters. The curves are valid for areas between 3 and 12 m^2, operating two shifts per day. The cost per meter is multiplied by the total meters of drift needed for development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 79.926(X)^{0.764}$

The operating labor costs are distributed as follows:

Direct labor...............	95%
Maintenance labor..........	5%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

	Small (3 to 6 m^2)	Large (6 to 12 m^2)	Av salary per hour (base rate)
Miners.....................	90%	83%	$18.31
Helpers....................	-	11%	13.86
Motor operators............	10%	6%	16.09

Average wage for labor is $17.56 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 73.283(X)^{0.602}$

The supply cost consists of 44% steel items, 23% explosives, 10% drill bits and steel, 10% ventilation materials, 5% material waste, 4% timber, 3% ballast, and 1% electricity. Supplies include drill bits and steel, powder, caps, primacord, rock bolts, water pipe, compressed air pipe, electricity, steel rail, ties, ballast, ventilation tubing, and material waste.

(E) Equipment Operating Cost $(Y_E) = 4.869(X)^{0.647}$
The equipment operating cost consists of 73% for maintenance and overhaul parts, 11% for fuel, 8% for ground engaging components, and 8% for lubrication. The equipment curve covers daily maintenance and overhaul parts, fuel, lubrication, and ground engaging components. Equipment used in drifting includes jacklegs, overshot muckers, ore cars, jackhammers, locomotives, and auxiliary fans.

ADJUSTMENT FACTORS

Rock Hardness Factor Drifting productivity is directly related to rock hardness. If the compressive strength of the rock is known, or an estimate can be made from table A-1 in the appendix, multiply the costs obtained from the curves by the following factors (base rock strength = 31,700 psi):

Labor factor $(F_L) = 0.388(C)^{0.093}$

Supply factor $(F_S) = 0.579(C)^{0.054}$

Equipment operation factor $(F_E) = 0.715(C)^{0.033}$
where C = compressive rock strength in pounds per square inch.

Rock Bolt Factor For regular bolting of the entire drift, (1.2 bolts per square meter), multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.08$

Supply factor $(F_S) = 1.10$

Equipment operation factor $(F_E) = 1.16$

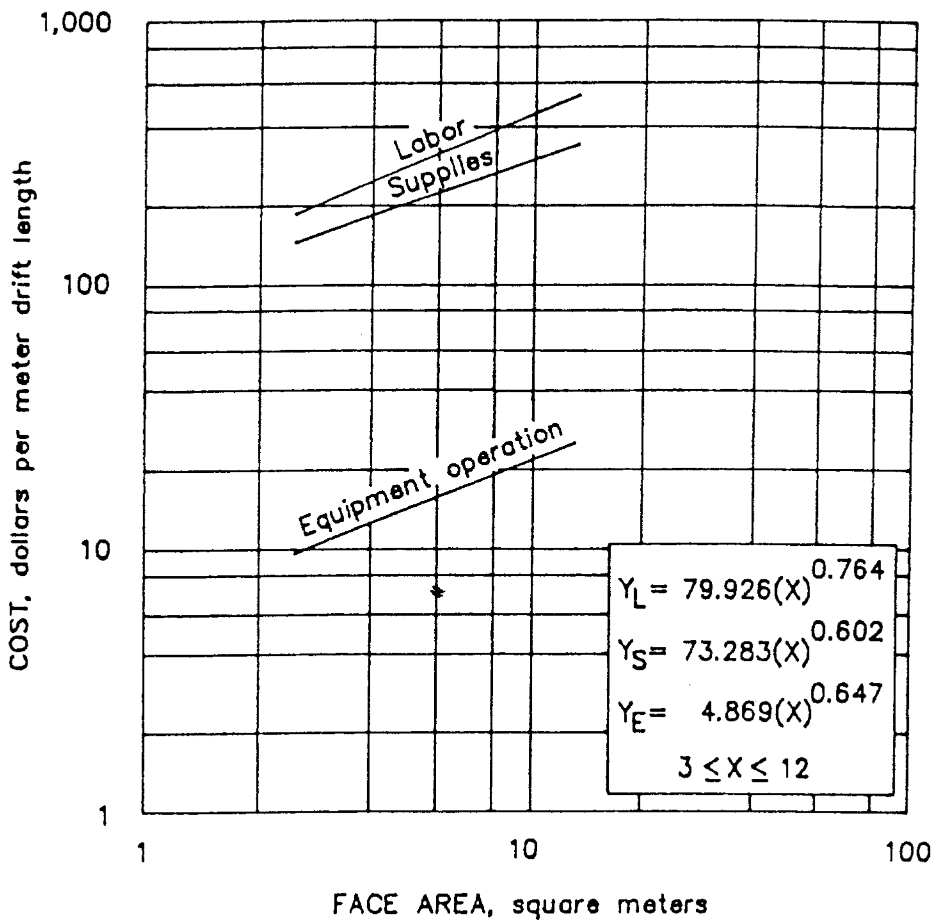
Timbering Factor If the drifts require timbering, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.30$

Supply factor $(F_S) = 1.39$

These factors will account for standard cap-and-post timbering plus lagging for the entire length of the drift.

Underground Mining–Capital Costs



4.2.1.4.1. Drift development
SMALL DRIFTS FOR RAIL HAULAGE

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.4.2. DRIFT DEVELOPMENT
SMALL DRIFTS FOR RUBBER-TIRED HAULAGE

Costs derived from these curves apply to drifts with average rock hardness, abrasiveness and standing characteristics are assumed. Advance rates range from 2.4 to 3.6 m/d, with productivity averaging 0.49 m per worker-shift. It has been assumed that 10% of the drift will require support consisting of 6-ft expansion shell rock bolts on a regular pattern. Drilling is accomplished with 3 in jacklegs.

The drifting cycle includes drilling, loading, blasting, venting, mucking, scaling, lunch, and travel. Mucking is accomplished using an LHD unit. Blasted material is hauled an average of 200 m to either a fill point or reconveyance point (ore pass, hoisting station, etc.). The expense of additional handling must be added through the hoisting and/or haulage curves.

Total cost per meter is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a face area (X), in square meters. The curves are valid for areas between 4 and 12 m^2, operating two shifts per day. The cost per meter is multiplied by the total meters of drift needed for development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 72.721(X)^{0.685}$
The operating labor costs are distributed as follows:

Direct labor...............	96%
Maintenance labor..........	4%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

	Small (4 to 8m^2)	Large (8 to 12 m^2)	Av salary per hour (base rate)
Miners.....................	84%	83%	$18.31
Helpers....................	16%	11%	13.86
LHD Operators..............	-	6%	16.53

Average wage for labor is $17.30 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 43.313(X)^{0.687}$
The supply cost consists of 33% steel items, 33% explosives, 15% ventilation materials, 13% drill bits and steel, 5% material waste, and 1% electricity. Supplies include drill bits and steel, powder, caps, primacord, rock bolts, water pipe, compressed air pipe, electricity, ventilation tubing, and material waste.

(E) Equipment Operating Cost $(Y_E) = 1.360(X)^{1.188}$
The equipment operating cost consists of 64% for maintenance and overhaul parts, 18% for tires, 13% for fuel, and 5% for lubrication. The equipment curve covers daily maintenance and overhaul parts, fuel, lubrication, and tires. Equipment used in drifting includes jacklegs, LHD's, auxiliary fans, and scissor lifts.

ADJUSTMENT FACTORS

Rock Hardness Factor Drifting productivity is directly related to rock hardness. If the compressive strength of the rock is known, or an estimate can be made from table A-1 in the appendix, multiply the costs obtained from the curves by the following factors (base rock strength = 31,700 psi):

