5.2. UNDERGROUND MINING--OPERATING COSTS

5.2.4. TRANSPORTATION

5.2.4.4. LONG-DISTANCE RAIL HAULAGE

The following tabulation gives the average cost, in cents per metric ton-kilometer, for shipping mineral materials from the Mountain-Pacific territorial area (including Denver, CO) to any of the five territorial areas within the continental United States. This information is valid as of January 1984.

AVERAGE SHIPPING COSTS FOR MINERAL MATERIALS, cents per metric ton-kilometer

Material shipped from Mountain-Pacific area	Area destination					
	Mountain-Pacific	Western	South-western	Southern	Official	U.S. average
Metallic ores	2.53	1.04[e]	2.87[e]	NA	NA	2.33
Iron concentrates	1.47	1.04[e]	NA	NA	NA	1.47
Copper precipitates	3.01	NA	NA	NA	NA	3.01
Bauxite ore	2.65	NA	2.91[e]	NA	NA	2.67
Alumina calcine	2.66	NA	2.87[e]	NA	NA	2.66
Nonmetallic minerals[1]	2.94	1.55	2.18	1.96	2.02	2.68
Crushed stone	4.13	NA	NA	NA	NA	4.11
Sand or gravel	2.73	4.75	NA	NA	NA	2.74
Industrial sand	2.54	1.01[e]	1.68[e]	NA	NA	2.54
Refractories	1.83	NA	NA	1.89	NA	1.85
Clay minerals	2.94	NA	NA	1.89	NA	2.37
Fertilizer minerals	3.47	2.65	1.49	2.05	2.25	2.09
Borate, crude	3.39	2.85	NA	1.89	NA	2.67
Sulfur	3.82	3.09	1.99	2.12	2.62	2.34
Gypsum crude	3.30	NA	NA	NA	NA	3.30
Diatomaceous earth	4.31	2.03	2.05	2.31	2.32	2.22
Nonmetallic minerals n.e.c.[2]	2.35	1.84	1.49	1.58	1.47	1.63
Coal	1.87	1.25	1.13	1.30	1.33	1.26

[e]Estimated. NA Not available.

[1]Most nonmetallic ores, except fuels.

[2]Includes agate, crude chalk, lithium, earth or soil, coral, rubidium, graphite, sericite, nepheline syenite, shale, well drilling cores, crude topaz, vermiculite-unexpanded, slag, perlite, cornwall, crystal quartz rock, quartzite, silaceous fluxing ore, silica rock, and zeolites.

Source: 1983 Carload Waybill Sample data collected by Dep. of Transportation, Federal Railroad Administration, Office of Conrail.

Costs for shipping certain mineral materials from the Mountain-Pacific area to other areas may be not available (NA) for two reasons; first, shipments of these materials has dropped dramatically during the last ten years, making evaluation of costs impossible. Second, certain mineral materials are typically not shipped between two areas. For example, copper precipitates traditionally are never shipped out of the Mountain-Pacific area.

To determine the total cost of transporting a specific mineral material, first select the appropriate cost from the table listings given above, then multiply that value by the distance in kilometers the material is to be shipped, and also by the metric tonnage to be shipped. Finally, divide the answer by 100 to get a value in dollars.

Example: The cost for shipping 100,000 metric tons of fertilizer minerals from Denver to a point in the Southern Area 2,500 km away is:

$$[(2.05¢/mt \cdot km) \times (100{,}000 mt) \times (2{,}500 km)/(100¢/\$) = \$5{,}125{,}000.$$

