4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.8. ORE POCKETS

The ore pocket curve is based on total capacity in metric tons. To derive the cost of an ore pocket for a given capacity, enter the capacity in metric tons. The value derived will give the cost for one ore pocket with the entered capacity. The curve is based on one pocket per entry, including the cost of excavation and the installation of a double-gate ore chute. For this reason, each ore pocket to be costed must be entered separately on the curve.

The total cost of each ore pocket is the sum of three separate curves (labor, supplies, and equipment operation) based on the capacity of each ore pocket (X), in total metric tons. The curves are valid for capacities between 100 and 10,000 mt, operating two shifts per day.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 21.695(X)^{0.931}$

The operating labor costs are distributed as follows:

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

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.....................	100%	$18.31

Average operating labor cost per worker-hour is $18.31 (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 1.961(X)^{0.994}$

The supply cost consists of 44% explosives, 45% steel items, and 11% miscellaneous items. Supplies include powder, caps, and drill bits and steel.

(E) Equipment Operating Cost $(Y_E) = 6,640.547(X)^{0.009}$

The equipment operating cost consists of 98% for the ore gate and repair parts, and 2% for fuel and lubrication. The cost covers daily maintenance and repair, repair parts, and lubrication for the drills and ore gates, plus the purchase of the gates.

ADJUSTMENT FACTORS

Rock Hardness Factor 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 pocket, (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 $(F_S) = 1.14$

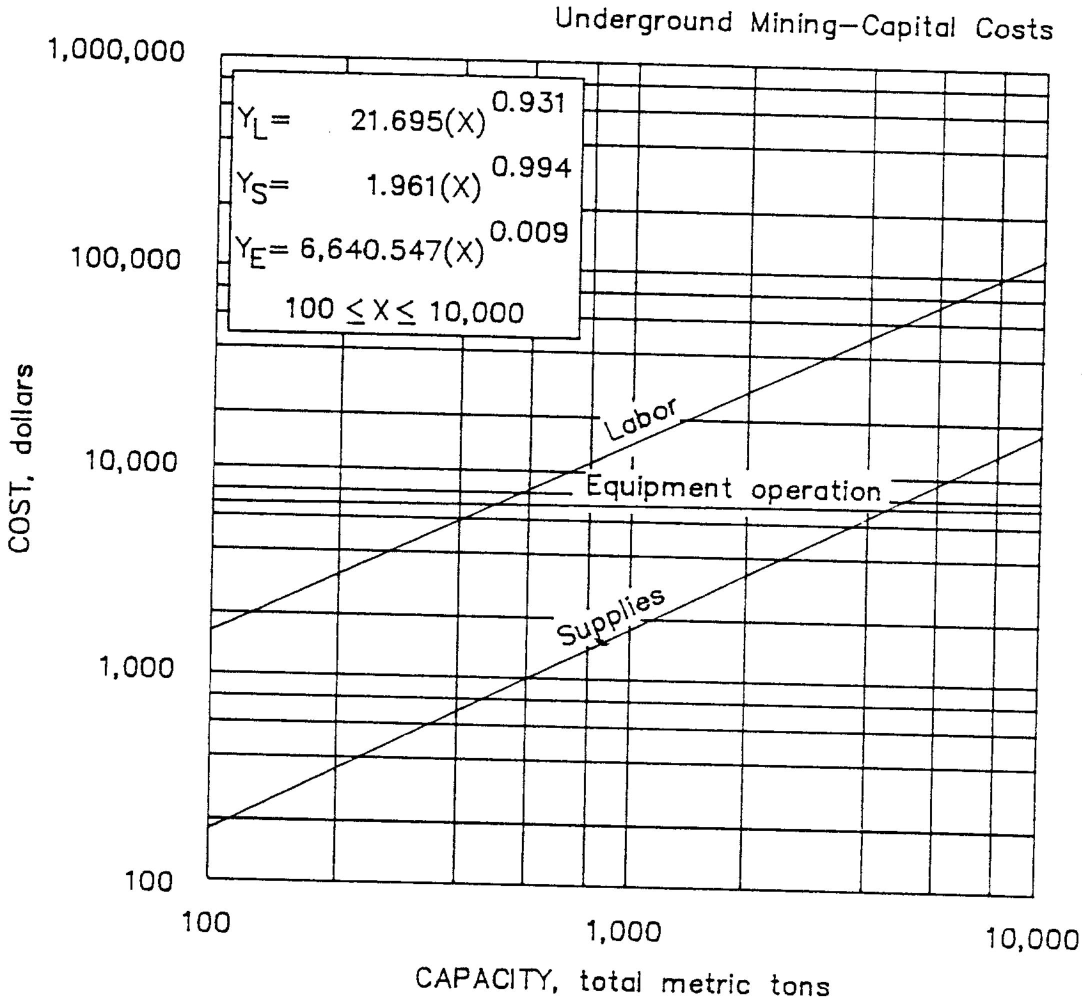
Equipment operation factor $(F_E) = 1.42$

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 $(F_L) = 1.5$

Supply factor $(F_S) = 1.2$

Equipment factor $(F_E) = 1.2$



4.2.1.8. Ore pockets

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.9. STOPE PREPARATION

Stope preparation includes any operation and excavation necessary to bring a stope into full-scale production. Stope preparation is, of course, different for every mining method, so each method is dealt with individually in the following sections In general, however, costs derived from the following curves cover every operation and excavation needed to develop the stope for full-capacity extraction, and to connect it with the main haulage system. A detailed list of items needed for individual methods is provided in each of the following sections. In order to obtain an accurate cost estimation, the evaluator must provide the dimensions and estimated tonnage of a typical stope designed for the deposit under evaluation.

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.9.1. STOPE PREPARATION BLOCK CAVING

Items needed for preparation of a block caving stope include panel drifts, access drifts, grizzly drifts, undercut drifts, draw raises, transfer raises, and cave induction. All ore chutes, grizzlies, and support and reinforcement items are included in the curve. Costs represent a system in which ore is moved to the main haulage level by gravity methods.

Total cost per block is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a typical block plan view area (X), product of length and width, in square meters. The curves are valid for areas between 2,400 and 6,300 m^2 (of any height), operating two shifts per day. The costs are then multiplied by the number of blocks required for preproduction development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 573.198(X)^{0.881}$
The operating labor costs are distributed as follows:

Direct labor...............	98%
Maintenance labor..........	2%

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.....................	72%	$18.31
Helpers....................	24%	13.86
LHD operators..............	4%	16.09

The average wage for labor is $17.15 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 650.100(X)^{0.883}$
The supply cost consists of 26% steel items, 25% concrete, 20% timber, 18% blasting supplies, 5% contingency, 4% drill bits and steel, and 2% all other items. Supplies necessary for the development of a block caving stope include drill bits and steel, blasting agent, caps, timber, concrete, rail, water and compressed air pipe, ventilation ducting, rockbolts, electricity, and steel for ore chutes and grizzlies.

(E) Equipment Operating Cost $(Y_E) = 11.355(X)^{0.885}$
The equipment operating cost consists of 76% for maintenance and overhaul parts, 9% for tires, 8% for fuel, and 7% for lubrication. The equipment curve covers daily maintenance and overhaul parts, tires, fuel, and lubrication. Equipment

used in stope preparation for block caving includes jacklegs, auxiliary fans, overshot muckers, locomotives, ore cars, LHD's, and fan drills.

ADJUSTMENT FACTORS

Nongravity Caving Factor If the ore is to be transferred to the main haulage system using slushers or LHD's, adjustments must be made to the costs. Multiply the costs obtained from the curves by the following factors:

Slushers:

Labor factor (F_L) = 0.85

Supply factor (F_S) = 0.83

Equipment operation factor (F_E) = 0.99

LHD's:

Labor factor (F_L) = 0.60

Supply factor (F_S) = 0.84

Equipment operation factor (F_E) = 0.77

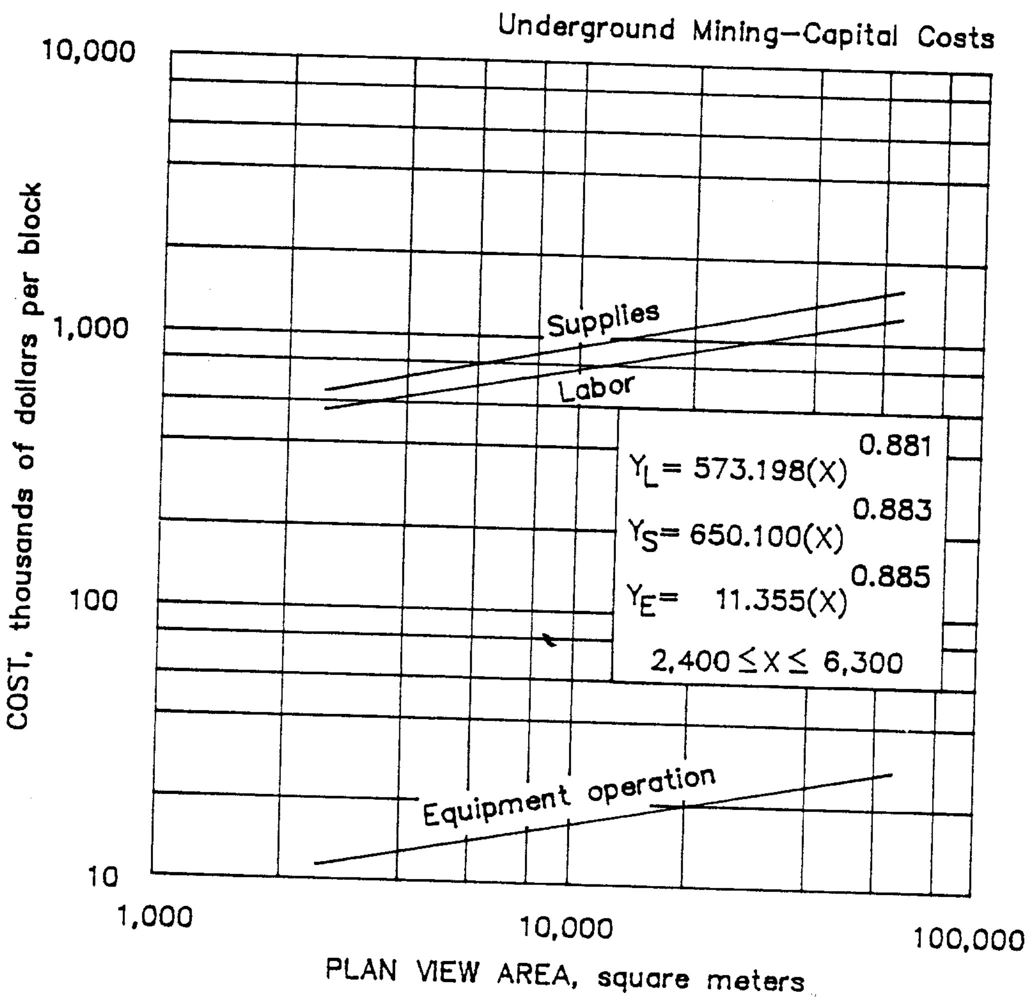
Rock Hardness Factor Block caving development costs are directly related to rock hardness. If the compressive strength of the rock is known, or an estimate can be made from table A-1 in the appendix, multiply the costs obtained from the equations by the following factors (base rock strength = 31,700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

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

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

Equipment operation factor (F_E) = $0.716(C)^{0.033}$

where C = compressive rock strength, in pounds per square inch.



4.2.1.9.1. Stope preparation
BLOCK CAVING

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.9.2. STOPE PREPARATION CONTINUOUS MINING

Continuous miner stopes are initiated with multientry panels directly off the main haulage level. The method changes little from the initial cuts to the completion of the stope. The cost of the main haulage level cannot be included in the stope preparation costs since many stopes benefit from this one entry. Because the cost per ton of excavation of the production entries from the haulage level is the same as that for production mining, no stope preparation cost is required.

For capital cost estimation, the length of main or secondary haulageways must be sufficient to open up the required number of stopes for initial production.

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.9.3. STOPE PREPARATION CUT AND FILL

Items needed for preparation of a cut-and-fill stope include a crosscut from the main haulageway, a blind raise access cut with two ore chutes, a manway, and a timber slide, and an initial bottom sill cut. The curves cover stopes ranging from 2.4 m wide by 61.0 m long to 4.9 m wide by 106.7 m long, and of any reasonable height.

Total cost per stope is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a plan view area (X), product of length and width, in square meters. The curves are valid for areas between 140 and 540 m^2, operating two shifts per day. The costs are then multiplied by the number of stopes required for preproduction development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 4,422.948(X)^{0.369}$
The operating labor costs are distributed as follows:

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

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

	Small (140 to 340 m^2)	Large (340 to 540 m^2)	Av salary per hour (base rate)
Miners.....................	69%	73%	$18.31
Helpers....................	25%	23%	13.86
Motor Operators............	6%	4%	16.09

The average wage for labor is $17.13 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 16,203.090(X)^{0.197}$
The supply cost consists of 31% timber, 25% blasting supplies, 24% steel items, 5% drill bits and steel, 5% contingency, 4% ventilation material, 3% sandfill preparation material, and 3% electricity and miscellaneous items. Supplies necessary for the development of a cut-and-fill stope include drill bits and steel, blasting agent, caps, timber, rail, ballast, steel pipe, ventilation ducting, rockbolts, burlap, electricity, and steel for ore chutes.

(E) Equipment Operating Cost $(Y_E) = 311.270(X)^{0.201}$
The equipment operating cost consists of 85% for maintenance and overhaul parts, 8% for lubrication, and 7% for ground engaging components. The equipment curve covers maintenance and overhaul parts, ground engaging components, and lubrication. Equipment used in stope preparation for cut-and-fill mining includes

jacklegs, stopers, jackhammers, auxiliary fans, overshot muckers, locomotives, ore cars, and slushers.

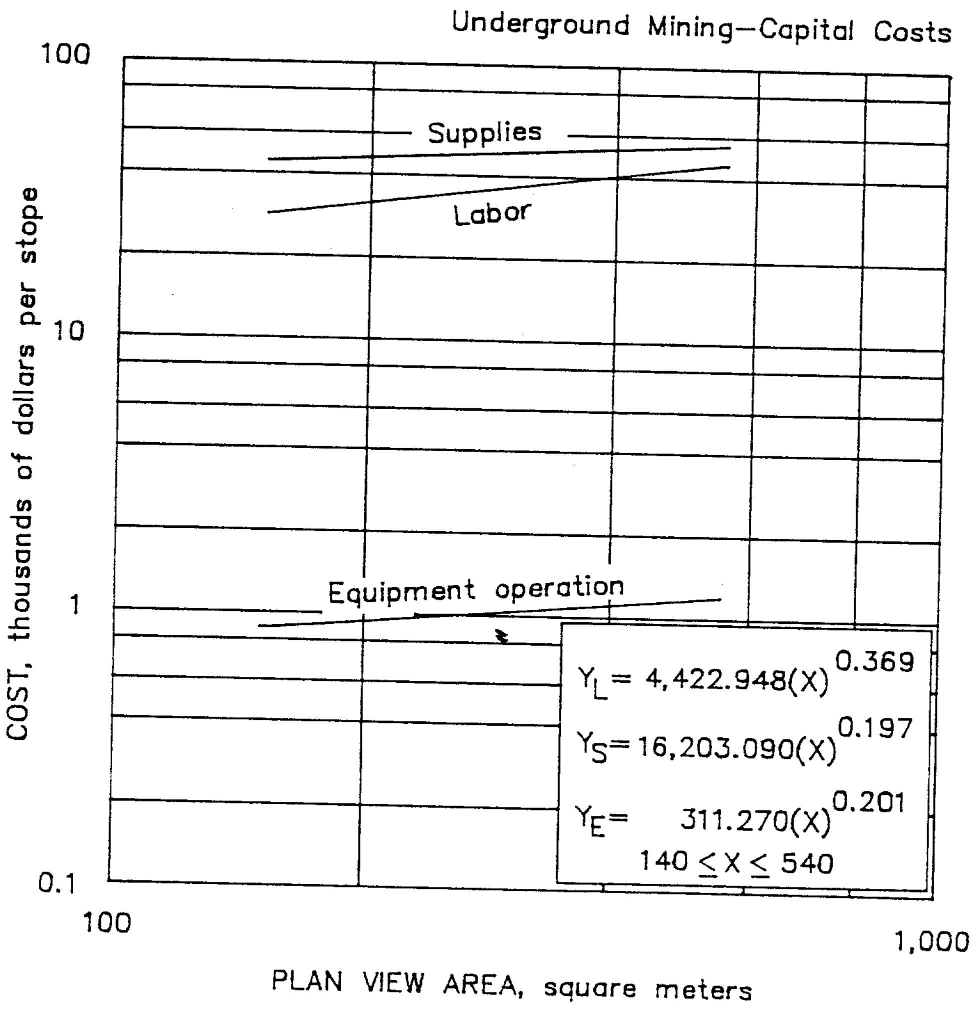
ADJUSTMENT FACTOR

Rock Hardness Factor Cut-and-fill stope development costs are 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 $(F_L) = 0.403(C)^{0.090}$

Supply factor $(F_S) = 0.590(C)^{0.052}$

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



4.2.1.9.3. Stope preparation
CUT AND FILL

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.9.4. STOPE PREPARATION LONGHOLE-SUBLEVEL

Items needed for preparation of a sublevel-longhole stope include sublevels, a bottom sill cut, a scram drift, crosscuts connecting the bottom sill and scram drifts, an access raise, and a slot raise. The curves cover stopes ranging from 5.4 m wide by 61.0 m high by 76.2 m long to 18.3 m wide by 121.9 m high by 152.4 m long.