Labor factor $(F_L) = 0.388(C)^{0.093}$

Supply factor $(F_S) = 0.579(C)^{0.054}$

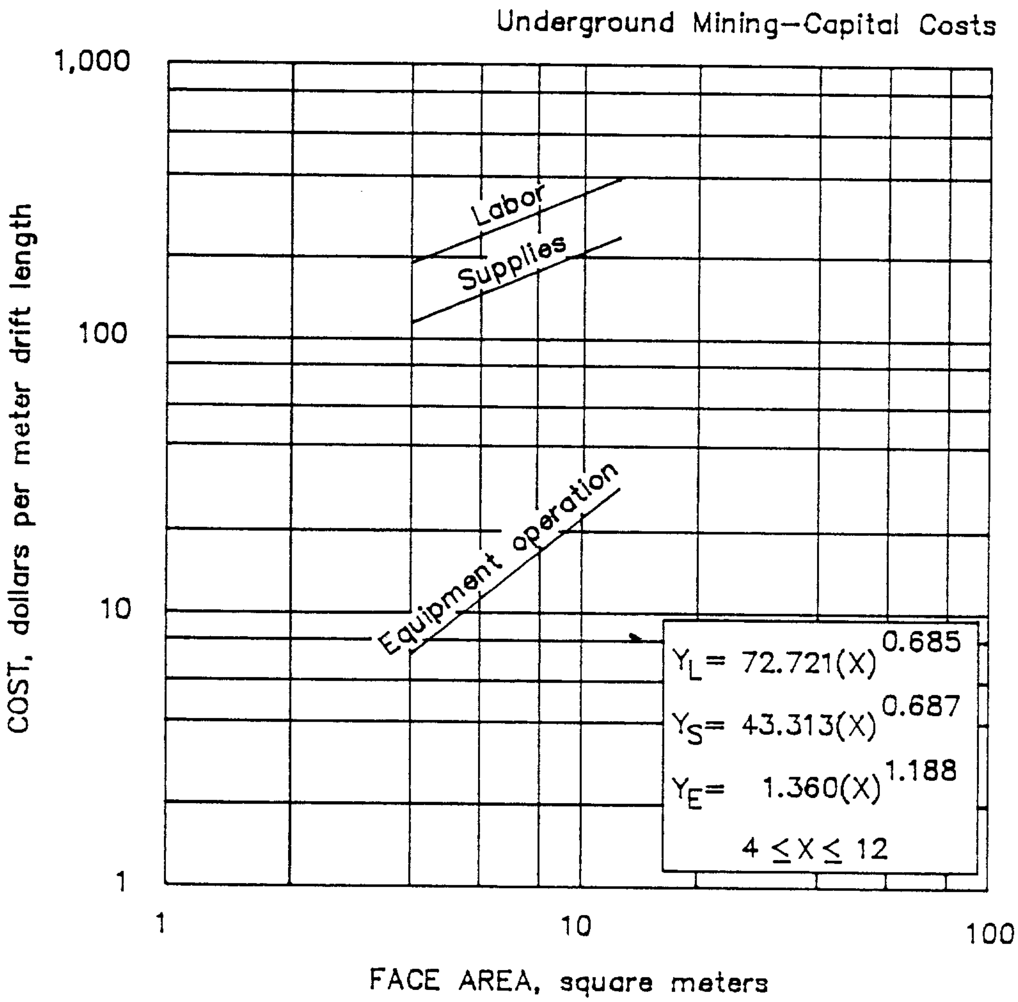
Equipment operation factor $(F_E) = 0.715(C)^{0.033}$
where C = compressive rock strength, in pounds per square inch.

Rock Bolt Factor For regular bolting of the entire drift, (1.2 bolts per square meter), multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.10$

Supply factor $(F_S) = 1.15$

Equipment operation factor $(F_E) = 1.11$



4.2.1.4.2. Drift development
SMALL DRIFTS FOR RUBBER-TIRED HAULAGE

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.4.3. DRIFT DEVELOPMENT
MEDIUM DRIFTS FOR RUBBER-TIRED HAULAGE

Costs derived from these curves apply to drifts with average rock hardness, abrasiveness and standing characteristics are assumed. Advance rates range from 5.4 to 6.0 m/d, with productivity averaging 0.71 m per worker-shift. It has been assumed that 10% of the drift will require support consisting of 6-ft expansion shell rock bolts on a regular pattern. Drilling is accomplished with two- or three-boom jumbos.

The drifting cycle includes drilling, loading, blasting, venting, mucking, scaling, lunch, and travel. Mucking is accomplished using an LHD unit. Blasted material is hauled an average of 200 m to either a fill point or reconveyance point (ore pass, hoisting station, etc.). The expense of additional handling must be added through the hoisting and/or haulage curves.

Total cost per meter is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a face area (X), in square meters. The curves are valid for areas between 6 and 20 m^2, operating two shifts per day. The cost per meter is multiplied by the total meters of drift needed for development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 86.960(X)^{0.349}$
The operating labor costs are distributed as follows:

Direct labor...............	93%
Maintenance labor..........	7%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

	Small (6 to 13 m^2)	Large (13 to 20 m^2)	Av salary per hour (base rate)
Miners.....................	69%	67%	$18.31
Helpers....................	21%	20%	13.86
LHD operators..............	10%	7%	16.53
Utility workers............	-	6%	16.98

The average wage for labor is $17.21 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 27.390(X)^{0.855}$
The supply cost consists of 53% steel items, 29% explosives, 12% ventilation materials, 5% material waste, and 1% electricity. Supplies include drill bits and steel, powder, caps, primacord, rock bolts, water pipe, compressed air pipe, electricity, ventilation tubing, and material waste.

(E) Equipment Operating Cost $(Y_E) = 4.497(X)^{0.684}$
The equipment operating cost consists of 57% for maintenance and overhaul parts, 24% for tires, 14% for fuel, and 5% for lubrication. The equipment curve covers daily maintenance and overhaul parts, fuel, lubrication, and tires. Equipment used in drifting includes jumbo mounted drifters, LHD's, jacklegs, auxiliary fans, and scissor lifts.

ADJUSTMENT FACTORS

Rock Hardness Factor Drifting productivity is directly related to rock hardness. If the compressive strength of the rock is known, or an estimate can be made from table A-1 in the appendix, multiply the costs obtained from the curves by the following factors (base rock strength = 31,700 psi):

Labor factor $(F_L) = 0.388(C)^{0.093}$

Supply factor $(F_S) = 0.579(C)^{0.054}$

Equipment operation factor $(F_E) = 0.715(C)^{0.033}$
where C = compressive rock strength in pounds per square inch.

Rock Bolt Factor For regular bolting of the entire drift, (1.2 bolts per square meter), multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.08$

Supply factor $(F_S) = 1.14$

Equipment operation factor $(F_E) = 1.42$

Shotcrete Factor If the drift is to be shotcreted, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.03$

Supply factor $(F_S) = 1.24$

Equipment operation factor $(F_E) = 1.15$

Concrete Factor If the drift is to be lined with concrete, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.64$

Supply factor $(F_S) = 1.72$

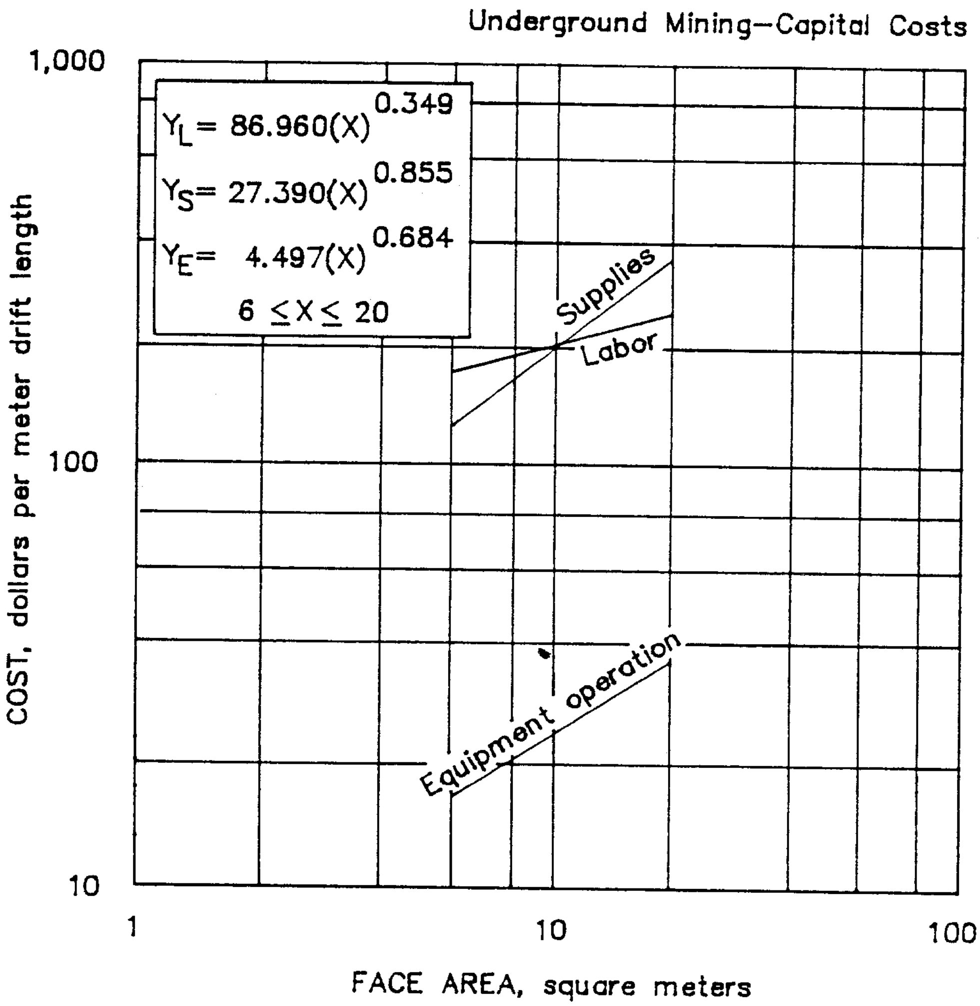
Equipment operation factor $(F_E) = 2.26$

Steel Set Factor If steel sets are to be used, multiply the costs obtained from the curves by the following factors:

Labor factor (F_L) = 1.37

Supply factor (F_S) = 2.47

Equipment operation factor (F_E) = 1.19



4.2.1.4.3. Drift development
MEDIUM DRIFTS FOR RUBBER–TIRED HAULAGE

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.4.4. DRIFT DEVELOPMENT
LARGE DRIFTS FOR RAIL HAULAGE

Costs derived from these curves apply to drifts with average rock hardness, abrasiveness and standing characteristics are assumed. Advance rates range from 5.0 to 6.8 m/d, with productivity averaging 0.57 m per worker-shift. It has been assumed that 10% of the drift will require support consisting of 6-ft expansion shell rock bolts on a regular pattern. Drilling is accomplished with 3 in jacklegs.