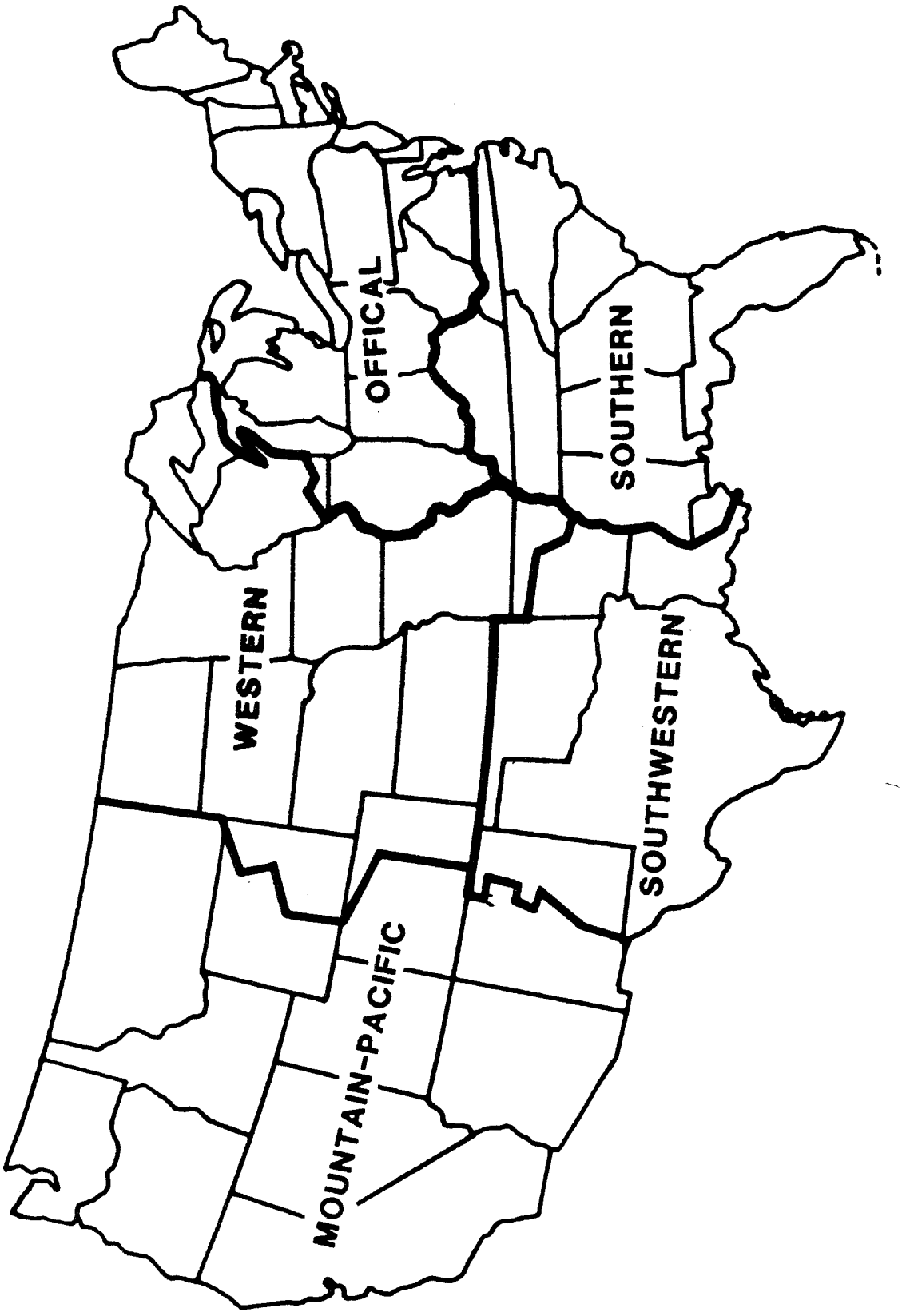
The following map shows the boundaries for the different territorial areas.

To estimate the cost for shipping mineral materials from one point to another, irrespective of territorial zones, use the following equation:

$$Y = [15.359(D)^{-0.275}]/100$$

where D = distance, in kilometers the material is to be shipped,
and Y = cost, in cents per metric ton kilometer.