Total cost per stope is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a profile view area (X), product of length and height, in square meters. The curves are valid for areas between 4,600 and 18,600 m^2, operating two shifts per day. The costs are then multiplied by the number of stopes required for preproduction development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 357.256(X)^{0.685}$
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 (4,600 to 11,600 m^2)	Large (11,600 to 18,600 m^2)	Av salary per hour (base rate)
Miners.....................	65%	65%	$18.31
Helpers....................	22%	22%	13.86
LHD operators..............	9%	8%	16.09
Utility workers............	3%	4%	15.94
Surveyors	1%	1%	15.08

The average wage for labor is $17.05 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 363.252(X)^{0.687}$
The supply cost consists of 46% blasting supplies, 16% steel items, 10% drill bits and steel, 9% ventilation materials, 9% timber, 5% contingency, and 5% electricity and miscellaneous items. Supplies necessary for the development of a sublevel-longhole stope include drill bits and steel, blasting agent, caps, timber, water and compressed air pipe, ventilation ducting, electricity, and rockbolts.

(E) Equipment Operating Cost $(Y_E) = 23.555(X)^{0.707}$
The equipment operating cost consists of 57% for maintenance and overhaul parts, 19% for tires, 17% for fuel, and 7% for lubrication. The equipment curve covers maintenance and overhaul parts, fuel, tires, and lubrication. Equipment

used in stope preparation for sublevel-longhole mining includes jacklegs, auxiliary fans, LHD's, booster compressors, jumbo mounted drifters, and airtrack-mounted longhole drills.

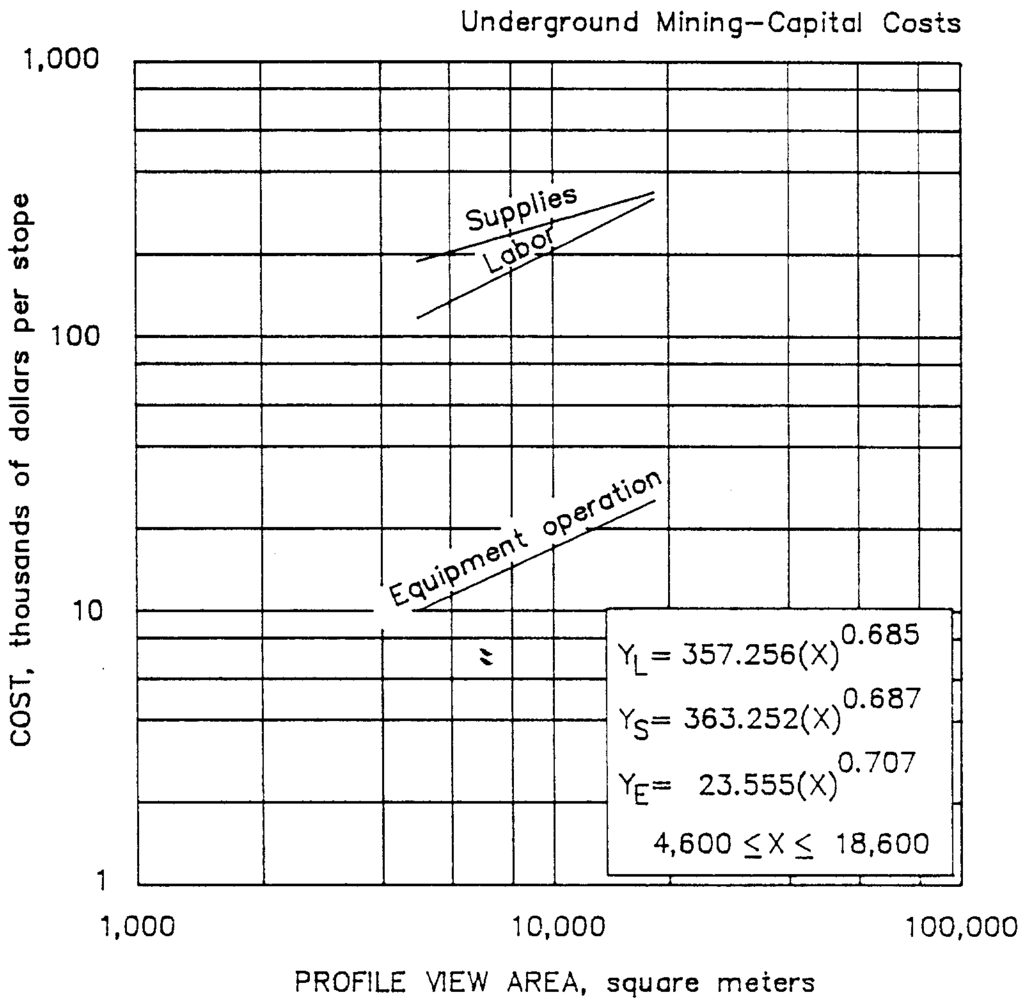
ADJUSTMENT FACTOR

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

Labor factor $(F_L) = 0.392(C)^{0.093}$

Supply 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.



4.2.1.9.4. Stope preparation
LONGHOLE/SUBLEVEL

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.9.5. STOPE PREPARATION RESUING

Items needed for preparation of a resuing stope include an access drift along the stope in the footwall, a blind raise access cut with two ore chutes and a manway, and a starter drift running the length of the stope. The blind raise runs the entire height of the stope, and both the raise and the starter drift are driven in ore and waste. Ore excavated during development is generally discarded as waste. The curves cover stopes ranging from 22.9 m long by 18.3 m high to 45.7 m long by 38.1 m high, and 1.5 m in width.

Total cost per stope is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a profile view area (X), product of length and height, in square meters. The curves are valid for areas between 350 and 2,000 m^2, operating two shifts per day. The costs are then multiplied by the number of stopes required for preproduction development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 1,077.505(X)^{0.448}$
The operating labor costs are distributed as follows:

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

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.....................	86%	$18.31
Helpers....................	9%	13.86
Motor operators............	5%	18.31

The average wage for labor is $17.80 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 4,004.706(X)^{0.290}$
The supply cost consists of 61% steel items, 13% blasting supplies, 12% timber, 6% ventilation materials, 4% drill bits and steel, 3% contingency, and 1% electricity and miscellaneous items. Supplies necessary for the development of a resuing stope include drill bits and steel, blasting agent, caps, timber, rail, ballast, steel pipe, ventilation ducting, electricity, and steel for ore chutes.

(E) Equipment Operating Cost $(Y_E) = 24.097(X)^{0.499}$
The equipment operating cost consists of 67% for maintenance and overhaul parts, 16% for ground engaging components, 9% for fuel, and 8% for lubrication. The

equipment curve covers maintenance and overhaul parts, ground engaging components, fuel, and lubrication. Equipment used in stope preparation for resuing includes jacklegs, stopers, auxiliary fans, overshot muckers, locomotives, ore cars, and slushers.

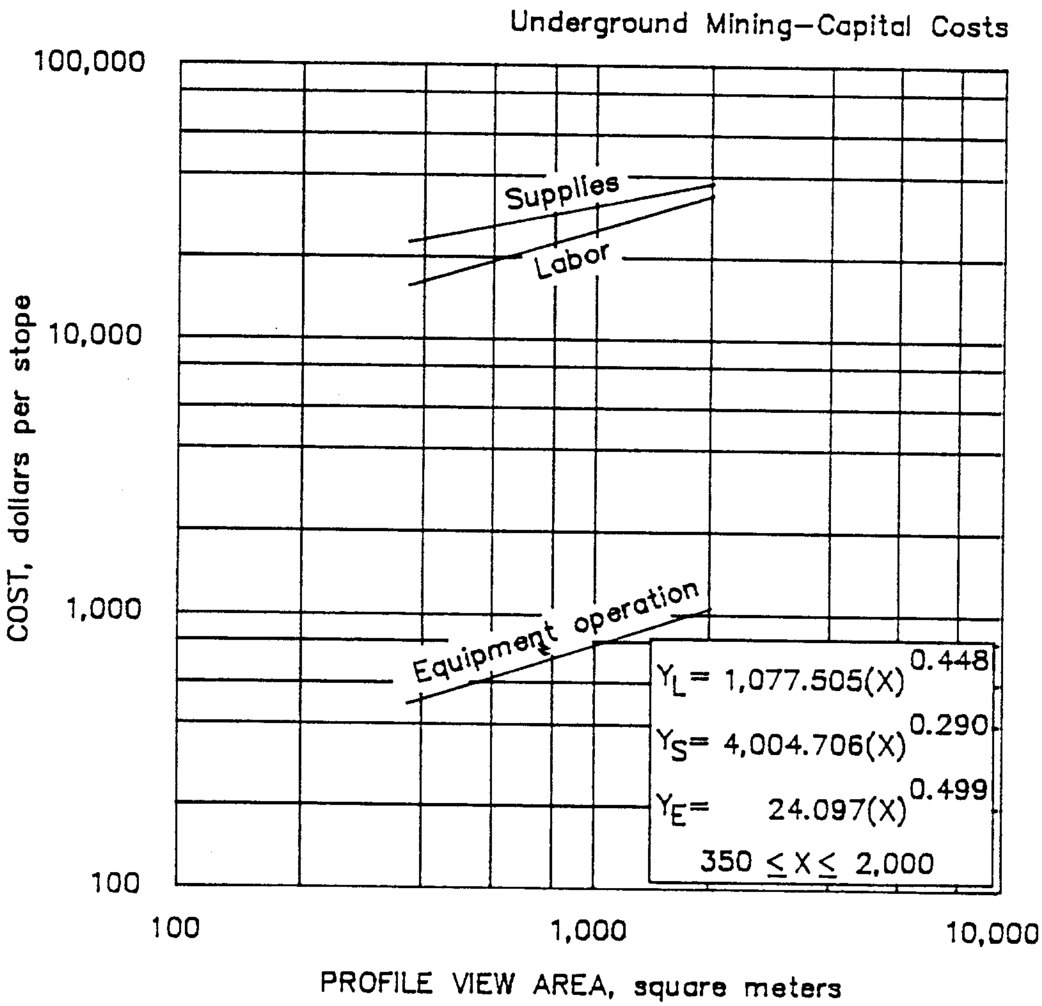
ADJUSTMENT FACTOR

Rock Hardness Factor Resuing stope development costs are 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 $(F_L) = 0.403(C)^{0.090}$

Supply factor $(F_S) = 0.590(C)^{0.052}$

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



4.2.1.9.5. Stope preparation
RESUING

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.9.6. STOPE PREPARATION
ROOM AND PILLAR, MEDIUM TO HARD ROCK

The main item needed to prepare a metallic room-and-pillar stope is an access drift from a main haulageway running the entire length of the panel.