The drifting cycle includes drilling, loading, blasting, venting, mucking, scaling, track laying, lunch, and travel. Muck is loaded into 6-to 10-yd^3 development cars using an overshot mucker. Blasted material is hauled an average of 200 m to either a fill point or reconveyance point (ore pass, hoisting station, etc.). The expense of additional handling must be added through the hoisting and/or haulage curves.

Total cost per meter is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a face area (X), in square meters. The curves are valid for areas between 8 and 25 m^2, operating two shifts per day. The cost per meter is multiplied by the total meters of drift needed for development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 27.037(X)^{0.857}$
The operating labor costs are distributed as follows:

Direct labor...............	90%
Maintenance labor..........	10%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

	Small (8 to 16 m^2)	Large (16 to 25 m^2)	Av salary per hour (base rate)
Miners.....................	73%	68%	$18.31
Helpers....................	12%	17%	13.86
Utility workers............	8%	-	16.98
Track workers..............	-	9%	16.53
Motor operators............	7%	6%	16.09

The average wage for labor is $17.34 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 63.689(X)^{0.693}$
The supply cost consists of 53% steel items, 19% explosives, 10% drill bits and steel, 8% ventilation materials, 5% material waste, 3% timber, 1% ballast, and 1% electricity. Supplies include drill bits and steel, powder, caps, primacord,

rock bolts, water pipe, compressed air pipe, electricity, steel rail, ties, ballast, ventilation tubing, and material waste.

(E) Equipment Operating Cost $(Y_E) = 1.437(X)^{1.056}$
The equipment operating cost consists of 83% for maintenance and overhaul parts, 9% for ground engaging components, 4% for fuel, and 4% for lubrication. The equipment curve covers daily maintenance and overhaul parts, fuel, lubrication, and ground engaging components. Equipment used in drifting includes jumbos, overshot muckers, ore cars, jacklegs, jackhammers, locomotives, scissor lifts, rail tampers, roof bolters, and auxiliary fans.

ADJUSTMENT FACTORS

Rock Hardness Factor Drifting productivity is directly related to rock hardness. If the compressive strength of the rock is known, or an estimate can be made from table A-1 in the appendix, multiply the costs obtained from the curves by the following factors (base rock strength = 31,700 psi):

Labor factor $(F_L) = 0.388(C)^{0.093}$

Supply factor $(F_S) = 0.579(C)^{0.054}$

Equipment operation factor $(F_E) = 0.715(C)^{0.033}$
where C = compressive rock strength, in pounds per square inch.

Rock Bolt Factor For regular bolting of the entire drift, (1.2 bolts per square meter), multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.02$

Supply factor $(F_S) = 1.09$

Equipment operation factor $(F_E) = 1.23$

Dual Track Factor To account for two sets of tracks in the drift, multiply the costs obtained from the curves by the following factors: (drifts greater than 16 m^2):

Labor factor $(F_L) = 1.11$

Supply factor $(F_S) = 1.26$

Equipment operation factor $(F_E) = 1.17$

Shotcrete Factor If the drift is to be shotcreted, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.02$

Supply factor $(F_S) = 1.16$

Equipment operation factor $(F_E) = 1.15$

Concrete Factor If the drift is to be lined with concrete, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.52$

Supply factor $(F_S) = 1.81$

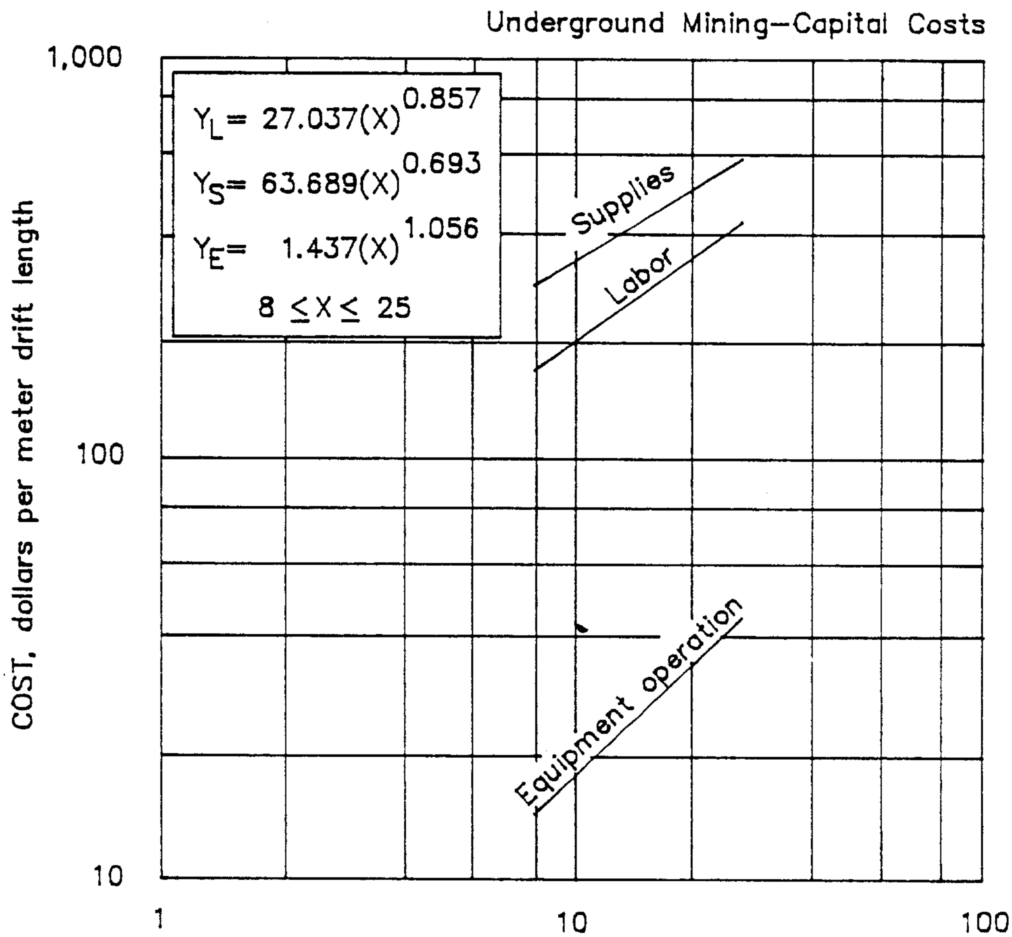
Equipment operation factor $(F_E) = 2.14$

Steel Set Factor If steel sets are to be used, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.29$

Supply factor $(F_S) = 1.95$

Equipment operation factor $(F_E) = 1.10$



4.2.1.4.4. Drift Development
LARGE DRIFTS FOR RAIL HAULAGE

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.4.5. DRIFT DEVELOPMENT
LARGE DRIFTS FOR RUBBER-TIRED HAULAGE

Costs derived from these curves apply to drifts with average rock hardness, abrasiveness and standing characteristics are assumed. Advance rates range from 4.6 to 5.4 m/d, with productivity averaging 0.55 m per worker-shift. It has been assumed that 10% of the drift will require support consisting of 6-ft expansion shell rock bolts on a regular pattern. Drilling is accomplished with two- or three-boom jumbos.

The drifting cycle includes drilling, loading, blasting, venting, mucking, scaling, lunch, and travel. Mucking is accomplished using front-end loaders and trucks. Blasted material is hauled an average of 200 m to either a fill point or reconveyance point (ore pass, hoisting station, etc.). The expense of additional handling must be added through the hoisting and/or haulage curves.