The resultant answer must be multiplied by the tonnage and the distance it is to be hauled to get a total cost in dollars.


OFFICAL
SOUTHERN
WESTERN
SOUTHWESTERN
MOUNTAIN-PACIFIC

5.2. UNDERGROUND MINING--OPERATING COSTS

5.2.4. TRANSPORTATION

5.2.4.5. LONG DISTANCE SURFACE CONVEYOR

These curves cover the cost of transporting material from the mine via a single-flight conveyor belt reinforced with high-strength steel and cover a capacity range of 15,000 to 150,000 mtpd. The material is conveyed up a 10^{o} slope for a distance of 1 km. The conveyor availability is 94%. Usually, the material is crushed or screened at the mine site before being conveyed. Screen and crusher costs are not included in this cost but are covered in separate sections.

The total daily cost is the sum of three separate cost curves (labor, supplies, and equipment operation) based on a production rate (X), in metric tons material transported per day. The curves are valid for operations between 15,000 and 150,000 mt, operating three shifts per day. The curves include all daily operating and maintenance costs associated with the conveyor operation.

BASE CURVE

(L) Labor Operating Cost $(Y_L) = 7.429(X)^{0.464}$
The operating labor costs are distributed as follows:

	Small (15 to 50,000 mtpd)	Large (50,000 to 150,000 mtpd)
Direct labor	71%	47%
Maintenance labor	29%	53%

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

	Small (15 to 50,000 mtpd)	Large (50,000 to 150,000 mtpd)	Av salary per hour (base rate)
Operator	64%	54%	$16.25
Assistant operator	36%	46%	13.97

The average wage for labor is $15.32 per worker-hour (including burden and average shift differential).

(S) Supply Operating Cost $(Y_S) = 0.068(X)^{0.933}$
The supply cost consists of 100% electric power.

(E) Equipment Operating Cost $(Y_E) = 2.226(X)^{0.358}$
The equipment operating cost consists of 95% for repair parts and 5% for lubrication for the idlers and mechanical parts.

ADJUSTMENT FACTORS

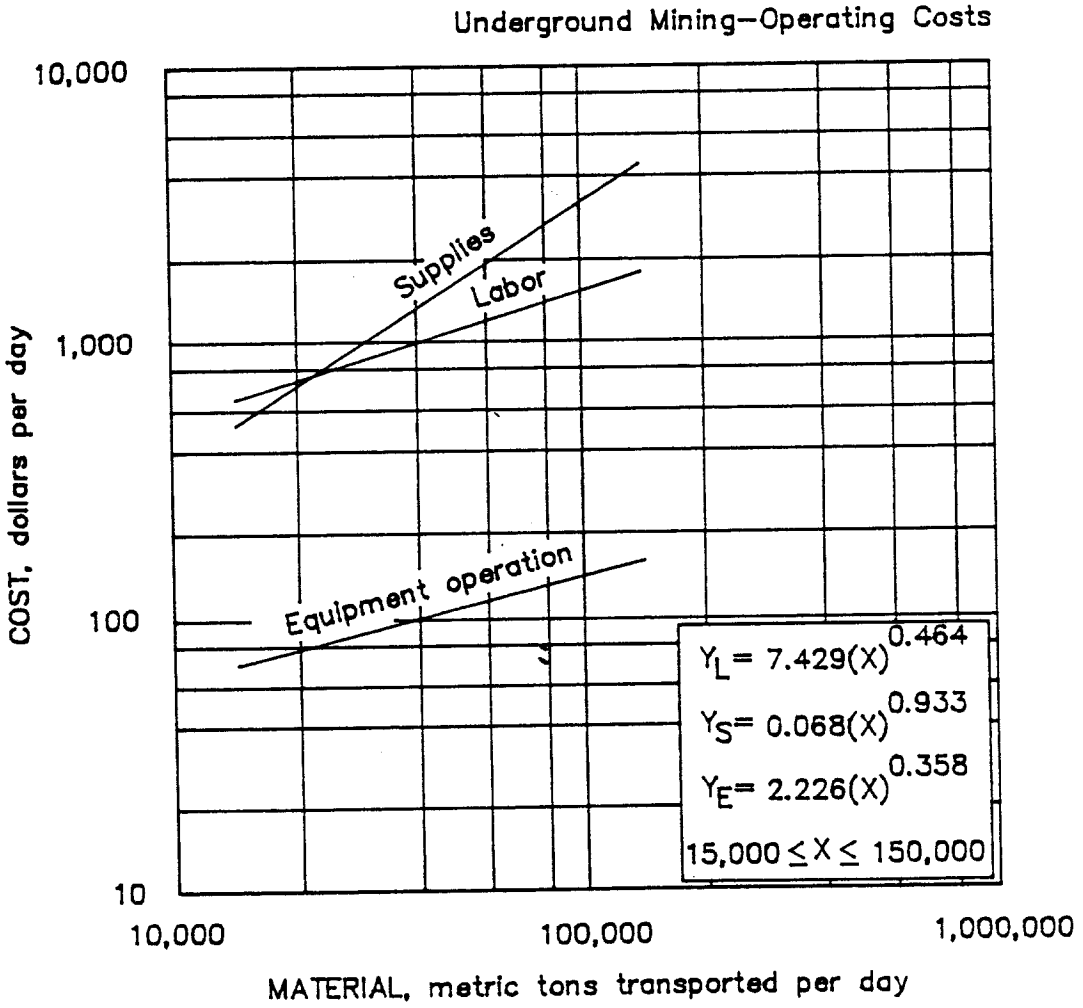
Length and Slope Factor To determine costs for varying conveyor lengths and slopes, multiply the costs obtained from the curves by the following factors:

Labor factor $(F_L) = 0.815+0.190(L)$

Supply factor $(F_S) = [0.208+0.0794(S)][L]$

Equipment operation factor $(F_E) = L$
where L = length of conveyor, in kilometers,
and S = slope of conveyor, in degrees (S is between 0^o and 15^o).

The cost for a decline conveyor is equal to that for a horizontal conveyor (0^o slope).



5.2.4.5. Long distance surface conveyor

5.2. UNDERGROUND MINING--OPERATING COSTS

5.2.4. TRANSPORTATION

5.2.4.6. LONG DISTANCE TRUCK HAULAGE

The trucking industry has undergone intensive change since its recent deregulation. Truck transportation of mineral materials has shifted predominantly away from the class rate system to the bulk commodity method. This has corresponded with a decrease in the number of carriers and an increase in competition. Each carrier now determines its own rate and tariff schedules.

Truck transportation costs as shown here cover the transportation of mineral materials by 23 mt rear-dump trucks. The area covered includes the western contiguous United States.

BASE CURVE

The base curve determines costs for the transportation of each metric ton of mineral materials via county and State maintained roads with less than or equal to 3% grades. The curves are based on the one way distance (X), in kilometers the material is hauled. The curves are valid for operations between 20 and 200 km.

(T) Truck transportation $(Y_{T\ 0\%-3\%\ GRADE}) = 0.227(X)^{0.715}$

Costs determined using this curve must be multiplied by the total tonnage to be hauled to obtain the final cost.

When the average grade of road is greater than 3%, but less than 6%, a tariff factor is included with the base curve equation.

(T) Truck transportation $(Y_{T\ 3\%-6\%\ GRADE}) = 0.180(X)^{0.909}$

Costs determined using this curve must be multiplied by the total tonnage to be hauled to obtain the final cost.

