4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.3. MINING EQUIPMENT

4.2.3.1. HOISTING FACILITIES

Selection of a mine hoist involves consideration of three sophisticated systems: mechanical, electrical, and the mine shaft. Each of these systems are dependent on numerous variables that are site-specific for each hoisting operation. To reduce complexities involved in determining capital costs, this section will deal with the two most common hoisting systems, double-drum and friction hoists.

When selecting the type of hoisting system, the estimator should consider the following:

1. Double-drum hoists are applicable to multilevel hoisting for all sizes of mines.
2. Friction hoists are applicable for deep level (+915 m) and/or single level hoisting.
3. Mines that hoist over 4,000 mtpd often have more than one hoist (i.e., one hoist may haul ore and waste and one hoist may be used for servicing the mine). The costs are only applicable for one hoist. If more than one hoist is required, recalculate the curve(s) for each additional hoist (see ADJUSTMENTS for service hoists).
4. Mines that hoist over 20,000 mtpd typically have more than one production hoist in conjunction with at least one service hoist.
5. In choosing a hoisting system it is best to remember that these facilities are usually designed for a higher capacity than required. This is especially true for smaller mines or mines anticipating an increase in capacity (i.e. a hoist operating at 100 mtph may have a design capacity of 200 mtph).
6. Single hoist mines typical hoist muck for about 80% of the daily schedule (i.e., 13 h of a 16 h work day), the remaining 20% of the schedule is devoted to transporting personnel and supplies and performing maintenance. Mines serviced by more than one production hoist typically hoist muck about 90% of the daily schedule.

BASE CURVE

The total capital cost is based on two single cost curves having a design capacity (X), in metric tons of ore and waste hoisted per hour. The curve is valid for capacities between 100 and 800 mtph. The curve includes costs associated with purchasing and erecting head frame, hoist house, hoist equipment, and ore and waste surge bins. Cost of collar foundation work and shaft loading pockets are covered in the section on shafts.

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

Double-drum hoist

Construction labor cost.....	20%
Construction supply cost.....	43%
Purchased equipment cost.....	37%

Friction hoist

Construction labor cost.....	18%
Construction supply cost.....	30%
Purchased equipment cost.....	52%

The total double-drum hoisting facility capital cost is $(Y_{C\ DOUBLE\text{-}DRUM}) = 12{,}131.769(X)^{1.026}$ and is distributed as follows:

(L) Construction Labor Cost $(Y_{L\ DOUBLE\text{-}DRUM}) = 2{,}426.354(X)^{1.026}$

(S) Construction Supply Cost $(Y_{S\ DOUBLE\text{-}DRUM}) = 5{,}216.661(X)^{1.026}$

(E) Purchased Equipment Cost $(Y_{E\ DOUBLE\text{-}DRUM}) = 4{,}488.754(X)^{1.026}$

The total friction hoisting facility capital cost is $(Y_{C\ FRICTION}) = 9{,}279.338(X)^{0.918}$ and is distributed as follows:

(L) Construction Labor Cost $(Y_{L\ FRICTION}) = 1{,}670.281(X)^{0.918}$

(S) Construction Supply Cost $(Y_{S\ FRICTION}) = 2{,}783.801(X)^{0.918}$

(E) Purchased Equipment Cost $(Y_{E\ FRICTION}) = 4{,}825.256(X)^{0.918}$

ADJUSTMENT FACTORS

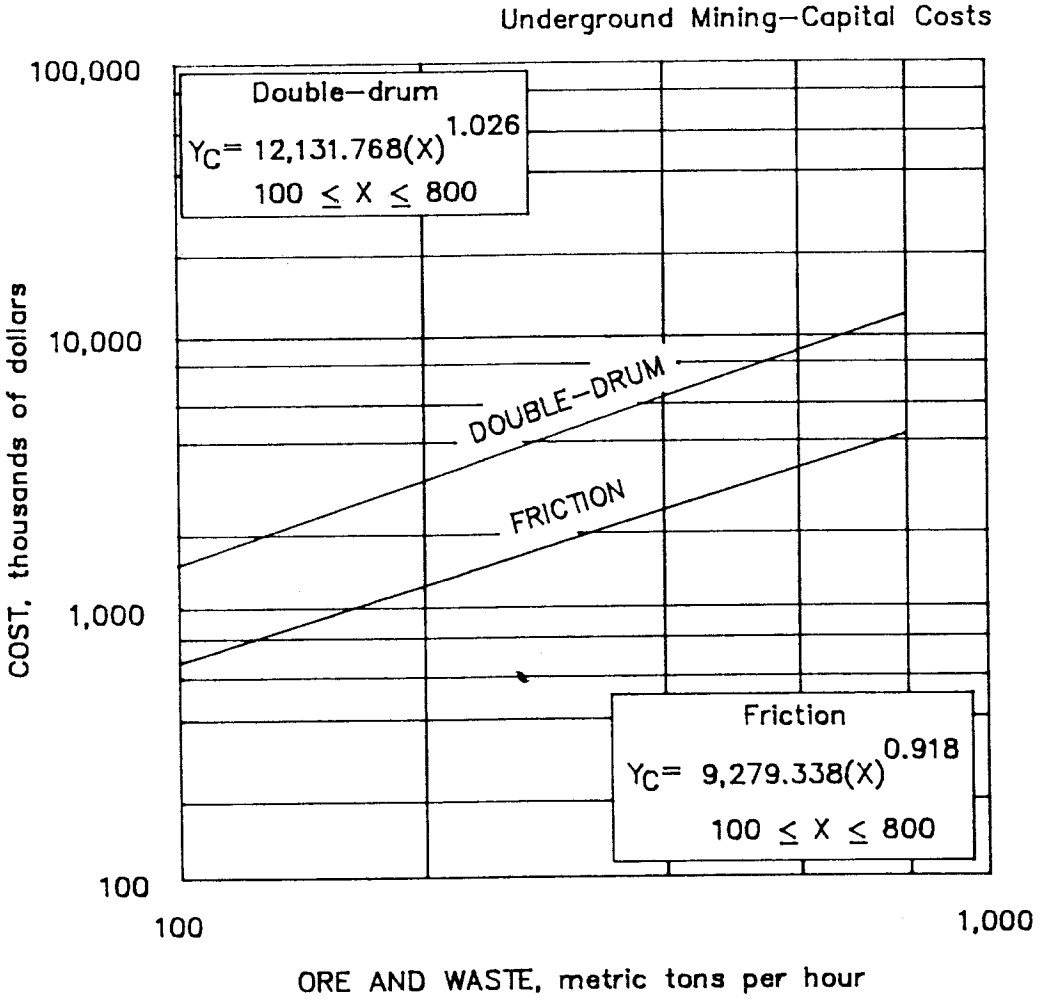
Depth Factor To determine the capital cost for hoist facilities whose maximum hoist depth varies from 915 m (3,000 ft), multiply the cost obtained from the curve by the following factor:

Double-drum hoist:
Depth factor $(F_D) = 0.094(D)^{0.345}$

Friction hoist:
Depth factor $(F_D) = 0.112(D)^{0.322}$
where D = maximum hoisting depth from surface, in meters.