Total cost per meter is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a face area (X), in square meters. The curves are valid for areas between 20 and 50 m^2, operating two shifts per day. The cost per meter is multiplied by the total meters of drift needed for development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 43.360(X)^{0.542}$

The operating labor costs are distributed as follows:

Direct labor..............	91%
Maintenance labor..........	9%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

	Small (20 to 50 m^2)	Large (35 to 50 m^2)	Av salary per hour (base rate)
Miners.....................	68%	59%	$18.31
Helpers....................	11%	20%	13.86
Loader operators...........	7%	6%	16.53
Utility workers............	14%	15%	16.98

The average wage for labor is $17.28 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 57.018(X)^{0.617}$

The supply cost consists of 34% explosives, 33% steel items, 15% drill bits and steel, 12% ventilation materials, 5% material waste, and 1% electricity. Supplies include drill bits and steel, powder, caps, primacord, rock bolts, water pipe, compressed air pipe, electricity, ventilation tubing, and material waste.

(E) Equipment Operating Cost $(Y_E) = 4.144(X)^{0.661}$
The equipment operating cost consists of 60% for maintenance and overhaul parts, 25% for fuel, 11% for tires, and 4% for lubrication. The equipment curve covers daily maintenance and overhaul parts, fuel, lubrication, and tires. Equipment used in drifting includes jumbo mounted drifters, front end loaders, jacklegs, auxiliary fans, and scissor lifts.

ADJUSTMENT FACTORS

Rock Hardness Factor Drifting productivity is directly related to rock hardness. If the compressive strength of the rock is known, or an estimate can be made from table A-1 in the appendix, multiply the costs obtained from the curves by the following factors (base rock strength = 31,700 psi):

Labor factor $(F_L) = 0.388(C)^{0.093}$

Supply factor $(F_S) = 0.579(C)^{0.054}$

Equipment operation factor $(F_E) = 0.715(C)^{0.033}$
where C = compressive rock strength, in pounds per square inch.

Rock Bolt Factor For regular bolting of the entire drift, (1.2 bolts per square meter), multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.12$

Supply factor $(F_S) = 1.13$

Equipment operation factor $(F_E) = 1.31$

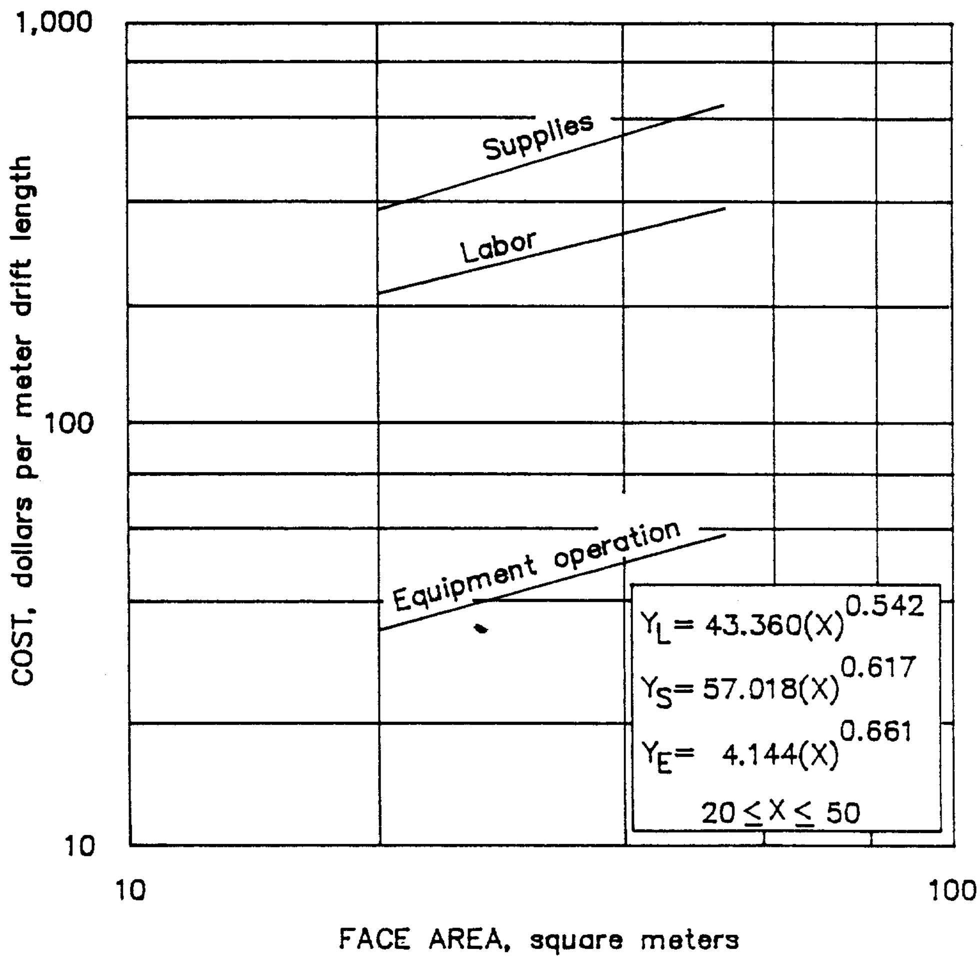
Shotcrete Factor If the drift is to be shotcreted, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 1.03$

Supply factor $(F_S) = 1.19$

Equipment operation factor $(F_E) = 1.15$

Underground Mining—Capital Costs



4.2.1.4.5. Drift development

LARGE DRIFTS FOR RUBBER—TIRED HAULAGE

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.4.6. DRIFT DEVELOPMENT DRIFT-TUNNEL BORING

This section covers costs associated with a mine using drift-tunnel boring machines (TBM's) and associated equipment.

The total cost per meter is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the excavated machine diameter (X), in meters. The curves are valid for diameters between 2.74 and 10.67 m, operating two shifts per day. The cost per meter is multiplied by the total meters of drift or tunnel needed for development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 142.640(X)^{0.000}$
The operating labor costs are distributed as follows:

Direct labor...............	62%
Maintenance labor..........	38%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

		Av salary per hour (base rate)
Operator...................	14%	$18.31
Helpers....................	22%	13.86
Support....................	64%	16.27

The average wage for labor is $15.92 per worker-hour (including burden and average shift differential).

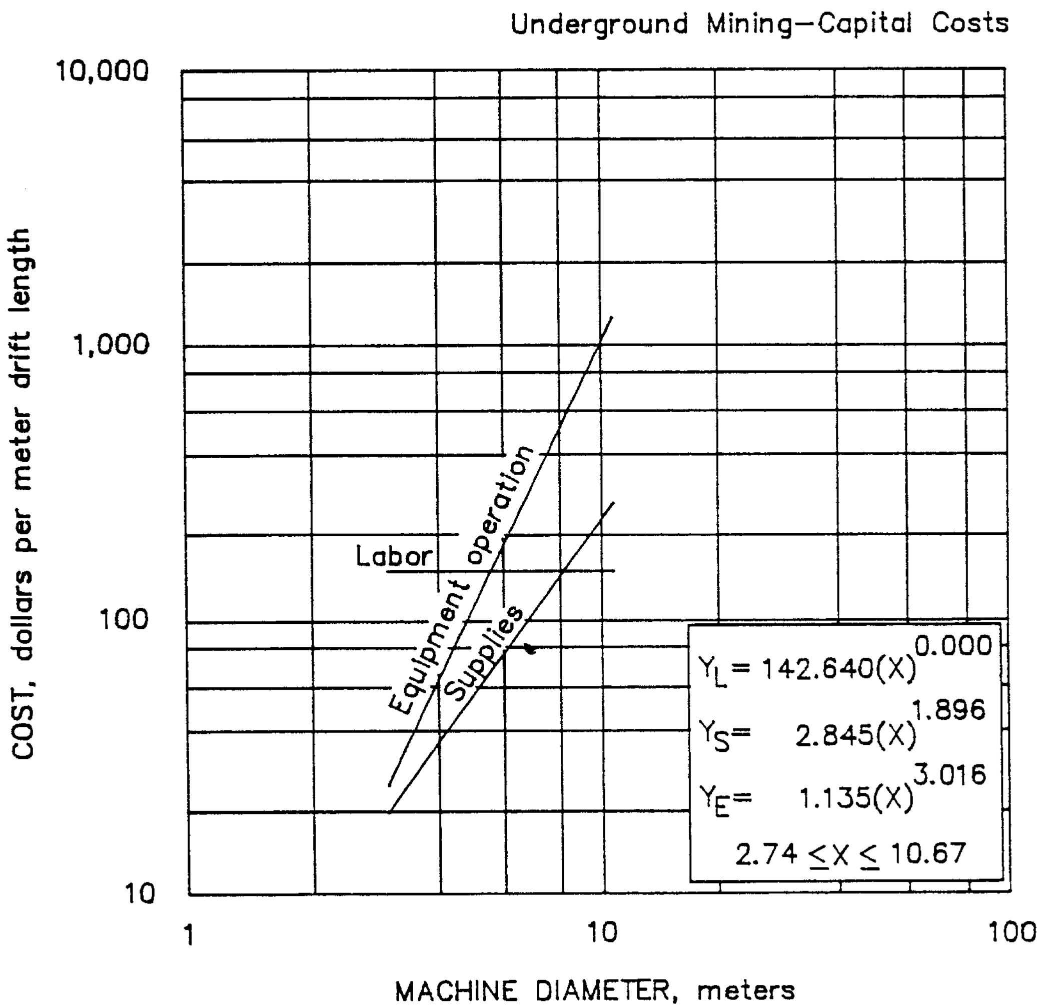
(S) Supply Operating Cost $(Y_S) = 2.845(X)^{1.896}$
The supply cost consists of 81% drill and cutter bits, 5% lubrication, 13% electricity, and 1% miscellaneous items. Supplies include oil, filters, wear items, and power.