Total cost per stope is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a plan view area (X), product of length and width, in square meters. The curves are valid for areas between 12,900 and 30,200 m^2 (of any reasonable height), operating two shifts per day. The costs are then multiplied by the number of panels required for preproduction development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 4.019(X)^{0.890}$
The operating labor costs are distributed as follows:

Direct labor...............	92%
Maintenance labor..........	8%

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

	Small (12,900 to 21,500 m^2)	Large (21,550 to 30,200 m^2)	Av salary per hour (base rate)
Miners.....................	46%	43%	$18.31
Helpers....................	11%	22%	13.86
Utility workers............	15%	12%	16.98
Utility helpers............	15%	12%	13.86
Loader operators...........	7%	8%	16.53
Surveyors..................	6%	3%	15.08

The average wage for labor is $16.53 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 2.686(X)^{0.997}$
The supply cost consists of 58% blasting supplies, 12% steel items, 11% drill bits and steel, 10% ventilation materials, 5% contingency, and 4% electricity and miscellaneous items. Supplies necessary for the development of a metallic room-and-pillar stope include drill bits and steel, blasting agent, caps, water and compressed air pipe, ventilation materials, electricity, and rockbolts.

(E) Equipment Operating Cost $(Y_E) = 0.046(X)^{1.128}$
The equipment operating cost consists of 59% for maintenance and overhaul parts, 21% for fuel, 13% for tires, and 7% for lubrication. The equipment curve covers maintenance and overhaul parts, fuel, tires, and lubrication. Equipment used in stope preparation for metallic room and pillar mining includes auxiliary fans, front-end loaders, jacklegs, scissor lifts, and jumbo-mounted drifters.

ADJUSTMENT FACTOR

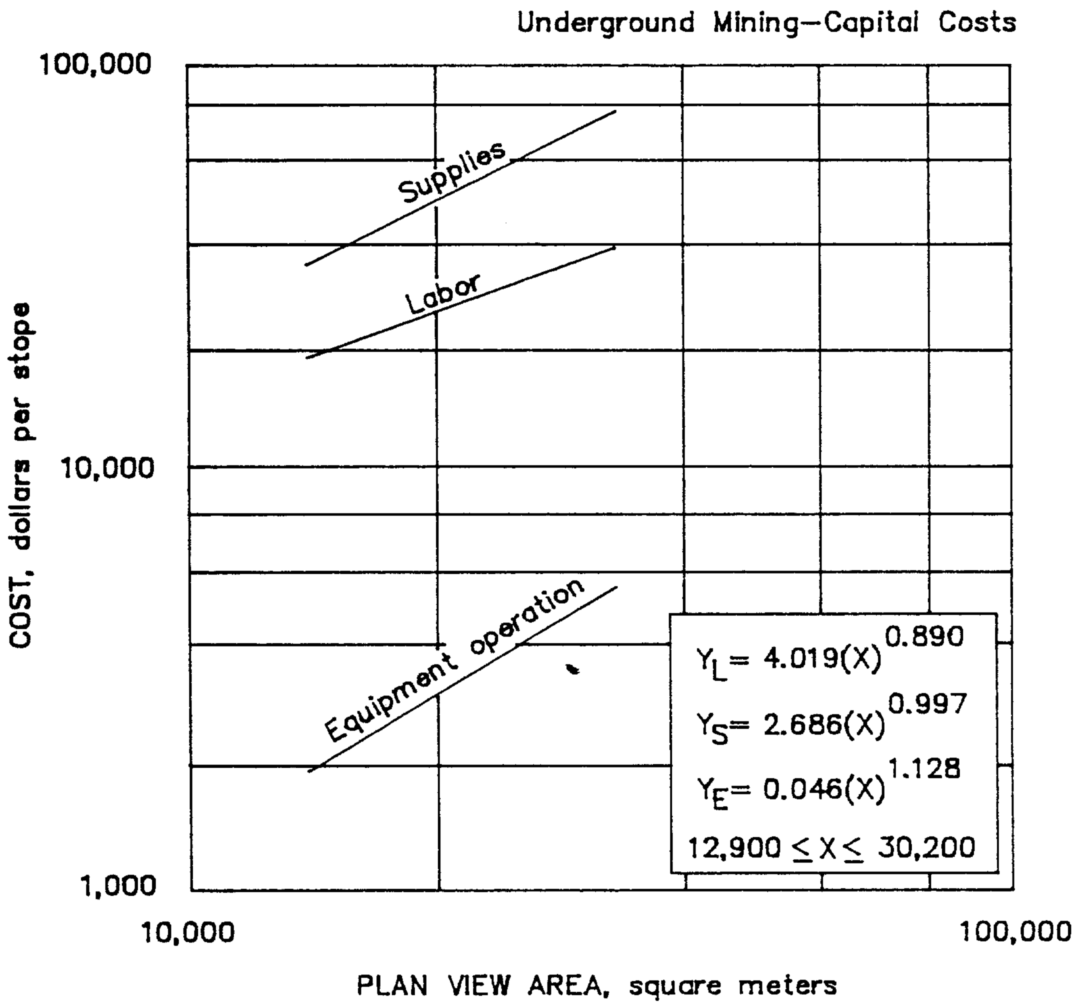
Rock Hardness Factor Drifting productivity is directly related to rock hardness. If the compressive strength of the rock is known, or an estimate can be made from table A-1 in the appendix, multiply the costs obtained from curves by the following factors (base rock strength = 31,700 psi):

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.



4.2.1.9.6. Stope preparation
ROOM & PILLAR, MEDIUM TO HARD ROCK

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.9.7. STOPE PREPARATION
ROOM AND PILLAR, NONMETALLIC SOFT ROCK

The main item needed to develop a nonmetallic room-and-pillar stope consists of an access drift from a main haulageway running the entire length of the panel.

Total cost per stope is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a plan view area (X), product of length and width, in square meters. The curves are valid for areas between 14,800 and 33,500 m^2 (of any height), operating two shifts per day. The costs are then multiplied by the number of panels required for preproduction development to obtain the capital cost.

BASE CURVES

(L) <u>Labor Operating Cost</u> $(Y_L) = 43.903(X)^{0.557}$
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 (14,800 to 4,150 m^2)	Large (24,150 to 33,500 m^2)	Av salary per hour (base rate)
Miners......................	15%	23%	$18.31
Loader operators...........	10%	15%	16.53
Shuttle operators..........	10%	15%	16.09
Utility workers............	29%	23%	16.98
Utility helpers............	24%	16%	13.86
Surveyors..................	12%	8%	15.08

The average wage for labor is $16.30 per worker-hour (including burden and average shift differential).

(S) <u>Supply Operating Cost</u> $(Y_S) = 20.909(X)^{0.632}$
The supply cost consists of 63% steel items, 10% drill bits and steel, 10% blasting supplies, 5% electricity, 4% ventilation materials, 4% contingency, and 4% miscellaneous items. Supplies necessary for the development of a nonmetallic room-and-pillar stope include drill bits and steel, blasting agent, caps, water and compressed air pipe, ventilation materials, electricity, and rock-bolts.

(E) <u>Equipment Operating Cost</u> $(Y_E) = 0.117(X)^{0.908}$
The equipment operating cost consists of 69% for maintenance and overhaul parts, 17% for tires, 11% for lubrication, and 3% for fuel. The equipment curve covers maintenance and overhaul parts, fuel, tires, and lubrication. Equipment used in stope preparation for nonmetallic room-and-pillar mining includes roof bolters,

ANFO trucks, undercutters, loaders, shuttle cars, portable transformers-rectifiers, and jumbo-mounted drifters.