Service Hoist If a hoist is to be used for service hoisting only (typical for operations which the production hoist is over 4,000 mtpd), enter the nonproduction hoist curve at 33% the production hoist capacity and use this value in the hoisting equations.

Service hoist $(X_S) = 0.33(X)$



4.2.3.1. Hoisting facilities

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.3. MINING EQUIPMENT

4.2.3.2.1. DRILL, BLAST, AND MISCELLANEOUS EQUIPMENT JACKLEGS

This section covers costs associated with a mine using jacklegs, stopers, and drifters as their primary drill equipment. For mines using jumbos as their primary drill equipment, refer to section 4.2.3.2.2.

The capital cost curve for drill, blast, and miscellaneous support equipment includes the purchase of underground equipment and items not previously included in other sections. The cost is based on the purchased equipment curve with a production rate (X), in metric tons material per day. The curve is valid between 100 to 10,000 mtpd, operating two shifts per day. These costs are based on equipment being delivered and made fully operable at an appropriate site in the Denver, CO area. Provision is made for standby equipment, spare parts, administrative, and maintenance units.

The costs on the curve are directly related to daily metric tons of production using jacklegs and related drilling equipment. Any costs associated with different drilling equipment (e.g., jumbos) should be costed using the appropriate curve. The drilling costs are to be added to costs from the appropriate haulage curves for the total capital equipment cost of the operation.

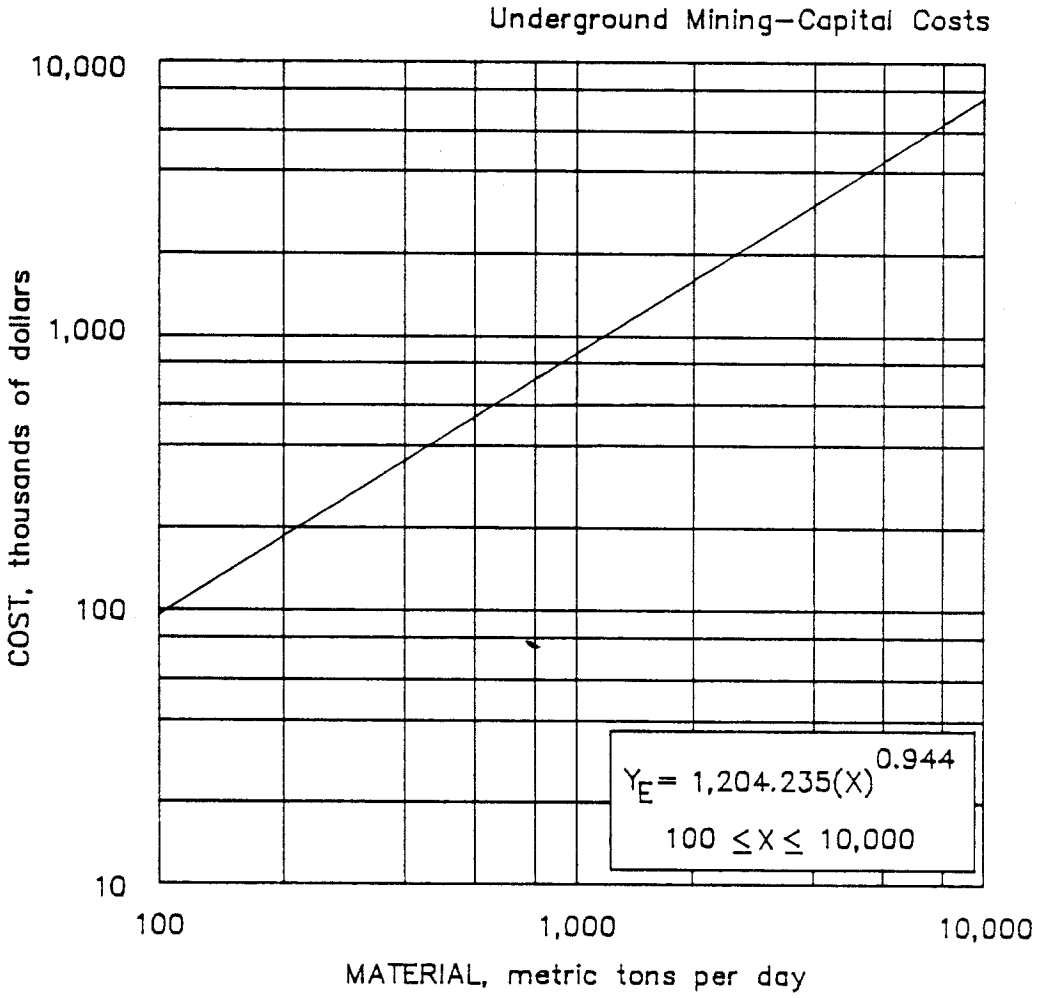
The equipment contained in this curve includes drills and support equipment. Hoisting, ventilation, compressed air, pumping equipment, and power transmission lines are included in other capital cost sections.

BASE CURVE

(E) Purchased Equipment Cost $(Y_E) = 1{,}204.235(X)^{0.944}$
The equipment operating cost consists of 50% for drills and 50% for miscellaneous equipment.

ADJUSTMENT FACTOR

Shift Factor The curve is based on a two-shift operation. Costs can be estimated for one- or three-shift operations by dividing the base number of shifts (2) by the actual number of shifts (1 or 3) to obtain a shift factor (F_1). The shift factor (F_1) is then multiplied by the actual daily tonnage (X) to derive the adjusted feed rate (X_1). Costs can then be estimated by using (X_1) as input to the equation.



4.2.3.2.1. Drill, blast, and misc. equipment
JACKLEGS

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.3. MINING EQUIPMENT

4.2.3.2.2. DRILL, BLAST, AND MISCELLANEOUS EQUIPMENT
JUMBOS

This section covers costs associated with a mine using jumbos as their primary drill equipment. For mines using jacklegs, stopers, and drifters as their primary drill equipment, refer to section 4.2.3.2.1.