(E) Equipment Operating Cost $(Y_E) = 1.135(X)^{3.016}$
The equipment operating cost consists of 69% for maintenance and overhaul parts and 31% for cutter costs. The equipment operating curve covers daily maintenance and repair, repair parts, and cutter costs.

ADJUSTMENT FACTOR

Contractor Factor A contractor is often used with drift-tunnel boring because of the specialized nature of the machinery. If a contractor is used, multiply the costs obtained from the curves by the following factor:

Labor factor $(F_L) = 1.94$



4.2.1.4.6. Drift development
DRIFT/TUNNEL BORING

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.5.1. RAISE DEVELOPMENT DRIVING RAISES

The costs calculated from these curves represent two-compartment, conventionally driven raises. It is assumed that the raises are timbered and lagged, and contain water and compressed air lines. Advance rates range from 0.83 m per worker-shift for a 2.3 m^2 raise to 0.49 m per worker-shift for a 9.3 m^2 raise. It is assumed that blasted material is hauled an average distance of 200 m to a conveyance point (ore pass, hoisting station, etc.) using rail mounted equipment. If the material is to be hauled out of the mine, the tonnage attributed to raising should be added to the haulage curves for the period of time necessary to complete the raise.

Total cost per meter is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a face area (X), in square meters. The curves are valid for areas between 2 and 9.5 m^2, operating two shifts per day. The cost per meter is multiplied by the total meters of raise needed for preproduction development to obtain the capital cost.

BASE CURVES

(L) <u>Labor Operating Cost</u> $(Y_L) = 134.819(X)^{0.438}$
The operating labor costs are distributed as follows:

Direct labor...............	96%
Maintenance labor..........	4%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

	Small (2 to 6 m^2)	Large (6 to 9.5 m^2)	Av salary per hour (base rate)
Miners.....................	85%	76%	$18.31
Helpers....................	12%	19%	13.86
Motor operators............	3%	5%	16.09

The average wage for labor is $17.53 per worker-hour (including burden and average shift differential).

(S) <u>Supply Operating Cost</u> $(Y_S) = 109.009(X)^{0.526}$
The supply cost consists of 51% timber, 19% explosives, 10% steel pipe, 10% ventilation materials, 4% material waste, 5% drill bits and steel, and 1% electricity. Supplies include drill bits and steel, powder, caps, lead wire, water pipe, compressed air pipe, vent duct, electricity, and timber.

(E) <u>Equipment Operating Cost</u> $(Y_E) = 2.267(X)^{0.757}$
The equipment operating cost consists of 57% for maintenance and overhaul parts, 33% for ground engaging components, and 10% for lubrication. The equipment curve covers maintenance and overhaul parts, ground engaging components, and

lubrication. Equipment used for raising includes stoper drills, fans, locomotives, ore cars, and overshot muckers.

ADJUSTMENT FACTORS

Timber Factor If the raise is not timbered and lagged, multiply the costs obtained from the curves by the following factors:

Labor factor (F_L) = 0.76

Supply factor (F_S) = 0.50

These factors will account for the fact that the only timber needed will be for ladders, landings, and drill platforms (stull supported), and that the labor will be reduced since no timber installation time will be required.

Raise Climber Factor If a raise climber is used, construction time is significantly reduced, but an extra piece of equipment is required. To modify the costs, multiply the costs obtained from the curves by the following factors:

Labor factor (F_L) = 0.56

Equipment operation factor (F_E) = 1.44

Rubber-Tired Equipment Factor If an LHD is used for muck disposal, it is assumed that the overshot mucker, battery locomotive, and rail cars would be eliminated. To compensate for this, multiply the costs obtained from the curves by the following factors:

Labor factor (F_L) = 0.99

Equipment operation factor (F_E) = 1.25

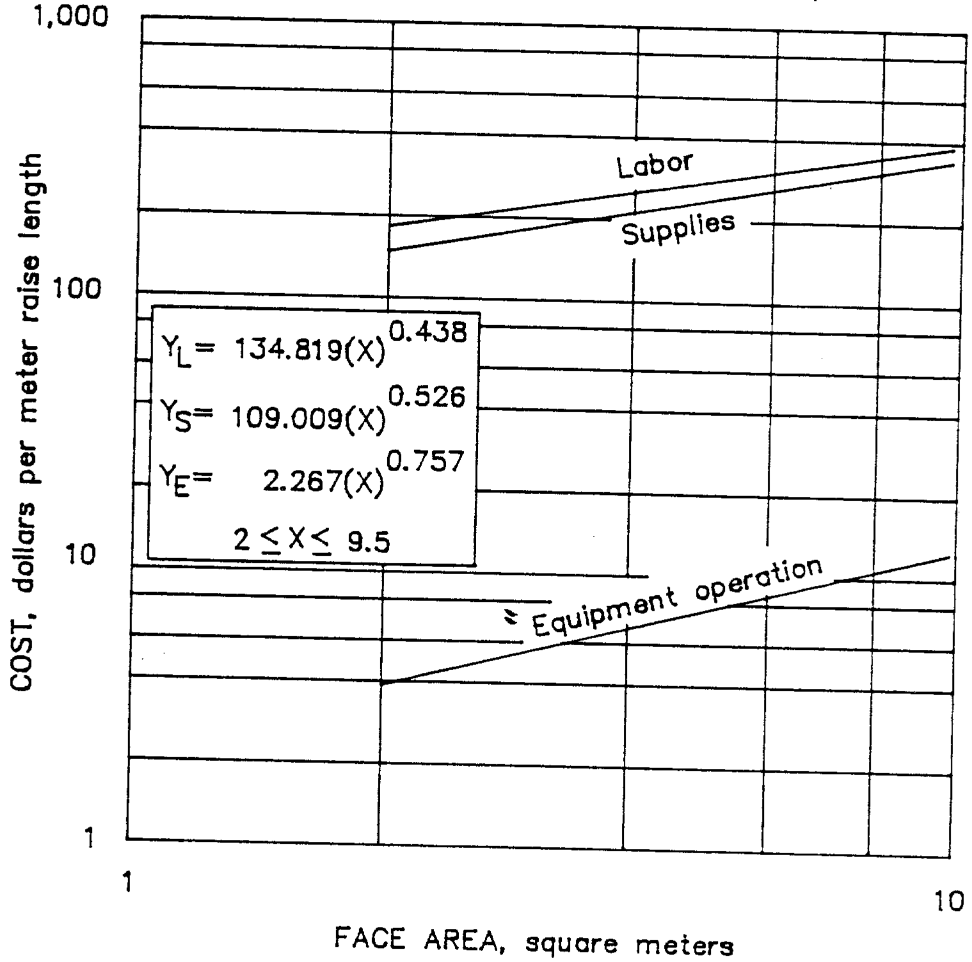
Steel Chute Factor The placement of a steel chute, with an air piston activated, reverse guillotine steel door, at the bottom of a raise requires additional labor and supplies. However, the need for an overshot mucker is eliminated. To account for the additional expense, for each raise, add to the costs obtained from the curves the following amounts:

Labor factor (F_L) = \$1,172.00

Supply factor (F_S) = \$6,940.00

To account for the absence of the overshot mucker multiply the equipment costs obtained from the curves by the following factor:

Equipment operation factor (F_E) = 0.80



4.2.1.5.1. Raise development
DRIVING RAISES

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.5.2. RAISE DEVELOPMENT
DROP RAISES

With the advent of down-the-hole drills, longhole or drop raising is becoming a popular method of driving large ventilation raises and ore passes. The costs estimated using these curves apply to any unlined raise driven using down-the-hole drills and vertical crater retreat blasting methods. Advance rates range from 1.5 m per worker-shift for a 4.6 m^2 raise to 1.0 m per worker-shift for a 13.4 m^2 raise. It is assumed that blasted material is hauled an average distance of 200 m to a conveyance point (ore pass, hoisting station, etc.) using rubber-tired LHD's. If the material is to be hauled out of the mine, the tonnage attributed to raising should be added to the haulage curves for the period of time necessary to muck the raise.