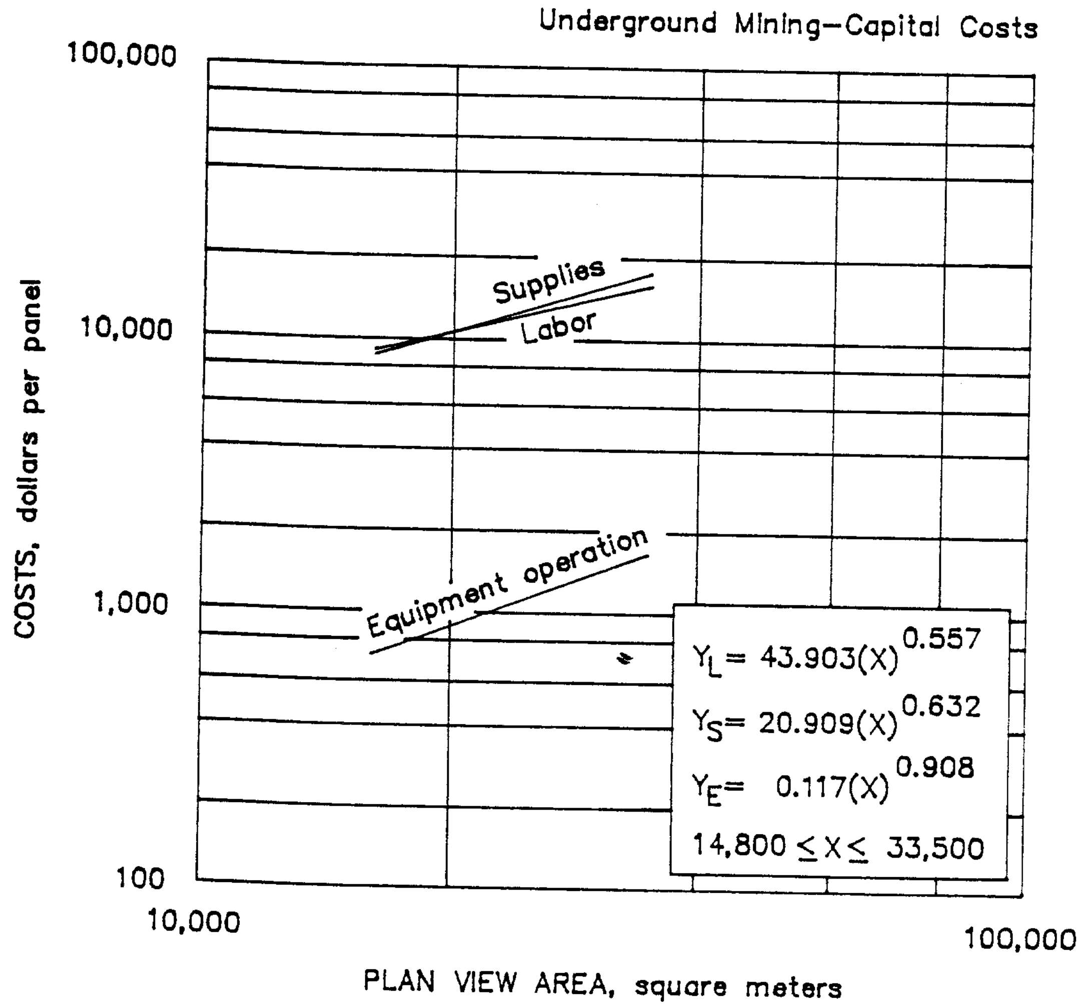
ADJUSTMENT FACTOR

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 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.



4.2.1.9.7. Stope preparation
ROOM & PILLAR, NONMETALLIC SOFT ROCK

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.9.8. STOPE PREPARATION SHRINKAGE

Items needed for preparation of a shrinkage stope include a bottom sill cut, a scram drift, crosscuts from the scram to the bottom sill drift, an access raise, and dog-holes along the raise to connect with the stope as mining progresses. The curves are based on the assumption that ore will be drawn from the crosscuts using LHD's. Stopes ranging from 2.4 m wide by 45.7 m long to 5.5 m wide by 76.2 m long are covered by the curve. Stope height is fixed at 61 m.

Total cost per stope is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a plan view area (X), product of length and width, in square meters. The curves are valid for areas between 100 and 440 m^2, operating two shifts per day. The costs are then multiplied by the number of stopes required for preproduction development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 9{,}917.618(X)^{0.329}$
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 (100 to 270 m^2)	Large (270 to 440 m^2)	Av salary per hour (base rate)
Miners.....................	70%	65%	$18.31
Helpers....................	23%	27%	13.86
LHD operators..............	7%	8%	16.09

The average wage for labor is $17.09 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 7{,}445.199(X)^{0.335}$
The supply cost consists of 37% blasting supplies, 19% steel items, 15% timber, 11% ventilation materials, 9% drill bits and steel, 5% contingency, and 4% electricity and miscellaneous items. Supplies necessary for the development of a shrinkage stope include drill bits and steel, blasting agent, caps, timber, water and compressed air pipe, ventilation ducting, electricity, and rockbolts.

(E) Equipment Operating Cost $(Y_E) = 373.610(X)^{0.388}$
The equipment operating cost consists of 64% for maintenance and overhaul parts, 20% for tires, 10% for fuel, and 6% for lubrication. The equipment curve covers maintenance and overhaul parts, fuel, tires, and lubrication. Equipment used in stope preparation for shrinkage mining includes stopers, jacklegs, auxiliary fans, LHD's, and jumbo-mounted drifters.

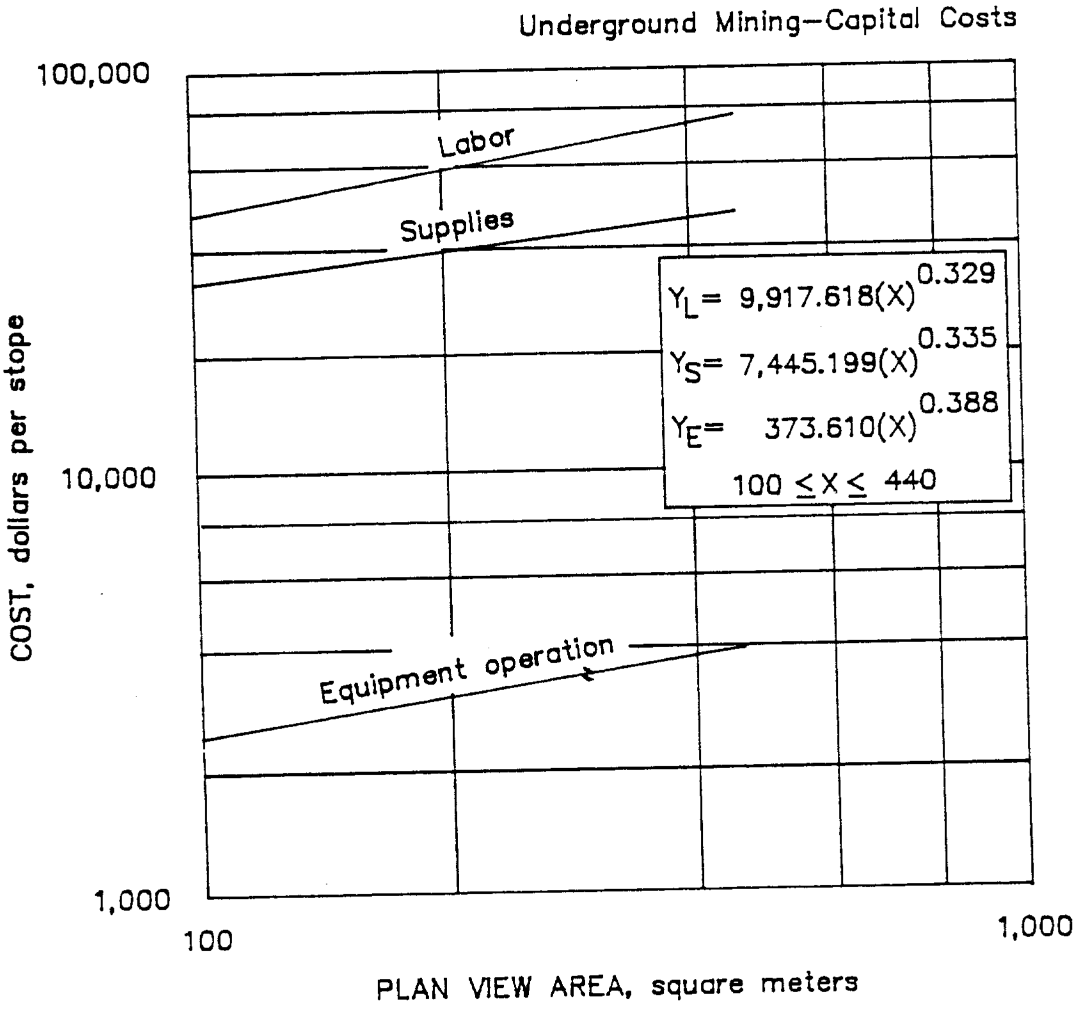
ADJUSTMENT FACTOR

Rock Hardness Factor Shrinkage stope development costs are 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 $(F_L) = 0.399(C)^{0.091}$

Supply factor $(F_S) = 0.585(C)^{0.053}$

Equipment operation factor $(F_E) = 0.717(C)^{0.033}$
where C = compressive rock strength, in pounds per square inch.



4.2.1.9.8. Stope preparation
SHRINKAGE

4.2. UNDERGROUND MINING - CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.9.9. STOPE PREPARATION SQUARE SET

Items needed for preparation of a square set stope include a crosscut from the main haulageway, an initial bottom sill cut, and a blind raise access cut with two ore chutes, a manway, and a timber slide. The curves cover stopes ranging from 2.4 m wide by 45.7 m long to 4.9 m wide by 76.2 m long, and of any reasonable height.