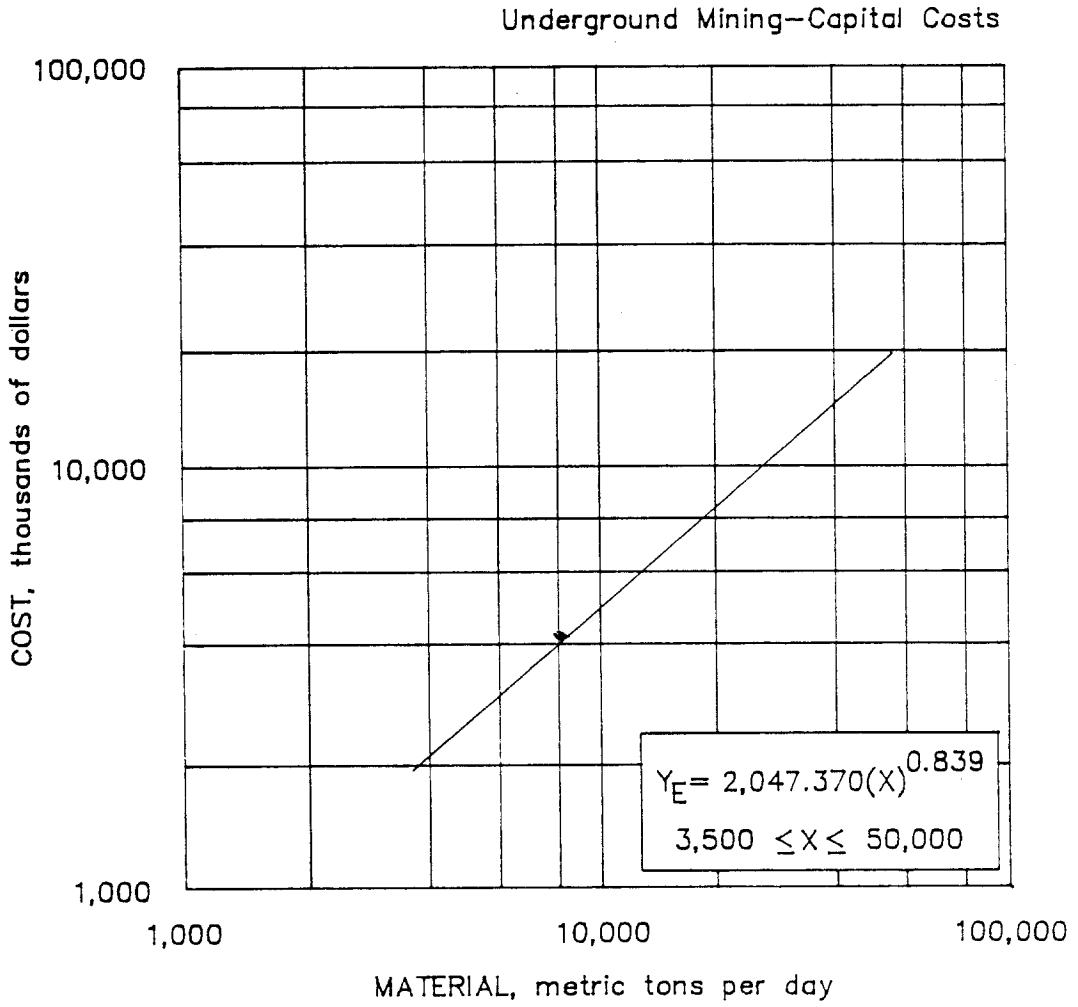
The capital cost curve for drill, blast, and miscellaneous support equipment includes the purchase of underground equipment and items not previously included in other sections. The cost is based on the purchased equipment curve with a production rate (X), in metric tons material per day. The curve is valid between 3,500 to 50,000 mtpd, operating two shifts per day. These costs are based on equipment being delivered and made fully operable at an appropriate site in the Denver, CO area. Provision is made for standby equipment, spare parts, administrative, and maintenance units.

The costs on the curve are directly related to daily metric tons of production using jumbos and related drilling equipment. Any costs associated with different drilling equipment (e.g., jacklegs) should be costed using the appropriate curve. The drilling costs are to be added to costs from the appropriate haulage curves for the total capital equipment cost of the operation.

The equipment contained in this curve includes drills, roof bolters, and support equipment. Hoisting, ventilation, compressed air, pumping equipment, and power transmission lines are included in other capital cost sections.

BASE CURVE

(E) Purchased Equipment Cost $(Y_E) = 2{,}047.370(X)^{0.839}$
The equipment operating cost consists of 50% for drills and 50% for miscellaneous equipment.



4.2.3.2.2. Drill, blast, and misc. equipment
JUMBOS

4.2. UNDERGROUND MINING-- CAPITAL COSTS

4.2.3. MINING EQUIPMENT

4.2.3.3. CONTINUOUS MINERS

This section covers costs associated with a mine using continuous miners, shuttle cars, and rock bolters. Costs in this curve cover the use of shuttle cars to move the ore (about 100 m) to a conveyor loading point. The costs associated with the conveyor haulage equipment are covered in sections 4.2.3.5. and 4.2.3.6.

The capital cost curve for continuous miners and related equipment includes the purchase of underground equipment and items not previously included in other sections. The cost is based on the purchased equipment curve with a production rate (X), in metric tons material per day. The curve is valid between 2,000 to 30,000 mtpd, operating two shifts per day. These costs are based on equipment being delivered and made fully operable at an appropriate site in the Denver, CO area. Provision is made for standby equipment, spare parts, administrative, and maintenance units.