Total cost per meter is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a face area (X), in square meters. The curves are valid for areas between 4.5 and 13.5 m^2, operating two shifts per day. The cost per meter is multiplied by the total meters of raise required for development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 58.314(X)^{0.374}$
The operating labor costs are distributed as follows:

Direct labor...............	86%
Maintenance labor..........	14%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

		Av salary per hour (base rate)
Drillers...................	29%	$18.31
Helpers....................	15%	13.86
Blasters...................	43%	18.31
LHD operators..............	13%	16.53

The average wage for labor is $17.41 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 136.383(X)^{0.205}$
The supply cost consists of 68% blasting materials, 24% drill bits and steel, 7% miscellaneous items, and 1% timber. Supplies include drill bits and steel, blasting agent, caps, primers, detonation cord, timber, and caristrap.

(E) Equipment Operating Cost $(Y_E) = 8.895(X)^{0.711}$
The equipment operating cost consists of 43% for maintenance and overhaul parts, 41% for fuel, 9% for tires, and 7% for lubrication. The equipment curve covers daily maintenance and overhaul parts, fuel, lubrication, and tires. Equipment used in drop raising includes down-the-hole drills mounted on air tracks, portable air compressors, LHD units, and portable bit grinders.

ADJUSTMENT FACTORS

Rock Hardness Factor Down-hole-drill productivity is directly related to rock hardness. If the compressive strength of the rock is known, or an estimate can be made from table A-1 in the appendix, multiply the costs obtained from curves by the following factors (base rock strength = 31,700 psi):

Labor factor $(F_L) = 0.388(C)^{0.093}$

Supplies factor $(F_S) = 0.579(C)^{0.054}$

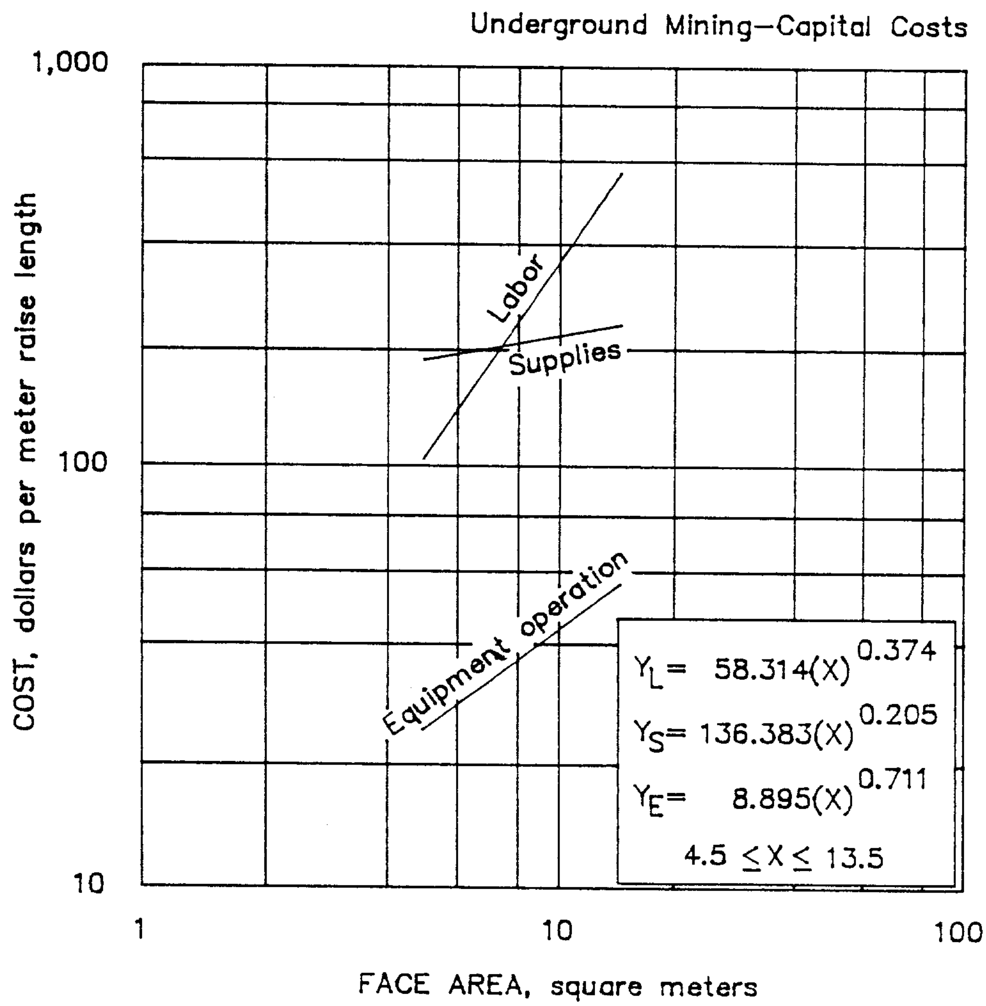
Equipment operation factor $(F_E) = 0.716(C)^{0.033}$
where C = compressive rock strength, in pounds per square inch.

Service Installation Factor Few drop raises are used as service raises. If, however, services are installed in the raise, multiply the labor and supply costs by the following factors:

Labor factor $(F_L) = 1.51$

Supplies factor $(F_S) = 1.37$

This will account for the purchase and installation of rockbolts, ladders, landings, and pipe.



4.2.1.5.2. Raise development
DROP RAISES

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.5.3. RAISE DEVELOPMENT
RAISE BORING

The costs calculated using these curves apply to any unlined bored raise that has been drilled down and reamed up. The curves take into account costs incurred in preparation of upper and lower stations, drill platform construction, boring machine installation, pilot hole drilling, reaming operations, and muck removal. Average advance rates, including station preparation, vary from 1.89 m per worker-shift for a 1.5-m-diameter raise to 1.06 m per worker-shift for a 3-m-diameter raise. It is assumed that reamer cuttings are hauled an average distance of 200 m to a conveyance point (ore pass, hoisting station, etc.) using rubber-tired LHD's. If the material is to be hauled out of the mine, the tonnage attributed to raise boring must be added to the haulage curves for the period of time necessary to complete the raise.

Total cost per meter is the sum of three separate cost curves (mining and repair labor, supplies, and equipment operation) calculated using a raise diameter (X), in meters. The curves are valid for diameters between 1.5 and 3 m, operating two shifts per day. This cost is multiplied by the total meters of raise needed during development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 81.941(X)^{1.376}$
The operating labor costs are distributed as follows:

Direct labor...............	49%
Maintenance labor..........	51%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

		Av salary per hour (base rate)
Miners......................	31%	$18.31
Raise bore operators.......	26%	18.31
Raise bore helpers.........	26%	13.86
LHD operators..............	8%	16.09
Helpers....................	8%	13.86
Nippers....................	1%	16.09

The average wage for labor is $16.60 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 180.595(X)^{1.097}$
The supply cost consists of 83% drill and cutter bits, 5% material waste, 4% drill steel, 3% electricity, 3% blasting materials, 1% rock support, and 1% miscellaneous items. Supplies include drill bits and steel for the air legs, drill bits, cutter bits, and drill steel for the boring machine, blasting agent, caps, detonation cord, rock bolts, wire mesh, concrete, and electricity.

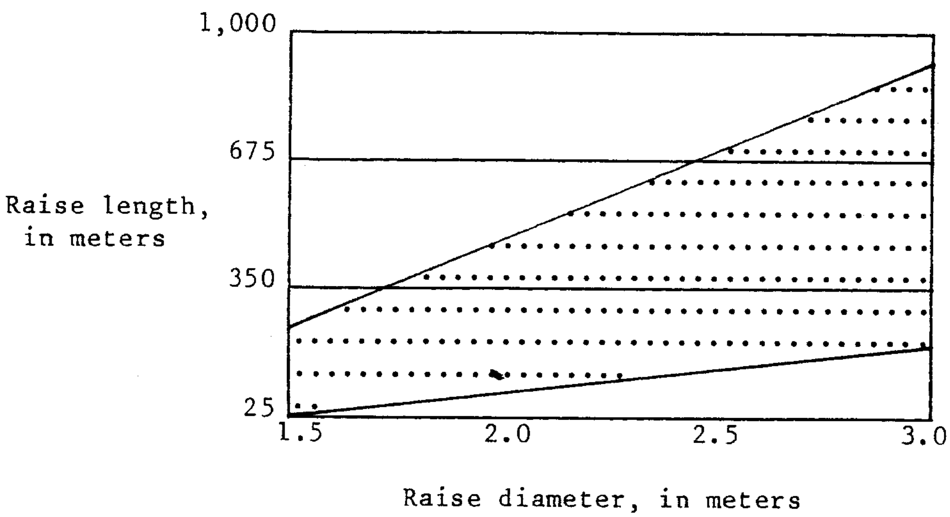
(E) Equipment Operating Cost $(Y_E) = 46.568(X)^{1.759}$
The equipment operating cost consists of 69% for maintenance and overhaul parts, 22% for ground engaging components, 7% for lubrication, and 2% for fuel and tires. The equipment curve covers overhaul and maintenance parts, ground engaging components, fuel, lubrication, and tires. The equipment used for raise boring and station preparation includes air leg drills, LHD units, and raise bore machines.