Total cost per stope is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a plan view area (X), product of length and width, in square meters. The curves are valid for areas between 100 and 400 m^2, operating two shifts per day. The costs are then multiplied by the number of stopes required for preproduction development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 6{,}114.261(X)^{0.340}$
The operating labor costs are distributed as follows:

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

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

	Small (100 to 250 m^2)	Large (250 to 400 m^2)	Av salary per hour (base rate)
Miners.....................	69%	73%	$18.31
Helpers....................	26%	24%	13.86
Motor operators............	5%	3%	16.09

The average wage for labor is $16.93 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 17{,}393.433(X)^{0.208}$
The supply cost consists of 43% timber, 20% steel items, 19% blasting supplies, 9% contingency, 3% drill bits and steel, 3% ventilation materials, and 3% electricity and miscellaneous items. Supplies necessary for the development of a square set stope include drill bits and steel, blasting agent, caps, timber, blocking, rail, ballast, steel pipe, ventilation ducting, electricity, and steel for ore chutes.

(E) Equipment Operating Cost $(Y_E) = 375.160(X)^{0.178}$
The equipment operating cost consists of 83% for maintenance and overhaul parts, 10% for lubrication, and 7% for ground engaging components. The equipment curve covers maintenance and overhaul parts, ground engaging components, and lubrication. Equipment used in stope preparation for square set mining includes jacklegs, stopers, auxiliary fans, overshot muckers, locomotives, ore cars, and slushers.

ADJUSTMENT FACTOR

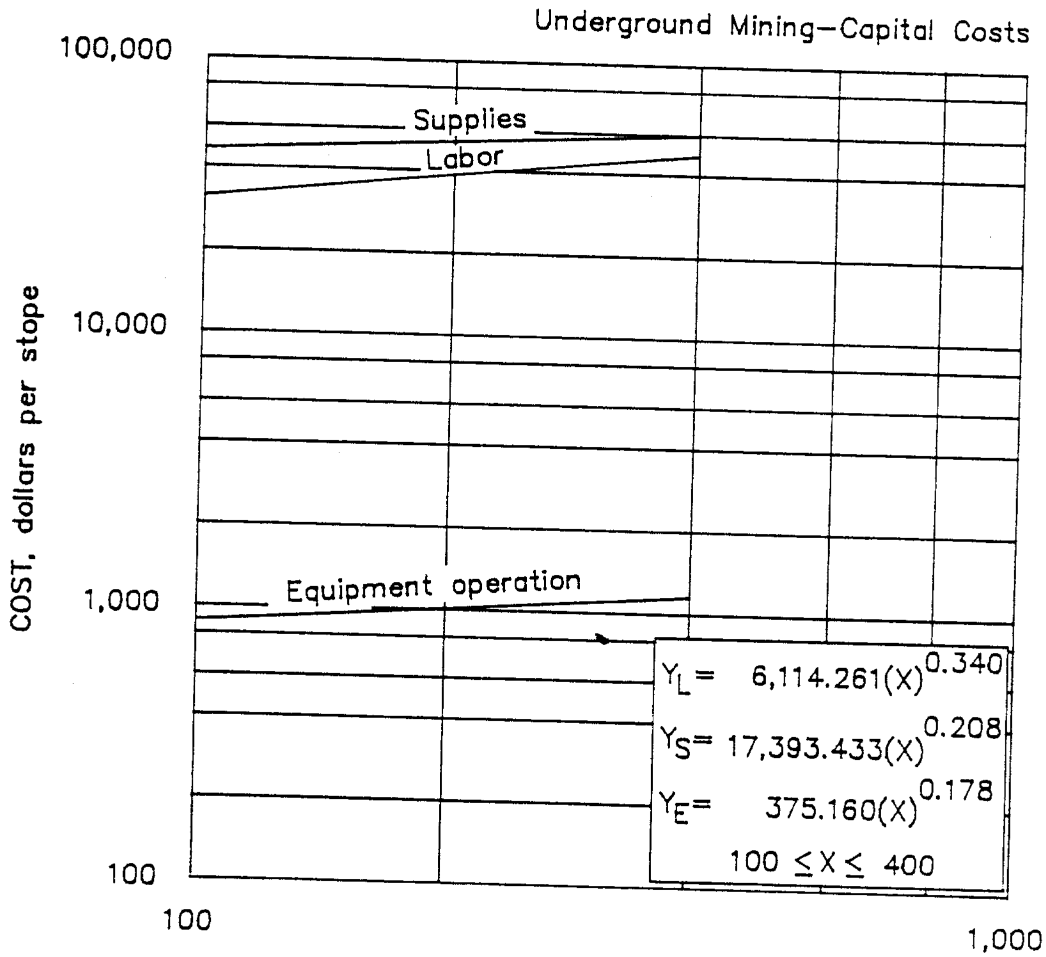
Rock Hardness Factor Square set stope development costs are directly related to rock hardness. If the compressive strength of the rock is known, or an estimate can be made from table A-1 in the appendix, multiply the costs obtained from curves by the following factors (base rock strength = 31,700 psi):

Labor factor $(F_L) = 0.403(C)^{0.090}$

Supply factor $(F_S) = 0.590(C)^{0.052}$

Equipment operation factor $(F_E) = 0.716(C)^{0.033}$

where C = compressive rock strength, in pounds per square inch.



4.2.1.9.9. Stope preparation
SQUARE SET

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.9.10. STOPE PREPARATION VERTICAL CRATER RETREAT

Items needed for preparation of a vertical crater retreat stope include a topsill cut, a bottom sill cut, and access drifts. The curves are based on the assumption that, during production, ore will be drawn from the bottom sill using remote controlled LHD's. Stopes ranging from 4.6 to 11.6 m wide are covered by the curves. Stope length is estimated at 61 m, but may be varied plus or minus 25% without affecting the accuracy of the calculations. Stope height must be within the limits of down-the-hole drills.

Total cost per stope is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a plan view area (X), product of length and width, in square meters. The curves are valid for areas between 250 and 750 m^2, operating two shifts per day. The costs are then multiplied by the number of stopes required for preproduction development to obtain the capital cost.

BASE CURVES

(L) Labor Operating Cost $(Y_L) = 2{,}254.882(X)^{0.464}$
The operating labor costs are distributed as follows:

Direct labor...............	94%
Maintenance labor..........	6%

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

	Small (250 to 500 m^2)	Large (500 to 750 m^2)	Av salary per hour (base rate)
Miners......................	60%	64%	$18.31
Helpers.....................	24%	23%	13.86
LHD operators..............	10%	10%	16.09
Utility workers............	4%	2%	15.42
Surveyors..................	2%	1%	15.08

The average wage for labor is $16.96 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 1{,}086.699(X)^{0.642}$
The supply cost consists of 51% blasting supplies, 20% steel items, 11% drill bits and steel, 10% ventilation materials, 5% contingency, and 3% electricity and miscellaneous items. Supplies necessary for the development of a vertical crater retreat stope include drill bits and steel, blasting agent, caps, water and compressed air pipe, ventilation ducting, electricity, and rockbolts.

(E) Equipment Operating Cost $(Y_E) = 10.062(X)^{0.969}$
The equipment operating cost consists of 64% for maintenance and overhaul parts,

19% for tires, 11% for fuel, and 6% for lubrication. The equipment curve covers maintenance and overhaul parts, fuel, tires, and lubrication. Equipment used in stope preparation for vertical crater retreat mining includes LHD's, jacklegs, auxiliary fans, and jumbo-mounted drifters.