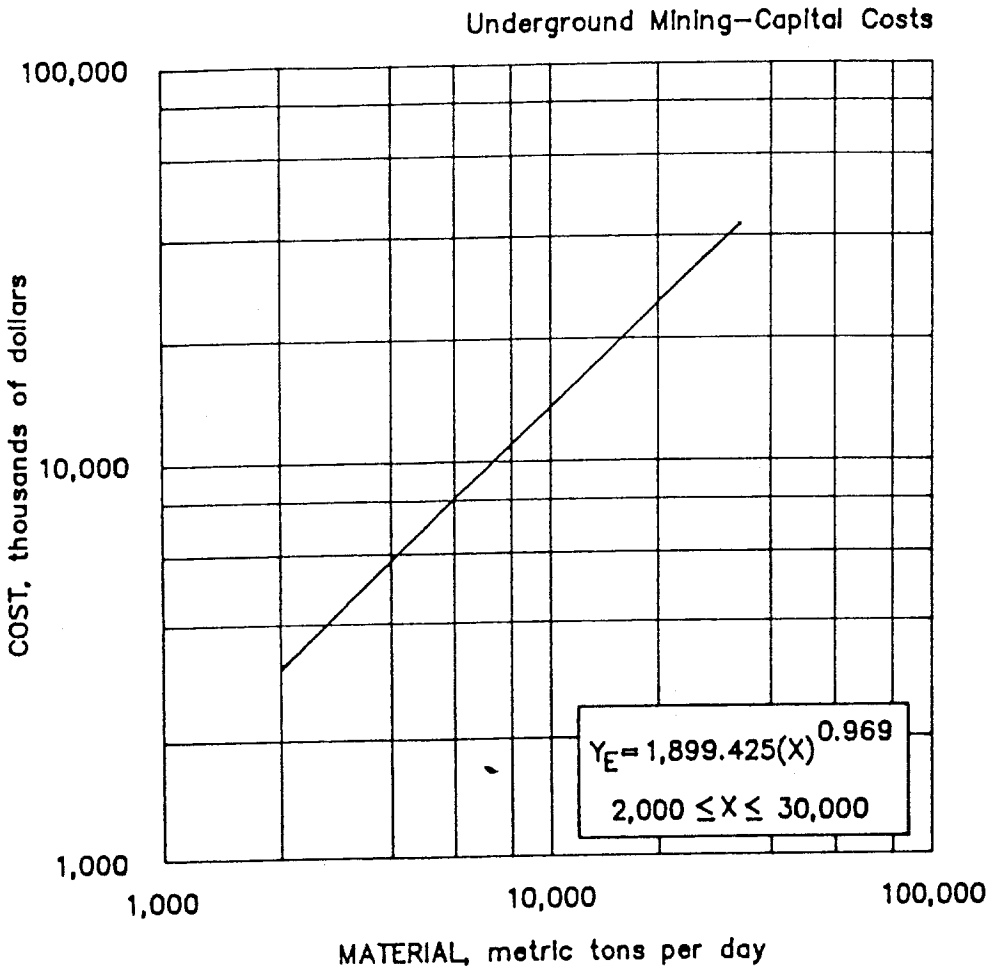
The costs on the curve are directly related to daily metric tons of production using continuous miners. Any costs associated with different equipment (e.g., jacklegs) should be costed using the appropriate curve. The continuous miner costs are to be added to costs from the appropriate haulage curves (e.g., conveyor haulage equipment) for the total capital equipment cost of the operation.

The equipment contained in this curve includes continuous miners, shuttle cars, rock bolters, and support equipment. Hoisting, ventilation, compressed air, pumping equipment, and power transmission lines are included in other capital cost sections.

BASE CURVE

(E) Purchased Equipment Cost $(Y_E) \approx 1{,}899.425(X)^{0.969}$

The equipment operating cost consists of 95% for continuous mining equipment and 5% for miscellaneous equipment.



4.2.3.3. Continuous miners

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.3. MINING EQUIPMENT

4.2.3.4. DRIFT-TUNNEL BORING MACHINES

This section covers costs associated with a mine using drift-tunnel boring and associated equipment. Costs in this curve cover the use of rail cars to move the material.

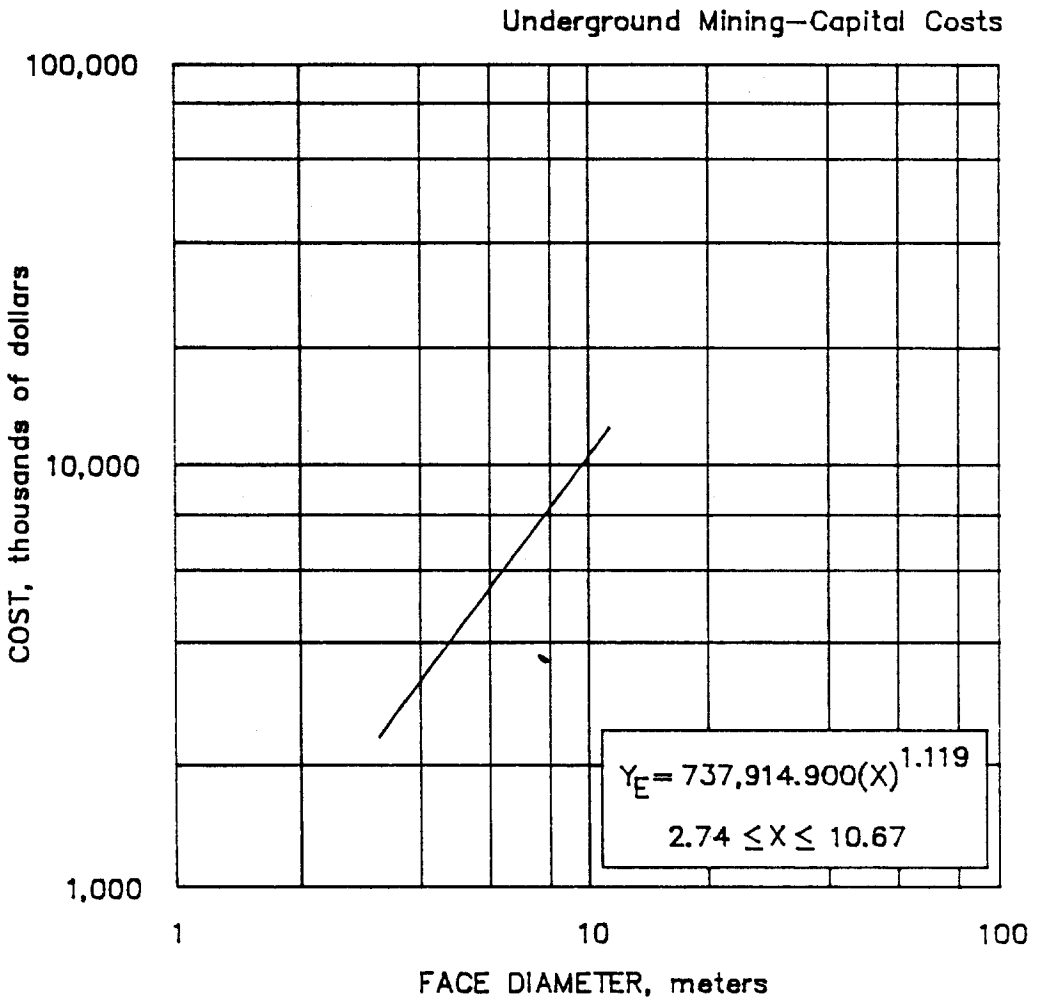
The capital cost curve for drift-tunnel boring and related equipment includes the purchase of underground equipment and items not previously included in other sections. The cost is based on the purchased equipment curve with a face diameter excavated by the borer (X), in meters. The curve is valid between 2.74 and 10.67 m. These costs are based on equipment being delivered and made fully operable at an appropriate site in the Denver, CO, area. Provision is made for backup equipment, administrative, and maintenance units.

The costs on the curve are directly related to the face diameter of the drift-tunnel boring machine. Any costs associated with different equipment (e.g., jacklegs) should be costed using the appropriate curve. The drift-tunnel boring costs are to be added to costs from other applicable equipment curves (e.g., conveyor haulage equipment) for the total capital equipment cost of the operation.

The equipment contained in this curve includes drift-tunnel borers, a rail system for the machine, and support equipment. Hoisting, ventilation, compressed air, pumping equipment, and power transmission lines are included in other capital cost sections.