ADJUSTMENT FACTORS

Raise Length Factor Because of the high costs incurred in station preparation and machine setup, the actual cost per meter will decrease as the length of the raise increases. The raise curves were derived using an assumed raise length of 100 m. If the length of the raise differs from this, multiply the costs obtained from the curves by the following factor:

Length factor $(F_L) = 1.468(L)^{-0.080}$
where L = raise length, in meters.

The following graph illustrates recommended lengths for various raise diameters:



Lining Factor If the raise is to be used as an ore chute or vent raise, it may be lined with steel. To account for this, multiply the labor and supply costs by the following factors:

Labor factor $(F_L) = 1.12$

Supply factor $(F_S) = 1.27(X)^{0.276}$
where X = raise diameter, in meters.

Service Installation Factor If services are installed in the raise, multiply the labor and supply costs by the following factors:

Labor factor $(F_L) = 1.21$

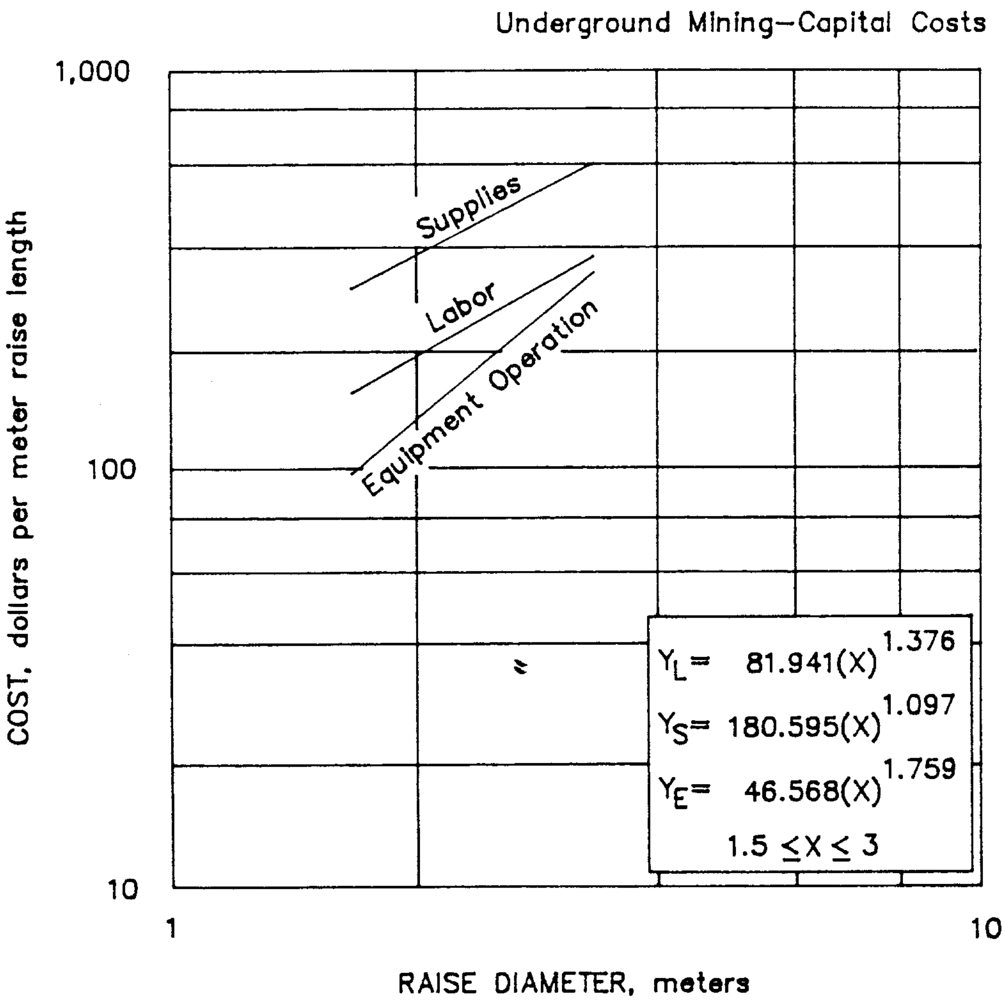
Supply factor $(F_S) = 1.16$

This will account for the purchase and installation of rockbolts, ladders, landings, and pipe.

Rock Hardness Factor The hardness of the rock being bored has a great effect on both penetration rate and cutter life. The curves were derived using rock with an assumed compressive strength of 50,000 psi. Total cost may range from 25% of the cost for rock with a compressive strength of 14,500 psi to 200% of the cost for rock with a compressive strength of 75,000 psi. Actual variances are very difficult to estimate; however, as a general rule of thumb, for differences in rock hardness, multiply the costs obtained from the curves by the following factor:

Hardness factor $(F_H) = 0.0000018(C)^{1.231}$

where C = compressive strength of rock in, pounds per square inch. See table A-1 in the appendix for average compressive rock strengths.



4.2.1.5.3. Raise development
RAISE BORING

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.6. INCLINES-DECLINES

The curve covers a range of inclines-declines with average advances of 2.2 m/d in the smaller openings and 0.6 m/d overall in the larger openings. The curve is based on using jumbo drills and LHD haulage. Assume the opening is at a 10^{o} angle. The cost per meter of advance does not change for angles 5^{o} to 15^{o}.

Total cost per meter is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a face area (X), in square meters. The curves are valid for areas between 4 and 50 m^2, operating one shift per day. The cost per meter is multiplied by the total meters of excavation needed during development to obtain the capital cost.

Services installed include water and compressed air lines, and heavy duty steel-reinforced vent tubing. Rock competency is considered good, with just 10% of the back requiring rock bolting.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 42.779(X)^{0.789}$
The operating labor costs are distributed as follows:

Direct labor...............	93%
Maintenance labor..........	7%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

		Av salary per hour (base rate)
Miners.....................	63%	$18.11
Helpers....................	23%	13.66
LHD operator...............	14%	15.89

The average wage for labor is $16.78 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 48.709(X)^{0.567}$
The supply cost consists of 40% explosives, 44% steel items, and 16% miscellaneous items. Supplies include drill bits and steel, powder, caps, primer, rock-bolts, vent line, compressed air and water pipes.

(E) Equipment Operating Cost $(Y_E) = 1.498(X)^{1.303}$
The equipment operating cost consists of 49% for repair parts, 32% for fuel and lubrication, and 19% for tires. The equipment operating curve covers daily maintenance and repair, repair parts, and lubrication for drills, fans, LHD's, and other equipment used to drive the opening.

ADJUSTMENT FACTORS

Rock Hardness Factor Drifting productivity is directly related to rock hardness. If the compressive strength of the rock is known, or an estimate can be made from table A-1 in the appendix, multiply the costs obtained from the curves by the following factors (base rock strength = 31,700 psi):

Labor factor (F_L) = $0.388(C)^{0.093}$

Supply factor (F_S) = $0.579(C)^{0.054}$

Equipment operation factor (F_E) = $0.715(C)^{0.033}$
where C = compressive rock strength, in pounds per square inch.