When the average road grade is equal to or greater than 6%, a different tariff factor will have to be included with the base curve equation, modifying it to

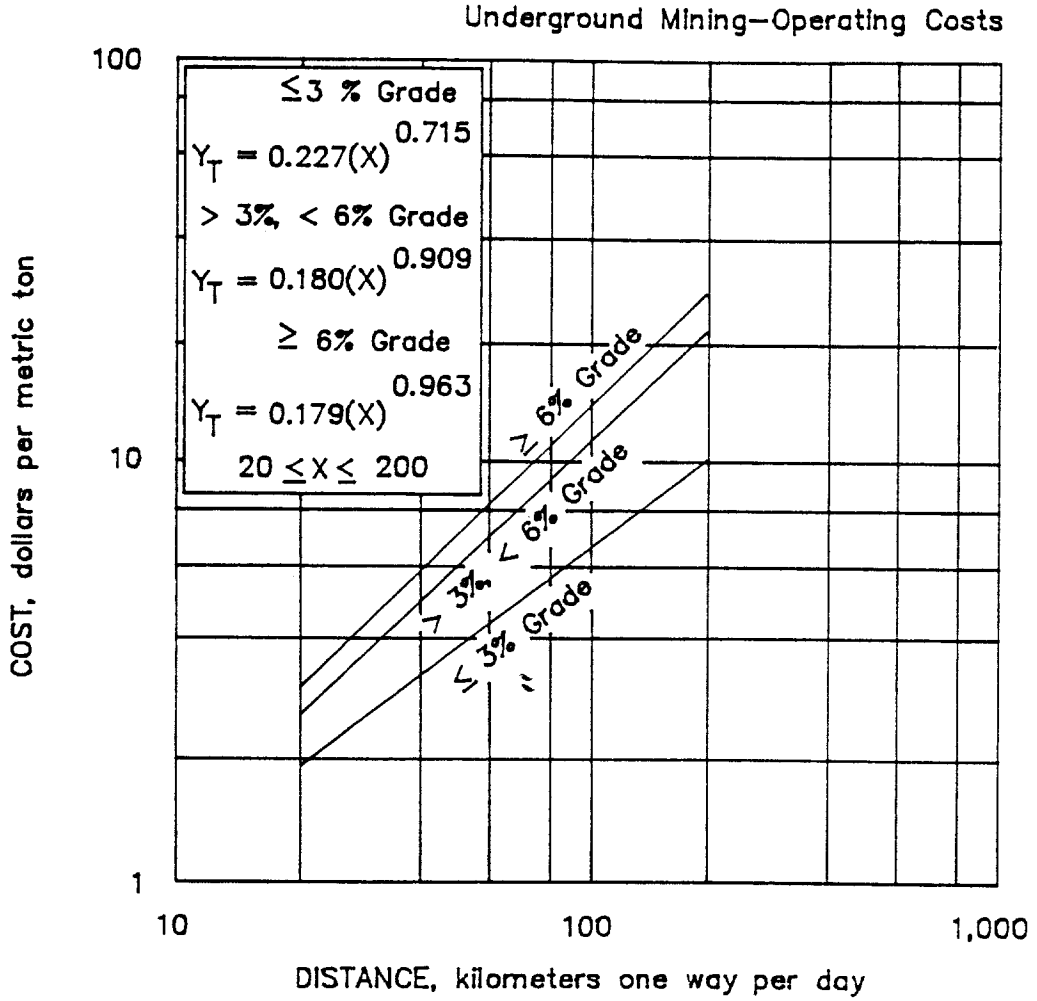
(T) Truck transportation $(Y_{T\ +6\%\ GRADE}) = 0.179(X)^{0.963}$

Costs determined using this curve must be multiplied by the total tonnage to be hauled to obtain the final cost.

ADJUSTMENT FACTORS

Long-Term Contract The final values arrived at through multiplying the tonnage by any of the three curves can be reduced by 10% to 20% if long term hauling contracts are to be used.

Tonnage If trucks with carrying capacities greater or less than 23 mt tons are used, the cost per metric should be modified accordingly.



5.2.4.6. Long distance truck haulage