BASE CURVE

(E) Purchased Equipment Cost $(Y_E) = 737{,}914.900(X)^{1.119}$
The equipment operating cost consists of 75% for drift-tunnel boring machine, 16% for support equipment, and 9% for miscellaneous equipment.



4.2.3.4. Drift/tunnel boring machine

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.3. MINING EQUIPMENT

4.2.3.5. CONVEYOR HAULAGE EQUIPMENT

The capital cost curve for conveyor haulage equipment includes the purchase of underground equipment and items not previously included in other sections. The cost is based on the purchased equipment curve with a production range (X), in metric tons material per day. The curve is valid between 1,000 and 50,000 mtpd, operating two shifts per day. These costs are based on equipment being delivered and made fully operable at an appropriate site in the Denver, CO, area. Provision is made for standby equipment, spare parts, administrative, and maintenance units.

The costs on the curve are directly related to the daily metric tons transported by conveyor haulage. The costs are based on a 300-m (980-ft) one-way haul distance in level to near-level workings. Any costs associated with a different transportation method should be costed using the appropriate equipment curve. The costs on this curve are to be added to costs from the drill-and-blast equipment curve plus any costs associated with equipment curves for other haulage methods.

The equipment contained in this curve includes purchase and installation of conveyors and support equipment. Hoisting, ventilation, compressed air, pumping equipment, and power transmission lines are included in other capital cost sections.

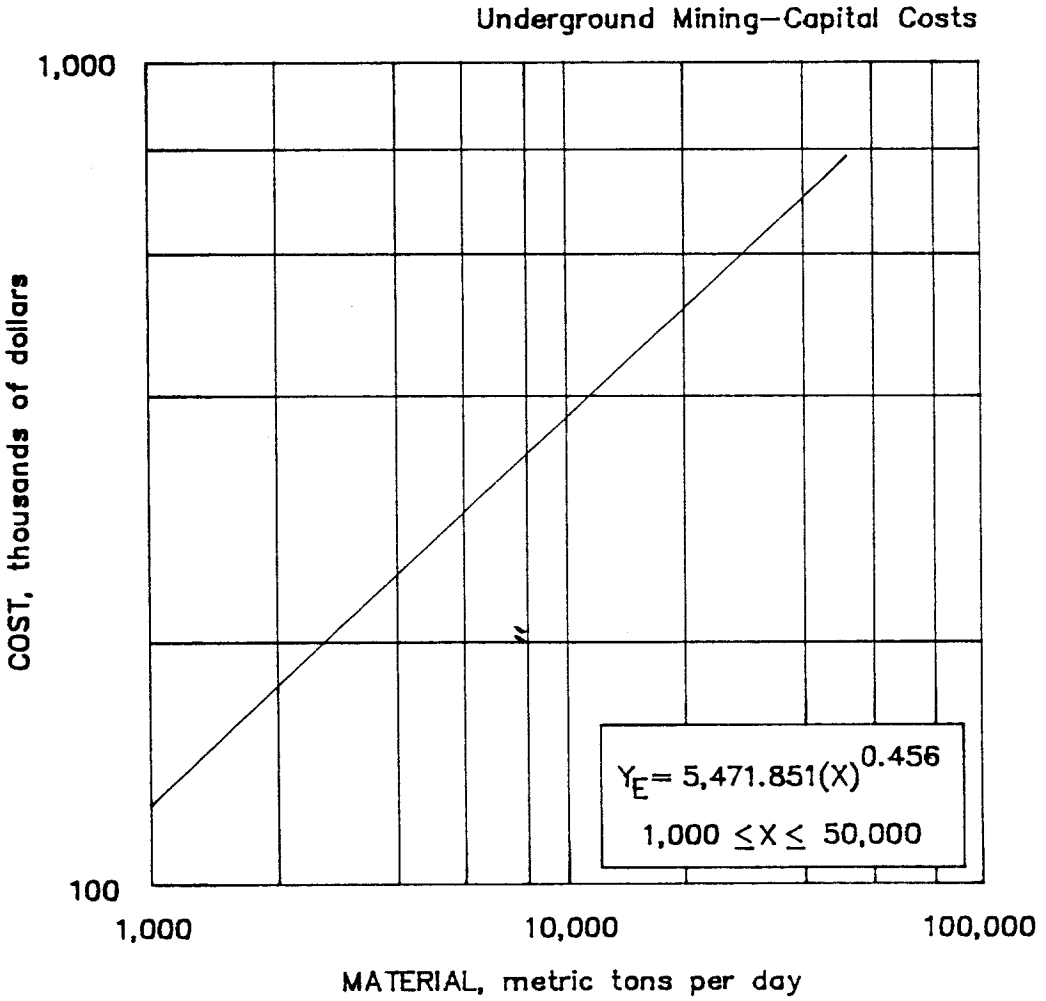
BASE CURVE

(E) Purchased Equipment Cost $(Y_E) = 5{,}471.851(X)^{0.456}$
The equipment operating cost consists of 92% for conveyor equipment, 3% for loading equipment, and 5% for miscellaneous equipment.

ADJUSTMENT FACTOR

Distance Factor For haul distances other than 300 m (980 ft) one way, multiply the costs obtained from the curves by the following factor:

Distance factor $(F_D) = 0.005(D)^{0.944}$
where D = one way haul, in meters.



4.2.3.5. Conveyor haulage equipment

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.3. MINING EQUIPMENT

4.2.3.6. CONVEYOR EXTENSIONS

The capital cost curve for conveyor extension equipment includes the purchase of underground equipment and items not previously included in other sections. The cost is based on the purchased equipment curve with a transportation rate (X), in metric tons material per day. The curve is valid between 1,000 to 50,000 mtpd, operating two shifts per day. These costs are based on equipment being delivered and made fully operable at an appropriate site in the Denver, CO, area. Provision is made for standby equipment, spare parts, administrative, and maintenance units.

The costs on the curve are directly related to the daily metric tons transported by conveyor haulage. This curve is primarily to be used for costs associated with adding on to an existing conveyor system. The costs are based on a 300-m (980-ft) one-way haul distance in level to near-level workings. Any costs associated with a different transportation method should be costed using the appropriate equipment curve. The costs on this curve are to be included with the costs from the drill-and-blast equipment curve plus any costs associated with equipment curves for other haulage methods in order to come up with a total equipment cost.

The equipment contained in this curve includes purchase and installation of conveyors and support equipment. Hoisting, ventilation, compressed air, pumping equipment, and power transmission lines are included in other capital cost sections.

The operating costs curve for conveyor haulage (5.2.3.5.) is appropriate for both conveyor and conveyor extension operating costs.