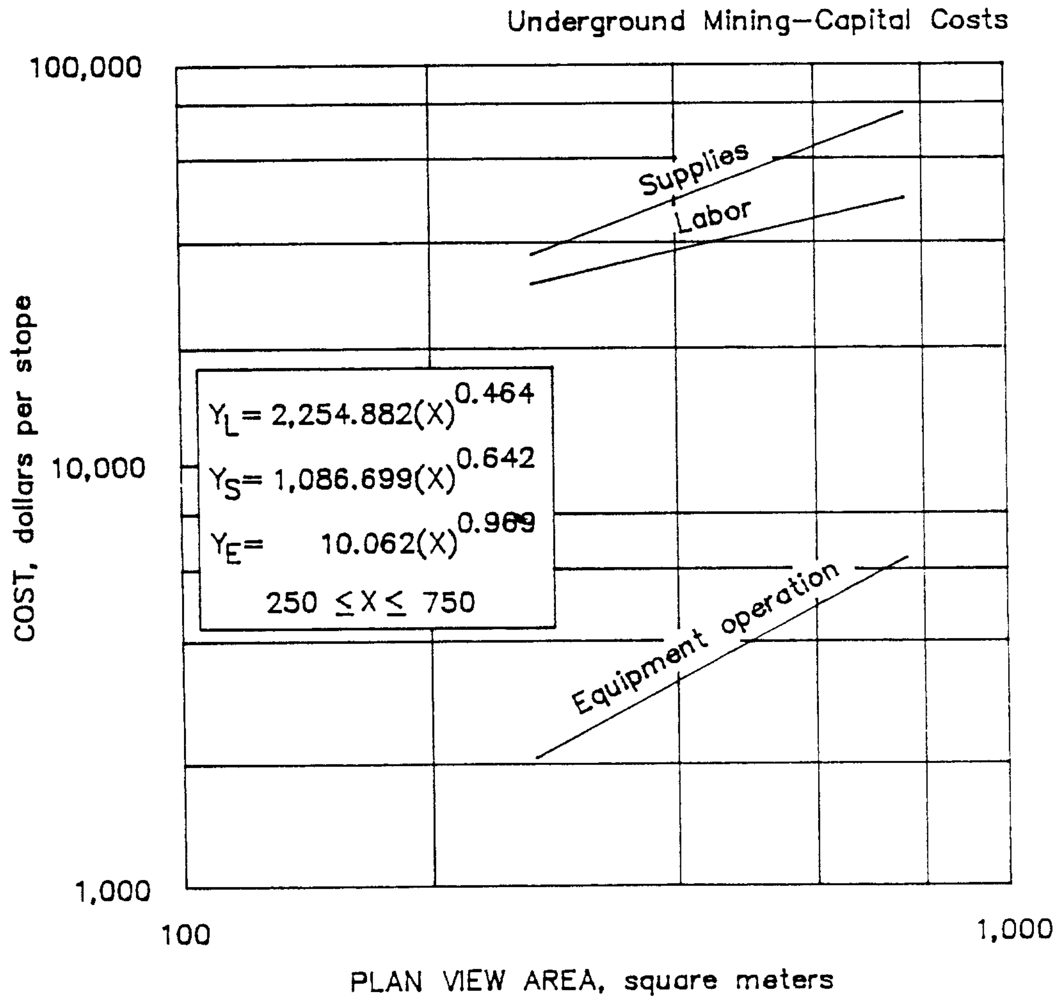
ADJUSTMENT FACTOR

Rock Hardness Factor Vertical crater retreat stope development costs are 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 $(F_L) = 0.404(C)^{0.089}$

Supply factor $(F_S) = 0.584(C)^{0.053}$

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



4.2.1.9.10. Stope preparation
VERTICAL CRATER RETREAT

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.10. MINE DEWATERING

The capital cost for mine dewatering is based on the utilization of vertical turbine pumps, including the cost of acquisition and installation of equipment.

The initial capital cost is based on a quantity of water in cubic meters pumped per day against a total dynamic head of 305 m (1,000 ft). The total dynamic head is the sum of the static head, the friction loss due to pipes and fittings, and the velocity head, minus the suction head. If the suction head is negative (suction lift), its value must be added to obtain the total dynamic head. The curve includes all costs associated with the acquisition and installation of required pumps and pump bases.

The total capital cost is based on a single cost curve having an water pumping rate (X), in cubic meters per day. The curve is valid for pumping rates between 2,000 and 60,000 m^3/d, operating three shifts per day.

BASE CURVE

The capital cost derived from the curve is a combination of the following costs:

Construction labor cost.......	7%
Construction supply cost......	2%
Purchased equipment cost......	91%

The total mine dewatering capital cost is $(Y_C) = 103.876(X)^{0.718}$ and is distributed as follows:

(L) <u>Construction Labor Cost</u> $(Y_L) = 6.544(X)^{0.718}$

(S) <u>Construction Supply Cost</u> $(Y_S) = 2.181(X)^{0.718}$

(E) <u>Purchased Equipment Cost</u> $(Y_E) = 95.150(X)^{0.718}$

CAPITAL COST DURING MINE DEWATERING

The capital cost is based on a quantity of water in cubic meters pumped per day against a total dynamic head of 305 m (1,000 ft). It is assumed that mine discharge and drilling water lines are left in place and are usable for mine dewatering purposes.

The daily cost during mine dewatering is the sum of three separate cost curves (labor, supplies, and equipment operation) based on the the quantity of water pumped (X), in cubic meters per day. The curves are valid for quantities from 2,000 and 60,000 m^3, operating three shifts per day. The daily cost is multiplied by the total number of days allowed for dewatering the mine.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 3,283.826(X)^{0.368}$
The operating labor costs are distributed as follows:

Direct labor...............	82%
Maintenance labor..........	18%

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)
Pumpman....................	42%	$15.44
Mechanics/electricians.....	15%	15.44
Underground miners.........	43%	18.11

Average operating labor cost per worker-hour is $16.58 (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 1.438(X)^{1.177}$
The supply cost consists of 90% electric power and 10% miscellaneous items such as lagging, hangers, brackets, and electrical fuses required during the mine dewatering period.

(E) Equipment Operating Cost $(Y_E) = 0.017(X)^{1.143}$
The equipment operating cost consists of 85% for repair parts and materials and 15% for lubrication.

ADJUSTMENT FACTORS

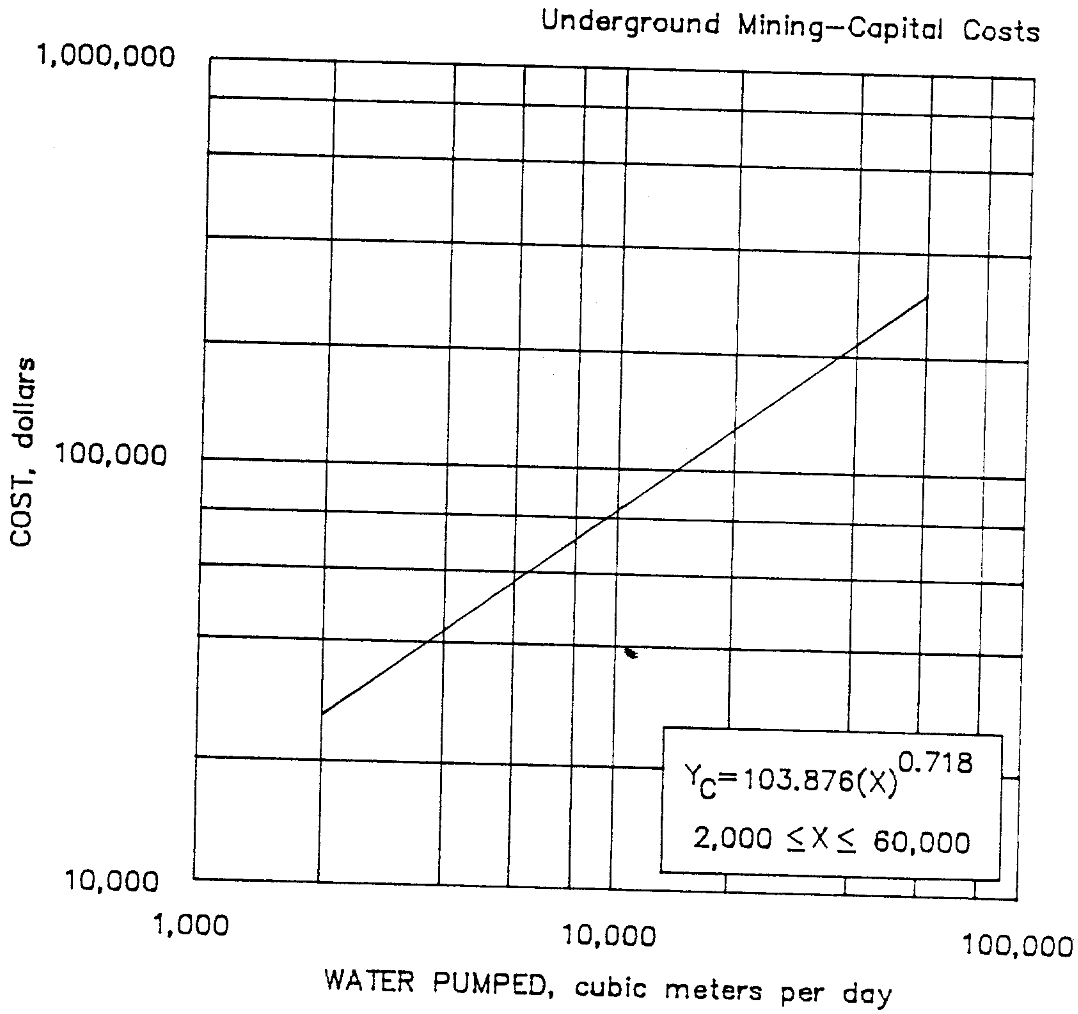
The capital cost curve during mine dewatering is based on a total dynamic head (TDH) of 305 m (1,000 ft). The cost curve is smoothed out on an average of 120 days allowed for mine dewatering task.