Rockbolt Factor For regular bolting of the entire drift (1.2 bolts per square meter) multiply the costs obtained from the curves by the following factors:

Labor factor (F_L) = 1.08

Supply factor (F_S) = 1.14

Equipment operation factor (F_E) =1.42

Shotcrete Factor If the drift is to be shotcreted, multiply the costs obtained from the curves by the following factors:

Labor factor (F_L) = 1.03

Supply factor (F_S) = 1.24

Equipment operation factor (F_E) = 1.15

Concrete Factor If the drift is to be lined with concrete, multiply the costs obtained from the curves by the following factors:

Labor factor (F_L) = 1.64

Supply factor (F_S) = 1.72

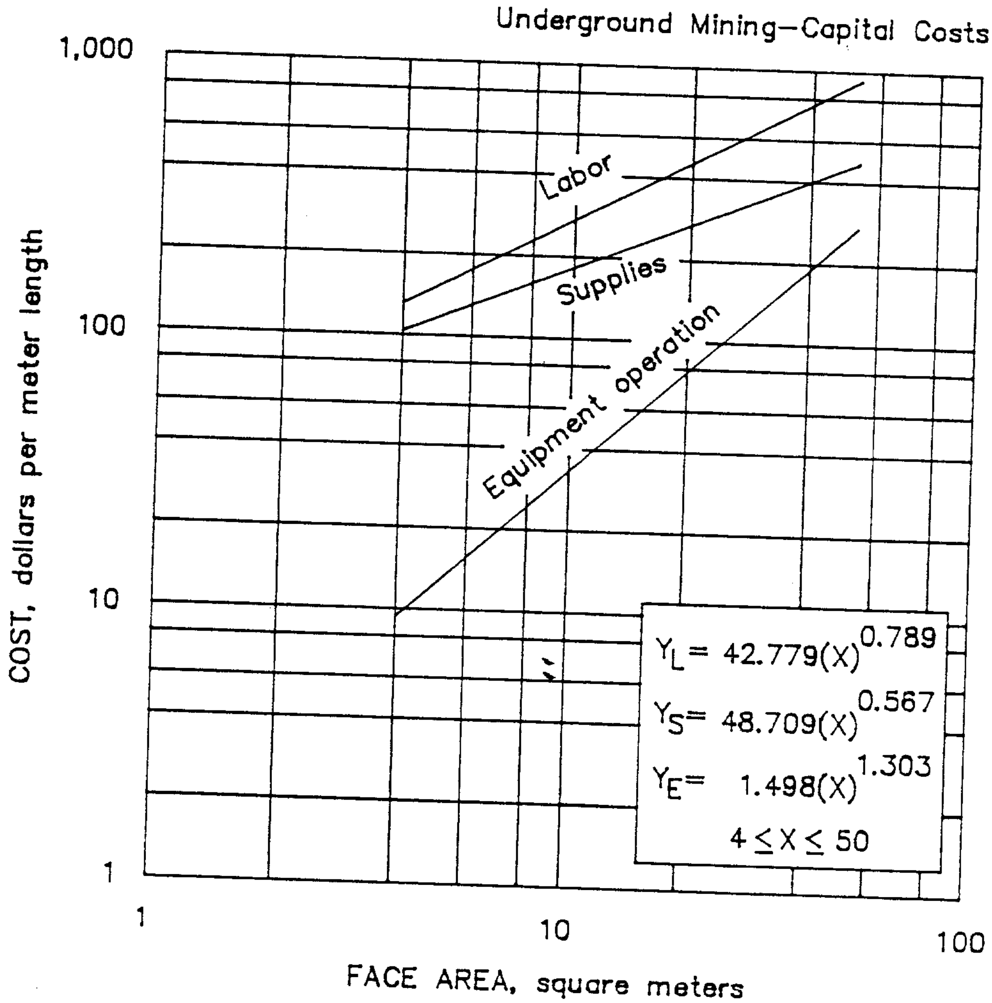
Equipment operation factor (F_E) = 2.26

Steel Set Factor If steel sets are to be used, multiply the costs obtained from the curves by the following factors:

Labor factor (F_L) = 1.37

Supply factor (F_S) = 2.47

Equipment operation factor (F_E) = 1.19



4.2.1.6. Inclines/declines

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.7. LARGE UNDERGROUND EXCAVATIONS

The costs derived from these curves apply to a horizontal opening driven with a two boom jumbo and LHD haulage a distance of 200 m. It is assumed the walls will be supported with rockbolts and wire mesh. If the material is to be hauled out of the mine, the tonnage attributed to excavating should be added to to the haulage curves for the period of time necessary to complete the excavation. It is assumed that all equipment needed for the excavation will be required for the mining operation, and will be considered in the mine equipment cost curve.

Total cost per meter is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a face area (X), in square meters. The curves are valid for areas between 13.94 and 334.45 m^2, operating one shift per day. The cost per meter is multiplied by the total meters of excavation needed during development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 10.817(X)^{0.947}$
The operating labor costs are distributed as follows:

Direct labor...............	91%
Maintenance labor..........	9%

The operating labor costs are based on straight days pay and consist of the following typical range of personnel:

		Av salary per hour (base rate)
Miners.....................	76%	$18.11
Helpers....................	19%	13.66
Motor operators............	5%	15.89

The average wage for labor is $17.16 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 23.050(X)^{0.793}$
The supply cost consists of 66% explosives, 28% steel items, and 6% ventilation. Supplies include drill bits and steel, powder, caps, primer cord, water pipe, compressed air pipe, vent duct, rockbolts and wire mesh.

(E) Equipment Operating Cost $(Y_E) = 1.739(X)^{0.917}$
The equipment operating cost consists of 45% for overhaul and repair parts, 35% for tires, and 20% for fuel and lubrication. The equipment operating curve covers daily maintenance and overhaul parts and lubrication for drills, fans, LHD's, and roof bolters.

ADJUSTMENT FACTORS

Track Haulage Factor If track haulage is used, the LHD will be replaced by a battery locomotive, overshot mucker, and rail cars. Rubber-tired equipment is more expensive to operate than rail-mounted equipment. Therefore, to account for cost of the equipment and installing rail, multiply the costs obtained from the curves by the following factors:

Supply factor (F_S) = 1.13

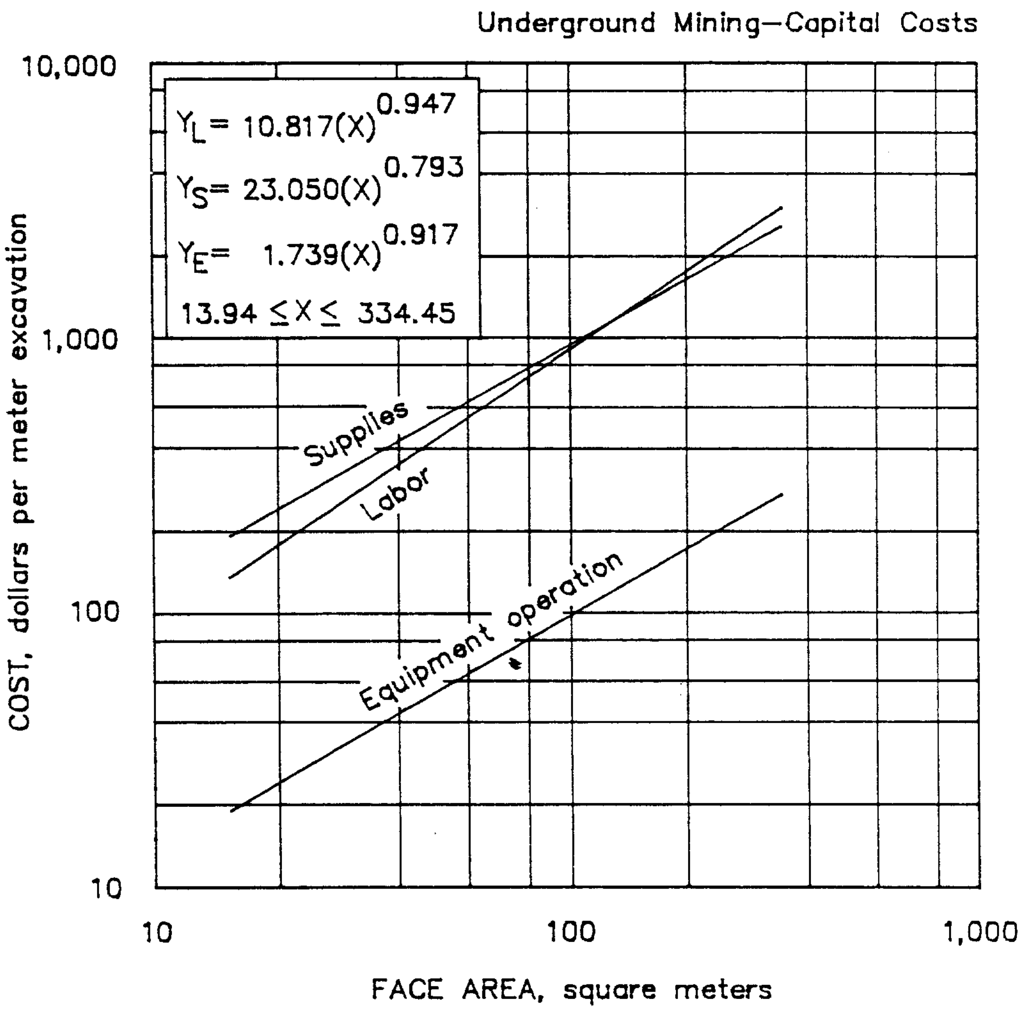
Equipment operation factor (F_E) = 0.71

Shotcrete Factor For additional expenses associated with coating the excavation to a shotcrete depth of 3.8 cm, multiply the costs obtained from the curves by the following factors:

Labor factor (F_L) = 1.05

Supply factor (F_S) = 1.59

Equipment operation factor (F_E) = 1.09



4.2.1.7. Large underground excavations