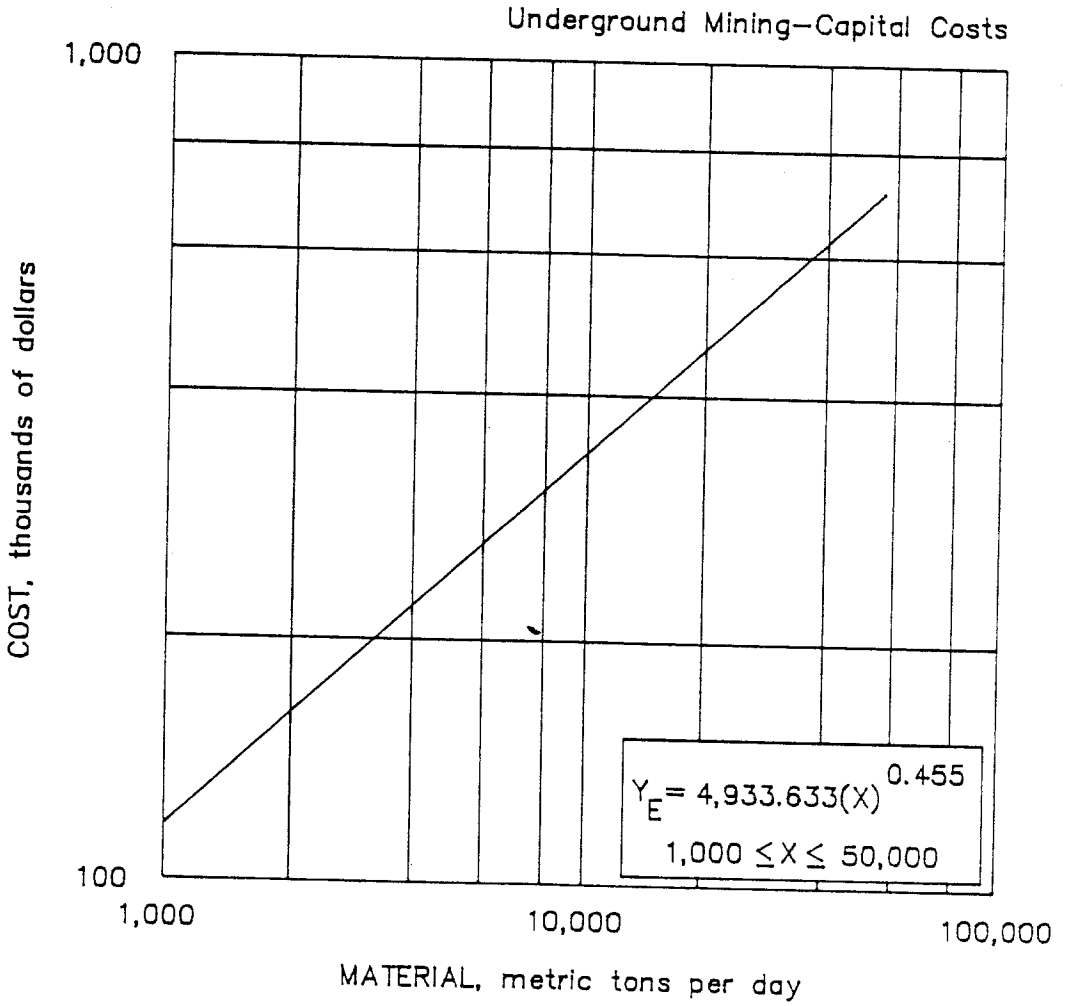
BASE CURVE

(E) Purchased Equipment Cost $(Y_E) = 4{,}933.633(X)^{0.455}$
The equipment operating cost consists of 92% for conveyor equipment, 3% for loading equipment, and 5% for miscellaneous equipment.

ADJUSTMENT FACTOR

Distance Factors For haul distances other than 300 m (980 ft) one way, multiply the costs obtained from the curves by the following factor:

Distance factor $(F_D) = 0.005(D)^{0.944}$
where D = one-way haul, in meters.



4.2.3.6. Conveyor extensions

4.2. UNDERGROUND MINING - CAPITAL COSTS

4.2.3. MINING EQUIPMENT

4.2.3.7. LOAD-HAUL-DUMP HAULAGE EQUIPMENT

The capital cost curve for LHD haulage includes the purchase of underground equipment and items not previously included in other sections. The cost is based on the purchased equipment curve with a production range (X), in metric tons material per day. The curve is valid between 100 and 10,000 mtpd, operating two shifts per day. These costs are based on equipment being delivered and made fully operable at an appropriate site in the Denver, CO, area. Provision is made for standby equipment, spare parts, administrative, and maintenance units.

The costs on the curve are directly related to the daily metric tons transported by LHD haulage. The costs are based on a 500 m (1,600 ft) one-way haul distance in level to near-level workings. Any costs associated with a different transportation method should be costed using the appropriate equipment curve. The costs on this curve are to be added to costs from the drill-and-blast equipment curve plus any costs associated with equipment curves for other haulage methods.

The equipment contained in this curve includes LHD's and support vehicles. Hoisting, ventilation, compressed air, pumping equipment, and power transmission lines are included in other capital cost sections.

BASE CURVE

(E) Purchased Equipment Cost $(Y_{E\ 100\text{-}2{,}000\ MTPD}) = 123{,}893.086(X)^{0.231}$
$(Y_{E\ 2{,}000\text{-}10{,}000\ MTPD}) = 370.020(X)^{1.000}$

The equipment operating cost consists of 95% for loading equipment and 5% for miscellaneous equipment.