Dynamic Head Factor The capital cost curve is based on 305 m (1,000 ft) of TDH. For variation in the total dynamic head, multiply the costs obtained from the curves by the following factor:

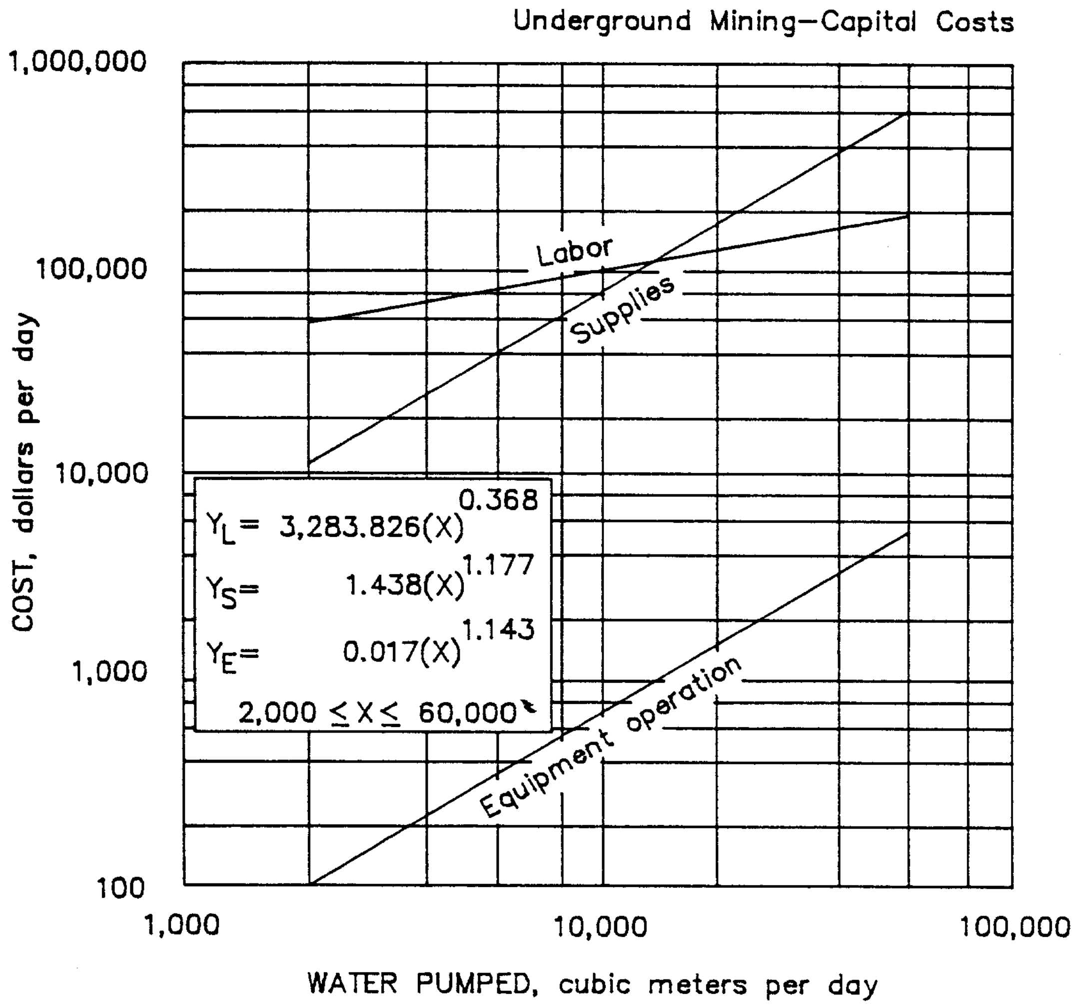
Dynamic head factor $(F_H) = 0.003(H)$
where: H = total dynamic head, in meters.

Days Factor For variation in the number of days worked, multiply the costs obtained from the curves by the following factor:

Days factor $(F_D) = 0.008(D)$
where: D = total number of days allowed for mine dewatering.



4.2.1.10.a Mine dewatering



4.2.1.10.b Mine dewatering

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.1. PREPRODUCTION DEVELOPMENT

4.2.1.11. MINE REHABILITATION

The capital cost for mine rehabilitation is based on the assumption that the mine equipment and surface mine plant have been maintained under a minimal repair and maintenance schedule and are functional prior to rehabilitation activities; therefore, no capital cost is included for equipment purchase.

The total cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a mine production rate (X), in metric tons material per day. The curves are valid for rates between 200 and 40,000 mtpd, operating one shift per day. The total rehabilitation cost is obtained by multiplying the daily cost by the number of days allowed for the mine rehabilitation.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 37,186.450(X)^{0.292}$
The operating labor costs are distributed as follows:

Direct labor...............	83%
Maintenance labor..........	7%
Supervision................	10%

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)
Underground miners.........	50%	$18.11
LHD Miners.................	23%	16.33
Hoistman...................	10%	15.44
Mechanics/electricians.....	7%	15.44
Supervision................	10%	22.08

The average wage for labor is $17.52 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(YS) = 23,064.633(X)^{0.367}$.
The supply cost consists of 49% electric power cable, 34% ground support, 7% electric power, 2% blasting agent and caps, and 8% miscellaneous items. The miscellaneous items include small tools, ventilation duct, hose, pipe and valves, etc.

(E) Equipment Operating Cost $(YE) = 1,510.633(X)^{0.438}$.
The equipment operating cost consists of 89% for repair parts and materials, 5% for lubrication, and 6% for miscellaneous costs. The miscellaneous costs consist of ancilliary equipment operation such as mine hoist, compressed air, and mine ventilation plant needed during mine rehabilitation.

ADJUSTMENT FACTORS

Ground Conditions Factors The cost curves for mine rehabilitation are based on fair ground conditions. To adjust the curves for poor ground conditions, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_{L\ POOR}) = 1.25$

Supply factor $(F_{S\ POOR}) = 1.11$

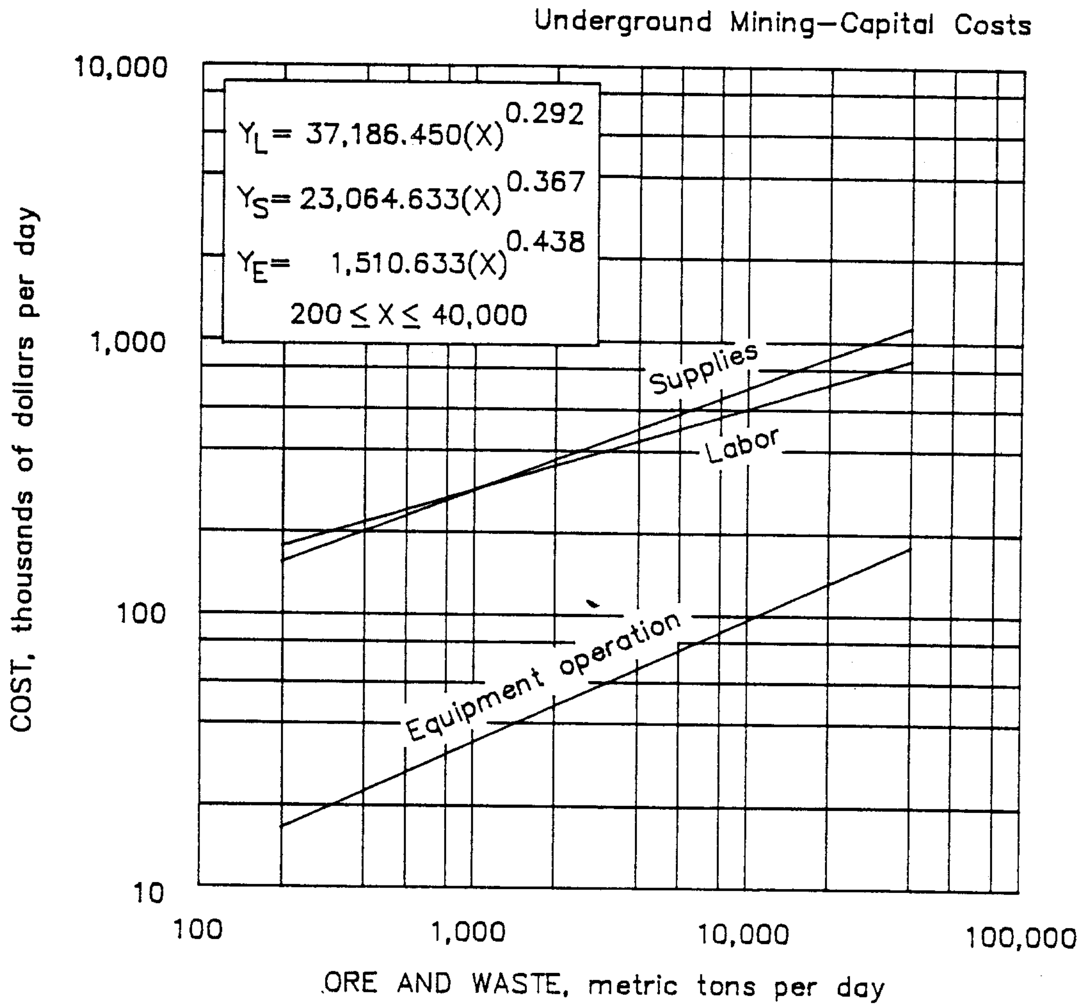
Equipment operation factor $(F_{E\ POOR}) = 1.25$

Conversely, to adjust the curves for good ground conditions, multiply the operating costs by the following factors:

Labor factor $(F_{L\ GOOD}) = 0.90$

Supply factor $(F_{S\ GOOD}) = 0.95$

Equipment operation factor $(F_{E\ GOOD}) = 0.90$



4.2.1.11. Mine rehabilitation