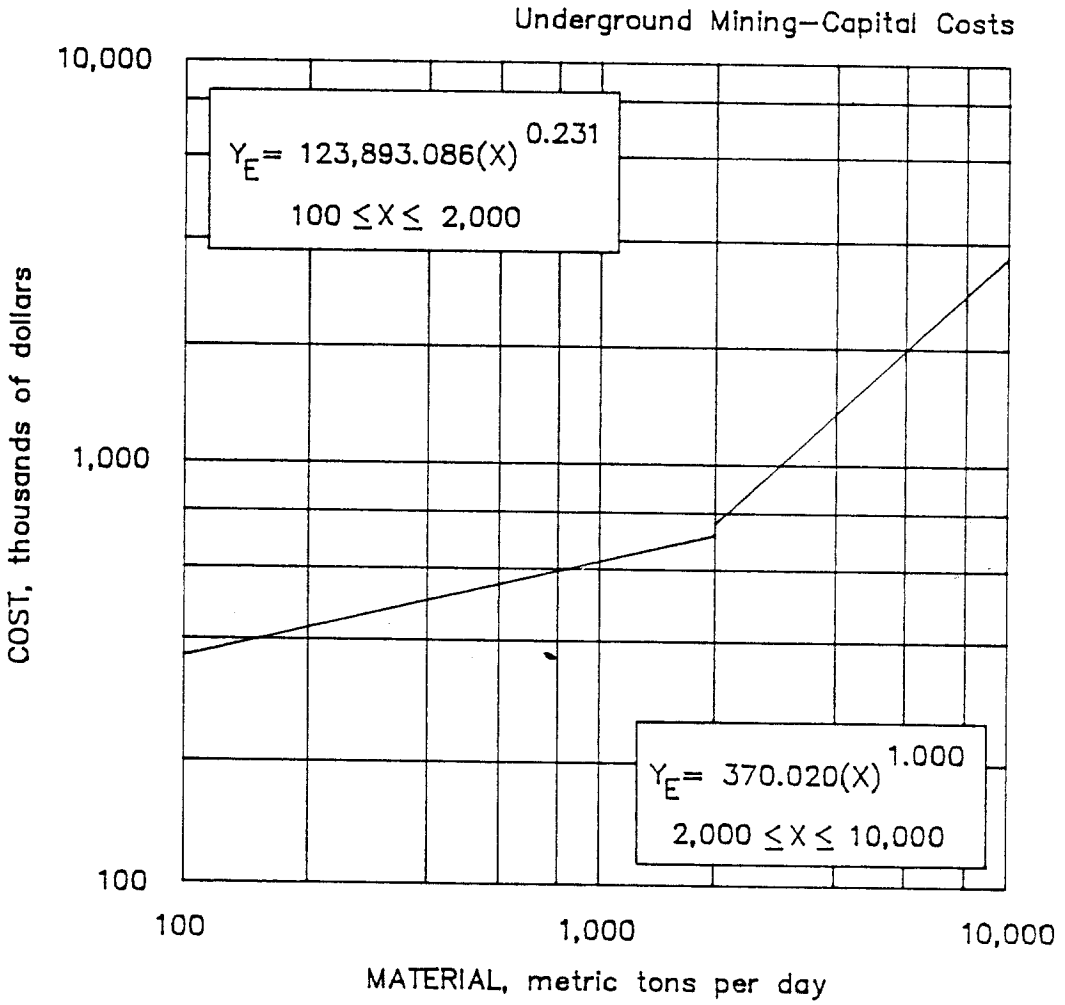
ADJUSTMENT FACTORS

Grade Factor The curve values are based on grades up 2%. For grades greater than 2%, multiply the costs obtained from the curves by the following factor:

Grade factor $(F_G) = 0.929(1.037)^G$
where G = grade in percent of incline or decline.

Distance Factor For haul distances other than 500 m (1,600 ft) one way, multiply the costs obtained from the curves by the following factor:

Distance factor $(F_D) = 0.098(D)^{0.382}$
where: D = one way haul, in meters.



4.2.3.7. L.H.D. haulage equipment

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.3. MINING EQUIPMENT

4.2.3.8. RAIL HAULAGE EQUIPMENT

The capital cost curve for rail haulage includes the purchase of underground equipment and items not previously included in other sections. The cost is based on the purchased equipment curve with a tonnage transported (X), in metric tons per day. The curve is valid between 100 and 50,000 mtpd, operating two shifts per day. These costs are based on equipment being delivered and made fully operable at an appropriate site in the Denver, CO, area. Provision is made for standby equipment, spare parts, administrative, and maintenance units.

The costs on the curve are directly related to the daily metric tons transported by rail haulage. The costs are based on a 915-m (3,000-ft) one-way haul distance in level to near-level workings. Any costs associated with a different transportation method should be costed using the appropriate equipment curve. The costs on this curve are to be included with the costs from the drill-and-blast equipment curve plus any costs associated with equipment curves for other haulage methods in order to come up with a total equipment cost.

The equipment contained in this curve includes locomotives, ore cars, flat cars, loaders, and support vehicles. Hoisting, ventilation, compressed air, pumping equipment, and power transmission lines are included in other capital cost sections.

BASE CURVE

(E) Purchased Equipment Cost $(Y_E) = 19{,}697.330(X)^{0.539}$
The equipment operating cost consists of 90% for haulage equipment, 5% for loading equipment, and 5% for miscellaneous equipment.

ADJUSTMENT FACTORS

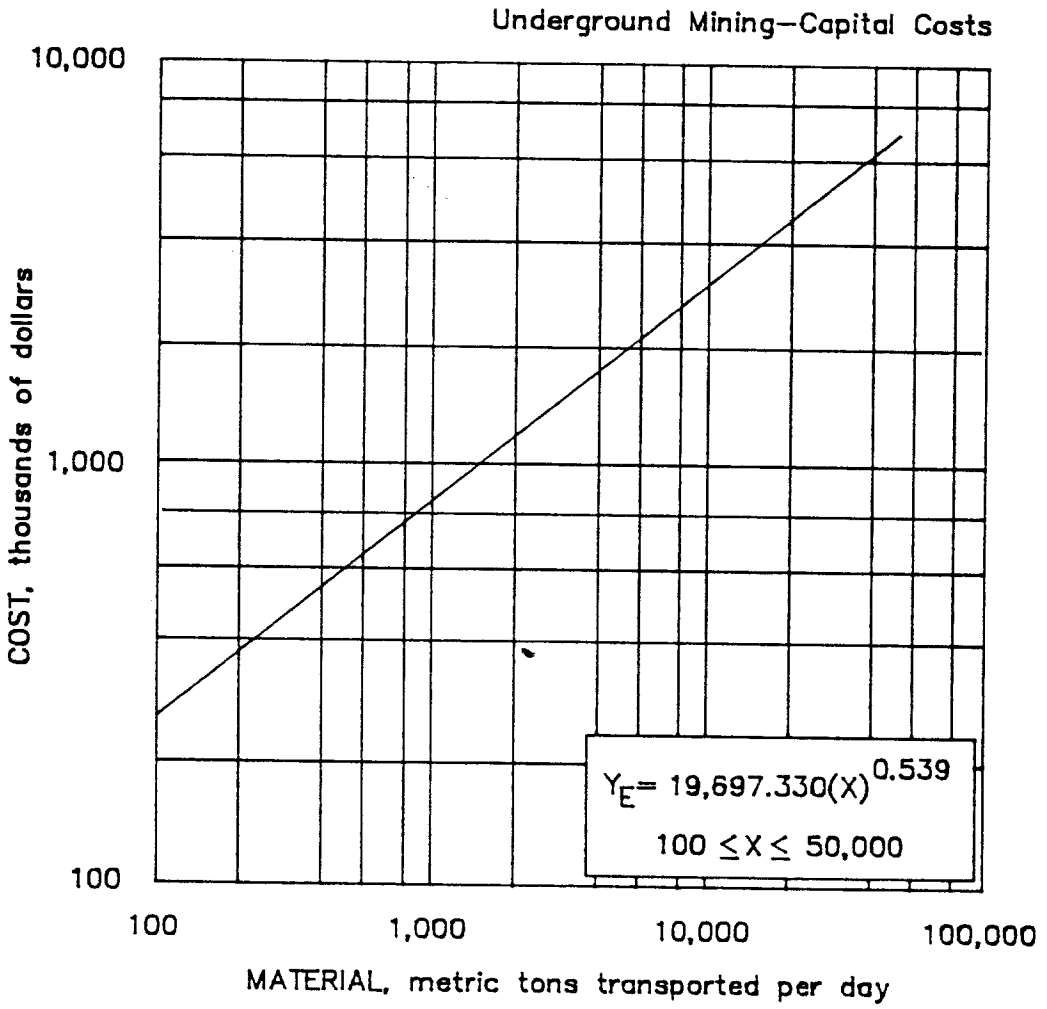
Locomotive Factor The curve is based on using battery locomotives. For other types of locomotives, multiply the costs obtained from the curve by the following factors:

Diesel locomotives factor $(F_{L\ DIESEL}) = 0.533$

Trolley locomotives factor $(F_{L\ TROLLEY}) = 1.273$

Distance Factor For haul distances other than 915 m (3,000 ft) one way, multiply the costs obtained from the curve by the following factor:

Distance Factor $(F_D) = 0.0013(D)^{0.968}$
where: D = one way haul, in meters.



4.2.3.8. Rail haulage equipment

4.2. UNDERGROUND MINING--CAPITAL COSTS

4.2.3. MINING EQUIPMENT

4.2.3.9. TRUCK HAULAGE EQUIPMENT

The capital cost curve for truck haulage includes the purchase of underground equipment and items not previously included in other sections. The cost is based on the purchased equipment curve with a tonnage transported (X), in metric tons per day. The curve is valid between 1,000 and 50,000 mtpd, operating two shifts per day. These
costs are based on equipment being delivered and made fully operable at an appropriate site in the Denver, CO, area. Provision is made for standby equipment, administrative, and maintenance units.

The costs on the curve are directly related to the daily metric tons transported by truck haulage. The costs are based on a 680-m (2,250-ft) one-way haul distance in level to near-level workings. Any costs associated with a different transportation method should be costed using the appropriate equipment curve. The costs on this curve are to be added to costs from the drill-and-blast equipment curve plus any costs associated with equipment curves for other haulage methods.

The equipment contained in this curve includes trucks, loaders, and support vehicles. Hoisting, ventilation, compressed air, pumping equipment and power transmission lines are included in other capital cost sections.

BASE CURVE

(E) Purchased Equipment Cost $(Y_E) = 2{,}759.215(X)^{0.838}$
The equipment operating cost consists of 57% for haulage equipment, 38% for loading equipment, and 5% for miscellaneous equipment.

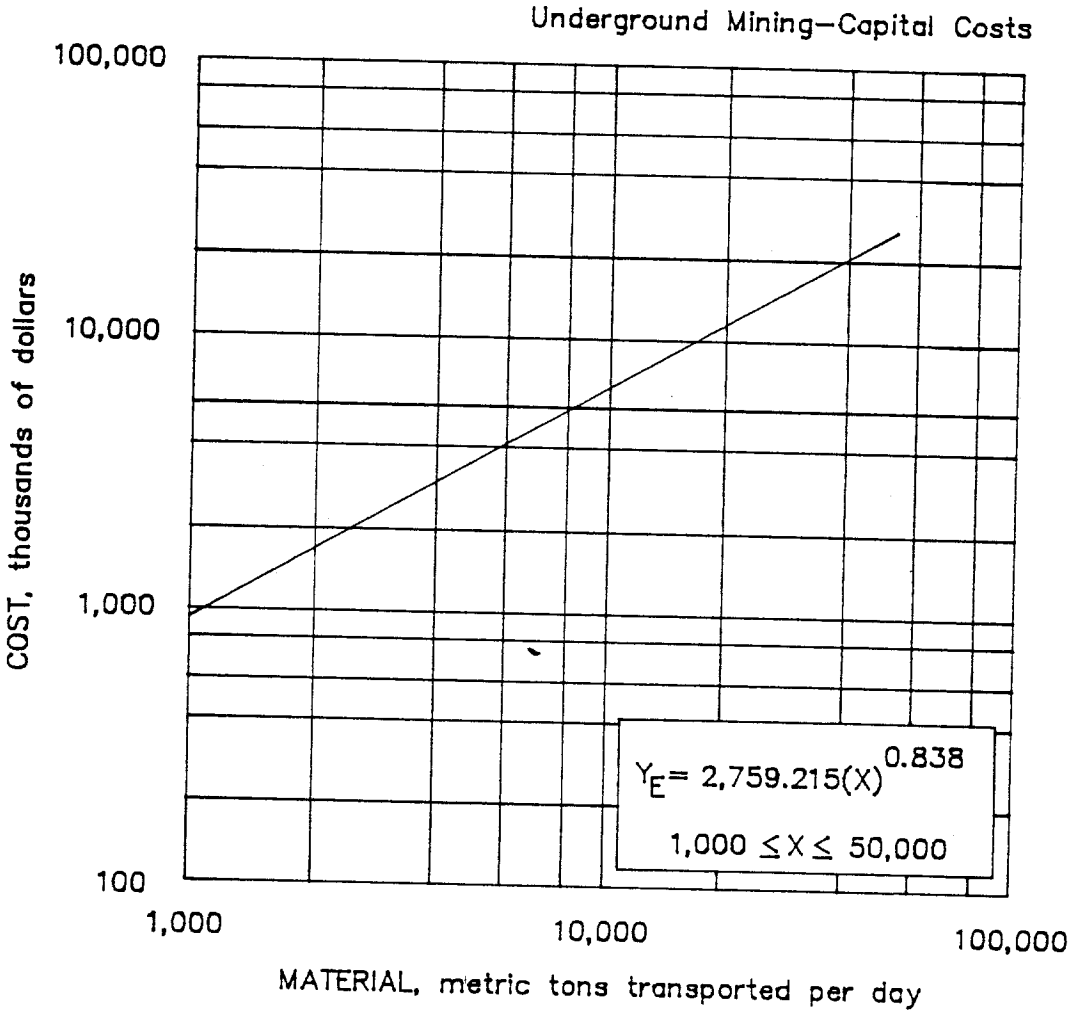
ADJUSTMENT FACTORS

Distance Factor For haul distances other than 680 m (2,250 ft) one way, multiply the cost obtained from the curve by the following factor:

Distance factor $(F_D) = 0.040(D)^{0.492}$
where D = one-way haul, in meters.

Incline Factor For haul grades greater than 2%, multiply the cost obtained from the curve by the following factor:

Incline factor $(F_I) = 1.0 + 0.016(G)$
where: G = grade, in degrees.



4.2.3.9. Truck haulage equipment